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ORIGINAL ARTICLE

Admissions criteria as predictors of first-term success at a chiropractic institution

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Objective: To determine the relationship between admissions criteria and grade point average (GPA) at the conclusion of the first-term of study at a chiropractic institution.
Methods: Secondary data analysis was used on the Fall 2017 entering cohort of doctor of chiropractic students. Independent samples *t*-tests and ordinary least squares linear regression were used to explain the extent to which incoming undergraduate GPA, undergraduate chemistry grade, undergraduate anatomy and physiology grade, and age, respectfully, influenced the end-of-trimester GPA.
Results: Linear regression found each of the four independent variables (undergraduate GPA, undergraduate chemistry grade, undergraduate anatomy and physiology grade, and age) to be significant influencers of end-of-trimester-1 GPA with undergraduate GPA being the most statistically significant predictor ($p < .001$).The difference in mean end-of-trimester GPAs for male and female students was not statistically significant. There also was no difference in mean end-of-trimester GPAs by race/ethnicity.
Conclusion: Current admissions requirements may need to emphasize incoming undergraduate GPA and target student support for older students. This study should be repeated for increased sample size, be performed at other chiropractic institutions, and consider additional cohorts to strengthen results.

Key Indexing Terms: Academic Success; Chiropractic; Graduate Education; School Admission Criteria; Students

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INTRODUCTION

While student persistence and success theories are known at the undergraduate level, graduate student development theories are scarce. Researchers and graduate school administrators must take into consideration elements from undergraduate student theories, adult learning theories, and the highly individualized nature of doctoral students and disciplines. Additionally, graduate school administrators must provide students with evidence-based resources to achieve content mastery and deal with the transitions associated with graduate student socialization and integration.

Though oftentimes considered a positive life change, other life events can influence a graduate student's outlook on their graduate studies.[1] First semester students have a desire to succeed, but may underestimate their abilities, and, therefore, integration into their new role as a graduate student is important.[1] Themes of transition into graduate studies emerge as: (1) personal identity and social/societal roles outside of class, (2) integration within academic community, (3) social support structures, (4) persistence, and (5) perceptions of success.[1]

Students enroll in graduate school for professional requirements, career advancement, and personal satisfaction.[1] Additionally, graduate students feel stress at varying levels, indicate they have competing demands and internal conflicts, and need to develop coping mechanisms, but also can receive positive effects of balance, goal realization, success, and satisfaction.[2] This mix of feelings sets graduate students up for complex experiences as they embark on graduate studies. Educators must devise strategies to assist and empower students from the moment they apply.

Multiple factors influence the retention of doctoral students in professional programs, and transition experiences of 1st semester students are particularly worth exploring. Successful socialization into graduate school moves beyond cognitive abilities demonstrated by previous academic successes and encompasses emotional and social experiences.[3] As their role of being a doctoral student becomes more salient, their development also can change, and is especially important if the student has personal or

professional obligations outside of their studies. This process of education at the graduate level is viewed as "dynamic and nonlinear."[3]

The first gauge of academic success provided to institutions comes in the form of undergraduate performance data, application information, and student demographics. Based on the literature, there are varied results for prerequisite performance as a predictor of academic success in chiropractic institutions and other allied health professional schools.[4] Additionally, education environments can contribute significantly to 1st-year health sciences undergraduate student success.[5] Delaying the first unsatisfactory grade also could be an important consideration for success in allied health programs.[6] Understanding the implications of complex preadmission factors tailor recommendations for chiropractic institutions is key.

The available research on how to retain doctoral students in professional programs is scarce, and research on chiropractic students is even more limited. Guidelines for the best practices in admissions and student support rely on a culmination of recommendations to provide some direction. Additional research is needed to further guide doctoral students, faculty, and program administrators. This research study will add to the growing body of research that is needed.

