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Predictors of Pharmacy Students' Performances in First Year at a University of Technology in Gauteng Province: Analysis Using Hierarchical Regression Models

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ABSTRACT

This cross-sectional quantitative study sought to identify factors associated with the performance of first-year pharmacy students. It made use of secondary data obtained from the Department of Pharmaceutical Sciences at Tshwane University of Technology (TUT). Even after adjusting for Grade 12 science subjects, the results of hierarchical logistic regression models show that male students were slightly less likely than female students to pass the first year of pharmacy in 2015, 2016, and 2017. Academic performance predictors could be used to reconfigure admissions criteria. As a result, a better understanding of the factors influencing pharmacy student performance may aid pharmacy educators in developing effective interventions to improve student performance. Identifying new predictors of academic performance may assist the TUT pharmacy school to retain and graduate better pharmacists. This study suggests that a similar study should be conducted using structural equation models and hierarchical regression models to confirm the current results using a data set containing other important predictors mentioned in previous studies.

Keywords: Hierarchical logistic regression model, Pharmacy programme, Student performance, Selection criteria, Predictors

INTRODUCTION

University students are potential nation builders who aspire to become professionals such as engineers, medical doctors, managers, and scientists, and materialize a nation's dreams (Talib & Sansgiry, 2012). Students in every discipline in universities have many obstacles to overcome to achieve their endeavour of optimal academic performance (Talib & Sansgiry, 2012). Adjustment which is a psychological concept that refers to the behaviour that permits people to meet the demands of the environment (Baker & Siryk, 1984), is a multi-dimensional process of interaction between an individual and his/her environment, in an attempt to bring about harmony between the demands and needs of the individual and his/her environment (Baker & Siryk, 1984). Adjusting to university involves the complementary processes of de-socialisation and socialisation (Pascarella & Terenzini, 1991). De-socialisation entails the changing or discarding of selected values, beliefs, and traits one brings to university in response to the university experience. Thus, a university environment demands certain behavioural patterns from students. Studies have found the adjustment to the university environment to be an important factor in predicting university outcomes (Petersen, Louw, & Dumont, 2009).

In addition, Petersen, Louw, and Dumont (2009) investigated the roles that adjustment and other psychosocial factors (such as help-seeking, academic motivation, self-esteem, perceived stress, and perceived academic overload) played in the university success of students from disadvantaged backgrounds in terms of both education and economics. According to the authors, the psychosocial variables explained the students' adjustment to university life more effectively than the academic performance group did.

Medical school is inherently "stressful" and demanding, especially pharmacy education. The overwhelming amount of information the student must learn severely restricts their ability to unwind and have fun. The academic performance of students has been linked to a variety of factors. This study's goal was to examine how predictors affected the first-year performance of pharmacy students.

MOTIVATION FOR STUDY

The current study was designed to paint a picture of a specific South African province and is likely to add a developing country's perspective to such a complex structure, which will help to resolve the issue of male and female students performing better academically. It may also serve as a springboard for paying close attention to and working harder with the weaker group to improve academic performance. The study might be useful for creating and implementing policies to raise the performance of students in the weaker group.

LITERATURE REVIEW

Since 1994, with the ushering in of South Africa’s democratic dispensation, the number of students enrolled in South Africa’s higher education institutions has increased tremendously (Badat, 2016; Letsoalo, 2021). Accompanying this growth of access to higher education is increasing diversity amongst the student population. Students from different social and cultural backgrounds, with different experiences and varying levels of education, bring with them different needs and academic potential (McKenzie & Schweitzer, 2001). The challenge for universities is to recognise this diversity of needs and cater to this changing and heterogeneous population of students.

Student academic performance and achievement occupy a very important place in education, as it does in the learning process (Sikhwari, 2016). However, the transition from secondary school to university represents a major change for many students. For example, more often than not, students enrolling for first-year university courses do not have sufficient, technical or computational knowledge, do not possess sufficient logical reasoning skills (Letsoalo, 2019) and are not accustomed to reading and thinking about mathematics using mathematical texts (Kajander & Lovric, 2005).

