

ORIGINAL ARTICLE

Correlation between academic performance and NBCE part I scores at a chiropractic college

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Objective: This study investigates the association between pre-National Board assessments and National Board Part 1 scores (NBCE) at a chiropractic college.

Methods: A convenience sample of 24 students enrolled in the doctor of chiropractic degree program was recruited for the study. These were 6th and 7th quarter students who had registered to take NBCE in March 2011. Each student's class scores were computed and average numeric means score derived. Subject clusters that make up testable subject categories in NBCE also were computed to obtain a single numeric mean score. Pretests were administered in all areas tested in NBCE. Results were compared to the student's scores in NBCE using correlation and multiple linear regression for 14 predictors and one response variable (NBCE).

Results: Among the 14 correlations for 19 students (due to missing data when running the correlation matrix), six were moderate-to-strong and statistically significant. Two predictors qualified for multiple linear regression (where $n = 22$): mean anatomy and mean chemistry, both of which revealed similar regression coefficients.

Conclusion: Mean anatomy and mean chemistry scores were shown to be the best predictors of NBCE Part 1 results in this sample.

Key Indexing Terms: Chiropractic; Correlation of Data; Educational Assessments; Forecasting

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INTRODUCTION

Students admitted to chiropractic colleges have an entry grade point average (GPA) of 2.5 and above in compliance with standards set by the regulating bodies. As is characteristic of students in all institutions of higher learning, some settle down to engage fully in the learning process, while others demonstrate less scholarly academic achievement. At our institution, students find themselves faced with national board examinations in the basic sciences by the time they finish their 6th quarter. To the surprise of many, above average students struggle to pass the national board exams with ease. It is not uncommon to find some of the average students passing, while the more brilliant students fail or barely make the bench mark score in each subject area.

Many colleges struggle to recruit students with a high GPA, with the prospects of seeing equivalent reciprocal performance at the end of their course or on national board exams. Studies have been done to show the correlation between entry point GPA and increased chances of admission. Cooke and Fontenella showed that the chances of acceptance increased by a factor of 2–5,

depending on students' GPA, even among the highly selective medical schools in the United States.¹ Chiropractic schools also equally weigh their admission of students on a satisfactory grade point average. More current research in chiropractic and other health fields support the view that a high pre-accumulative GPA is a good predictor of one's academic success.^{2–5} Whereas some studies show that students with a higher entry GPA tend to perform better, others show the contrary. Abedi studied the correlation between graduate academic success and undergraduate academic performance and concluded that undergraduate GPA did not have any relationship with graduate academic success.⁶ As well, Wright and Palmer did not find any significant correlation between undergraduate GPA and graduate school GPA in 86 business administrative students who were moderately low or very low performers.⁷ However, it had a significant role in the very successful students.⁷

These kinds of trends seen commonly in students have led to the initiation of this study, which tests the association between 14 academic performance predictors and scores on the National Board of Chiropractic Examiners Examination Part 1 (NBCE). National board

examinations not only concern the student who takes them, but every employee within the chiropractic institution. This is because student success on National Boards is an important contributor to the vitality of the institution. It is necessary that tangible predictors be found that can lead to increased pass rates and higher board scores. The purpose of this project was to find practical and useful predictors of success that would change and improve national board scores in our chiropractic school.

METHODS

A total of 24 students enrolled in the doctor of chiropractic degree program at Sherman College of Chiropractic was recruited for the study. These were students who had registered to take Part I of the NBCE in March 2011. The students had completed taking the basic science courses tested on NBCE, including anatomy, biochemistry, microbiology, spinal anatomy, physiology, and pathology. These courses were grouped according to the sections tested on part I of the NBCE. Each subject category is comprised of more than one subject. Anatomy is comprised of histology, gross anatomy, and neuroanatomy. Biochemistry encompasses selected elements of biology, chemistry, and nutrition. Spinal anatomy combines spinal biodynamics and sections of anatomy. Physiology covers cardiopulmonary, renal, endocrine, neurologic, and gastrointestinal physiology. Pathology includes laboratory diagnosis and micropathology. The college's institutional review board exempted this study, as it met the criteria listed in the US Department of Health and Human Services Codes of Federal Regulations (45 CFR 46).