The doctor of chiropractic (DC) credential in the United States is earned at a professional school that requires prerequisite courses in an undergraduate setting before admission. Conflicting findings among key admissions variables and correlations to outcome measures become evident in the review of current literature. Past chiropractic research has addressed the correlations between undergraduate grade point average (GPA), course performance, and licensing exams, but there remains a need to revisit the research and provide a 21st century perspective.[7,8] This emphasizes the need for chiropractic education to further its own research in lieu of relying on research regarding other health professional school settings and update previous research findings. While other studies have considered later indicators of academic success in chiropractic education, first-term academic advising is critical to DC students considering alternative paths for their future career goals. The results of this research will inform admissions practices and may provide variables to consider when planning academic support for individuals at our institution.

We determined the relationship between DC admissions criteria and the end-of-trimester-1 GPA at a chiropractic institution. The following research questions guided the study:

1. To what extent does age, incoming prerequisite GPA, undergraduate chemistry grade, and undergraduate anatomy and physiology grade influence the end-of-trimester GPA for first-time trimester-1 chiropractic students?
2. Is there a statistically significant difference in mean end-of-trimester-1 GPA among the students of different races/ethnicities?
3. Is there a statistically significant difference in mean end-of-trimester-1 GPA between male and female students?

The importance of this study is grounded in the ethics of graduate student success. The financial cost of education, even at the graduate school level, is rising. Chiropractic educators are morally obligated to ensure students are receiving the best return on their investment.

METHODS

Study Site

The study site is a fully accredited private university, located in a southwestern state of the United States, specializing in health disciplines, with its flagship DC program as its most popular program.[9] For admission into the chiropractic program, prospective students must have successfully completed at least 90 credit hours of undergraduate coursework with a GPA of 3.0 or higher. Of the 90 credit hours completed, at least 24 must be in life and physical sciences with at least half containing a substantive laboratory component. General Chemistry also must be one of the 90 hours. The other courses making up the 24 hours of physical sciences are recommended to be anatomy and physiology, and some combination of biomechanics, kinesiology, organic chemistry, physics, zoology, biology, physiology, microbiology, or similar courses.

The chiropractic education program consists of 10 consecutive trimesters.[10] The first seven trimesters are in didactic courses with laboratory sections, while the final three trimesters serve as a supervised clinical experience. Of the seven didactic trimesters, the first three trimesters are typically considered the basic sciences foundational courses, with the very first trimester consisting of major gateway courses into the chiropractic curriculum.

Sample

This study was deemed exempt by the Parker University institutional review board. For this study, admission and academic records were reviewed for the Fall 2017 entering cohort of DC students at the study site ($n = 143$). To determine the minimum sample size needed for this study, we conducted a power analysis.[11] By using the mean difference of 0.5 with a standard deviation of 0.5, α level was set at 0.05 and power at 80%, the calculation indicated a sample size of 32 would be sufficient. Inclusion criterion was first-time enrolled students in all seven first trimester DC courses. Exclusion criteria were students retaking one or more trimester-1 course, students who had previously withdrawn from courses, and students readmitted after academic dismissal. A roster of students was pulled for the course titled Introduction to Clinical Reasoning, as the course has a high pass rate and few students re-sit the course. From the roster of 143, 18 students were excluded from the study based on the exclusion criteria. The final sample size was 125 students. Descriptive statistics are located in Table 1.

Variables

The following information was collected from each student: undergraduate anatomy and physiology grade, race/ethnicity, sex, undergraduate chemistry grade, and cumulative GPA at the conclusion of their first trimester.

Table 1 - Descriptive Statistics

Variable	N	Minimum	Maximum	*M*	*SD*
Age	125	21	36	25.08	2.819
Incoming GPA	125	2.20	4.00	3.4778	.30309
Undergraduate chemistry grade	125	1.65	4.00	2.9995	.64900
Undergraduate anatomy/physiology grade	109	2.00	4.00	3.1099	.67444
End-of-trimester GPA	125	1.11	4.00	3.1167	.56905
Sex					
Male	74	1.11	4.00	3.0601	.63228
Female	51	1.91	4.00	3.1989	.45581
Race/ethnicity					
Unknown	1	3.30	3.30	3.3000	
Hispanic	29	1.55	4.00	3.0717	.57115
Asian	5	2.02	3.31	2.7420	.49378
Black/African American	5	1.11	4.00	3.0378	1.29661
White	82	1.64	4.00	3.1775	.50651
2 or More	3	2.28	3.20	2.5860	.53174

M, Mean; *SD*, standard deviation.