Students at university have access to both study opportunities and opportunities for psychosocial development (Tao, Dong, Pratt, Hunsberger, & Pancer, 2000). Therefore, life transitions, such as university attendance, entail the reconstruction of relationships between the individual and the environment. Among others, one element contributing to students’ lack of preparation for postsecondary coursework is the disconnect between high school curricula and university expectations (Kizito, Munyakazi, & Basuayi, 2016). According to Harwell, Post, Cutler, Maeda, Anderson, Norman, and Medhanie (2009), school mathematics does not adequately prepare students for university mathematics. School mathematics curricula are examination driven and encourage a surface approach to learning, with an emphasis on mastering algorithms and procedures. University learning, on the other hand, requires a deeper approach to learning, involving conceptual understanding and problem-solving (Harwell, et al., 2009; Kizito, Munyakazi, & Basuayi, 2016).

Factors Associated with Students' performances.

Studies identified and assessed a plethora of factors influencing academic performance. Therefore, this paper is not exhaustive. For example, Battle and Michael (2002), Ready (2010), and Letsoalo, Maoto, and Chuene (2018) support the notion that student performance is influenced by a variety of demographic, socioeconomic, psychological, and environmental factors. Letsoalo (2019) reported that students' race was not an important factor in predicting student performance in the first year of the pharmacy programme. Young and Fraser (1994) reported that both gender and school-level differences contributed significantly toward explaining variations in student performance. Among others, Tinklin (2003), and Cor and Brocks (2018) reported that student gender is a significant predictor of academic attainment. However, Liao and Adams (1977), Steele-Johnson and Leas (2013), and Gillette, et al. (2017) reported that gender is not a significant predictor of whether a student will pass or not. While gender is considered to play a role in determining student success, studies have yielded inconsistent results.

Kyei and Nemaorani (2014) concluded that parents' socio-economic status, age, sex, location of the school, the type of school - private or public, the average number of students in a class [class size], and competence in the English language, in case of second language speakers, may affect student performance. The Department of Education, Training and Employment (DETE) of Queensland established a link between school attendance and students' socioeconomic status. Ready (2010) reported that those students who live in poverty are 25% more likely to miss at least three days of school per month. While some student absences are unavoidable or understandable due to illness or the like, many are not. Unforeseen circumstances, such as a medical emergency, a family death, a court subpoena, a traffic/transportation delay, or personal illnesses, contribute significantly to students' absences from class, with low performers more likely to report this as a reason for their absences than high performers (Hidayat, Vansal, Kim, Sullivan, & Salbu, 2012). The relationship between attendance rates and student performance is such that being absent on a daily basis has a negative impact on performance (Balfanz & Byrnes, 2012; Russo & Talbert-Johnson, 2013).

Social support is one of the most important protective factors for determining an adjustment to the university freshmen (Tao, Dong, Pratt, Hunsberger, & Pancer, 2000). Maton, et al. (1996) found that the function of social support from different sources varied across different cultural backgrounds. Specifically, parental support was more strongly related to Black students' adjustment, whereas peer support was more strongly related to White students' adjustment.

Financial difficulties are among the most frequent reasons given by poor South African students, especially Blacks, for not pursuing or completing their tertiary education. Students from low income, less educated families are most likely to drop out (Letseka & Maile, 2008). Arguably, socioeconomic status is associated with student performance.

Windle, Spronken-Smith, Smith, and Tucker (2018) reported that demographic variables, which include gender, are associated with lower GPA performances across the Bachelor of Pharmacy (BPharm) programme they investigated; and that gender was associated with academic performance and failure. Therefore, gender was significantly associated with whether a student will succeed in the pharmacy programme, but conditionally. Different studies which examined the effect of demographic data reached different conclusions. The results obtained by Steele-Johnson and Leas (2013) demonstrated that researchers can gain a better understanding of race and gender differences in academic performance by examining the intersection of such effects.

McKenzie and Schweitzer (2001) found that previous academic performance is by far the most powerful predictor of university performance. They also reported that integration into university, self-efficacy, and employment responsibilities were predictors of university grades. Byrne and Flood (2008) found a significant relationship between prior academic achievement, prior knowledge of accounting, gender, motives, expectations, and preparedness for higher education, on the one hand, and academic performance in the first year of an accounting program, on the other hand, in a paper that examined the associations between prior academic achievement, prior knowledge of accounting, gender, motives, expectations, and preparedness for higher education.