Four main categories of variables were used to ascertain the results of this study, as follows:

1. Entering GPA: The students' entry point GPA was obtained to establish the acceptable GPA ranges within which qualifying students are admitted in the Doctor of Chiropractic degree program. The students' entering GPA was correlated to their current class GPA, average class scores, the NBCE Pretest scores and their respective Part I of NBCE results.
2. Academic performance (class score): The students' performances in all classes that constitute Part I of NBCE were obtained from the registrars' office. This was used for comparison purposes. Their respective averages were compared to NBCE pretests to determine any significant trends. These were used to measure the level of commitment to the discipline of study by students. They also were correlated with their NBCE performance.

For accurate analysis, the academic performance for each student was evaluated in each subject. This was represented by the final grade obtained in each subject. Since each testable section in NBCE is comprised of different subjects, like subjects were grouped together to give a testable subject category. The Anatomy average was obtained by combining Histology and all gross Anatomy courses (Anatomy

I II III). Biochemistry and Nutrition were combined to give the Chemistry average. All microbiology courses were merged to give the Microbiology average just like Spinal Biodynamics for the Spinal Anatomy average. Laboratory Diagnosis and Micropathology scores were the derivatives of the Pathology average. Endocrine/Reproduction, GI/Renal physiology, Neuromusculoskeletal Diagnosis, Neuroanatomy, Neuro/Muscle, and Neuropathophysiology gave the Physiology average. It is important to note that there is an overlap of subjects taught. For example, some of the content covered in Anatomy courses is pertinent to Spinal Anatomy NBCE testing. Subjects were grouped as above for the most accurate analysis.

3. Pre-test score: The students were given a weighted breakdown of each subject area to be tested by the NBCE. The breakdown indicated the subjects in which they would be tested and the topics of testing. It went further to show the percentile weighting of each topic in each subject as tested by NBCE.

A testing schedule was formulated. Students were to spend the first two weeks of the school quarter preparing for National Boards under individual focused study. They were given the testing schedule and asked to prepare accordingly for one subject each week. At the end of each week, the students took a written exam in the respective subject.

To avoid too much variation and for uniformity purposes, the students were directed to identified subject matter for their preparation. They were to focus on their class package of notes and could use only one supplementary source of notes.

Respective faculty members in charge of different subjects were asked to set the pretest examinations. The exams were set to the rigor of the school's final exam standard in mirroring the standards of NBCE. This exercise lasted another six weeks – testing students in the six sections that constitute Part I of NBCE.

The results of this exercise constituted the third variable, which was obtained from the Student Success department. This, too, was a measure of the level of commitment from the students in preparing for the board examinations. Students were encouraged to continue studying the same material until they took their board examinations. All subjects had a mean score and a pretest except for physiology, which did not have a pretest because of conflicts in scheduling pretest exams alongside internal midterm exams.

4. NBCE performance: The fourth variable, considered as the dependent (response) variable was the student's scores in the NBCE.

Between main categories 3 and 4, 13 predictors were used. Along with entry GPA, a total of 14 predictors was included in the study (Table 1). The number of students for

Table 1 - Summary Statistics for the One Dependent Variable (Mean NBCE) and 14 Independent Variables

| Variable | N | Mean | SD | Min | Max |
|------------------------|----|-------|-------|-------|-------|
| Mean NBCE | 24 | 524.4 | 76.2 | 392 | 664 |
| Entry GPA | 24 | 3.16 | 0.38 | 2.70 | 3.96 |
| Current GPA | 24 | 3.14 | 0.50 | 2.37 | 4.0 |
| Mean class score | 24 | 84.74 | 5.36 | 74.70 | 94.82 |
| Mean anatomy | 22 | 87.82 | 5.29 | 78.00 | 96.25 |
| Pretest anatomy | 24 | 80.83 | 10.64 | 62 | 99 |
| Mean chemistry | 22 | 81.46 | 6.31 | 72.67 | 94.33 |
| Pretest chemistry | 20 | 84.50 | 7.88 | 70 | 99 |
| Mean microbiology | 23 | 85.15 | 6.73 | 73 | 96 |
| Pretest microbiology | 23 | 83.91 | 8.13 | 70 | 99 |
| Mean spinal anatomy | 22 | 84.52 | 6.73 | 70 | 95 |
| Pretest spinal anatomy | 24 | 84.29 | 5.40 | 76 | 94 |
| Mean pathology | 24 | 87.06 | 6.27 | 76.25 | 97.67 |
| Pretest pathology | 23 | 81.91 | 9.08 | 65 | 98 |
| Mean physiology | 24 | 83.74 | 5.63 | 76.13 | 94.29 |

each predictor varied slightly, ranging from 20–24, depending upon missing data due to the fact that some of the participants were transfer students who were not enrolled at the institution where the basic sciences are offered early in the curriculum.

