Received: 20 May 2021 | Revised: 7 July 2022 | Accepted: 8 July 2022

DOI: 10.1111/ijsa.12397

RESEARCH ARTICLE

International Journal of Selection and Assessment | WILEY

# Once the best student always the best student? Predicting graduate study success using undergraduate academic indicators: Evidence from research masters' programs in the Netherlands

Anastasia Kurysheva | Nivard Koning | Christine M. Fox | Harold V. M. van Rijen | Gönül Dilaver

Department of Biomedical Sciences, Center of Education and Training, University Medical Center Utrecht, Utrecht, Netherlands

**Correspondence**
Anastasia Kurysheva, Department of Biomedical Sciences, Center of Education and Training, University Medical Center Utrecht, P.O. Box 85500, HB-4.05, 3508 GA Utrecht, Netherlands.
Email: a.kurysheva@umcutrecht.nl

## Abstract

In the face of increasing and diversifying graduate application numbers, evidence-based selective admissions have become a pressing issue. By conducting multilevel regression analyses on institutional admissions data from a Dutch university, this study aims to determine the predictive value of undergraduate academic indicators for graduate study success on research masters' programs in the life sciences. The results imply that in addition to undergraduate grade point average, undergraduate thesis grade is a valid predictor of graduate grade point average. To a small extent, the examined undergraduate academic indicators also predict graduate degree completion and time to degree. The results from this study can be used by admissions committees for evaluating and improving their current practices of graduate selective admissions.

KEYWORDS

admissions, GPA, graduate education, master's degree, student selection, study success, thesis

## Practitioner points

- There is substantial scientific evidence that undergraduate grade point average (UGPA) is a valid predictor of certain dimensions of graduate study success. This paper adds to this evidence by showing that undergraduate thesis grade is also a valid predictor of graduate grade point average (GGPA).
- The predictive power of the type of prior higher education institution for the examined dimensions of graduate study success is small at best.
- Undergraduate academic indicators are better predictors of GGPA than of graduate degree completion or time to degree.
- The results of this study can be used for improving admissions decision-making at graduate schools, especially ones with a research-oriented curriculum.

## 1 | INTRODUCTION

The goal of university admissions committees is to create a selective admissions process that meets societal expectations of objectiveness, fairness, and transparency. Over the last two decades, countries with widespread instruction in English have seen a steady increase in demand for graduate education (Association of Universities in the Netherlands, 2021; Statista, 2020; the Higher Education Statistics Agency, 2020). This demand has challenged admissions committees for several reasons. First, many universities now face a disparity in the number of graduate school places versus the number of applicants. This has created a situation where some students, whilst eligible, are rejected. Admissions committees, therefore, must be able to justify their selection decisions. Second, because of the growing number of internationally mobile students (Organisation for Economic Co-operation and Development [OECD], 2022), application files have become more diverse. Admissions committees are now faced with the challenge of comparing foreign applications (from different education systems with different evaluation processes) against applications from national students. Third, despite efforts to increase access to higher education for underrepresented groups such as first-generation students, students with disabilities, and students with migration backgrounds (Kurysheva et al., 2019; Torgerson et al., 2014; Younger et al., 2018), these groups still have less chance of accessing Higher Education Institutions (HEIs; Salmi & Bassett, 2014). For these reasons, university admissions committees need valid selection methods.

HEIs implement an array of selection methods for making admissions decisions. Some HEIs use information on applicants' prior individual characteristics (e.g., prior study success) as well as institutional factors (i.e., factors related to students' prior HEI). We refer to both of them as *undergraduate academic indicators*. In this study, we examine to what extent the undergraduate academic indicators predict graduate study success.

### 1.1 | Graduate study success

Kyllonen et al. (2005) distinguish three subgroups of higher education outcomes: (1) study success, or convenience measures (such as grade point average [GPA], time to degree, attrition), (2) performance factors (such as discipline, teamwork, leadership, management), and (3) affective measures (such as attitudes, interest, liking). In this study, we examine determinants of the first subgroup of higher education outcomes—study success. The other two subgroups are almost never formally assessed in a consistent manner across students and programs, while study success is easily obtainable as HEIs keep records on various dimensions of students' study success (Kyllonen et al., 2005). Following the other studies on prediction of study success (e.g., Schwager et al., 2015), we operationalize graduate study success through three dimensions: (1) *graduate degree completion*, (2) *graduate GPA (GGPA)*, and (3) *graduate time to degree* (i.e., time taken to complete a master's degree).

The different theoretical models propose that both individual characteristics, as well as institutional factors, determine study success (Bean, 1980; Cabrera et al., 1993; Tinto, 1975). Below, we justify our hypotheses on relationships between undergraduate academic indicators and graduate study success by providing theory-based arguments supported by relevant research findings.

### 1.2 | Undergraduate academic indicators

#### 1.2.1 | Undergraduate GPA (UGPA)

Theory suggests that prior study success plays a pivotal role in determining future study success (Galla et al., 2019; Schneider & Preckel, 2017). Prior grades (e.g., UGPA) have especially been shown as good determinants of subsequent study success (its various dimensions). The proposed mechanism of this relationship is that grades represent a composite measure of students' IQ, knowledge, skills, noncognitive constructs (e.g., self-regulatory competencies), and personality traits (including conscientiousness, perseverance, and diligence). Therefore, prior grades as composite measures may be better predictors of future study success than narrow measurements (such as cognitive ability tests; Borghans et al., 2016; Tai, 2020).

While certain noncognitive constructs and personality traits (foremost, conscientiousness) are known as good predictors of study success (Busato et al., 2000; Poropat, 2009), their usage in selective admissions is not feasible due to various forms of applicant faking (ranging from impression management to conscious distortions of answers) which occurs once applicants are asked to self-report in a high-stake situation (Niessen et al., 2017). In this regard, composite measures such as undergraduate GPA have a substantial advantage because they are significantly influenced by noncognitive constructs and personality (Borghans et al., 2016), while at the same time they do not have disadvantages of self-reports.

Existing evidence supports this proposed relationship between UGPA and graduate study success. Higher UGPA is related to higher graduate grade point average (GGPA; Burton et al., 2005; Fu, 2012; Howell et al., 2014; Moneta-Koehler et al., 2017; Zimmermann et al., 2015). When it comes to other dimensions of graduate study success, the evidence is mixed. For example, some studies also found a positive relationship between UGPA and graduate degree completion (e.g., Mendoza-Sanchez et al., 2022; Moneta-Koehler et al., 2017; Schwager et al., 2015; Wollast et al., 2018), while others did not (Cox et al., 2009; Dore, 2017). The same applies for graduate time to degree: Some studies found a negative relationship between UGPA and graduate time to degree (Howell et al., 2014; Mendoza-Sanchez et al., 2022) and others did not (Dabney, 2012; Moneta-Koehler et al., 2017). Based on theoretical underpinnings and the findings of prior literature, we expect that UGPA should positively relate to GGPA, but with less certainty, positively to graduate degree completion and negatively to graduate time to degree (Hypothesis 1).

### 1.2.2 | Undergraduate research experience

According to several theoretical frameworks, another individual characteristic that may determine graduate study success is prior research experience, which students gain during their undergraduate studies. Among these theories are theories on determinants of skill acquisition (Ericsson & Charness, 1994; Gilmore et al., 2015), Campbell's model of job performance (Campbell et al., 1993; Miller et al., 2021), and the cognitive apprenticeship model (Brown et al., 1989; Collins et al., 1989). The theories on determinants of skill acquisition propose that a skill develops with practice over time and, therefore, the achieved level of skills depends on having training of those skills (Gilmore et al., 2015). The model of job performance distinguishes declarative knowledge, procedural knowledge, and motivation as factors influencing study success (Campbell et al., 1993). In this regard, prior research experience may be related to all three factors (Miller et al., 2021): Research experience leads to gains in declarative knowledge (i.e., knowledge about a discipline), procedural knowledge (i.e., knowledge about relevant procedures in this discipline), and motivation (i.e., students who have already engaged in research-related tasks during their bachelor's program and are willing to proceed with research-related tasks by applying to a graduate research master's program presumably to do so because they appreciated the prior experience and are motivated to carry on with conducting research-related tasks). Finally, the cognitive apprenticeship model (Brown et al., 1989; Collins et al., 1989) suggests that apprentices (i.e., undergraduate students conducting research) advance their knowledge and skills by interacting with established researchers in their fields. This interaction creates conditions in which supervisors model "disciplinary-appropriate thinking" (Gilmore et al., 2015, p. 837), which in turn helps students enhance their performance on various dimensions of graduate study success in this discipline.

Considering these theoretical underpinnings of the critical importance of undergraduate research for graduate study success on research programs, the findings of literature may appear surprising. The meta-analytical evidence shows that undergraduate research experience is largely unrelated to graduate academic performance but with less statistical certainty to degree attainment and publication performance (Miller et al., 2021). The findings in the meta-analysis of Miller et al. (2021) could be explained by the fact that more than half of the included studies used the generic dichotomous operationalization of undergraduate research experience ("present or absent"). When undergraduate research experience is operationalized differently (e.g., as "duration of research experience in months" or "whether or not the student wrote a thesis during their bachelor's program"), some studies find the relationship between research experience and certain dimensions of graduate study success (see Cox et al., 2009; Gilmore et al., 2015; Weiner, 2014), while others do not (Hall et al., 2017).