Giuliano, Gortney, and Binienda (2016) evaluated predictors of student performance in the pharmacy curriculum outcomes assessment (PCOA) examination. Significant predictors included GPA, Pharmacy College Admissions Test (PCAT) reading, accommodators (compared to assimilators), and students who did not prefer reading. According to Gillette, et al. (2017), the PCAT, the Health Science Reasoning Test (HSRT), and cumulative pharmacy GPA were the only consistently significant predictors of higher PCOA total scores.

Mar, Barnett, Tang, Sasaki-Hill, Kuperberg, and Knapp (2010) hypothesised that prior to matriculation into pharmacy school, experience gained in the pharmacy workplace may have resulted in the accumulation of skills that could be useful during the students' pharmacy school education. However, it is unclear whether specific types of pharmacy experiences differ in their importance in completing either classroom education, experiential (APPE) education, or both. However, their result indicated no significant difference in academic or clinical performance between those students with prior pharmacy experience and those without. Furthermore, sub-analyses by work setting, position type, and substantial pharmacy work experience revealed no relationship between student performance.

The emotions which students experience within the learning environment are known to be related to important outcomes, such as academic success and academic adjustment, and also to student health and well-being (Saklofske, Austin, Mastoras, Beaton, & Osborne, 2012). The importance of personality and coping style in relation to stress in students has been examined in many studies, with stress being found to be the most strongly related to neuroticism and coping style. The results obtained by Conard and Matthews (2008) indicate that neuroticism is a stronger determinant of student stress than perceived workload. Many students experience difficulty in managing the academic workload at university (Bitzer & Troskie-De Bruin, 2004). The way students conceive of learning relates to the way they approach their studies which, consequently, affects the quality of their learning outcomes.

Stress can have an impact on learning and memory. Although an appropriate level of stress can improve learning ability (Kaplan

& Sadock, 2000), excessive stress can cause physical and mental health problems (Kaplan & Sadock, 2000; Sohail, 2013). Stress is defined as "the non-specific response of the body to any demand for change" and describes how the body reacts to external changes (Sohail, 2013). Stress among students could greatly affect their learning activities and general well-being. Waghachavare, Dhumale, Kadam, and Gore (2013) found a significant relationship between stress and various domains of undergraduate pharmacy students' quality of life. Sohail (2013), for example, reported that a higher level of stress is associated with poor academic performance. It is thus necessary to implement some personal and institutional strategies to reduce the impact of stress on pharmacy students' quality of life while encouraging the use of positive stress management strategies.

Educationally disadvantaged students seem to experience great difficulty in coping with the academic workload in their first year at university. The workload is one of the factors that influence the academic adaptation process during the first year in higher education (Bitzer & Troskie-De Bruin, 2004). The danger with the steep increase in the time necessary to cope with the workload at university is that students are not able to adapt effectively, either because they do not perceive the demands of the task correctly (Letsoalo, 2021) or because they do not know how to manage their time effectively.

Petersen, Louw and Dumont (2009, p. 102) stressed that students' perceptions of the demands of the academic tasks and their perceptions of their ability to succeed in completing the tasks influence the amount of effort they put into academic work, and an insufficient amount of effort may lead to academic failure. Difficulties with managing academic workload have been shown to harm academic adjustment to university and academic performance (Chambel & Curral, 2005; Petersen, Louw, & Dumont, 2009).

Admission criteria into pharmacy programme

For many years, it has been a source of concern to select the most promising students for admission to pharmacy schools. Aside from the commitment to select the most qualified applicants, schools of pharmacy or pharmacy educators face a number of other challenges, including the responsibility to maintain quality educational programs, the need for a diverse student body, the desire to reduce student attrition, and the development and support of traditional and non-traditional educational programs.

South Africa's tertiary institutions use selection criteria that are based on an admission point score (APS) review. The final APS consists of the results obtained in all subjects completed in Grade 12. The marks obtained in these subjects are converted using the APS conversion table and are then totalled, as presented in Table 1. If the candidate matriculated before 2008 in South Africa or has matriculated in another country, then the university where the application is being processed has a specific grading tool to convert these candidates' marks to the relevant APS as approved by the South African Qualification Authority. While prepharmacy courses vary by school of pharmacy, most require a number of courses in general and organic chemistry, biology, physics, and mathematics. [Organic] Chemistry and physics constitute physical science. Other required prepharmacy classes vary by institution.