Upon obtaining results for NBCE part I in April 2011, the following correlations were calculated using Stata IC 12.1 (StataCorp, College Station, TX) between the variables where a correlation and multiple linear regression (MLR) analysis was performed. Correlation standards were derived from Colton's study⁸ in statistics: 0.00–0.25 = weak to no relationship, 0.25–0.50 = fair relationship, 0.50–0.75 = moderate to good relationship, whereas values greater than 0.75 constituted good to excellent relationship.

Nonlinear relationships were observed in some of the scatterplots, where the following independent variables were used: Mean microbiology, pretest microbiology, mean spinal anatomy, and pretest pathology. Consequently, the Spearman correlation was used. Since multiple ($n = 14$) correlations were performed, a Bonferroni-adjusted alpha of 0.0036 (0.05/14) was applied. A p value $<$ the alpha was considered statistically significant. The aforementioned four predictors exhibiting nonlinear relationships in scatterplots were excluded in MLR.

Several models were run for MLR. Predictors exhibiting the greatest collinearity according to variance inflation factors >10 were removed one at a time in subsequent models. Predictors having the largest p -values were also removed one-at-a-time in subsequent models. Since unequal variance was observed in the various scatterplots, the "robust" option was used in the regression command. A p value in MLR $<$ the traditional alpha of 0.05 was considered statistically significant.

The results of the four students who did not complete the testing program also were analyzed. These served as a screening tool in measuring commitment to the discipline of study. All student records were kept confidential. Students were assigned random codes unknown to them for analyzing their performance.

The study's sample size (of 24) was dictated (and, therefore, limited) by the number of students who registered to take the NBCE examination at our relatively small chiropractic college in March 2011. However, this sample size is approximately the minimum size needed to achieve at least a moderate strength correlation of approximately $|0.400|$.⁹

RESULTS

Summary statistics are provided in Table 1. Eight of the 14 correlations revealed direct, statistically significant correlations, and these were moderate-to-excellent in strength (Table 2). Among these were mean anatomy and mean chemistry (Figs. 1 and 2), both of which qualified for the final MLR model. Regression coefficients were 6.1 for mean anatomy (95% confidence interval [CI] = 2.4–9.7) and 6.0 for mean chemistry (95% CI = 2.6–8.6, Table 3).

DISCUSSION

Six independent variables (mean anatomy, mean chemistry, current GPA, mean class score, mean pathology, and mean spinal anatomy) emerged as having the strongest correlations with NBCE Part 1 scores. Two of these variables, mean anatomy and mean chemistry, qualified for more rigorous testing in multiple linear regression as predictors for the NBCE scores. Both predictors revealed similar predictive strength, with coefficients of approximately 6.0. This means that for every 1% increase in either of these predictors, a corresponding six point increase in average NBCE scores can be expected. These findings are similar to the 1997⁹ and 1999¹⁰ studies of Zhang. In both studies, entry GPA was correlated less strongly with NBCE Part 1 scores, while correlated more strongly with academic performance in basic science subjects.

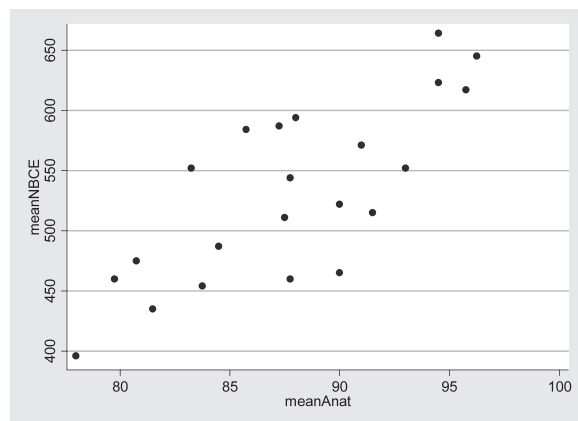
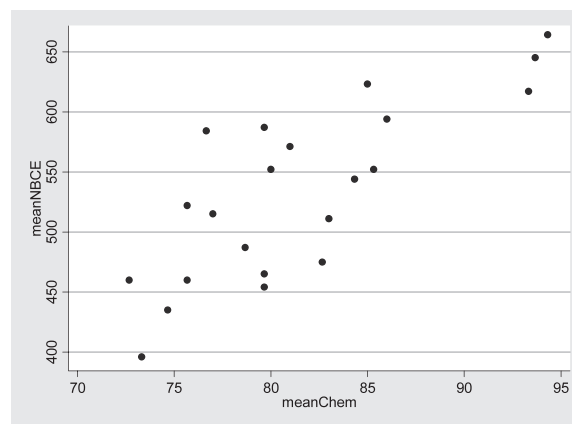
Table 2 - Spearman Correlations for One Response Variable (NBCE) and 14 Independent Variables