Course grades were converted from letters to numeric GPA scores by weighting the grade and hours on the standard 4-point scale. Dummy coding was used to create new variables for sex and race/ethnicity. Based on the literature and available data from the study site, the independent variables considered were numerical undergraduate anatomy and physiology grade, numerical undergraduate chemistry grade, undergraduate prerequisite GPA, and numerical age of the student upon matriculation.

The literature review demonstrated National Board of Chiropractic Examiners (NBCE) scores as an indicator of student success in chiropractic education. In this study, NBCE scores were not obtained because it is administered following completion of coursework that this cohort has not yet completed. Chiropractic College Aptitude Test (CCAT) data, while previously found to be an important indicator of student potential,[12] were not obtained, as the study site does not use this measure as an admissions requirement. The dependent variable for this study was the cumulative GPA after completing the first trimester of coursework in the DC program.

Data Collection and Analysis

The de-identified data were collected through registrar reports, student information system queries, and transcript evaluations. The data were combined in Microsoft Excel version 14.7.7 (Microsoft Corp., Redmond, WA) and then uploaded to IBM SPSS Statistics version 21.0 (SPSS, Inc., Chicago, IL). Descriptive statistics are shown in Table 1.

Ordinary Least Squares (OLS) analysis was used to examine the relationship between trimester-1 GPA and the independent variables (age, incoming prerequisite GPA, undergraduate chemistry grade, and undergraduate anatomy and physiology grade). A Levene's test for 1-way Analysis of Variance (ANOVA) indicated the assumption of homogeneity was violated. Therefore, we conducted a Kruskal-Wallis H test instead of 1-way ANOVA. The Kruskal-Wallis H test is a nonparametric alternative to 1-way ANOVA, and the Kruskal-Wallis H test does not assume a normal distribution of the residuals or homogeneity of variance.[13] Independent samples *t*-test was used to compare trimester-1 GPA means based on sex.

RESULTS

Results from the OLS, Kruskal-Wallis H test, and independent samples *t*-test are presented in Tables 2 to 5. The regression equation for the independent variables and end-of-trimester-1 GPA was statistically significant ($F[4,104] = 8.20$, $p < .001$) with $R^2 = .24$. This means that 24% of the variance in end-of-trimester-1 GPA can be explained by the combination of independent variables (age, incoming prerequisite GPA, undergraduate chemistry grade, and undergraduate anatomy and physiology grade). Most significantly, incoming prerequisite GPA is a heavy influencer, with age also statistically significant ($p < .001$). Undergraduate chemistry grade and undergraduate anatomy and physiology grade do not have a statistically significant relationship with end-of-trimester-1 GPA.

The Kruskal-Wallis test did not yield a statistically significant result for differences in GPA across race/ethnicity ($\chi^2[4] = 3.94$, $p = .42$). The differences in trimester-1 GPA for male ($M = 3.06$, SD = .632) and female ($M = 3.2$, SD = .45) students also was not statistically significant ($t[123] = -1.426$, $p = .16$) with unequal variances assumed. In summary, for demographic

Table 2 - Significance of the OLS Model

	SOS	df	Mean Square	F	*p*
Regression	7.637	4	1.909	8.204	.000***
Residual	24.204	104	.233		
Total	31.841	108			

N = 109; *SOS*, *sum of squares*; *df*, *degrees of freedom*.
* $p < .05$.
** $p < .01$.
*** $p < .001$.