Given the importance of producing effective professionals for the health and wellbeing of the public, selecting top-quality students who will master their training is of critical importance (Kuncel, et al., 2005)

Table 1. Conversion Table for Converting Percentage to Admission Point Score

Overall Percentage of marks obtained in the subject	Admission Point Score (APS)
80 - 100	7
70 - 79	6
60 - 69	5
50 - 59	4
40 - 49	3
30 - 39	2
20 - 29	1
Less than 20	0

One of the most challenging issues that schools of pharmacy face are the identification of students most capable of successful completion of the professional programme, as well as their successful entrance into, and their safe and effective performance in, the pharmacy profession (Schlesselman & Coleman, 2011). Thus, admissions decisions must be consistent in identifying successful students and, eventually, good practitioners (Allen & Bond, 2001).

Selection criteria are in place to select only those candidates who are viable and most suited to, not only succeed in the course but, to excel in the field after graduation (Unni, et al., 2011; Wilcox & Lawson, 2018). Mar, et al. (2010) have indicated that previous pharmacy work experience is likely to play a role in the admission decision process, as it is assumed that applicants with prior workplace exposure have a more complete understanding of the role of pharmacists in a practice setting. The institution may have additional requirements, depending on the qualification that a student wants to pursue, with each programme having specific requirements (Letsoalo, 2019).

The Pharmacy College Admission Test (PCAT), which has been used since 1974 in the United States (Kuncel, et al., 2005), is a standardised test used by pharmacy programmes to select students. It is considered by most pharmacy programmes and in 2003 was required by 51 pharmacy programmes as an effective tool to be used for making admissions decisions (Kuncel, et al., 2005). For example, the University of Texas uses the PCAT as a supplement to the universal point scale. Thus, grade point average GPA and PCAT scores have formed the backbone of didactic measures used in the pharmacy admissions process to predict future success (Wilcox & Lawson, 2018). In most of the studies addressing the academic success of pharmacy students, the institutions concerned have used pharmacy GPA scores as an indicator of academic performance in pharmacy schools. Although GPA is the conventional method used to measure student performance, GPA may not be as sensitive as the raw assessment scores (Unni, et al., 2011).

Pharmacists remain an important component of any society since their knowledge and experience, collectively called skills, help individuals, especially patients, to live a better life (American Public Health Association, 2018). Therefore, it is crucial for institutions that offer pharmacy programmes to select students who will be prosperous, not only in the pharmacy programme but in the profession as well. Since pharmacy programmes are expensive to run, a sound selection process is important, to avoid the personal and organizational costs of making a poor choice (Unni et al., 2011).

Kuncel et al. (2005) indicated that the PCAT and pre-pharmacy GPA were positively correlated with the first-year GPA;

implying that both PCAT scores and pre-pharmacy GPAs were moderate to strong predictors of grades earned in pharmacy programmes. However, it is well known that one of the most important attributes of a successful clinician is the ability to think critically in patient care situations. In other words, a key to success in the health profession is critical thinking and one useful measure has been the California Critical Thinking Skills Test, CCTST (Wilcox & Lawson, 2018). As summarised in Shaw, Kennedy, Jensen and Sheridan (2015), there is considerable evidence that quantitative measures, such as grades in science and mathematics, pre-pharmacy GPAs, and scores in pre-admissions tests such as the PCAT and the Pharmacy Education Eligibility Test (PEET), are highly predictive of success during the pharmacy programme, of graduation rates, and success in national board examinations. For example, GPA and PCAT performance were reportedly significant predictors of academic performance in pharmacy (Stowe, et al., 2014).

Success as a clinical practitioner in any health profession requires solid critical thinking (CT) skills. It is assumed that surrogate measures of CT skills can be found in GPA and achievement test scores. Wilcox and Lawson (2018) highlighted that only a few studies to date have examined the correctness of this assumption. Selection procedures for pharmacy students in English speaking countries differ in the degree of emphasis placed on skills in communication and general academic ability. As such, a variety of non-didactic measures have also been utilised in the admissions selection process because of their perceived value and to offset the limitations of didactic measures. Some communication problems among students have been noted informally in the final year of a pharmacy programme in the United States (Norwood, Friedman, Lage, Stewart, & Robinson, 1986; Jones, 2000), as well as among Australian graduates by the Australian registration authorities during licensure reviews. One survey of preceptors and externs noted weaknesses or deficiencies in this area (Parish, 1993; Jones, 2000).