| Independent Variable | <i>n</i> | <i>r</i> | <i>p</i> |
|------------------------|----------|----------|----------|
| Entry GPA | 24 | 0.458 | 0.0245 |
| Current GPA | 24 | 0.609 | 0.0016 |
| Mean class score | 24 | 0.758 | 0.0000 |
| Mean anatomy | 22 | 0.730 | 0.0001 |
| Pretest anatomy | 24 | 0.673 | 0.0003 |
| Mean chemistry | 22 | 0.764 | 0.0000 |
| Pretest chemistry | 20 | 0.599 | 0.0053 |
| Mean microbiology | 23 | 0.513 | 0.0124 |
| Pretest microbiology | 23 | 0.592 | 0.0029 |
| Mean spinal anatomy | 22 | 0.736 | 0.0001 |
| Pretest spinal anatomy | 24 | 0.545 | 0.0059 |
| Mean pathology | 24 | 0.701 | 0.0001 |
| Pretest pathology | 23 | 0.561 | 0.0053 |
| Mean physiology | 24 | 0.582 | 0.0029 |

r, Spearman correlation coefficient; *p*, *p* value for the coefficient.

The majority of students admitted to doctor of chiropractic programs have an entry GPA of 2.50–3.50. The very brilliant and the above average groups of students sometimes struggle to pass national board examinations. What makes the difference in determining success or failure in the lives of these competent students?

The 1997 study of Zhang⁹ on the correlation of student entry level GPA, class performance, and the NBCE examinations enumerates detailed findings on the correlations between entry GPA and NBCE scores, which he supports using a Dartmouth Medical school study¹¹ to compare undergraduate science GPA, MCAT scores, and the academic caliber of the undergraduate schools of the applicants to predict success effectively in the first year of study. He further contrasts this with the findings from a study by Hall and Stocks,¹² which he concluded by saying that the quantity of science-based undergraduate premedical education did not affect the performances of the selected medical school students in their preclinical years of medical school. In our search for a correlation between academic performance and national board scores, we

**Figure 1 - Scatter plot for NBCE and mean anatomy scores.****Figure 2 - Scatter plot for NBCE and mean chemistry scores.**

concurred with Zhang's noted reasons. Abedi further posits about why undergraduate GPA could not have a relationship with any of the measures of graduate academic success, citing lack of comparability since GPAs are obtained from different educational institutions, lack of variability since the majority of undergraduate GPAs fall between 2 and 3.5, and the non-normality of the GPAs since many students with lower GPAs do not even apply for admission to more prestigious schools.⁶

More recent studies, such as correlation of preadmission organic chemistry courses and academic performance to biochemistry,¹³ have been conducted by chiropractic colleges in an attempt to find solutions for weak performance in science subjects tested in Part 1 of NBCE. As evidenced by McCall et al¹⁴ and De Ball et al,¹⁵ the concern is not just in chiropractic schools but also in other health care institutions, such as dentistry and pharmacy schools. The results of our study support the findings of others, like Fergusson,¹⁶ who concluded that previous academic performance was a good, but not a perfect, predictor of achievement in medical training.

In the 1999 report of Zhang,¹⁰ where he studied results for 52 students, entry GPA was correlated with the various components of NBCE Part 1 subjects, with the coefficients ranging between low and moderate strength. Our study was similar to this, even with our lower sample size, to the extent that entry GPA revealed the lowest correlation among the 14 independent variables. The 1999 Zhang study analyzed chiropractic college scores in relation to each other as well as to individual NBCE subjects, whereas the present study analyzed chiropractic college scores only

Table 3 - Multiple Linear Regression with Two Predictors and NBCE Part 1 as the Response Variable

| Predictor | Coefficient | <i>t</i> | <i>p</i> | 95% CI |
|----------------|-------------|----------|----------|---------|
| Mean anatomy | 6.1 | 3.46 | 0.003 | 2.4–9.7 |
| Mean chemistry | 6.0 | 3.87 | 0.001 | 2.6–8.6 |

t, *t* statistic; *p*, *p* value for the *t* statistic; 95% CI, the interval that the coefficient is expected to occur 95% of the time.

in relation to the average NBCE Part I scores, which is a composite of the various NBCE Part I subjects.