The undergraduate level is usually the first educational level with research training (at least in the form of a bachelor's thesis, which is often an obligatory component of undergraduate university curriculum). This undergraduate prior research experience such as thesis is typically assessed in a standardized form (i.e., the duration of work on a bachelor's thesis is regulated by the number of ECTS assigned; the research quality is assessed by grades). A grade for undergraduate prior research experience (labeled thesis grade) represents a convenient variable for research models and a convenient admissions requirement in practice, as the standardized form provides more comparability across students. Thesis grade is also relatively objective: It is the quantitative assessment by experts in the field and this assessment often follows a certain rubric or at least requires certain extent of justification. Equally important, out of all undergraduate study activities, undergraduate thesis is the most pertinent and the most recent indicator in relation to research-oriented graduate education.

In spite of these considerations, there have been no studies conducted on the relationship between undergraduate thesis grade and GGPA. We aim to fill in this gap and to explore the predictive potential of thesis grade. Based on theoretical arguments of prior research experience importance in determining graduate study success and research findings of usefulness of other operationalizations of research experience rather than dichotomous "present or absent," we hypothesize that undergraduate thesis grade should positively relate to degree completion and GGPA on research-intense masters' programs and negatively to graduate time to degree (Hypothesis 2).

### 1.2.3 | Institutional factors

In addition to individual determinants of study success, the theoretical models also indicate that (prior) institutional factors represent determinants of (future) study success (Bean, 1980; Cabrera et al., 1993; Tinto, 1975). The characteristics of prior HEI may be associated with students' preparedness for a certain graduate program. For example, it is plausible to assume that the structure of curriculum and focus on certain learning objectives at a prior HEI is related to knowledge and skills of its graduates. If a student followed a research-oriented curriculum during their undergraduate program, they are more prepared and will perform better at a research-intensive graduate program than a student who followed a practice-oriented curriculum during their undergraduate studies.

Among the wide range of institutional factors, we choose to focus on the type of HEI. The type of HEI captures basic curriculum characteristics and learning goals of different HEIs (i.e., practice-oriented vs. research-oriented curriculums). In addition, using this variable as a proxy for institutional factors provides good statistical power to our analysis and generalizability to our findings, because students may be grouped in categories based on their type of prior HEI.

Type of prior HEI has not received much research attention in the literature. We found one study on a German sample of business administration and economics graduate students, which showed that the type of HEI (categorized as university, college [Fachhochschule],

academy [Berufakademie], and school abroad) had a weak effect on graduate study success (Chadi & de Pinto, 2018). We aim to address this gap by including type of prior HEI as one of the predictors in our research model. We expect that students from practice-oriented undergraduate programs score lower on the three dimensions of graduate study success compared to students from research-oriented undergraduate programs. However, we also expect that after UGPA has been taken into account, the relationship between type of HEI and graduate study success would be weak in terms of substantial significance, even though statistically significant (Hypothesis 3).

### 1.3 | Theoretical contributions

With this study, we hope to make the following contributions to the field of graduate selective admissions. First, we aim to test the predictive validity of UGPA not only for GPA, but also for degree attainment and time to graduate degree: Testing these relationships will clarify the mixed findings of prior literature regarding the predictive value of UGPA for these last two dimensions. Second, the aspects of undergraduate research work previously examined such as "undergraduate research experience present versus undergraduate research experience absent" (Cox et al., 2009; Miller et al., 2021) or "duration of research experience" (Gilmore et al., 2015; Hall et al., 2017; Weiner, 2014) do not reflect the *quality* of students' undergraduate research work. Our study, to the best of our knowledge, is the first one that examines whether assessments regarding quality of undergraduate students' independent research work (i.e., a grade for undergraduate thesis) predict graduate study success. Finally, we explore whether the data supports the expectation that students from practice-oriented HEIs perform less well than students from HEIs with intensive research-oriented training in research masters' programs.

## 2 | METHOD

Cognizant of the fact that there are multiple considerations when it comes to determining whether an undergraduate academic indicator is suitable for use in student selection (see Patterson et al., 2016, 2018; Posselt, 2016), this study focuses on predictive validity. It addresses predictive validity of undergraduate academic indicators for graduate study success on research masters' programs in the field of life sciences. We choose to focus on the research masters' programs in the life sciences because of the intensive study loads in research laboratories which require extensive and often long-lasting immersion in research practice. The goal of this study is to help provide guidance for graduate school admissions committees regarding which undergraduate academic indicators should be considered in student selection. We examine the direct relationships between three undergraduate academic indicators[1] and three operationalizations of graduate study success. To better understand the generalizability of this study and to set it within the context of other graduate programs, a national and institutional context is provided below.

### 2.1 | National context

This study has been conducted in a large research university in the Netherlands. The Dutch higher education system is comprised of 14 public research universities that grant academic degrees up to the PhD level (including some university colleges which offer selective international liberal arts and sciences bachelors' programs), 37 universities of applied sciences (which grant professional degrees up to master's level), and a few small specialized private institutions (van der Wende, 2020). At research universities, research-intensive education aims to advance understanding of the phenomena studied within academic disciplines, to facilitate application of scientific knowledge, and to generate new knowledge. Universities of applied sciences offer higher professional education–theoretical and practical training related to professions that necessitate a higher vocational qualification (Eurydice Network, 2020).

In this article, we focus on masters' programs at research universities. For comparison, the Netherlands has adapted the Framework for Qualifications of the European Higher Education Area (QF-EHEA) which consists of three cycles (Bachelor's/Master's/PhD). It was introduced with the Bologna Process in 2002 (Lub et al., 2003; Witte et al., 2008) and covers levels 6-8 in the European Qualifications Framework. This means that the master's phase in the Netherlands is comparable to a master's phase in 48 countries within the EHEA (European Higher Education Area [EHEA], n.d.). This three cycles framework is also compatible to both the United States and Canada with only subtle differences with the United Kingdom which also offers an MPhil option that sits between a master's and PhD.

It is possible to enter a Dutch master's program in a research university with an undergraduate degree either from a Dutch research university, university college, university of applied sciences, or the equivalent from a foreign HEI. Dutch research universities offer not only taught but also research masters' programs. Research masters' programs differentiate themselves from taught masters' with an emphasis on research, duration (2 years and 120 EC instead of 1 year and 60 EC), and selective admissions of students (Snijder, 2016). They aim to prepare students for research-related positions both inside and outside academia (NVAO, 2016). The curriculum of these programs is specifically focused on obtaining and practicing research competencies and skills. For example, internships at research laboratories typically constitute components of research masters' programs in the life sciences.

### 2.2 | Institutional context

We used data from an interdisciplinary graduate school of a major Dutch research university with 13 RM programs in the life sciences. At this graduate school, the demand for study placement increases

annually. The major research project of 9 months represents the main component of the graduate curriculum. The remaining part of the curriculum consists of a minor research project, different mandatory and optional courses, and a writing assignment. The weighted grade for these components constitutes GGPA. The research projects are usually conducted in the university's laboratories. Students are exposed to a variety of research processes and are expected to conduct their own research that involves multiple stages, starting from research design and data collection to writing a research report.

## 2.3 | Participants

No recruitment was needed because we used the institutional data (i.e., data from the university administrative system). This data usage was approved by the Netherlands Association for Medical Education Ethical Review Board (dossier number: 2019.8.2). The data came from six cohorts of 1792 masters' students. Out of these students, 1570 (88%) completed their masters' studies and 222 (12%) dropped out at some point during their masters' programs.

Out of the sample of 1792 students, which is labeled Sample 1, three additional analytical subsamples were derived (Samples 2, 3, and 4). Samples 1 and 2 were used to predict the binary variable graduate degree completion. Sample 1 consisted of students who came from four different types of undergraduate HEIs ($N_{completed\_and\_droppedout\_from\_different\_HEI} = 1792$). Sample 2 consisted of students who studied their masters' at the same university as their bachelors'; therefore, their undergraduate thesis grade was available[2] ($N_{completed\_and\_droppedout\_\&the\_same\_HEI} = 1249$). Samples 3 and 4 were used to predict two metric variables (GGPA and graduate time to degree). These study success dimensions were only available for students who completed their studies. Sample 3 consisted of students who came from four different types of undergraduate HEIs ($N_{completed\_from\_different\_HEI} = 1570$). Sample 4 consisted of students who studied their masters' at the same university as their bachelors'; therefore, their undergraduate thesis grade was available ($N_{completed\_and\_droppedout\_\&the\_same\_HEI} = 1112$). Information on sample sizes and characteristics is presented in Table 1 and the intercorrelations of continuous study variables are presented in Table 2.

## 2.4 | Measures

### 2.4.1 | Independent variables

*Percentile ranks of UGPA*

UGPA refers to an average grade for all curriculum components of an undergraduate program, weighted according to the number of credits for each component. The UGPA of each student was transferred to the percentile ranks due to different grading systems that are applied at different Dutch and international education systems. Percentile ranks allowed us to place all student grades from different grading systems on one scale. The adequacy of usage of percentile ranks was double-checked via a stability check of results, using UGPA on a US scale (from 0 till 4) instead of percentile ranks.