According to Shaw, Kennedy, Jensen, and Sheridan (2015), the majority of pharmacy schools used traditional selection processes. Approaches in pharmacy schools emphasised prior academic performance, particularly in science subjects. The authors discovered that, with one exception, all schools had some form of interview, with several schools moving to multiple mini-interviews (MMI). Interviews, on the other hand, produced mixed results [see Stowe et al. (2014) and McAndrew, Ellis, and Valentine (2017)].

STATISTICAL CONSIDERATIONS

The building of probabilistic models that describe, or appropriately approximate, the true generating mechanism of a phenomenon under study is an essential subject in data analysis (Ntzoufras, 2009; Hilbe, 2009). Regression analysis (a statistical technique for studying and modelling the relationship between variables) is a fundamental aspect of many research initiatives. Regression is the study of dependence, which is the process of identifying the function satisfied by the points on the scatterplot (Weisberg, 2005; Hilbe, 2009).

In a regression problem wherein only one predictor variable generically called X and one response variable called Y, the data consist of values (x_i, y_i) where $i = 1,2,\cdots,n$ of (X,Y) is observed on each of n units or cases. The goal of regression is to understand how the values of Y change as X is varied over its range of possible values. A case in which two or more independent variables are fitted in a model is called the multivariable case. Therefore, the strength of a modelling technique lies in its ability to model many variables, some of which may be on different measurement scales (Hosmer & Lemeshow, 2000).

Many educational research problems call for the analysis and prediction of a binary outcome, e.g., whether a student will succeed at the university or not. Logistic regression sometimes called the logistic model or logit model, analyses the relationship between multiple independent variables and a categorical dependent variable, and estimates the probability of occurrence of an event by fitting data to a logistic curve (Agresti, 2002).

Standard statistical techniques, such as [simple] linear regression, assume that each of the primary observations [that make up a dataset] is independent of all of the others (Burton, Gurrin, & Sly, 1998). There has been a great deal of interest recently in mixed-effect models for repeated measures data. Those are data generated by observing several study units repeatedly under differing experimental conditions where the study units are assumed to constitute a random sample from a target population (Letsoalo, 2018). Observations from repeated measure studies or clustered measure studies are usually correlated. Linear mixed-effects models, also called linear mixed models, multilevel regression models, or hierarchical regression models, are an extension of simple and multiple linear regression models that allow both fixed and random effects and are particularly used when data are clustered and non-independent (Wu & Zhang, 2006). Such data are often available in hierarchical structures. The hierarchical regression model for binary data is called the logistic hierarchical model. The linear mixed-effects model is written as (Wu & Zhang, 2006, p. 18; Goldstein, 2011; Hox, 2013):

$$\boldsymbol{y}_i = \boldsymbol{X}_i\beta + \boldsymbol{Z}_i b_i + \boldsymbol{\varepsilon_i}$$

where $\boldsymbol{b}_i \sim N(\boldsymbol{0}, \boldsymbol{D})$, $\varepsilon_i \sim N(\boldsymbol{0}, \boldsymbol{R}_i)$, $i = 1,2,\cdots,n$ and $\boldsymbol{y}_i$ and $\boldsymbol{\varepsilon_i}$ are respectively, the vectors of responses and measurement errors for the i^{th} subject, and β and b_i are respectively, the vectors of fixed-effects (population parameters) and random-effects (individual parameters), and $\boldsymbol{X}_i$ and $\boldsymbol{Z}_i$ are the associated fixed-effects and random-effects design matrices, respectively (Wu & Zhang, 2006). The data used in this study is an example of clustered data because a student was observed multiple times through his or her performances in different registered modules. Details of hierarchical models are provided by Raudwnbush and Bryk (2002), Gelman and Hill (2006), Wu and Zhang (2006), and Hox, Moerbeek, and Van de Schoot (2017), among others.

PROBLEM STATEMENT

Disparities between males and females in academic performance, especially achievement in science, technology, engineering, and mathematics (STEM) subjects, has been a concern among educators for several decades (Guiso, Monte, Sapienza, & Zingales, 2008). The STEM subjects are used to select suitable students for the Bachelor of Pharmacy (BPharm) programmes at tertiary institutions. The BPharm programme offered at the Tshwane University of Technology (TUT) is a four-year undergraduate degree that uses both a problem- and outcomes-based learning (PBL) approach to teaching. The process of implementing PBL is called the Seven-Jump-Step process (Mabope & Meyer, 2014).

