The time to degree or dropout amongst full-time master's students at University of KwaZulu-Natal

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Universities around the world are grappling with strategies to increase throughput and minimise dropout rates of postgraduate students. This study focuses on students at the University of KwaZulu-Natal and we attempt to estimate the time that it takes for these students to successfully complete or drop out from a master's programme. We used survival analysis to identify the factors which affect this. The results of this analysis showed that having some form of financial aid and/or being a student in the Faculties of Humanities or Management, all significantly shortened the length of time that it took to eventually drop out from a master's programme. For students who successfully completed a master's degree, having some form of financial aid, being of international origin and/or being registered in the Faculties of Health, Humanities, Law or Management, all helped to significantly shorten the length of time it took to successfully complete a master's programme. Students in the Faculty of Medicine, however, took longer to successfully complete their studies. Black Africans took less time to complete their master's degrees when compared with otherwise identical students from the other race groups.

Introduction

Over the past few years, the traditional concept of what constitutes a 'knowledge base' for a given country has evolved to include knowledge production and the development of innovation at the highest levels so that the country can stay ahead in a globally competitive world. Because PhD graduates have the necessary skills to make greater contributions to the knowledge base of a country, universities, which are the primary producers of this high-end knowledge, have become tasked with increasing this pool of graduates.[1] In particular, the South African Department of Science and Technology has set in place a Ten-Year Plan that seeks to promote innovation in research[2] by funding South African universities (through the Department of Higher Education and Training) according to a formula based on the drivers that promote research and teaching outputs.[3] The funding formula is heavily weighted towards rewarding institutions that graduate PhD candidates, with the result that the registration and throughput of PhD students have now become a very important area of focus for all higher education institutions in this country. Likewise, master's programmes are geared to promote contribution to research. The higher education institution funding formula is weighted in favour of research-based master's programme throughput rather than structured master's programmes based on structured course modules taught through lectures, seminars, laboratory work, or distance learning. A research-based master's programme requires the student to undertake his or her own research project in a specialised field of study.

A study conducted by the Academy of Science of South Africa[4] on all the universities in the country found that South Africa is lagging behind other countries with regard to the production of PhD students. South African universities only produce 26 doctoral graduates per million citizens which is far below other countries (Brazil: 52 per million, Korea: 187 per million, Australia 264 per million, and Sweden: 427 per million).[5] South Africa's inability to produce enough doctoral graduates who can at best, help to build the 'knowledge base' of our economy or at worst, simply replace the existing cohort of academics in our higher education system, has therefore become a huge challenge that needs to be addressed by all the universities in South Africa.[6]

A study conducted by the Department of Education in 2000 based on a cohort of first-time undergraduate students, found that only 30% of these students had graduated 5 years after entering the higher education institution, 56% had dropped out of university, and the remaining 14% were still pursuing their studies 5 years after having enrolled.[7] Focusing on first-time enrolments for a master's degree, a Council on Higher Education study[8] in 2008 found that nationally, enrolment increased at an average annual rate of 4.4% between 2000 and 2005. This increase, however, was tempered by a steady decline in completion rates for the degree (from 67% in 2001 to 52% in 2005).[8] Furthermore, focusing only on students who had successfully completed their master's degrees, the study found that they were taking on average 3 years to complete their degree and were graduating at a relatively late age (34 years). This means that many master's students typically interrupt their studies after completing their bachelor's and honours degrees to enter the job market, only to take up their master's studies later on. The interruption in studies is probably due to a lack of financial resources impacting on their preparedness for advanced study, and could be a contributor to these students taking longer to graduate.

These conclusions are drawn from a study prior to 2005[8] at national level; however, nothing is known about University of KwaZulu-Natal (UKZN) students in particular. One of the aims of this paper is therefore to focus only on students enrolled for a master's programme at UKZN and to establish whether they exhibit a graduation pattern that is different from that of other universities in the country. Although a detailed study has been conducted on the attrition rate of undergraduate students,[9] very little is known about the throughput rate of postgraduate students. It is therefore important to initiate research that will identify factors that will help to improve the throughput rate among UKZN master's degree students.