The percentile ranks placed each student in a relative position to others from their own country. We used the data only from the largest groups ($n \geq 20$), so that percentile ranks could be derived. Among the Dutch students, the percentile ranks were given within three groups: students from Dutch university colleges (UGPAs on a scale from 1 to 4), Dutch research universities (UGPAs on a scale from 1 to 10), and universities of applied sciences (UGPAs on a scale from 1 to 10). The largest international student groups, who were greater than or equal to 20 in size, came from the European Union (EU). Namely, the international student groups included British (UGPAs on a scale from 0 to 100), Greek (UGPAs on a scale from 1 to 10), Italian (UGPA on a scale from 0 to 30), and Spanish (UGPAs on a scale from 1 to 10). Other EU student groups and student groups outside of the EU were left out of the analysis due to insufficient numbers per group.

*Undergraduate thesis grade*

An undergraduate thesis is a common part of undergraduate curriculum. This variable (on the Dutch grading scale from 1 to 10) represents a grade for an undergraduate thesis or research project.

*Type of prior HEI*

This variable is nominal and represents types of HEIs where students completed their undergraduate programs. In our data, four types of HEIs were distinguished: Dutch research universities, Dutch university colleges, Dutch university of applied sciences, and international HEIs (see Table 1 for frequencies of each). The international HEIs were considered as one category. This is because in this specific sample only applications with the type of prior HEI—comparable to a Dutch research university—are usually processed further by the admissions committees. International students with an undergraduate degree from a HEI that is on the level of the Dutch universities of applied sciences are rarely ever admitted. Likewise, it is not common to admit students with an undergraduate degree from international colleges with liberal arts and sciences degrees (which would be an analogue to the Dutch university colleges). Therefore, in terms of the level of their type of prior HEI, the group of international students can be considered comparable to the group of students from Dutch research universities. It was then decided to keep students from international HEIs as one group, which is in line with other studies in the field (e.g., Chadi & de Pinto, 2018).

### 2.4.2 | Dependent variables

*Graduate degree completion*

Graduate degree completion is a binary variable wherein the category "master's degree attained" (coded as 1) was defined as obtaining a master's degree within four years after the start of the master's program and a category "master's degree was not attained" was defined as an actual stoppage with the master's program (coded as 0).

**TABLE 1** Samples' demographical and educational characteristics

| Characteristics | Sample 1. Graduates and drop-outs from different prior HEIs (*N* = 1792) | Sample 2. Graduates and drop-outs who studied their masters' at the same university as their bachelors' (*N* = 1249) | Sample 3. Graduates from different prior HEIs (*N* = 1570) | Sample 4. Graduates who studied their masters' at the same university as their bachelors' (*N* = 1112) |
|---|---|---|---|---|
| Gender: males (*n*) | 741 | 521 | 627 | 456 |
| Age range in years | 17–49 | 17–49 | 18–38 | 19–38 |
| $M_{age}$ | 22.5 | 22.3 | 22.4 | 22.2 |
| $SD_{age}$ | 2.1 | 2.0 | 1.9 | 1.8 |
| $Mdn_{age}$ | 22.0 | 22.0 | 22.0 | 22.0 |
| Citizenship (%) | | | | |
| The Netherlands | 92 | 98 | 91 | 98 |
| Other EU | 8 | 1 | 8 | 1 |
| Outside of EU | <0.1 | <1 | <1 | <1 |
| Type of prior HEI (%) | | | | |
| Dutch research university | 84 | 100 | 84 | 100 |
| Dutch university college | 4 | | 4 | |
| Dutch university of applied sciences | 7 | | 7 | |
| International HEI | 5 | | 5 | |
| Prior field of study (%) | | | | |
| Biology | 34 | 41 | 34 | 41 |
| Biotechnology | 2 | | 2 | |
| Biology and medical laboratory | 5 | | 5 | |
| Biomedical sciences | 31 | 36 | 32 | 36 |
| Chemistry | 5 | 6 | 5 | 6 |
| Liberal arts and sciences | 6 | 1 | 5 | |
| Medicine | 1 | 1 | 1 | 1 |
| Pharmaceutics | 5 | 6 | 5 | 6 |
| Psychology | 5 | 5 | 5 | 6 |
| Other | 6 | 4 | 6 | 4 |
| Missingness (values; %) | 1.7 | 4.0 | 1.5 | 3.6 |

Abbreviations: EU, European Union; HEI, Higher Education Institutions.

*Graduate GGPA*

GGPA (on the Dutch grading scale from 1 to 10) represents an average grade for all curriculum components of a research master's program weighted according to their credit value.

*Graduate time to degree*

Graduate time to degree is measured as actual duration in months of the masters' studies for each student. The expected duration on the research masters' programs at this graduate school is 24 months. However, students are allowed to graduate earlier or later, and it is common in this graduate school to graduate a few months later than the nominal duration of 24 months. Graduate time to degree in our student sample ranged from 19 to 84 months with a median of 28 months.

### 2.4.3 | Research model and data analysis approach

Figure 1 presents our research model. It shows the examined relationships as well as intercorrelations between the predictors.

**TABLE 2** Intercorrelations between study variables

| Variable | *n* | *M* | SD | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|---|---|
| Sample 1 | | | | | | | |
| 1. Percentile rank of UGPA | 1689 | 49.82 | 28.71 | 1 | | | |
| 2. Degree completion | 1792 | 0.88 | 0.33 | 0.053* | 1 | | |
| Sample 2 | | | | | | | |
| 1. Percentile rank of UGPA | 1186 | 49.54 | 28.83 | 1 | | | |
| 2. Undergraduate thesis grade | 1011 | 7.76 | 0.72 | 0.52*** | 1 | | |
| 3. Degree completion | 1249 | 0.89 | 0.31 | 0.06 | 0.09** | 1 | |
| Sample 3 | | | | | | | |
| 1. Percentile rank of UGPA | 1186 | 49.54 | 28.83 | 1 | | | |
| 2. GGPA | 1206 | 7.83 | 0.58 | 0.53*** | 1 | | |
| 3. Graduate time to degree | 1090 | 30.72 | 7.93 | −0.13*** | −0.27*** | 1 | |
| Sample 4 | | | | | | | |
| 1. Percentile rank of UGPA | 1059 | 50.09 | 28.84 | 1 | | | |
| 2. Undergraduate thesis grade | 902 | 7.78 | 0.71 | 0.52*** | 1 | | |
| 3. GGPA | 1099 | 7.87 | 0.55 | 0.58*** | 0.47*** | 1 | |
| 4. Graduate time to degree | 1099 | 30.72 | 7.93 | −0.13*** | 0.15*** | −0.27*** | 1 |

*Note*: Type of prior HEI is a multinominal variable; therefore, it could not be included into the correlational table.
Abbreviations: HEI, Higher Education Institutions; GGPA, graduate grade point average; UGPA, undergraduate grade point average.
*$p < .05$; **$p < .01$; ***$p < .001$.

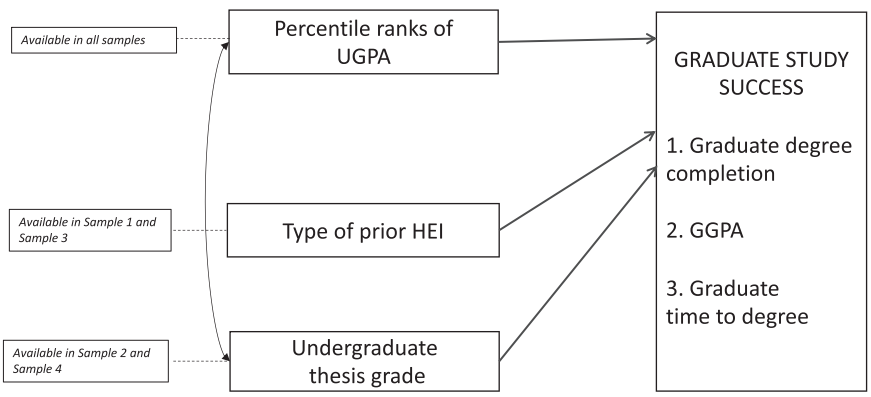


**FIGURE 1** The model with undergraduate academic indicators—predictors of graduate study success. HEI, Higher Education Institutions; GGPA, graduate grade point average; UGPA, undergraduate grade point average.

Though the variables of interest are on an individual level, the data have the multilevel structure (students nested in 68 study groups which in turn are nested in 13 programs). To account for the dependency of students within groups and programs, the hierarchical linear modelling was applied. We ran the analyses on three dimensions of graduate success separately and not on one multivariate outcome because such a multivariate outcome would make the interpretation of findings barely explainable and, therefore, useless for admission practitioners. Analysis was conducted in HLM 8. Since the percentage of missingness was low (in all four samples less than 5% of data was missing), we handled the missingness using the Expectation-Maximization (EM) method.

## 3 | RESULTS

Table 2 shows the Pearson correlations between the study variables. Both percentile rank of UGPA and undergraduate thesis grade are significantly related to the three dimensions of graduate study success: positively to degree completion and GGPA and negatively to time to degree.