During the admissions process, pharmacy schools consider a number of criteria (in order) to identify students who will perform well academically and professionally while enrolled in the programme. TUT admits students to its pharmacy programme using one or a combination of at least two of four methods. The institution must continue to identify the factors that influence student performance during the first year of pharmacy school. As a result, the impetus for this research. The findings of this study are hoped to help institutions adjust their admission criteria and intervene in students' academic progress as needed.

STUDY AIM

The study aimed to assess factors that are associated with the performance of students who have enrolled for the first year of pharmacy at the TUT. Specifically, this study was undertaken to determine whether student gender was a significant predictor of student academic performance, even after adjusting for English language, Life science (also called Biology), Mathematics, and Physical science. To achieve this aim, the researchers developed the following null hypothesis:

> *Gender is not significantly associated with student success in the first year of the pharmacy programme at TUT.*

MATERIAL AND METHODS

This cross-sectional quantitative exploratory study (Kirk, 2013; Christensen, Johnson, & Turner, 2015) used data obtained from the Department of Pharmaceutical Sciences at the TUT. The dataset contained information about 166 (100 [60.24%] female, 61 [36.75] male, and 5 [3.01%] unknown/undisclosed) first-year students in the pharmacy programme. The students were categorised into three students' cohorts, namely, students who were in the first year in the academic years 2015 (n = 49), 2016 (n = 65) and 2017 (n = 52). Two (3.08%) and three (5.77%) students from the 2016 and 2017 cohorts, respectively, had an unspecified gender. The analysed dataset excluded repeaters, as they would potentially skew the results. The dataset included information on the participants' matric status, gender, race, nationality, matric subject results, APS, interview scores, potential assessment scores, acceptance scores, and marks earned in the first year of the Bachelor of Pharmacy programme.

Because the cohorts were inherently distinct, the analysis did not use pooled data. The institution blindfolded the data, thus there was no variable in the dataset that might overtly or implicitly identify the participants. The statistical software package used for data analysis was Stata Release 15 (StataCorp, 2017). To predict whether or not a student will be successful in the first year of pharmacy school, hierarchical logistic regression models, both crude and adjusted models, were utilized (Gilliver & Valveny, 2016). Frequencies and percentages were used to present descriptive statistics for all categorical variables. The 95% confidence limit was used in the analysis. Specifically, if the observed p-value was less than 0.05, the (null) hypothesis was not accepted.

RESULTS

Summary Statistics

In the 2015, 2016 and 2017 academic years, the study cohorts comprised 49 (33 [67.35%] female and 16 [32.65%] male), 63 (42 [66.67%] female and 21 [33.33%] male), and 49 (25 [51.02%] female and 24 [48.08%] male) students, respectively. In all academic years, the number of female students was (slightly) higher than the number of male students.

Figure 2 depicts the increase in the proportions of male students during the period of three years, from 32.65% in 2015 to 48.98% in 2017. This meant that the proportion of female students dropped from 67.35% in 2016 to 51.02% in 2017. In other words, in the 2015, 2016 and 2017 academic years, female students made up 33/49 (67.35 %), 42/63 (66.67%), and 25/49 (51.02%), respectively. Similarly, in the 2015, 2016 and 2017 academic years, there were 16/49 [32.65%], 21/63 [33.33%], and 24/49 [48.98%] male students, respectively. The proportions of male and female students were comparable in 2017