Table 3 - Coefficients for the OLS Model

	Unstandardized Coefficients		Standardized Coefficients		
	b	Std. Error	B	*t*	*p*
(Constant)	1.494	.665		2.246	.027*
UGCHEM	.048	.076	.057	.631	.530
UGAP	.077	.080	.095	.961	.339
INCGPA	.662	.186	.367	3.565	.001***
AGE	−.041	.016	−.223	−2.602	.011*

N = 109.
* $p < .05$.
** $p < .01$.
*** $p < .001$.

data, there was no statistically significant difference in means based on sex or race/ethnicity.

DISCUSSION

A literature review concerning academic success and retention predicted by admissions variables was conducted for chiropractic education and across other professional school disciplines. There is a difference in perceived value of prerequisites and actual need for prerequisites in dental education. In one study of 90 students, the number of undergraduate science credits earned upon matriculation did not influence the scores on the Dental Admission Test, basic science grades, nor on the dental national board exam scores.[14] However, based on student perceptions, additional prerequisite science courses should be considered when revising admissions standards. Participants pointed to undergraduate basic sciences as potential admissions considerations.

At another dental school, undergraduate science GPA was correlated with dental school GPA and scores on the national board exams.[15] Undergraduate GPA did not show any significance to either GPA or national board exams. This opens up discussions about the difference between undergraduate GPA and undergraduate science GPA.

One study concluded undergraduate coursework in science, score on the ACT, completion of undergraduate degree, undergraduate chemistry grade (undergraduate organic chemistry, specifically), year of study, and transfer student status statistically significantly predicted academic success, as measured by pharmacy 1st-year cumulative GPA.[16] Another study also found that students with a four-year degree before matriculation into a pharmacy program had significantly higher 1st-year GPAs than students without four-year degrees.[6] These findings contributed to the selection of variables for this research study and influenced the creation of research questions.

Table 4 - Kruskal-Wallis H Test Results for Race/Ethnicity

	T1GPA
Kruskal-Wallis H	3.937
df	4
Asymp. Sig.	.415

In another pharmacy school study, undergraduate GPA was not an indicator of student success, whereas undergraduate science GPA was an indicator of student success.[15] It also is important to note that completing an undergraduate degree before matriculation predicted a higher 1st-year cumulative GPA, but not completing an undergraduate degree was not a contributor to academic probation. Again, student success in healthcare education settings is as complex, if not more so, than the complexities of graduate student success.

In a pharmacy school, institutional type in which organic chemistry was taken did not have a statistically significant relationship with North American Pharmacist Licensure Examination (NAPLEX) scores.[17] However, Pharmacy College Admission Test (PCAT) score, prerequisite GPA, and critical thinking score positively correlated with NAPLEX scores, with PCAT scores revealing the most significant relationship. Additionally, they found completing an undergraduate degree before entry in a pharmacy school does not influence NAPLEX scores but could provide a prerequisite knowledge base for students entering the school.

Additionally, NAPLEX scores were not statistically significantly predicted by a student's possession of a previous degree in one study.[18] Math-science GPA, pre-pharmacy GPA, transfer status, and no grades of D or F were positively correlated with NAPLEX score, while pre-pharmacy GPA had the strongest correlation. There were significant differences between scores of on-time and delayed graduation students. A student who had at least one D or F had a significantly lower probability of passing the NAPLEX. The probability of passing the NAPLEX was significantly higher for students with higher cumulative pharmacy GPAs. Pre-pharmacy GPA, math-science GPA, and number of Ds or Fs should be admissions considerations in pharmacy schools.[18]

In pharmacy education, regardless of admission pathway, PCAT scores and GPAs should be considered as indicators of future student success.[19] As is typical in chiropractic education, basic science coursework in pharmacy schools tend to make students struggle the most. One pharmacy school found a statistically significant positive relationship between pharmacy technician experience and academic performance.[20] The type of institution at which pharmacy program prerequisites were completed was not a significant predictor of academic success.