Data

This study focused on a cohort of master's students who registered at UKZN between the years 2004 and 2011. It followed each student's progress until completion of their degrees or until they dropped out from their studies.

A single record for each full-time registered master's student was created along with a set of variables indicating: their year of entry into the programme; whether or not they received some form of financial aid; the faculty in which they were registered; their race, gender and age (when first registered); and whether or not they were international students. Two response variables were also created: the first recording the total number of years for which the student was registered and the second whether the student had graduated, dropped out, or was still studying at the end of our study period.

Race was categorised as: African, white or Asian. Faculty was categorised as: Education, Engineering, Health Sciences, Law, Humanities, Development and Social Sciences, Science and Agriculture, Medicine, or Management Studies. Admission into the master's programme was based on an excellent undergraduate academic record, a letter of recommendation, and/or some form of previous professional experience. Typically, one would want to include the undergraduate record of each student as a predictor for success in the programme but most of the students who enrolled for a master's programme at UKZN came from universities and countries that had their own grading systems. For the purposes of this study, we were not able to gain access to these records. Instead, we have used the variable labelled 'international' to adjust for this; recording the variable as 'yes' if the student had no South African residency and 'no' if otherwise. Financial aid was given a yes/no response.

Focusing on the number of students who enrolled for a master's programme at UKZN, Figure 1 indicates that this number steadily increased over the period of our study. An exponential fit, $y_t = 221.6 * exp(0.0782 \times t)$ provided the best fit ($R^2 = 0.9981$), indicating that the year-on-year admission rate of master's students at UKZN between 2004 and 2007 increased on average by 8.13% each year (this follows because the multiplicative effect in the quoted exponential fit of a single unit increase in the academic year takes on the value $exp(0.0782) = 1.08134$). Figure 1 needs to be contrasted with the national average of 4.4% growth experienced by all other universities in South Africa.[8]

Descriptive statistics relating to the age of master's students at the time of first admission into a particular faculty at UKZN are given in Table 1. It is clear that the average age for admission of students into the Faculties of Science and Agriculture and Engineering is lower than in other faculties. A possible reason for this anomaly may be that students in other faculties are being forced to complete some form of mandatory internship programme before enrolling for a master's degree. Across all faculties, the average age on admission into a master's programme was found to be 27.3 years for the period of our study.

Figure 2 shows student status at the end of the registration period. The modal number of study years for successful completion of a master's degree is two. The first year is the modal dropout year. After one year of registration, 11.6% were able to graduate, 35.4% dropped out and 53% registered for the second year to continue their studies. After 2 years of registration, 40.6% of these students successfully completed their master's studies, 21.5% dropped out and 37.9% continued their studies into a third year. Figure 2 shows that the majority of students who completed their master's degrees did so in year two. In year three and four, the probability of degree attainment was much higher than dropping out or extending the study for another year. After 4 years, only a few students remained in the

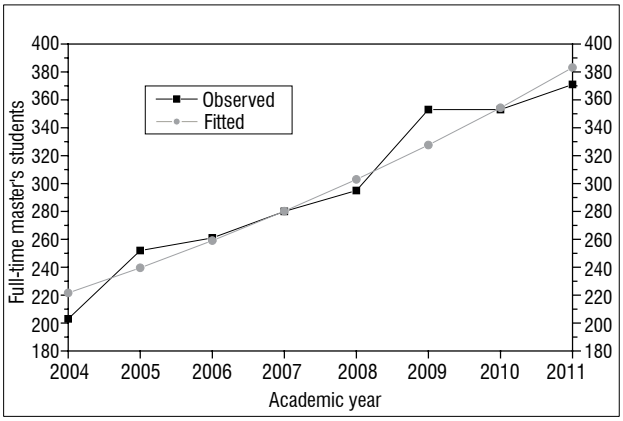

Figure 1: Admission pattern of full-time master's students enrolled at University of KwaZulu-Natal.