Below, we describe the results for the incremental validity of type of prior HEI and undergraduate thesis grade above and beyond UGPA for each of the graduate study success dimension. Tables 3.1, 4.1, and 5.1 are based on analyses of Samples 2 and 4 which included students who did their masters' at the same university

**TABLE 3.1** Hierarchical regression results for graduate degree completion (Sample 2)

| Variable | Model 0 | Model 1 | Model 2 |
|---|---|---|---|
| Fixed effects | | | |
| Intercept | 8.95*** [6.79, 11.80] | 9.17*** [6.92, 12.14] | 9.28*** [7.00, 12.32] |
| Percentile rank of UGPA | | 2.01* [1.00, 1.02] | 1.00 [1.00, 1.01] |
| Thesis grade | | | 1.38 [1.00, 1.91] |
| Random effects | | | |
| Variance components | | | |
| Level 1 | 3.29 | 3.29 | 3.29 |
| Level 2 | 0.24 | 0.25 | 0.24 |
| Level 3 | <0.001 | <0.001 | <0.01 |
| Goodness of fit | | | |
| Deviance | 3153.91 | 3148.05 | 3144.29 |
| Number of estimated parameters | 3 | 4 | 5 |
| Model comparison test | | $\chi^2$ (1) = 5.87* | $\chi^2$ (1) = 3.76* |
| AIC | 3159.91 | 3156.05 | 3154.29 |

*Note*: The reported estimates of predictors are odds ratios. Confidence intervals are in square brackets.

Abbreviations: AIC, Akaike Information Criterion; GGPA, graduate grade point average; UGPA, undergraduate grade point average.

*$p$ < .05; ***$p$ < .001.

as their bachelors'; therefore, their undergraduate thesis grade was available. Tables 3.2, 4.2, and 5.2 are based on analyses of Samples 1 and 3 which included students from all types of HEIs.

## 3.1 | Graduate degree completion as a dependent variable

Tables 3.1 and 3.2 show that the result from uncorrected correlations—UGPA as a significant predictor of degree attainment—holds even after accounting for the dependency of students within groups and programs by applying hierarchical modelling (Model 1), which is in line with Hypothesis 1. Table 3.1 shows that once thesis grade is added to the model with UGPA, the model fit increases significantly, though the estimate for undergraduate thesis grade does not reach the chosen alpha level of 0.05. The improvement in AIC is small. Even though the hypothesized positive relationship between thesis grade and graduate time to degree was detected (Hypothesis 2; see Table 2), we note that thesis grade does not show incremental validity beyond UGPA in predicting degree attainment.

Further models provide the results for the incremental validity of type of HEI above and beyond UGPA. Model 2 of Table 3.2 shows that students from Dutch research universities and from foreign HEIs have higher odds of completing a graduate program compared to students from Dutch universities of applied sciences and students from Dutch university colleges. This finding is partially in line with Hypothesis 3 (where it concerns students from Dutch universities of applied sciences, but not where it concerns students from Dutch university colleges). We also note that with adding each predictor, the Akaike Information Criterion (AIC)—an indicator of relative quality of statistical models—improves but rather to a small extent.

## 3.2 | Graduate grade point average as a dependent variable

Tables 4.1 and 4.2 show the positive relationship between percentile rank of UGPA and GGPA (Model 1), as expected in Hypothesis 1. This significant positive relationship holds even after including other predictors in the model. Table 4.1 shows the incremental validity of prior thesis grade beyond percentile rank of UGPA (Model 2). This was expected, according to Hypothesis 2. The model with significant predictors (Model 2) explained substantial amount of variance in GGPA (40%).

Table 4.2 depicts the results for the incremental validity of Type of prior HEI beyond percentile rank of UGPA. Model 2 shows that students from Dutch universities of applied sciences attainted significantly lower GGPAs compared to students from Dutch research universities, Dutch university colleges, and foreign HEIs. This finding is in line with Hypothesis 3. The addition of type of HEI increased the explained variance in GGPA by a small amount (2%). The model with all study variables explained almost one-third of the total variance in GGPA.

## 3.3 | Graduate time to degree as a dependent variable

Tables 5.1 and 5.2 show that the predictive validity of UGPA for graduate time to degree holds even after accounting for the dependency of students within hierarchical structure: the higher the percentile rank of UGPA, the shorter graduate time to degree (Model 1). This is in line with Hypothesis 1. Table 5.1 shows that undergraduate thesis grade has incremental predictive validity above and beyond UGPA: Students with higher undergraduate thesis grade take less time to complete a research master's program (Model 2). This finding is in line with Hypothesis 2. The total amount of explained variance in graduate time to degree is small.

Adding type of prior HEI to the model with UGPA significantly improves the model fit (Table 5.2, Model 2). Students, who completed their undergraduate degree outside of the Netherlands, have significantly shorter time to graduate degree than students from Dutch research universities and students from Dutch university colleges. There is no significant difference in graduate time to degree between students from Dutch universities of applied sciences and

**TABLE 3.2** Hierarchical regression results for graduate degree completion (Sample 1)

| Variable | Model 0 | Model 1 | Model 2 |
|---|---|---|---|
| Fixed effects | | | |
| Intercept | 7.35*** [6.00, 9.01] | 7.43*** [6.11, 9.05] | 4.39*** [2.64, 7.32] |
| Percentile rank of UGPA | | 1.01* [1.00, 1.01] | 1.01* [1.00, 1.01] |
| *Dummies (Type of prior HEI)*[a] | | | |
| Dutch research university | | | 1.81* [1.13, 2.92] |
| Dutch university college | | | 0.82 [0.40, 1.67] |
| Foreign HEI | | | 3.91** [1.42, 10.78] |
| Random effects | | | |
| Variance components | | | |
| Level 1 | 3.29 | 3.29 | 3.29 |
| Level 2 | 0.07 | 0.08 | 0.08 |
| Level 3 | 0.01 | <0.01 | <0.01 |
| Goodness of fit | | | |
| Deviance | 4633.71 | 4627.82 | 4612.15 |
| Number of estimated parameters | 3 | 4 | 7 |
| Model comparison test | | $\chi^2$ (1) = 5.89* | $\chi^2$ (3) = 15.67** |
| AIC | 4639.71 | 4635.82 | 4626.15 |

*Note*: The reported estimates of predictors are odds ratios. Confidence intervals are in square brackets.

Abbreviations: AIC, Akaike Information Criterion; CI, confidence interval; HEI, Higher Education Institutions; UGPA, undergraduate grade point average.

[a]The reference category: "Dutch university of applied sciences." Rerunning analysis to test other dummies of types of prior HEI in Model 2 delivers also other significant differences, namely for a dummy variable "Dutch university college versus Dutch research university [ref]," Exp(b) = 0.45**, CI = [0.26, 0.80] and for "Foreign HEI versus Dutch university college [ref]," Exp(b) = 4.77**, CI = [1.65, 13.76].

*$p$ < .05; **$p$ < .01; ***$p$ < .001.

**TABLE 4.1** Hierarchical regression results for graduate grade point average (Sample 4)

| Variable | Model 0 | Model 1 | Model 2 |
|---|---|---|---|
| Fixed effects | | | |
| Intercept | 7.82*** [7.70, 7.94] | 7.84*** [7.77, 7.93] | 7.86*** [7.80, 7.91] |
| Percentile rank of prior average grade | | 0.01*** [0.01, 0.01] | 0.01*** [0.01, 0.01] |
| Prior thesis grade | | | 0.21*** [0.16, 0.25] |
| Random effects | | | |
| Variance components | | | |
| Level 1 | 0.28 | 0.19 | 0.18 |
| Level 2 | 0.01 | <0.01 | <0.01 |
| Level 3 | 0.03 | 0.01 | 0.01 |
| Total explained variance (%) | | 35 | 40 |
| Goodness of fit | | | |
| Deviance | 1765.58 | 1348.2282.1 | 1272.64 |
| Number of estimated parameters | 4 | 5 | 6 |
| Model comparison test | | $\chi^2$ (1) = 417.35*** | $\chi^2$ (1) = 75.58*** |

*Note*: Confidence intervals are in square brackets.

***$p$ < .001.

**TABLE 4.2** Hierarchical regression results for graduate grade point average (Sample 3)

| Variable | Model 0 | Model 1 | Model 2 |
|---|---|---|---|
| Fixed effects | | | |
| Intercept | 7.81*** [7.69, 7.93] | 7.82*** [7.74, 7.90] | 7.61*** [7.49, 7.73] |
| Percentile rank of UGPA | | 0.01*** [0.01, 0.01] | 0.01*** [0.01, 0.01] |
| *Dummies (Type of prior HEI)*[a] | | | |
| Dutch research university | | | 0.23*** [0.13, 0.33] |
| Dutch university college | | | 0.29*** [0.15, 0.43] |
| Foreign HEI | | | 0.25*** [0.11, 0.39] |
| Random effects | | | |
| Variance components | | | |
| Level 1 | 0.27 | 0.20 | 0.20 |
| Level 2 | 0.01 | <0.01 | <0.01 |
| Level 3 | 0.04 | 0.02 | 0.01 |
| Total explained variance (%) | | 30 | 32 |
| Goodness of fit | | | |
| Deviance | 2463.46 | 1985.87 | 1960.12 |
| Number of estimated parameters | 4 | 5 | 8 |
| Model comparison test | | $\chi^2$ (1) = 477.59*** | $\chi^2$ (3) = 25.75*** |

*Note*: Confidence intervals are in square brackets.

