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ORIGINAL ARTICLE

Predictors of performance of students in biochemistry in a doctor of chiropractic curriculum

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Objective: This study investigated the effect of completion of course prerequisites, undergraduate grade point average (GPA), undergraduate degree, and study habits on the performance of students in the biochemistry course at Palmer College of Chiropractic Florida.
Methods: Students self-reported information regarding academic preparation at the beginning of the semester using a questionnaire. Final exam grade and final course grade were noted and used as measures of performance. Multivariate analysis of variance was used to determine if number of prerequisites completed, undergraduate GPA, undergraduate degree, hours spent studying in undergraduate study, and hours spent studying in the first quarter of the chiropractic program were associated significantly with the biochemistry final exam grade or the final grade for the biochemistry course.
Results: The number of prerequisites completed, undergraduate degree, hours spent studying in undergraduate study, and hours spent studying in the first quarter of the chiropractic program did not significantly affect the biochemistry final exam grade or the final grade for the biochemistry course, but undergraduate GPA did. Subsequent univariate analysis and Tukey's post hoc comparisons revealed that students with an undergraduate GPA in the 3.5 to 3.99 range earned significantly higher final course grades than students with an undergraduate GPA in the 2.5 to 2.99 range.
Conclusion: No single variable was determined to be a factor that determines student success in biochemistry. The interrelationship between the factors examined warrants further investigation to understand fully how to predict the success of a student in the biochemistry course.

Key Indexing Terms: Biochemistry; Chiropractic; Education; School Admission Criteria

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INTRODUCTION

Students who enter the doctor of chiropractic (DC) program at Palmer College of Chiropractic Florida vary in their educational backgrounds. Although completion of a 4-year undergraduate degree is required, that degree might be a science (including engineering) or a nonscience degree. Prerequisites might have been completed as part of the degree program, separately from the degree program or, in the case of a student with a sufficiently high undergraduate grade point average (GPA), not completed. Given these differences in educational backgrounds and level or degree of academic preparation, the question arises as to whether students with different backgrounds and experiences in their undergraduate program vary in their ability to succeed in our professional program, particularly in the biochemistry course.

Previous studies have investigated various factors and their relationships to student academic success in health-care curriculums. It generally is assumed that the successful completion of prerequisite courses is important for student success in the course for which that prerequisite is required. In support of that assumption, McRae[1] found that organic chemistry can be used as an indicator of future academic success in a chiropractic biochemistry course. Caplan et al[2] compared medical student grades in biochemistry, gross anatomy, histology, physiology, and microbiology to their grades in similar premedical courses, and found that the only difference in performance was shown by the students who had completed the prelude courses in biochemistry. However, Wright et al[3] found no statistically significant differences between average undergraduate biochemistry grades or grade distribution among students with or without an organic chemistry prerequisite at the undergraduate level. They did observe a strong, highly significant positive relationship between cumulative GPA and the biochemistry grade. Humphrey et al[4] found that completion of basic science prerequisites did not

Table 1 - Multivariate Analysis of Prerequisites Completed, Undergraduate GPA, Undergraduate Degree, Hours Spent Studying in Undergraduate Study, and Hours Spent Studying in the First Quarter of the DC Program and Final Exam Grade and Final Grade for the Biochemistry Course

	Wilks' λ	*F*	df Num, Nenom	*p*	*n*
Pre-requisites	0.9696	0.253	8, 130	0.979	83
Undergraduate GPA*	0.7906	2.701	6, 130	0.017	83
Undergraduate degree	0.8497	1.379	8, 130	0.212	83
Hours studying (undergraduate)	0.9391	2.107	2, 65	0.130	83
Hours studying (DC program)	0.9339	0.566	8, 130	0.804	83

Num, numerator; Denom, denominator; df, degrees of freedom.
** Denotes statistical significance.*

significantly enhance students' performance in basic science courses in dental school. In addition, Canaday and Lancaster[5] compared first-year medical students who had completed courses, such as biochemistry, anatomy, embryology, and histology, to students who had not taken these courses, and found no significant differences in the academic performance of these two groups.