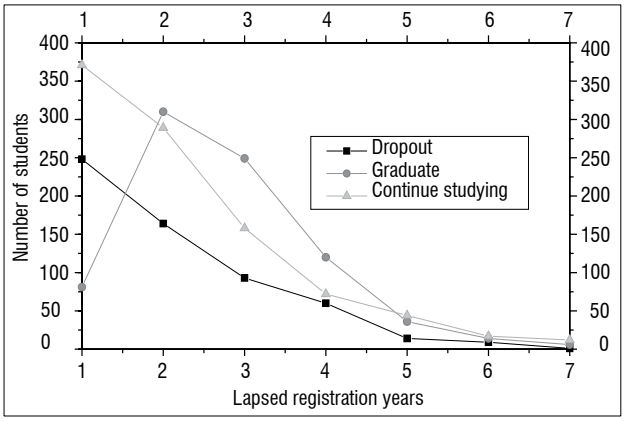

Figure 2: Number of master's students with lapsed registration enrolled at University of KwaZulu-Natal between 2004 and 2011.

Table 1: Age of master's students on admission to the University of KwaZulu-Natal according to faculty descriptive statistics

Faculty	Statistics					
	n	Mean	SD	First quartile	Median	Third quartile
Education	68	34.9	8.71	26.5	34.5	43
Engineering	268	24.6	3.81	23	23	25
Health Sciences	125	27.3	6.84	23	25	28
Humanities and Development Studies	568	29.5	8.74	23	25	33
Law	16	28.9	7.80	23	25.5	33.5
Management Studies	219	30.3	7.86	24	28	35
NRM School of Medicine	107	26.9	6.28	23	24	27
Science and Agriculture	997	25.5	5.03	23	24	26
Total	2368	27.3	6.99	23	24	28

master's programme. After year four, the dropout rate remained small, with an equal likelihood of graduating or continuing with the study.

Methodology

In this study, it was important to make a clear distinction between the actual occurrence of a particular event and the time it took for the event to occur. Focusing on two possible sources of exit, namely graduation and dropout, we started by attempting to link the probability of exit (from either cause) to some of the other variables recorded in the data set (e.g. gender, age, race, financial aid, international student). We then made use of survival analysis techniques[10] to help identify how the above-mentioned factors affected the length of time (in years) that it took for graduation or dropout to occur.

While some students, called censored individuals, were still pursuing their studies when the data collection period expired, survival analysis provided a methodology for dealing with the problem, provided that the censoring took place in a non-informative manner.[10] Given our context, one would expect students to carefully weigh up the benefits of completing a master's qualification with the costs and possible benefits of entering the job market at an earlier stage. When viewed from this perspective, the decision to complete or drop out of university becomes a competing risk problem.

Scott[11] developed a model that makes use of this competing risks methodology. We included this model in our modelling framework, where we were interested in determining how some of the demographic factors (associated with each student) affected the length of time (in years) that it took for graduation to occur (where dropout is being treated as a competing risk) and the length of time (in years) it took for dropout to occur (where graduation is treated as a competing risk).

Focusing on the actual length of time it took for a student to graduate or drop out from a master's programme at UKZN, the hazard rates associated with dropout and degree completion for each year after start of registration for master's study were computed. As the data cover the period 2004 until 2011, the last year for which these hazard rates could be modelled was $t=7$ (7 years after the start of master's study).