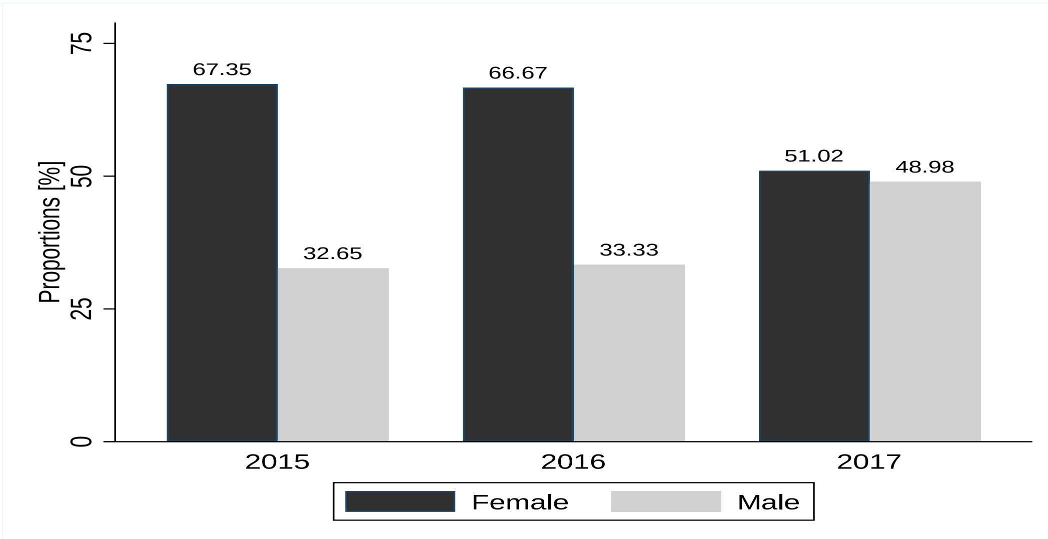

Figure 2. Distribution of gender by the academic year

Inferential Statistics

The likelihood of students' success in 2015, 2016 and 2017 academic years was determined using unadjusted (or crude) and adjusted hierarchical logistic regression models. The odds ratio (OR) was the parameter of interest, which was used to compare the relative odds of the intended outcome (which was a first-year success) based on exposure to the variable (Szumilas, 2010). Table 2 illustrates a possible interpretation of OR.

Table 2: Interpretations of Odds Ratios

Odds ratio (OR)	**Interpretation**
Less than 1 (OR < 1)	Exposure is associated with lower odds of the outcome
Equal 1 (OR = 1)	Exposure does not affect the odds of the outcome
Greater than 1 (OR > 1)	Exposure is associated with higher odds of the outcome

Crude estimates

The results of an unadjusted logistic regression are shown in Table 3. In 2015, 2016, and 2017, male students were 0.333 (p = 0.150, 95% CI: 0.058 – 1.546), 0.533 (p = 0.260, 95% CI: 0.179 – 1.591), and 0.563 (p = 0.324, 95% CI: 0.179 – 1.765) less likely than female students to succeed in their first year of BPharm. Female students had a slight advantage over male students in terms of academic success. In 2015, 2016, and 2017, men's chances of success declined by factors of 0.333, 0.533, and 0.563, respectively, but the differences between the groups were not significant

Table 3: Gender Comparisons - Crude Estimates

Academic Year	Covariate		OR	Std. Err.	*P*>|*z*|	95% Conf. Interval
2015	Gender					
		Female*	1			
		Male	0.333	0.251	0.15	(0.058 to 1.546)
2016	Gender					
		Female*	1			
		Male	0.533	0.297	0.26	(0.179 to 1.591)
2017	Gender					
		Female*	1			
		Male	0.563	0.328	0.324	(0.179 to 1.765)

*baseline category

Adjusted models.

The language of instruction in the pharmacy programme at TUT is English. The adjusted model given in Table 4, indicated that English, mathematics, physical science, and life science were not significant indicators of whether or not a student will succeed in their first year of pharmacy school. Furthermore, after controlling for English, physical science, mathematics, and life sciences, the model revealed that male students were 0.243 (p = 0.392; 95% CI: 0.009 to 6.215), 0.356 (p = 0.200; 95% CI:0.073 to 1.725), and 0.330 (p = 0.318; 95% CI: 0.037 to 2.912) less likely to succeed than female students in 2015, 2016, and 2017, respectively. In terms of academic success in the first year of Bachelor of Pharmacy programme, female students had a slight advantage over male students.

DISCUSSION AND RECOMMENDATIONS

The objective of the study was to investigate the effect of Grade 12 science-based subjects on student success in a problem- and outcomes-based Bachelor of Pharmacy programme at the TUT.

Table 4: Gender Comparisons - Adjusted Models

It remains critical to identify factors that are positively related to pharmacy school academic performance. The result indicated that Grade 12 science-based subjects were not significant predictors of academic performance in the first year of the pharmacy programme at TUT. Particularly, the crude and adjusted estimates indicated no significant difference between male and female students' performances.