Abbreviations: HEI, Higher Education Institutions; UGPA, undergraduate grade point average.

[a]The reference category: "Dutch university of applied sciences."

***$p < .001$

**TABLE 5.1** Hierarchical regression results for graduate time to degree (Sample 4)

| Variable | Model 0 | Model 1 | Model 2 |
|---|---|---|---|
| Fixed effects | | | |
| Intercept | 30.41*** [29.53, 31.29] | 30.35*** [29.39, 31.31] | 30.29*** [29.33, 31.25] |
| Percentile rank of prior average grade | | −0.04*** [−0.06, −0.02] | −0.01 [−0.03, 0.01] |
| Prior thesis grade | | | −1.98*** [1.16, 2.80] |
| Random effects | | | |
| Variance components | | | |
| Level 1 | 59.33 | 58.23 | 56.90 |
| Level 2 | 1.06 | 0.88 | 1.13 |
| Level 3 | 1.32 | 1.75 | 1.75 |
| Total explained variance (%) | | 1 | 3 |
| Goodness of fit | | | |
| Deviance | 7722.91 | 7702.21 | 7679.92 |
| Number of estimated parameters | 4 | 5 | 6 |
| Model comparison test | | $\chi^2$ (1) = 20.70*** | $\chi^2$ (1) = 22.28*** |

*Note*: Confidence intervals are in square brackets.

***$p < .001$.

**TABLE 5.2** Hierarchical regression results for graduate time to degree (Sample 3)

| Variable | Model 0 | Model 1 | Model 2 |
|---|---|---|---|
| Fixed effects | | | |
| Intercept | 29.64*** [28.78, 30.50] | 29.57*** [28.63, 30.51] | 28.56*** [26.91, 30.21] |
| Percentile rank of UGPA | | −0.04*** [−0.06, −0.02] | −0.04*** [−0.06, −0.02] |
| *Dummies (Type of prior HEI)*[a] | | | |
| Dutch research university | | | 1.37 [−0.12, 2.86] |
| Dutch university college | | | 0.62 [−1.73, 2.97] |
| Foreign HEI | | | −2.14 [−4.28, −0.00] |
| Random effects | | | |
| Variance components | | | |
| Level 1 | 54.51 | 53.58 | 52.88 |
| Level 2 | 1.06 | 0.80 | 0.85 |
| Level 3 | 1.60 | 2.05 | 2.00 |
| Total explained variance (%) | | 1 | 3 |
| Goodness of fit | | | |
| Deviance | 10771.21 | 10742.23 | 10722.34 |
| Number of estimated parameters | 4 | 5 | 8 |
| Model comparison test | | $\chi^2$ (1) = 28.98*** | $\chi^2$ (3) = 19.89*** |

*Note*: Confidence intervals are in square brackets. The analysis of other dummies in Model 2 showed significant effects of dummy variables "Foreign HEI versus Dutch research university" ($b$ = −3.51***, 95% CI [−5.16, −1.86]) and "Foreign HEI versus Dutch university college" ($b$ = −2.76*, 95% CI [−5.19, −0.33]).

Abbreviations: CI, confidence interval; HEI, Higher Education Institutions; UGPA, undergraduate grade point average.

[a]The reference category: "Dutch university of applied sciences."

*$p$ < .05; ***$p$ < .001.

students from other types of HEIs. These results do not support Hypothesis 3. Again, the total explained variance of the model with all study variables included is small.

## 4 | DISCUSSION

We tested whether (and to what extent) we can predict graduate study success using student undergraduate academic indicators in a sample of students across several masters' programs in the life sciences. Our study found that the strongest predictor was percentile rank of UGPA which showed predictive validity for all three outcomes: The higher percentile rank of UGPA was related to highr odds of completing a graduate program, higher GGPA, and shorter time to degree. Undergraduate thesis grade had incremental validity beyond UGPA in predicting GGPA and graduate time to degree: The higher undergraduate thesis grade, the higher GGPA and shorter graduate time to degree. Type of prior HEI was found to be predictive of degree completion and GGPA: Students from Dutch research universities and from foreign HEIs have higher odds of completing a graduate program compared to students from Dutch universities of applied sciences and students from Dutch university colleges. We found that our models explain substantial amounts of variance in GGPA but not in graduate time to degree. We also found that our models predicted odds of graduate degree completion only to a small extent.

### 4.1 | Predictive value of undergraduate academic indicators for graduate degree completion

We expected that UGPA and thesis grade would be positively related to degree attainment (Hypothesis 1 and 2, respectively). Our data supported both expectations, even though we note that thesis grade did not show incremental validity above UGPA. We also expected that students from universities of applied sciences will have lower odds of completing their research master's program because their undergraduate training was not research-intensive (Hypothesis 3). This hypothesis was supported by our data. In addition to that, however, we also discovered that students from Dutch university colleges (which officially represent part of research universities) also have lower odds of completing their research master's program. We explain this by the fact that students in Dutch university colleges follow Liberal Arts and Sciences education, which teaches a wide

range of topics: this range is significantly broader than more specific courses that students follow within regular curricula of Dutch and foreign research universities. Considering that degree completion is a motivationally determined outcome (Kuncel et al., 2014), it may be that the latter two groups are more motivated to persist in their master's education as they are more familiar with specific topics and had chosen them more conscientiously, while students from university colleges find it difficult to motivate themselves to study the narrow scientific topics within one specific field.

Importantly, the examined undergraduate academic indicators predict graduate degree completion only to a small extent. We see two possible complementary reasons for this finding. The first reason might be that the dropping out of students in this sample was not related to their academic ability but to other factors during their masters' programs. As the empirical research shows, these could be reasons related to psychological resources, personality, study motivation, study conditions, study decisions, institutional guidance, and study performance during a graduate program (Cox et al., 2009; Heublein, 2014). The second plausible reason might be that degree completion is determined by conscientiousness, motivation, drive, interest, or adaptability (Kuncel et al., 2014; Schwager et al., 2015) and, therefore, it is a hard-to-predict outcome, especially using prior academic indicators which do not directly assess these qualities. It might be that methods that evaluate noncognitive constructs (e.g., conscientiousness or time management; Butter & Born, 2012) or advanced assessment of academic work (presentations, various operationalizations of research experience; Pacheco et al., 2015) are better suited for prediction of degree completion.

### 4.2 | Predictive value of undergraduate academic indicators for GGPA

When predicting GGPA, the strongest predictor in our analysis was UGPA. The predictive validity of UGPA corroborates our Hypothesis 1 which was based on theoretical underpinnings of UGPA as a complex measure that captures several influential determinants of study success and on findings of previous studies showing a stable relation between UGPA and GGPA (Chadi & de Pinto, 2018; Howell et al., 2014; Park et al., 2018; Zimmermann et al., 2017). Undergraduate thesis grade showed incremental validity above UGPA and slightly improved the predictive power of our model. Considering that prior studies on undergraduate research experience as a predictor of GGPA have never operationalized it through undergraduate thesis grade (see Miller et al., 2021; for the overview of prior operationalizations), we cannot place our finding in the context of literature. However, it does align with our Hypothesis 2 and corroborates the meta-analytical findings which show that prior achievement (in this case, performance on a research-related task such as undergraduate thesis) is one of the best predictors of future achievement (Richardson et al., 2012; Schneider & Preckel, 2017). We consider that it could be beneficial to explore this operationalization further, especially as it allows us to place students on one metric, at least those who come from the same prior HEI. In doing so, it is important to keep the possible effects of unintentional internal grading culture in mind.

Our next finding regarding prediction of GGPA is that students from universities of applied sciences obtain significantly lower GGPAs than students from other types of HEIs, in line with Hypothesis 3. This can be explained by a more practice-oriented curriculum of universities of applied sciences versus a research-oriented curriculum of research universities. It makes sense that the lack of preparation for the theoretical aspects of research places these students at a disadvantage compared with students from research-oriented HEIs and leads at the end of a research master's program to lower GGPA. It is important to note, however, that despite incremental validity beyond and above UGPA, the gain in explained variance from type of HEI is small. This means that GGPA is not heavily determined by type of prior HEI in presence of UGPA, as we expected.

### 4.3 | Predictive value of undergraduate academic indicators for graduate time to degree

With caution, we hypothesized that UGPA and thesis grade would be negatively related to graduate time to degree (Hypothesis 1 and 2). Even though we found these hypothesized relationships to be statistically significant, the extent to which we can explain variance in graduate time to degree is small (around 3%). We also hypothesized that students from universities of applied sciences may take longer time to complete their research master's program because their prior practice-oriented training may not provide them with all the knowledge and skills needed to complete the research-intense internships and assignments in the required time (Hypothesis 3). Our results do not support this hypothesis. It might be that the students from universities of applied sciences manage well with the timeline of their research-intense curriculum because they were trained in practical aspects such as working with biological material, keeping a logbook of experiments, and so forth. While these students from universities of applied sciences may struggle with designing a research proposal, formulating theory-driven hypotheses, and so forth, their peers with undergraduate degrees from research universities might struggle with the practical aspects, which students from universities of applied sciences are good at. All together, these strengths and weaknesses of students from two different types of universities balance each other, which leads to the absence of significant difference in their graduate time to degree.