The question our study sought to answer is what predictors can chiropractic schools use to improve performance on National board examinations? Our study found a relatively weaker correlation for entry GPA compared to chiropractic academic performance. Entry GPA was not the major determinant of a student's academic success as noted in other studies.²⁻⁵

Such consistent trends evident in most institutions of higher learning tend to point to each enrolling institution to cultivate enrolled students into competent and polished doctors at the end of the curriculum to meet the demanding needs of the public. The majority of participants in our study had been encouraged to keep up with their studies right from the time of admission. Their entry GPA was brought into play to qualify the fact that most of the students admitted in the Doctor of Chiropractic program were of good academic standing, but a high entry GPA did not guarantee higher success on NBCE part I. The students' academic performance (class scores) together with the pretest scores were used as an evaluation tool to show the commitment of the students to the discipline of study. The NBCE scores were used as a measure of the level of success for each student.

It was evident from the results that students who kept abreast with their studies had higher scores in NBCE. These are students who maintained a higher class average and current GPA. Those who kept up with the rigorous testing exam that constituted the results of the pretest also scored highly on the national board examination. Those who were unable to keep up with the rigor either pulled out completely or missed a couple of tests. Their average results mirrored that same pattern. The very top scorers in each pretest category tended to maintain the higher scores even in NBCE.

Most graduate schools go out of their way to recruit and attract students who have higher entry GPA. At the back of the mind is the notion that the higher their GPA, the better chances of success for the student and institution. Just as Abedi⁶ concluded, one's performance in undergraduate level of education was of no significant prediction for graduate level success, and our study not only affirms it but goes further to identify tangible predictors of academic success in our program.

Three predictors stand out that point students and educators towards success: Obtaining high class scores, maintaining high GPA, and keeping up with the rigor of intense testing in graduate school programs. Each of these predictors closely monitors students' involvement and commitment to their discipline of study. They depict one's ability, comprehension, and conceptualization of content taught at each advancing level. Rigorous testing kept to the level of national board examinations helps to get the students within the mindset of the forthcoming examinations. They prepare them not just mentally, but emotionally in addition to driving them into focused study. Taking national board examinations is a stressful event for most students. With many sections of the exam administered one after the other within 2 days, constant or regular

testing helps students adjust to such stress. When candidates are sure that the pretests administered are to the required and expected standards of the anticipated examinations, their performance either encourages them to face national exams with confidence or forces them to settle down and prepare better.

There are exceptionally few studies that analyze the multiple predictors used in our study within the chiropractic profession. As Zhang points out in his 1997 study,⁹ a moderate statistical correlation ($r = 0.517$) was found when entry GPA was correlated with NBCE test scores. Students' class performance yielded a moderate to strong correlation with national board scores ($r = 0.662$). This study revealed a higher correlation ($r = 0.758$) when the students' performance was correlated to NBCE scores, despite its major weakness of having a small sample size.

One limitation of this study was to test students who were enrolled fully for the winter quarter. With a full class and continuous assessment test schedule in operation, many students would have benefited from extra time to prepare better for the pretest exercise. The students were not tested in Physiology due to conflict in normal class testing and pretest schedules. Results may have been better had the students had more time to prepare for NBCE. This is one aspect of curriculum review and implementation that individual institutions might implement in creating a more time-friendly schedule for students taking NBCE.

The sample used for our study was relatively small, which makes it weaker than the Zhang studies in regard to sample size. This is due to the fact that it was conducted in a small college. Another limitation is that the student sample was from only one college, thus inhibiting generalization to other chiropractic colleges. The sample used in this study came from only one class, thereby inhibiting generalization to other classes at our institution. Expanding this study to other institutions with appropriate sample sizes can add knowledge and reveal results that can be beneficial in implementing of policies regarding the enrollment, teaching, and testing of students.

CONCLUSIONS

Our preliminary data showed six independent variables having statistically significant associations with NBCE Part I scores. Among these variables are the predictors of mean anatomy scores and mean chemistry scores. A high entry GPA did not guarantee higher scores in the Doctor of Chiropractic degree program or on NBCE Part I. Embracing a discipline of study, maintaining high class scores, and keeping up with rigorous testing likely enhance success.

Further study with a larger randomized sample is recommended.

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CONFLICTS OF INTEREST

The authors declared no conflicts of interest.

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