Table 5 - Independent Samples *t*-Test Results for Sex

							95% Confidence Interval	
Sex	**N**	***M* T1GPA**	***SD***	**df**	***t***	***p***	**Lower Bound**	**Upper Bound**
Male	74	3.0601	.63228	123	01.426	.156	-.33151	.05387
Female	51	3.1989	.45581					

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

NAPLEX scores were not correlated with sex, possession of undergraduate degree, nor having unsatisfactory grades in a pharmacy program.[21] NAPLEX scores were correlated with Pre-NAPLEX score, race/ethnicity, PCAT scores, undergraduate GPA, undergraduate science GPA, pharmacy GPA, and on-time graduation status. Pharmacy GPA was noted as the most significant predictor of NAPLEX scores.

While other medical and healthcare fields have provided research to affirm or rebut the relationship among admissions factors, such as undergraduate coursework and entrance exams, chiropractic education research is scarce on this topic. The nature of chiropractic education and the field itself warrants reasonable comparison to seemingly similar fields but needs further research specific to the chiropractic discipline. Appropriate DC admissions requirements and targeted academic support should then follow.

The CCAT is a tool that exists to gauge students' abilities in science and mathematics to inform academic decisions regarding chiropractic education.[22] The tool is not used widely in chiropractic admissions, but is a standard worth noting and one currently being explored for admissions implications. At 1 school, undergraduate GPA, postsecondary degree completion, and undergraduate GPA accounted for 48% of the variance in CCAT scores and were considered significant predictors of success in the basic science portion of chiropractic curriculum.[23] At another school, 44.3% of students predicted to perform unsatisfactory by the CCAT did, in fact, perform unsatisfactory in coursework.[12]

As previously mentioned, an undergraduate degree is not a requirement for admission to the DC program at the study site. However, discussion persists concerning the perceived benefits of possessing a degree before chiropractic program matriculation. At one institution, there was a difference between students who completed an undergraduate degree before matriculation and those who did not in terms of their cumulative GPA at the end of the first year of chiropractic coursework.[24] However, researchers found no statistically significant relationship between undergraduate GPA and cumulative GPA at the end of the first year of chiropractic coursework. Contrary to the above study, in the United Kingdom, a chiropractic school found completing or not completing an undergraduate degree upon matriculation had no effect on chiropractic course grades.[25] This is congruent with a medical school study that found presence of an undergraduate degree in physics does not necessarily correlate with success in a graduate medical physics course.[26]

Another academic performance indicator to consider is national board exam scores. The National Board of Chiropractic Examiners administers the national board exam to evaluate chiropractic students' abilities in basic sciences, clinical sciences, clinical competencies, and practical experiences.[27] At one chiropractic institution, an anatomy score was calculated by combining histology and gross anatomy courses, and a chemistry score was calculated by combining biochemistry and nutrition.[28] Results revealed that if a student's mean anatomy score or mean chemistry score increased by 1%, the student could anticipate a 6-point increase in their NBCE exam average score. Overall, when given an NBCE pretest, chiropractic students who scored highest by category generally achieved higher scores on the NBCE exam.[28]

Chiropractic basic science curriculum is provided as the foundation for Part I of the NBCE exam. Three main predictors of NBCE success were high course grades, high GPA, and persistence through the chiropractic program.[28] While undergraduate GPA did not directly predict NBCE Part I scores, undergraduate GPA did predict basic science GPA; basic science GPA and NBCE practice exam scores then predicted NBCE Part I scores.[29] Basic science GPA and NBCE practice exam scores accounted for 72% of the differences in NBCE Part I scores.[29]

Course performance, another indicator of student success, should be considered as well. First-year grades have been found to influence degree attainment at a chiropractic school.[30] Additionally, undergraduate organic chemistry class performance is a statistically significant indicator of chiropractic biochemistry class performance.[31] Undergraduate GPA range also had a statistically significant relationship with chiropractic biochemistry course grades.[4] Given that organic chemistry is not a requirement for admissions at the study site, and given the importance of the biochemistry course in chiropractic education, these courses should be considered when assessing academic performance.