What we did not hypothesize in our Hypothesis 3, but what we found is that international students have significantly shorter time to degree than Dutch students from research universities and university colleges. We think that this finding is striking. Although the international students may experience a cultural shock (Zhou et al., 2008), both within and outside of studies (housing, teaching methods, and adjustment to new culture), they still take less time to complete a master's degree than local students who had research-intensive undergraduate education in

their own country. Some of this can be explained by the fact that all international students in our analyses were from the EU, therefore, their academic and social integration scores are comparable to domestic students (Rienties et al., 2014). This finding can also be explained by the fact that many international students receive grants or loans as a part of an international exchange program, and this funding is usually provided for the official duration of their master's program (e.g., for 2 years in the case of masters' programs addressed in this study). Therefore, finishing on time could be a strong motivator for international students because it prevents them from taking out further loans or having to apply for additional grant money.

Despite the relationships that we discussed above, it is important that all three examined undergraduate academic indicators predict graduate time to degree only to a small extent. This result is in line with findings on undergraduate level where it was shown that precollege characteristics account for a small amount of variance in time to degree (Yue & Fu, 2017), and we have two possible explanations. The first explanation is that among the undergraduate academic indicators we examined, there were none that measured motivation of students. There are, however, some indications that intrinsic motivation exerts positive influence on study progress (Slijper et al., 2016). We could not use assessments of motivation due to a practical reason (they were not available in our institutional data). We would also like to note that the existing selection methods based on motivation such as personal statements have not been shown as valid instruments (Murphy et al., 2009). Thus, we do not expect that having assessments of motivation available would deliver a substantial gain in explained variance in graduate time to degree.

Our second explanation is that what occurs during a graduate program plays a more important role in graduate study delays than undergraduate academic indicators. The factors during a graduate program that are influential for study delays are individual (e.g., student sense of belonging), supervisory (e.g., clarity of supervisor's communication with their student), and departmental/institutional (e.g., graduate policies and practices, workload during a program; de Valero, 2001; Ruete et al., 2021; van de Schoot et al., 2013; van Rooij et al., 2021). In additon to these three factors, we think that research masters' students might feel pressure to produce early-career publications (Crane & Pearson, 2011) because publishing academic work makes a difference when applying to a research-oriented position in the future (Stoilescu & McDougall, 2010). This pressure impacts students' decisions to produce a publication at the cost of longer time to degree. Overall, it appears that time to degree represents a variable that is hard to predict using information available upon admissions to a graduate program.

## 4.4 | Theoretical contributions

Our study adds to the existing literature on valid selection methods in the following regards. First, we clarified the mixed findings on whether UGPA is predictive of graduate time to degree and degree attainment. In line with a number of prior studies (Howell et al., 2014; Mendoza-Sanchez et al., 2022; Moneta-Koehler et al., 2017; Schwager et al., 2015; Wollast et al., 2018), we found that UGPA is a statistically significant predictor of graduate time to degree and degree attainment. However, it explains little variance in time to degree and increases the odds of completing a graduate degree to a small extent. This may be a reason why a number of other studies (Cox et al., 2009; Dabney, 2012; Dore, 2017; Moneta-Koehler et al., 2017) failed to detect this relationship using their data. So even though UGPA seems to be weakly related to graduate time to degree and degree attainment, researchers may want to focus on exploring whether other information, available upon admissions, can add or even outperform UGPA in prediction of these two dimensions of graduate study success.

The second theoretical contribution is that this study found support for the theoretical underpinnings regarding research experience as one of the determinants of graduate study success (Gilmore et al., 2015; Miller et al., 2021). Our operationalization of undergraduate research experience in the form of thesis grade appeared as a valid predictor and delivered incremental validity above UGPA. Such an operationalization has not been tested before, and the replication studies would be valuable: More evidence of the usefulness of this operationalization of undergraduate research experience could justify the inclusion of thesis grade as an admissions requirement for research-oriented masters' programs.

The third theoretical contribution is that our assumption that prior HEI may represent one of the determinants of graduate study success found empirical support. Along with that, we showed that this relationship is weak. The practitioners, therefore, will possibly be facing a dilemma whether to use type of HEI as a selection method or not. We discuss these and other practical aspects of our findings in the section below.

## 4.5 | Practical contributions

The application of undergraduate thesis grade as a selection method could be considered in practice, especially in programs with a similar research-oriented focus and where admission committees regard GGPA as an important dimension of graduate study success of their students. However, we call for a conscious choice in doing so. If we select students, who are already good in what they are supposed to do during their graduate program, what is the added value of the program in the learning process? Do we not exclude students who come from nonresearch undergraduate schools? Or should programs select and teach those who will gain the most (e.g., students who were less successful in research-related tasks such as an undergraduate thesis or simply never had a chance to work on a thesis during their undergraduate studies). We suggest that universities and graduate programs make this decision of using undergraduate thesis grade for selection purposes, accounting for their mission statements and vision of their student body.

Another practical consideration regarding the implementation of grades is that although this study showed their predictive validity

(i.e., of undergraduate thesis grade and UGPA), it is important to account for the context in which these grades were obtained. While the traditional meritocratic equality of opportunity model of fair access implies that study places go to the most highly capable, irrespective of their social-economic background, an alternative model is gaining recognition and states that indicators of merit, including grades, need to be assessed contextually in light of an applicant's socioeconomic circumstances (Boliver & Powell, 2021). To make this possible, the individual HEIs should be allowed to gather and use data on socioeconomic status for conducting research on this topic which is almost never the case in certain European countries (partly a consequence of the recently adopted European Data Protection Regulation).

As for the type of prior HEI, when applying it as a selection criterion, admissions committees should consider the indications that certain types of prior HEI are associated with lower socioeconomic status (e.g., on average, students from Dutch universities of applied sciences tend to have lower socioeconomic status than their peers in research universities; The Netherlands Association of Universities of Applied Sciences, 2012). Therefore, the application of type of prior HEI as a selection criterion could mask student selection based on socioeconomic characteristics which would be morally and legally inappropriate. Instead, it might be practical to provide these students with additional guidance during their graduate studies to ensure graduate study success.

### 4.6 | Limitations

This study does not come without limitations. First, we used data of already selected students and did not have information on how students, who were not selected, would have performed. However, since we were interested in detecting relationships between undergraduate academic indicators and graduate study success and not establishing the means or cut-off scores, there is no reason to assume that these relationships would be fundamentally different in a wider sample of all applicants.

The next limitation is that student admissions data registered in the administrative system at this graduate school are limited to variables from official transcripts. The scores on other documents that require additional assessment of admissions committees (recommendation letters, interviews, personal statements, etc.) were not standardized across programs at this graduate school, therefore, could not be included into the statistical analysis. However, the fact that our data came from official transcripts basically excluded the possibility of unreliable data. Moreover, the undergraduate academic indicators, which were the focus of this paper, are usually present in most similar graduate schools' data sets which allows considerable generalizability of our findings.

Another limitation is that this study is conducted within one graduate school of one university. However, students from 13 different research masters' programs were included from relatively diverse field of studies which provides an opportunity for a certain generalizability of our findings for other research-oriented graduate programs.

## 5 | CONCLUSIONS

In this study, we aimed to validate certain widely used undergraduate indicators to help create a more objective, efficient, and inclusive master's admissions process. What we found is that undergraduate thesis grade is a valid predictor of GGPA in addition to UGPA. Therefore, these indicators should be considered for selection purposes for research-oriented graduate programs in the life sciences and possibly for programs with a similar focus. We also showed that type of prior HEI does not add much to the prediction of graduate study success after the prior grades have been taken into consideration. All examined undergraduate academic indicators did not contribute much to prediction of graduate degree completion and time to degree. While this study took place in a Dutch HEI, our findings, especially those on UGPA and undergraduate thesis grade are generalizable to research-intensive programs across EHEA. The graduate programs outside EHEA can consider them as well, accounting for the differences in structure of graduate programs. Likewise, our models, which combined different international student groups by using percentile ranks, can be applied across different HEIs.

### ACKNOWLEDGMENTS

The authors would like to thank prof. dr. Marijk van der Wende for her supervision of this study and the overarching PhD project focused on graduate selective admissions. The authors are also grateful to educational data specialist Guus Dikker. His professional advice on data processing was very valuable. This study received internal institutional funding.

### CONFLICT OF INTEREST

The authors declare no conflict of interest.

### DATA AVAILABILITY STATEMENT

Raw data were generated at the Utrecht University Graduate School of Life Sciences. Derived data supporting the findings of this study are available from the corresponding author A.K. on request.

### ORCID

*Anastasia Kurysheva* http://orcid.org/0000-0001-7425-1345
*Gönül Dilaver* http://orcid.org/0000-0002-6227-2197

### ENDNOTES

[1] We have also conducted an analysis where we included prior field of study (biology, biomedical sciences, medicine, psychology, chemistry, liberal arts and sciences, pharmaceutics, biotechnology, biology and medical laboratory) as a predictor in the last step of our model. This analysis delivered negligible increment in explained variance. It is available for interested parties by request.