At this point, it is useful to outline two essential concepts in survival analysis. The risk set in a particular year t ($t = 1, 2,\ldots,7$) represents the group of students who we know can experience one of the above-mentioned outcomes during year t. The risk set does not include individuals who have already experienced one of the above events. That is, the hazard rate associated with outcome k ($k=1,2$) in year t ($t=1,\ldots,7$) $[h(k,t)]$ represents the probability that a randomly selected individual experiences outcome k (dropout or degree completion) in year t, given that he/she has experienced no such outcome before year t. While the hazard rate functions can be used to determine the probability of experiencing a particular outcome in a given year, they can also be used to compute the probability associated with having experienced a particular event *by* a certain year t.

Results

Figure 3 displays a set of cause specific cumulative hazard and survival functions for graduation and dropout in our data set. Before year three, the cumulative hazard associated with dropout is higher than the cumulative hazard associated with master's completion. Notably, the median time associated with a successful master's completion is slightly more than 2 years with the median dropout time being slightly longer than 2 years. It is interesting to note that within 2 years of registration, at least 50% of the master's students in our study period had experienced one or another of the above events.

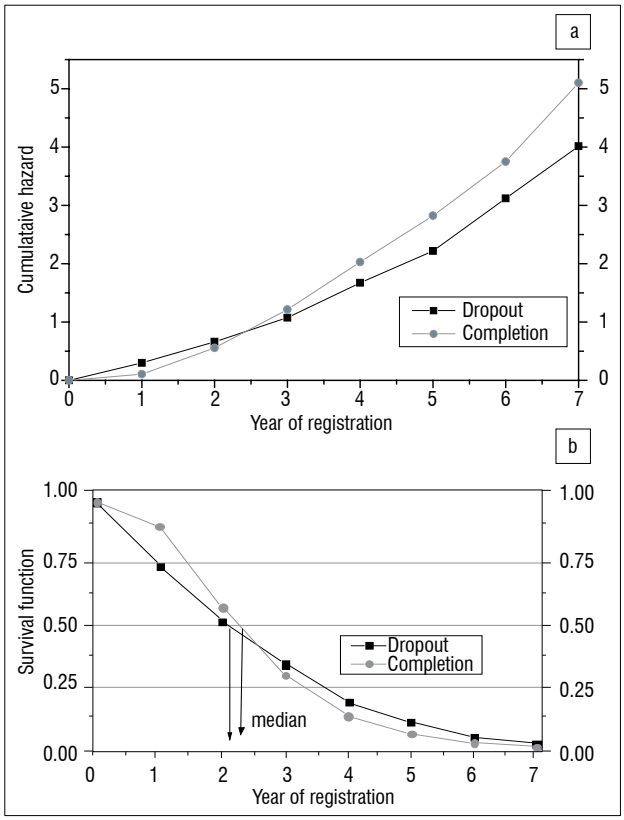

Figure 3: (a) Cumulative hazard and (b) survival functions for master's students who graduated or dropped out of study at University of KwaZulu-Natal.