The study's findings indicate that female students had a higher chance of success than their male counterparts, according to both crude and adjusted estimates. In other words, TUT's pharmacy programme provides "[more] favourable conditions" for female students' success than it does for male students. There were, however, no statistically significant differences between the gender groups. As a result, males and females had comparable chances of success. The current study findings were consistent with those in Faisal, Shinwari and Hussain (2017), and Ip, Pal, Doroudgar, Bidwal, & Shah-Manek (2018) wherein male and female students performed insignificantly in the pharmacy programme.

Academic Year	Covariate	OR	Std. Err.	P > |z|	95% Conf. Interval
2015	Gender				
	Female*	1			
	Male	0.243	0.402	0.392	(0.009 to 6.215)
	English	0.472	0.835	0.671	(0.015 to 15.126)
	Mathematics	1.989	2.153	0.525	(0.239 to 16.590)
	Physical Science	0.881	0.910	0.903	(0.116 to 6.675)
	Life Sciences	0.367	0.424	0.386	(0.038 to 3.537)
2016	Gender				
	Female*	1			
	Male	0.356	0.287	0.200	(0.073 to 1.725)
	English	0.514	0.266	0.199	(0.186 to 1.418)
	Mathematics	0.643	0.360	0.430	(0.215 to 1.924)
	Physical Science	1.688	0.942	0.349	(0.565 to 5.039)
	Life Sciences	1.003	0.389	0.994	(0.469 to 2.146)
2017	Gender				
	Female*	1			
	Male	0.330	0.367	0.318	(0.037 to 2.912)
	English	0.849	0.611	0.820	(0.207 to 3.483)
	Mathematics	0.755	0.524	0.685	(0.193 to 2.945)
	Physical Science	0.711	0.563	0.667	(0.150 to 3.358)
	Life Sciences	3.045	2.541	0.182	(0.594 to 15.626)

*baseline category

Table 5 presents some of the factors that are deemed predictors of students' performances in the pharmacy programmes. It indicates that absenteeism, student background, demographic factors, psychological factors, socioeconomic factors and the ability to decode meaning from the symbolic language used in pharmacy programmes, and the results of the assessment tests used to select suitable qualifying students are vital. This paper suggests that the use of structural equation modelling (SEM) together with hierarchical regression models adjusting for the given significant factors in Table 5 may explain the total variation in the overall students' performances in the pharmacy programmes. In particular, the adjusted model may produce the plausible model to predict students' performance in pharmacy programme As the responsibilities of pharmacy practice expand beyond filling prescriptions to providing pharmaceutical care, universities and schools of health sciences must identify pre-admission factors related to applicants' ability to provide patient-care services in a multidisciplinary setting. Therefore, this finding has serious implications for the admission policies and strategies of universities, especially pharmacy programmes.

Table 5: predictors of student performance

Class Attendance	
Student orientation (background)	
	Location of the school
	School type
	Logical reasoning skills
	environment
	Pre-University computational knowledge
	English competency
Demographic	
	Gender
	Age
Psychological	
	Social support
	Peers Support
Socio-economic	
	Parents' type of work
	Parents' educational statuses
	Financial support
Symbolic language	
	Mathematics statement
	Organic chemistry
	Physics
Pharmacy curriculum outcomes assessment (PCOA)	
Pharmacy college assessment test (PCAT)	

The performance of students is affected by myriad factors, including a student's preferred learning style; the availability of finances; students' living conditions; socialisation factors, time management and dedication to studies, which includes absenteeism, all, play a role. Arguably, institutional intervention strategies, which may assist students to achieve academic success, also have a positive contributing role. Of course, once a student is selected, then the institution also needs to consider how to support a student to overcome the effects of these "numerous additional factors".

Policies governing educational assessment are constantly evolving around the world. According to the findings of this study, Grade 12 results should not be used as the sole predictors of student performance in the first year of a pharmacy programme. To determine the level of preparedness of first-year entrants, a carefully developed diagnostic assessment tool, along with matriculation results, should be developed so that appropriate support can be developed for them.

Future research could validate the efficacy of the pharmacy programme using data generated by a carefully developed diagnostic assessment tool. In other words, this study recommended that a study be conducted to confirm the current results using a dataset that includes other factors mentioned in other studies.

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DECLARATION OF INTEREST

The authors declare that they have no financial relationship(s) that may have inappropriately influenced them in writing this article.

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