Undergraduate GPA often is used as a predictor of student success in many healthcare programs. Previous studies have shown varying degrees of support of this connection. Green et al[6] found a significant relationship between the GPA of first-year chiropractic students, and their matriculation GPA and undergraduate science grades. Potolsky et al[7] found that previous academic performance was an indicator of the success of first-year nursing students. Balogun et al[8] found that the preprofessional GPA was one of the best predictors of academic performance in physical therapy. Market[9] found a positive correlation between the academic performance of first-year medical students, and their undergraduate GPA and medical college admission test scores. Wilkinson et al[10] found a similar correlation between GPA and academic performance in medical school.

Various other factors, such as performance on entrance examinations, have been examined as predictors of success in the basic sciences curriculum of healthcare programs. Cunningham et al[11] found that a preadmission examination proved a valuable indicator of student success in the basic sciences curriculum of a chiropractic program. Sandow et al[12] found that higher undergraduate GPA and higher Dental Admission Test (DAT) scores were correlated with higher board scores for dental students. Kenya et al[13] found a correlation between class grades and National Board of Chiropractic Examiners scores in anatomy and chemistry.

Considering the numerous predictors reported in the literature, this study attempts to determine what factors determine the success of first-year students in the biochemistry course in our DC program. Specifically, this study determined if the number of prerequisites completed, undergraduate GPA, undergraduate degree, hours spent studying in undergraduate study, and hours spent studying in the first quarter of the DC program were associated significantly with the biochemistry final exam grade or the final grade for the biochemistry course.

METHODS

The sample for this study was 83 students enrolled in a first-quarter biochemistry course at our college in the fall of 2011. This study was reviewed and exempted by the Palmer College of Chiropractic institutional review board. The students completed a questionnaire that gathered information on the number of chemistry prerequisites completed (General Chemistry I, General Chemistry II, Organic Chemistry I, and Organic Chemistry II), undergraduate GPA, undergraduate degree (science or nonscience), and undergraduate study habits (average number of hours spent studying each week, see Appendix). Final exam scores and final course grades were recorded.

Multivariate analysis of variance was used to determine if number of prerequisites completed, undergraduate GPA, undergraduate degree, hours spent studying in undergraduate study, and hours spent studying in the first quarter of the DC program significantly affected the biochemistry final exam grade or the final grade for the biochemistry course. If a significant effect was noted, univariate analysis and Tukey's HSD post hoc comparisons were performed. All statistics were conducted using Minitab 15 Statistical Software (Minitab, Inc, State College, PA) and α set at 0.05.

RESULTS

A total of 83 completed surveys was returned and used for analysis. No student reported a GPA of 4.0 or above or below 2.0. The number of prerequisites completed, undergraduate degree, hours spent studying in undergraduate study, and hours spent studying in the first quarter of the DC program did not significantly affect the biochemistry final exam grade or the final grade for the biochemistry course (Table 1). However, multivariate analysis revealed a significant effect of undergraduate GPA (Table 1). Subsequent univariate analysis revealed that undergraduate GPA affected the final course grade ($F_{3, 79} = 4.54$, $p = .005$, $n = 83$), but not the final exam grade ($F_{3, 79} = 1.46$, $p = .232$, $n = 83$). Tukey post hoc comparisons revealed that students with an undergraduate GPA in the 3.5 to 3.99 range scored significantly higher than students with an undergraduate GPA in the 2.5 to 2.99 range (Table 2).

Table 2 - Mean + 1 SEM for Final Course Points by Undergraduate GPA

	Mean + 1 SEM
3.5–3.99	147.6 + 5.11
3.0–3.49	143.1 + 3.48
2.5–2.99	133.6 + 4.75
2.0–2.49	140.0 + 22.29

Students with an undergraduate GPA in the 3.5 to 3.99 range scored significantly higher than students with an undergraduate GPA between 2.5 to 2.99.

DISCUSSION

The goal of this investigation was to determine whether there is any difference in academic success in first-year chiropractic students in their biochemistry course. It generally is assumed that completion of the prerequisites and investing study time in a class raise the chance of student success. Additionally, it would seem reasonable that undergraduate study habits would continue into a post-undergraduate program. However, the only statistically significant effect identified in this study was that of undergraduate GPA on the final overall grade. This supports the conclusions of previous studies (Green et al,[6] Potolsky et al,[7] Balogun et al,[8] Market,[9] and Wilkinson et al[10]). This would suggest that whatever factors made the student successful in their undergraduate program also make the student successful in subsequent studies.