To summarize, age and incoming prerequisite GPA upon entering the DC program influence the trimester-1 GPA. This is consistent with current literature indicating these as adequate admissions criteria. Concerning the second and third emerging research questions addressing race/ethnicity and sex, despite notable differences in the descriptive statistics, there was no statistically significant difference in GPA for students of different races/ethnicities nor between male and female students. Therefore, this

research study points to retaining current admissions requirements for the chiropractic institution in this study. However, thresholds for GPA minimums should be considered, as admissions requirements should accurately reflect anticipated academic success.

This research study also considered age as a potential influencer of trimester-1 GPA. While other studies have considered previous academic attainment, age has not been considered. Our results indicated younger age as a predictor of first-term success, as measured by GPA, when other academic factors are held constant. Targeted student support for students entering with lower incoming GPAs, with lower undergraduate anatomy and physiology grades, with lower undergraduate chemistry grades, and older students should be considered for maximized retention from the first to second terms of chiropractic education.

Limitations

Limitations of this study should be considered. Secondary data analysis relies on the quality of data collected for a different purpose. As such, there is the potential for inherent inconsistencies, like missing data, as was the case for this study. Human error beyond data entry also should be mentioned, as multiple data sources had to be combined for statistical analysis. Transcript evaluation also was performed by interpretation of current undergraduate transcripts on file. The researchers are not expert transcript evaluators and with students matriculating from various undergraduate and graduate settings, transcript evaluation was subjective in nature. The small sample size of 125 also is a consideration for statistical power.

Another limitation of this study is the fact that it was conducted at a single institution. Because data were retrieved from the student data system, no sampling strategy was used. Also no randomized controlled trial was conducted. This limitation may have impacts on the interpretation of the *t*-test and Kruskal-Wallis test results. To address this limitation, we used OLS to account for other independent variables that may affect our results. Nevertheless, readers should be careful when generalizing our results to their own institutions.

Future Studies

Future studies should address the limitations of this research study. This study should be repeated for increased sample size, be performed at other chiropractic institutions, and consider additional cohorts to strengthen results. Other studies should consider a variety of different undergraduate conditions. For example, considerations of location, mode, and time passed since completing undergraduate coursework could yield additional information, especially since age was a predictor of trimester-1 GPA in this study. Additionally, numeric thresholds for the considered independent variables should be explored to inform admissions acceptance cutoffs.

Other measures of student success also could be explored, such as NBCE scores, CCAT scores, academic retention exam scores, and more. Factors beyond admissions characteristics also should be explored, as chiropractic students in 1 study attending less than 80% of their scheduled classes were three times more likely to earn at least one unsatisfactory course grade.[25] The complexities of student success reach beyond admissions criteria.

A key limitation mentioned in the literature review section concerned the lack of theoretical foundation for quantitative studies in chiropractic education. While not unique to this study, limited presence of theory in the field complicates conclusions drawn from quantitative studies. Qualitative studies should be conducted to create theories, specifically theories for chiropractic student success.

When performing the literature review, qualitative admissions factors were presented in various graduate settings and should be considered for future studies.[26] More qualitative research is needed on the subject of admissions criteria and student success.[4] For example, while outside the scope of this study, critical thinking skills could be considered key predictors of student success.[32] Quantitative predictive models can exclude applicants who may fall below a threshold in 1 of many admission areas but have the motivation and ability to overcome the deficit.

CONCLUSION

Admission criteria are the first indicator of student preparation and a major influencer of student success. This study contributed to the growing body of chiropractic education literature and affirmed previous studies in health care fields. Current admissions criteria for a DC professional program should weight incoming undergraduate GPA more than other admissions factors, while also considering the age of an applicant for targeted student support. Undergraduate preparation is a key consideration when determining first-term success of chiropractic students and should be monitored continuously to reduce attrition and set future chiropractors up for a successful education and career.

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