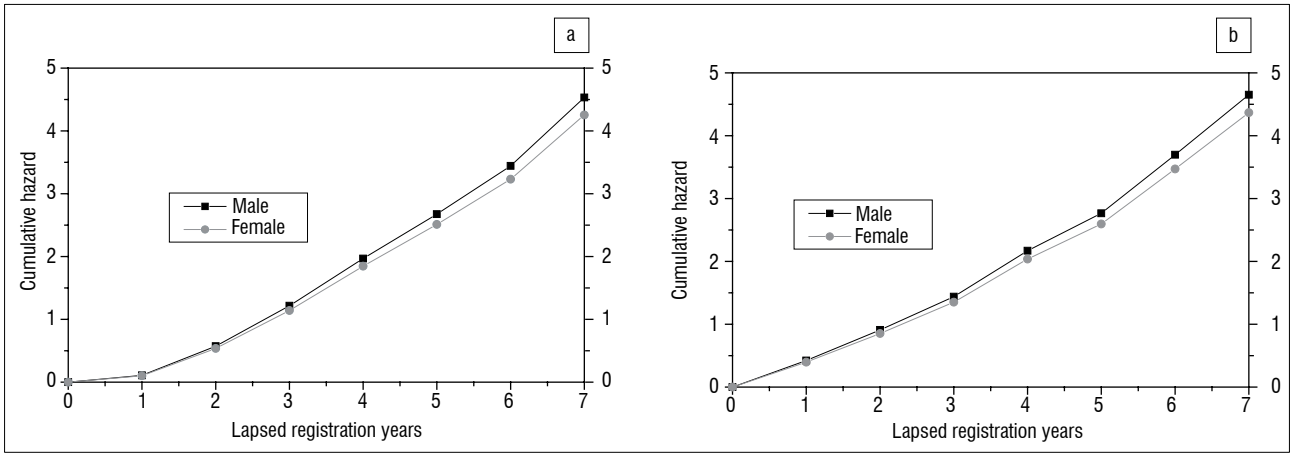

Figure 4: Cumulative hazard functions by gender for master's students who (a) graduated or (b) dropped out of study at the University of KwaZulu-Natal.

In order to gain a better understanding of the effect of certain explanatory variables on the time to completion or dropout after registration for a master's degree, the cumulative hazard functions for dropping out or successfully completing the degree are presented separately for men and women in Figure 4. The hazard rates for dropout or eventual graduation show that gender has no influence on dropout or on completion.

The cumulative hazard functions for race are presented in Figure 5. No significant difference appears to exist between the race groups.

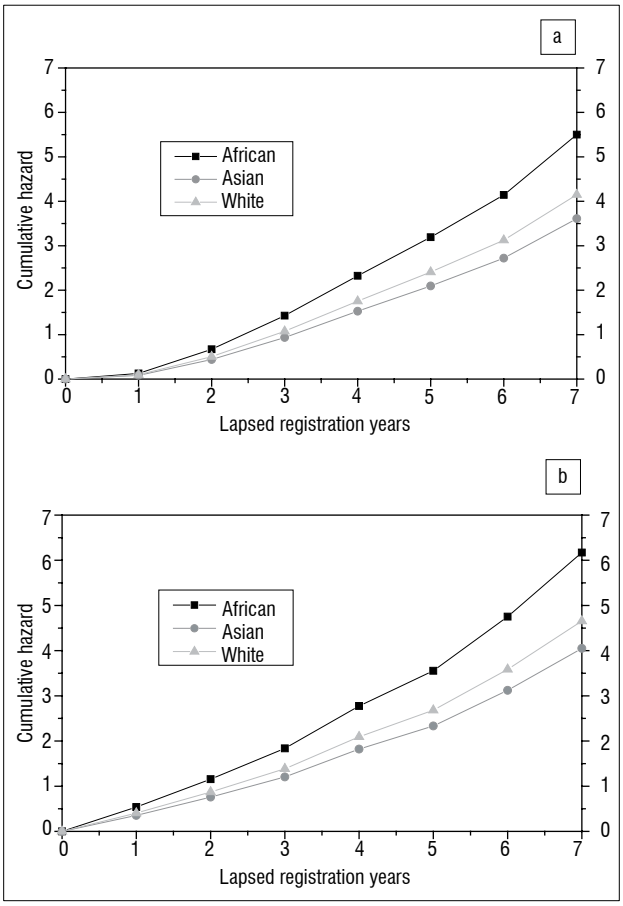

Figure 5: Cumulative hazard functions by race for master's students who (a) graduated or (b) dropped out of study at the University of KwaZulu-Natal.

The hazard functions for students who received some form of financial aid are given in Figure 6. Table 2 shows that financial aid appears to have a significant effect on dropout and graduation, particularly from year three onwards.