[2] Ideally, we would have wanted to use undergraduate thesis grade as a predictor in all our analyses. Unfortunately, these grades were not

registered in the administrative system for students who had come from different universities. They were registered only for students who studied their bachelor's program at the same university as their master's program. For this reason, we had to analyze four samples instead of two.

## REFERENCES

Association of Universities in the Netherlands. (2021). Instroom nieuwe masterstudenten [Influx of new masters' students]. https://vsnu.nl/instroom-master.html

Bean, J. P. (1980). Dropouts and turnover: The synthesis and test of a causal model of student attrition. *Research in Higher Education*, *12*(2), 155–187. https://doi.org/10.1007/BF00976194

Boliver, V., & Powell, M. (2021). Fair admission to universities in England: Improving policy and practice. *Nuffield Foundation*. https://www.nuffieldfoundation.org/wp-content/uploads/2021/01/Fair-admission-to-universities-in-England.pdf

Borghans, L., Golsteyn, B., Heckman, J., & Humphries, J. (2016). What grades and achievement tests measure. *Proceedings of the National Academy of Sciences of the United States of America*, *113*(47), 13354–13359. https://doi.org/10.1073/pnas.1601135113

Brown, J. S., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. *Educational Researcher*, *18*(1), 35–42. https://doi.org/10.3102/0013189X018001032

Burton, N. W., & Wang, M. (2005). *Predicting long-term success in graduate school: A collaborative validity study* (Report No. 99-14R. ETS RR-05-03). Educational Testing Service. http://grad.uga.edu/wp-content/uploads/2017/09/GRE_Research_Report.pdf

Busato, V. V., Prins, F. J., Elshout, J. J., & Hamaker, C. (2000). Intellectual ability, learning style, personality, achievement motivation and academic success of psychology students in higher education. *Personality and Individual Differences*, *29*(6), 1057–1068. https://doi.org/10.1016/S0191-8869(99)00253-6

Butter, R., & Born, M. P. (2012). Enhancing criterion-related validity through bottom-up contextualization of personality inventories: The construction of an ecological conscientiousness scale for Ph.D. candidates. *Human Performance*, *25*(4), 303–317. https://doi.org/10.1080/08959285.2012.703730

Cabrera, A., Nora, A., & Castaneda, M. (1993). College persistence: Structural equations modeling test of an integrated model of student retention. *The Journal of Higher Education*, *64*(2), 123–139. https://www.jstor.org/stable/2960026

Campbell, J. P., McCloy, R. A., Oppler, S. H., & Sager, C. E. (1993). A theory of performance. *Personnel Selection in Organizations*, *3570*, 35–70.

Chadi, A., & de Pinto, M. (2018). Selecting successful students? Undergraduate grades as an admission criterion. *Applied Economics*, *50*(28), 3089–3105. https://doi.org/10.1080/00036846.2017.1418072

Collins, A., Brown, J. S., & Newman, S. E. (1989). Cognitive apprenticeship: Teaching the crafts of reading, writing, and mathematics. In L. B. Resnick (Ed.), *Knowing, learning and instruction* (pp. 453–494). Essays in honor of Robert Glaser.

Cox, G. W., Hughes, W. E., Jr., Etzkorn, L. H., & Weisskopf, M. E. (2009). Predicting computer science Ph.D. completion: A case study. *IEEE Transactions on Education*, *52*(1), 137–143. https://doi.org/10.1109/TE.2008.921458

Crane, N. J., & Pearson, Z. (2011). Can we get a pub from this? Reflections on competition and the pressure to publish while in graduate school. *The Geographical Bulletin*, *52*, 77–80. https://gammathetaupsilon.org/the-geographical-bulletin/2010s/volume52-2/article4.pdf

Dabney, K. P. T. (2012). *Differences within: A comparative analysis of women in the physical sciences-motivation and background factors (Publication No: AAT 3507074)* [Doctoral dissertation, ProQuest Dissertations and Theses]. University of Virginia https://doi.org/10.18130/V3XZ9R

de Valero, Y. F. (2001). Departmental factors affecting time-to-degree and completion rates of doctoral students at One Land-Grant Research Institution. *The Journal of Higher Education*, *72*(3), 341–367. https://doi.org/10.2307/2649335

Dore, M. L. (2017). *Factors in the admissions process influencing persistence in a Master's of Science program in marine science* [Doctoral dissertation]. Nova Southeastern University. https://nsuworks.nova.edu/fse_etd/110/

Ericsson, K. A., & Charness, N. (1994). Expert performance: Its structure and acquisition. *American Psychologist*, *49*(8), 725–747. https://doi.org/10.1037/0003-066X.49.8.725

European Higher Education Area. (n.d.). Three-cycle system. https://www.ehea.info/page-three-cycle-system

Eurydice Network. (2020). Key features of the Dutch education system. https://eacea.ec.europa.eu/national-policies/eurydice/content/netherlands_en

Fu, Y. (2012). *The effectiveness of traditional admissions criteria in predicting college and graduate success for American and international students* [Doctoral dissertation]. University of Arizona. ProQuest LLC. https://eric.ed.gov/?id=ED536665

Galla, B. M., Shulman, E. P., Plummer, B. D., Gardner, M., Hutt, S. J., Goyer, J. P., & Duckworth, A. L. (2019). Why high school grades are better predictors of on-time college graduation than are admissions test scores: The roles of self-regulation and cognitive ability. *American Educational Research Journal*, *56*(6), 2077–2115. https://doi.org/10.3102/0002831219843292

Gilmore, J., Vieyra, M., Timmerman, B., Feldon, D., & Maher, M. (2015). The relationship between undergraduate research participation and subsequent research performance of early career STEM graduate students. *The Journal of Higher Education*, *86*(6), 834–863. https://doi.org/10.1353/jhe.2015.0031

Hall, J. D., O'Connell, A. B., & Cook, J. G. (2017). Predictors of student productivity in biomedical graduate school applications. *PLOS ONE*, *12*(1), e0169121. https://doi.org/10.1371/journal.pone.0169121

Heublein, U. (2014). Student drop-out from German higher education institutions. *European Journal of Education*, *49*(4), 497–513. https://doi.org/10.1111/ejed.12097

Howell, L. L., Sorenson, C. D., & Jones, M. R. (2014). Are undergraduate GPA and general GRE percentiles valid predictors of student performance in an engineering graduate program? *International Journal of Engineering Education*, *30*(5), 1145–1165. https://scholarsarchive.byu.edu/facpub/1343/

Kuncel, N. R., Kochevar, R. J., & Ones, D. S. (2014). A meta-analysis of letters of recommendation in college and graduate admissions: Reasons for hope. *International Journal of Selection and Assessment*, *22*(1), 101–107. https://doi.org/10.1111/ijsa.12060

Kurysheva, A., van Rijen, H. V. M., & Dilaver, G. (2019). How do admission committees select? Do applicants know how they select? Selection criteria and transparency at a Dutch University. *Tertiary Education and Management*, *25*(4), 367–388. https://doi.org/10.1007/s11233-019-09050-z

Kyllonen, P., Walters, A. M., & Kaufman, J. C. (2005). Noncognitive constructs and their assessment in graduate education: A review. *Educational Assessment*, *10*(3), 153–184. https://doi.org/10.1207/s15326977ea1003_2

Lub, A., van der Wende, M., & Witte, J. (2003). Bachelor-master programmes in the Netherlands and Germany. *Tertiary Education and Management*, *9*(4), 249–266. https://doi.org/10.1080/13583883.2003.9967108

Mendoza-Sanchez, I., deGruyter, J. N., Savage, N. T., & Polymenis, M. (2022). Undergraduate GPA predicts biochemistry PhD completion and is associated with time to degree. *CBE—Life Sciences Education*, 21. https://doi.org/10.1187/cbe.21-07-0189

Miller, A., Crede, M., & Sotola, L. K. (2021). Should research experience be used for selection into graduate school: A discussion and

meta-analytic synthesis of the available evidence. *International Journal of Selection and Assessment*, *29*(1), 19–28. https://doi.org/10.1111/ijsa.12312

Moneta-Koehler, L., Brown, A. M., Petrie, K. A., Evans, B. J., & Chalkley, R. (2017). The limitations of the GRE in predicting success in biomedical graduate school. *PLOS ONE*, *12*(1), e0166742. https://doi.org/10.1371/journal.pone.0166742

Murphy, S. C., Klieger, D. M., Borneman, M. J., & Kuncel, N. R. (2009). The predictive power of personal statements in admissions: A meta-analysis and cautionary tale. *College & University*, *84*(4), 83–88.