Although previous researchers had found either a positive (McRae[1]) or negative (Wright et al[3]) correlation between organic chemistry grades (not just completion) and chiropractic biochemistry grades, this study did not find such a relationship. This study examined the completion, but not the grade in the prerequisite classes. It is possible that simply completing a course might not be sufficient preparation. An additional confounding factor to this study is that when the instructor identifies students who lack the prerequisites, additional reading is suggested to them. It is possible that this is serving as some degree of compensation for the prerequisites. Finally, the quality of the prerequisite courses might be a factor. A comparison of the grades of students who took their prerequisites as part of a traditional undergraduate program to the grades of those who completed accelerated programs might be warranted.

There was no significant difference in biochemistry performance between those students with and without science degrees. Since both groups were encouraged to complete the prerequisite courses before starting our DC program, the differences in the level of preparation of each group might not be significant.

Study habits were not associated significantly with student success. It is possible that some students compensated for inadequate preparation for the biochemistry course by investing more study time compared to those students who felt better prepared. It should be noted that the students who reported the lowest GPAs did not have the lowest final examination grades. It is possible that these students invested more study time and received higher grades as a result. The variation in grades is larger in this group than in other groups. This variation might have been caused by a few individuals who studied more and, as a result, raised the mean for this GPA group. It also is possible that the quality of the study time was more significant than the quantity. A shorter period of quality study time might be more productive than a longer period of less focused study time. Additionally, a limitation of this study becomes apparent when examining the study habit information reported by the students. The accuracy of self-reported information, such as that gathered in questionnaires, always is questionable. This is illustrated by several students in the data pool of this study reporting that the number of hours that they spent studying biochemistry is larger than the total number of hours that they spent studying each week.

Further investigation is needed to examine the undergraduate experiences of students more closely. A comparison of grades in the prerequisite courses to the final biochemistry grade might shed more light on the factors affecting student success. Biochemistry often is taken as part of an undergraduate science degree program and would be expected to have a positive impact on student success in the chiropractic biochemistry class. Finally, student motivation can be key to student success. A combination of adequate, high-quality undergraduate preparation combined with productive study time in a course may yield the best results.

CONCLUSION

The interrelationship between the factors examined (final examination grades, final grades, prerequisites completed, hours invested in studying, undergraduate GPA, and undergraduate degree) warrants further investigation. Although it would appear that student preparation does not have an effect on the outcome of the biochemistry course, it is unlikely that this is the case. It is more probable that the relationship is more complex than dependency on a single variable. With this in mind, it is critical that further investigation is conducted to ensure the development of admissions criteria that enables the matriculation of students capable of being successful in the biochemistry class and the DC program as a whole.

CONFLICT OF INTEREST

The authors have no conflict of interest to declare.

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APPENDIX: Student Questionnaire Regarding Student Preprogram Preparation for Graduate Level Biochemistry

1. Function 1 Biochemistry has 4 prerequisites. They include General Chemistry I, General Chemistry II, Organic Chemistry I, and Organic Chemistry II. How many of these prerequisites have you completed prior to beginning PCCF?
   a. None
   b. 1
   c. 2
   d. 3
   e. 4
2. What was your undergraduate GPA?
   a. 4.0+
   b. 3.5–3.9
   c. 3.0–3.49
   d. 2.5–2.9
   e. 2.0–2.49
   f. Less than 2.0
3. On average, how many hours did you spend studying each week during your undergraduate time?
   a. Less than 5
   b. Between 5 and 10
   c. Between 10 and 15
   d. Between 15 and 20
   e. More than 20
4. Is your undergraduate degree
   a. A science degree (including engineering)
   b. A non-science degree
5. On average, how many TOTAL hours did you spend studying each week during this quarter?
   a. Less than 5
   b. Between 5 and 10
   c. Between 10 and 15
   d. Between 15 and 20
   e. More than 20