The exploratory hazard functions presented in Figures 3–7 control for a single variable. An extension of the Cox[12] proportional hazards regression model to a multinomial logistic regression model allows for modelling the effect of several explanatory variables in a competing risks model based setting.[3,11,13] Under this competing risks model, a cause k specific hazard rate, $h_t(k, i)$, for subject i that takes into account the competing risks assumption ($k=1$ for dropout, $k=2$ for master's completion) at time t ($t=1, 2,...,7$) can be given by

$$h_t(k,i) = \frac{\exp(X_{1ti}\beta_{k1}+X_{2ti}\beta_{k2}+...+X_{pti}\beta_{kp})}{1+\sum^{2}_{k=1}\exp(X_{1ti}\beta_{k1}+X_{2ti}\beta_{k2}+...+X_{pti}\beta_{kp})}$$

where $X_1, X_2,...,X_p$ denote a set of p explanatory variables that help to form this hazard rate at time t.

The coefficients, $\beta_{k1},\beta_{k2},...,\beta_{kp}$ for $k=1,2,...$ can be estimated using a maximum likelihood methodology. The results obtained can be interpreted in much the same way as the results for a Cox proportional hazards model. More specifically, a positive valued estimate for β_{kj} would suggest that an increase in the value of the variable j increases the hazard rate associated with the occurrence of the cause specific outcome k (i.e. shortens the length of time until the event occurs). Similarly, a negative valued estimate for β_{kj} would suggest that an increase in the value of variable j decreases the hazard rate associated with the occurrence of the cause specific outcome k (i.e. lengthens the time until occurrence of the event). The fitted model results along with their p-values are presented in Table 2. For all analyses, SAS software was used; $p \leq 0.05$ was considered statistically significant.

The hazard ratios given in Table 2 suggest that race, gender, nationality and age have no significant effect on the hazard rate associated with students dropping out from the master's programme. Financial aid, however, exerts a significant effect on the hazard rate associated with dropout. If we exponentiate the estimated coefficient of 0.140 obtained for the financial aid variable, we obtain a percentage change in the hazard rate associated with eventually dropping out that can be associated with a single unit increase in the covariate variable that we have called financial aid. Thus, a student with financial aid has a 15.0% higher hazard rate associated with dropping out from their studies when compared with a student who has not received financial aid. Using students from the Faculty of Science and Agriculture as a baseline category, the statistically significant positive valued estimates obtained for students in the Faculties of Management and/or Humanities suggest that they drop out more quickly from their

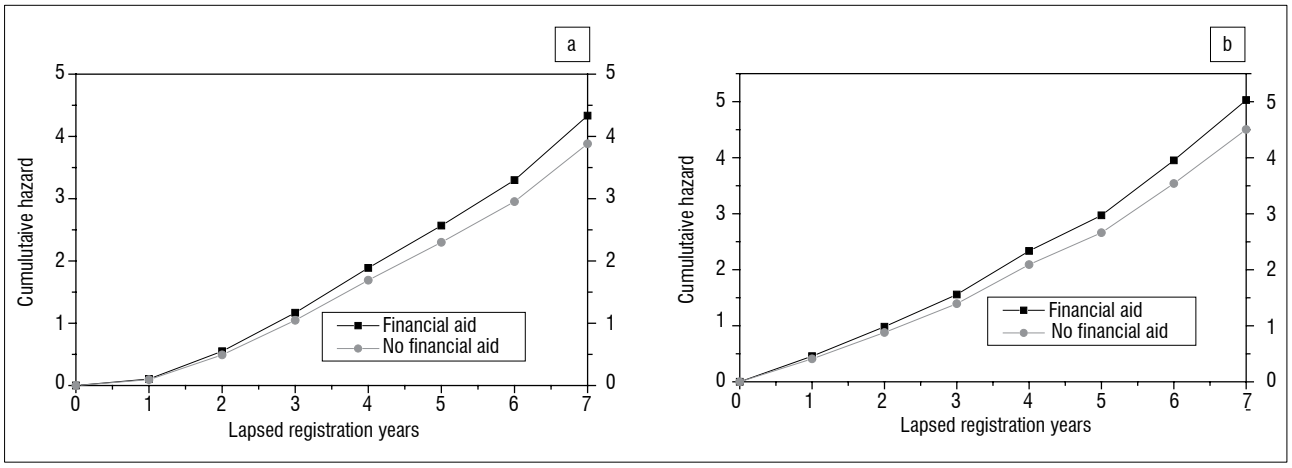

Figure 6: Cumulative hazard functions by financial aid for master's students who (a) graduated or (b) dropped out of study at the University of KwaZulu-Natal.

studies compared with otherwise identical students (in terms of the factors selected) in the Faculty of Science and Agriculture.