Niessen, A. S. M., Meijer, R. R., & Tendeiro, J. N. (2017). Measuring non-cognitive predictors in high-stakes contexts: The effect of self-presentation on self-report instruments used in admission to higher education. *Personality and Individual Differences*, *106*, 183–189. https://doi.org/10.1016/j.paid.2016.11.014

NVAO. (2016). Specification of additional criteria for research master's programmes. https://www.nvao.net/files/attachments/.1255/Nadere_uitwerking_aanvullende_criteria_onderzoeksmasters_30_mei_2016_EN_def_nieuwe_huisstijl.pdf

OECD. (2022). International student mobility (indicator). https://doi.org/10.1787/4bcf6fc3-en

Pacheco, W. I., Noel, R. J., Porter, J. T., & Appleyard, C. B. (2015). Beyond the GRE: Using a composite score to predict the success of Puerto Rican students in a biomedical PhD program. *CBE Life Sciences Education*, *14*(2), 1–7. https://doi.org/10.1187/cbe.14-11-0216

Park, H.-Y., Berkowitz, O., Symes, K., & Dasgupta, S. (2018). The art and science of selecting graduate students in the biomedical sciences: Performance in doctoral study of the foundational sciences. *PLOS One*, *13*(4), e0193901. https://doi.org/10.1371/journal.pone.0193901

Patterson, F., Knight, A., Dowell, J., Nicholson, S., Cousans, F., & Cleland, J. (2016). How effective are selection methods in medical education? A systematic review. *Medical Education*, *50*(1), 36–60. https://doi.org/10.1111/medu.12817

Patterson, F., Roberts, C., Hanson, M. D., Hampe, W., Eva, K., Ponnamperuma, G., Magzoub, M., Tekian, A., & Cleland, J. (2018). 2018 Ottawa consensus statement: Selection and recruitment to the healthcare professions. *Medical Teacher*, *40*(11), 1–9. https://doi.org/10.1080/0142159X.2018.1498589

Poropat, A. E. (2009). A meta-analysis of the five-factor model of personality and academic performance. *Psychological Bulletin*, *135*(2), 322–338. https://doi.org/10.1037/a0014996

Posselt, J. R. (2016). Inside graduate admissions: Merit, diversity, and faculty gatekeeping. Harvard University Press. https://doi.org/10.1080/00220671.2016.1184524

Richardson, M., Abraham, C., & Bond, R. (2012). Psychological correlates of university students' academic performance: A systematic review and meta-analysis. *Psychological Bulletin*, *138*(2), 353–387. https://doi.org/10.1037/a0026838

Rienties, B., Luchoomun, D., & Tempelaar, D. (2014). Academic and social integration of master students: A cross-institutional comparison between Dutch and international students. *Innovations in Education and Teaching International*, *51*(2), 130–141. https://doi.org/10.1080/14703297.2013.771973

Ruete, D., Zavala, G., Leal, D., Lopez Lira, P., Medina, L. P. S. M., Aravena, M. E., & Costa, G. (2021, July). *Early detection of delayed graduation in master's students* [Paper presentation]. American Society for Engineering Education Annual Conference, Virtual Meeting. https://strategy.asee.org/36999

Salmi, J., & Bassett, R. M. (2014). The equity imperative in tertiary education: Promoting fairness and efficiency. *International Review of Education*, *60*(3), 361–377. https://doi.org/10.1007/s11159-013-9391-z

Schneider, M., & Preckel, F. (2017). Variables associated with achievement in higher education: A systematic review of meta-analyses. *Psychological Bulletin*, *143*(6), 565–600. https://doi.org/10.1037/bul0000098

Schwager, I. T. L., Hülsheger, U. R., Bridgeman, B., & Lang, J. W. B. (2015). Graduate student selection: Graduate record examination, socio-economic status, and undergraduate grade point average as predictors of study success in a western European university. *International Journal of Selection and Assessment*, *23*(1), 71–79. https://doi.org/10.1111/ijsa.12096

Slijper, J., Kunnen, E. S., Onstenk, J., & van Geert, P. (2016). The role of time perspective, motivation, attitude, and preparation in educational choice and study progress. *Education Research International*, *2016*, 1–15. https://doi.org/10.1155/2016/1382678

Snijder, J. K. (2016). *Mastering research: A study about the effectiveness of research master programmes in the Netherlands* [Doctoral dissertation]. University of Twente. https://doi.org/10.3990/1.9789036541466

Statista. (2020). Number of master's degrees earned in the United States from 1949/50 to 2029/30, by gender. https://www.statista.com/statistics/185160/number-of-masters-degrees-by-gender-since-1950/

Stoilescu, D., & McDougall, D. (2010). Starting to publish academic research as a doctoral student. *International Journal of Doctoral Studies*, *5*, 79–92. http://ijds.org/Volume5/IJDSv5p079-092Stoilescu299.pdf

Tai, J. (2020). Do College Grades Predict Future Success? https://www.forbes.com/sites/theyec/2020/10/19/do-college-grades-predict-future-success/?sh=60cb5a735af6

the Higher Education Statistics Agency. (2020). Higher education student statistics: UK, 2018/19—qualifications achieved. https://www.hesa.ac.uk/news/16-01-2020/sb255-higher-education-student-statistics/qualifications

The Netherlands Association of Universities of Applied Sciences. (2012). Achtergrondnotitie. Toegankelijkheid Hoger Onderwijs en de Rol Studiefinanciering [Background note. Access to higher education and the role of Student Finance]. https://www.vereniginghogescholen.nl/system/knowledge_base/attachments/files/000/000/390/original/Toegankelijkheid_hoger_onderwijs_rol_studiefinanciering_-_achtergrondnotitie_HBO-raad_over_leenstelsel.pdf?1443427985

Tinto, V. (1975). Dropout from higher education: A theoretical synthesis of recent research. *Review of Educational Research*, *45*(1), 89–125.

Torgerson, P. C., Gascoine, L., Heaps, C., Menzies, V., & Younger, K. (2014). Higher education access: Evidence of effectiveness of university access strategies and approaches. A report to The Sutton Trust. Durham University. https://www.suttontrust.com/wp-content/uploads/2019/12/Higher-Education-Access-Report-1.pdf

van de Schoot, R., Yerkes, M. A., Mouw, J. M., & Sonneveld, H. (2013). What took them so long? Explaining PhD delays among doctoral candidates. *PLoS One*, *8*(7), e68839. https://doi.org/10.1371/journal.pone.0068839

van der Wende, M. (2020). Netherlands, higher education. In M. David, & M. Amey (Eds.), *The SAGE encyclopedia of higher education* (pp. 1079–1080). SAGE Publications, Inc. https://doi.org/10.4135/9781529714395.n403

van Rooij, E., Fokkens-Bruinsma, M., & Jansen, E. (2021). Factors that influence PhD candidates' success: The importance of PhD project characteristics. *Studies in Continuing Education*, *43*(1), 48–67. https://doi.org/10.1080/0158037X.2019.1652158

Weiner, O. D. (2014). How should we be selecting our graduate students. *Molecular Biology of the Cell*, *25*(4), 429–430. https://doi.org/10.1091/mbc.e13-11-0646

Witte, J., van der Wende, M., & Huisman, J. (2008). Blurring boundaries: How the Bologna process changes the relationship between university and non-university higher education in Germany, the

Netherlands and France. *Studies in Higher Education*, *33*(3), 217–231. https://doi.org/10.1080/03075070802049129

Wollast, R., Boudrenghien, G., Van der Linden, N., Galand, B., Roland, N., Devos, C., De Clercq, M., Klein, O., Azzi, A., & Frenay, M. (2018). Who are the doctoral students who drop out? Factors associated with the rate of doctoral degree completion in universities. *International Journal of Higher Education*, *7*(4), 143–156. https://doi.org/10.5430/ijhe.v7n4p143

Younger, K., Gascoine, L., Menzies, V., & Torgerson, C. (2018). A systematic review of evidence on the effectiveness of interventions and strategies for widening participation in higher education. *Journal of Further and Higher Education*, *43*(6), 1–32. https://doi.org/10.1080/0309877X.2017.1404558

Yue, H., & Fu, X. (2017). Rethinking graduation and time to degree: A fresh perspective. *Research in Higher Education*, *58*(2), 184–213. https://doi.org/10.1007/s11162-016-9420-4

Zhou, Y., Jundal-Snape, D., Topping, K., & Todman, J. (2008). Theoretical models of culture shock and adaptation in international students in higher education. *Studies in Higher Education*, *33*(1), 63–75. https://doi.org/10.1080/03075070701794833

Zimmermann, J., Brodersen, K. H., Heinimann, H. R., & Buhmann, J. M. (2015). A model-based approach to predicting graduate-level performance using indicators of undergraduate-level performance. *Journal of Educational Data Mining*, *7*(3), 151–176. https://doi.org/10.5281/ZENODO.3554733

Zimmermann, J., von Davier, A. A., Buhmann, J. M., & Heinimann, H. R. (2017). Validity of GRE general test scores and TOEFL scores for graduate admission to a technical university in Western Europe. *European Journal of Engineering Education*, *43*(1), 144–165. https://doi.org/10.1080/03043797.2017.1343277

**How to cite this article:** Kurysheva, A., Koning, N., Fox, C. M., van Rijen, H. V. M., & Dilaver, G. (2022). Once the best student always the best student? Predicting graduate study success using undergraduate academic indicators: Evidence from research masters' programs in the Netherlands. *International Journal of Selection and Assessment*, 30, 579–595. https://doi.org/10.1111/ijsa.12397