Focusing on those students who will eventually successfully complete their master's programme, the results in Table 2 suggest that gender has no effect on the successful completion of a master's degree. Chosen field of study does, however, seem to exert an influence on completion amongst students in the Faculties of Health, Humanities, Law and Management, all taking a significantly shorter period of time to complete their studies compared with otherwise identical students in the Faculty of Science and Agriculture. However, students in the Faculty of Medicine appear to take a significantly longer period to successfully complete their studies compared with otherwise identical students from the Faculty of Science and Agriculture.

The positive valued estimates obtained in Table 2 for international students and students with financial aid suggest that these students are successfully completing their studies more quickly than otherwise identical (in terms of gender, age, faculty and race) students who have no financial aid or who are of local origin. Using the white race group as a baseline category, the African race group shows a significantly higher completion hazard, implying that they are taking a shorter period of time to successfully complete their master's degree compared with otherwise identical white race group counterparts.

The negative valued estimate obtained for the age based covariate indicates that older students are taking longer to successfully complete their master's degrees. Figure 7 shows the cumulative hazard functions plotted for the effect of age on dropout and successful completion.

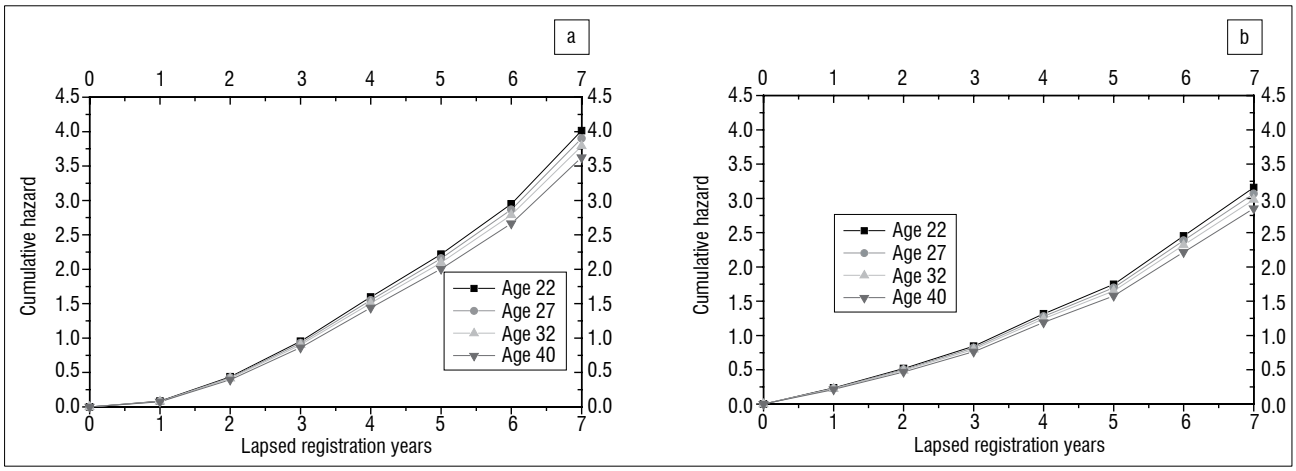

Figure 7: Age-specific cumulative hazard functions at the reference values for master's students who (a) graduated or (b) dropped out of study at the University of KwaZulu-Natal.

Table 2: Results of the competing risk survival model fit for master's students who received some form of financial aid

Risk factor	Dropout			Master's completion		
	Estimate	*p*-value	Hazard ratio	Estimate	*p*-value	Hazard ratio
Race (Reference=White)						
African	0.083	0.265	1.087	0.144	0.025*	1.155
Asian	-0.027	0.732	0.973	-0.040	0.548	0.961
Gender (Reference=Female)						
Male	0.083	0.181	1.087	-0.064	0.243	0.938
International (Reference=No)						
Yes	0.036	0.669	1.037	0.143	0.033*	1.154
Financial aid (Reference=No)						
Yes	0.140	0.036*	1.150	0.175	0.001*	1.191
Faculty (Reference=Science and Agriculture)						
Education	-0.141	0.464	0.868	0.169	0.321	1.184
Engineering	0.222	0.054	1.249	-0.093	0.219	0.911
Health	0.188	0.146	1.207	0.688	0.000*	1.990
Humanities	0.407	0.000*	1.502	0.170	0.009*	1.185
Law	0.393	0.050	1.482	1.174	0.001*	3.235
Management	0.477	0.000*	1.612	0.364	0.029*	1.439
Medicine	-0.244	0.174	0.783	-0.574	0.000*	0.563
Age (Continuous variable)	**0.001**	**0.723**	**1.00**	**-0.57**	**0.000***	**0.563**

**Significant at 5% level of significance*

Interestingly enough, the results in Table 2 indicate that age does not appear to have a significant effect on the time to dropout of students in the master's programme.

Summary and conclusion

The study shows that gender does not have a significant effect on the throughput rate of students when one considers the time that it takes to successfully complete or drop out from a master's programme. This may indicate equal competiveness in both genders for success, bearing evidence of the success of our policies which promote equal academic opportunities for both genders.

Age on admission has a negative effect on the time it takes to graduate. Older students seem to take longer to successfully complete a master's degree compared with otherwise identical students who are younger. One of the reasons for this variation might be that older learners have more family or personal commitments.

Receiving some form of financial aid appears to reduce the length of time that it takes for a student to drop out from a master's programme. Likewise, receiving financial aid reduces the length of time that it takes to successfully complete a master's programme. This might be due to the contractual conditions set by funders in the form of repayment or limited period of support. The other possible explanations for the paradox that funding helps a student to graduate more quickly and also to drop out more quickly, could be that students who successfully complete the master's programme use this source of funding to purchase extra books and other academic support materials, and attend conferences which helps them to graduate more quickly. Students who eventually drop out 'because of this funding' may indicate that the funding is no longer sufficient for their needs. Similarly, according to Lewin[14], more than a third of American college dropouts reported that even if they were given grants to pay for their books and tuition, it would be hard to go back to school given their work and family commitments.

Race had no effect on those who eventually dropped out from their studies. For students who eventually graduated, there was, however, evidence that the time it took to graduate was shorter for African students.

International students (i.e. students from beyond South African borders) all seemed to perform very favourably considering their throughput rates. In particular, amongst the students who eventually graduated, being of international origin seemed to shorten the length of time it took to complete their degree.

Different faculties seemed to have varying levels of success with regard to dropout and throughput rates. Focusing on the students who eventually dropped out, the ones in the Faculty of Medicine appeared to take longer to drop out or graduate from their studies compared with students from other faculties.

Considering the limited resources available for research funding, it is important to understand the influences on dropout or completion rates in the master's programme. We identified some of the demographic factors that may be affecting the throughput rates at UKZN. The list of factors selected were by no means exhaustive as the study was limited to data available through the UKZN data management and information archives. As such, this study should be viewed as a starting point for further reflection on what drives throughput rates for master's study at UKZN.

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Authors' contributions

T.Z. was responsible for the data analysis, design of the study and writing the manuscript. D.N. was responsible for the data organisation and for critically revising the manuscript. M.M. made editorial and conceptual contributions.

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