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## **Predictors of Student Success in an Entry-Level Baccalaureate Dental Hygiene Program**

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***Purpose.*** The purpose of this study was to measure the utility of various predictors used by the Old Dominion University Gene W. Hirschfeld School of Dental Hygiene baccalaureate degree dental hygiene program in selecting dental hygiene students who are most likely to graduate and be successful in passing the National Board Dental Hygiene Examination (NBDHE). The following factors were examined: grade point average (GPA); science GPA; final grade in various prerequisite courses; final grade in first-year dental hygiene courses; academic setting where prerequisite courses were completed; multiple attempts to achieve a passing course grade; and admissions criteria points (ACP).

***Methods.*** The sample selected for study consisted of the academic records of dental hygiene students admitted to the program from 1998 to 2002 ( $n = 235$ ), who would have been eligible to take the NBDHE from 2000 to 2004. Data were analyzed using multiple logistic regression to determine success as measured by graduation ( $n = 146$ ). With NBDHE as the criterion variable, data were analyzed using the multiple linear regression to determine successful entry into the profession ( $n = 130$ ); significance was predetermined at the 0.05 level.

***Results.*** Data analysis revealed that final course grade in oral pathology was a significant predictor of successful graduation ( $P = 0.0008$ ). Variables that predicted NBDHE success were final course grade in oral pathology, final course grade in oral anatomy and histology, and the ACP rating ( $P < .0001$ ,  $P < .0001$ , and  $P = .0245$ , respectively). There was no statistically significant relationship for other variables.

***Conclusion.*** Final grades in oral pathology and oral anatomy and histology can significantly predict graduation and NBDHE success at this institution, suggesting that educators look to improving student performance after admission to the program to improve the likelihood of success. Additionally, when this institution's admission variables were combined into a cluster of variables (ACP), they proved significant at predicting success.

**Keywords:** Dental hygiene education, admissions, student success, graduation, National Board Dental Hygiene Examination

### **Introduction**

Predicting academic success is a persistent challenge for dental hygiene programs whose lock-step curricula make replacing students who drop out midway through the program difficult, if not impossible. Selecting students from a pool of qualified

applicants who are most likely to succeed is the goal of dental hygiene educators throughout the country. Success is often defined as graduation within a specified time frame following enrollment. An equally challenging goal is to graduate competent oral health care providers who will pass the National Board Dental Hygiene Examination (NBDHE) and enter into the profession able to meet the needs of the community.

Numerous studies have attempted to identify what variables predict academic and professional success. Investigations of cognitive variables such as grade point averages, science course grades, and scores on standardized tests have produced mixed results in determining correlation between the variable of interest and academic success.<sup>1-5</sup> Studies of noncognitive variables, such as dental assisting experience, personality tests, and admissions interviews, have produced equally mixed results.<sup>4</sup> Other variables, such as custom-designed ranking systems utilized by some admissions committees to organize applicants prior to selection, and academic settings where an applicant took the required prerequisite courses, have been the focus of recent research.<sup>2,10-11</sup>

At the time of this investigation, there were 273 entry-level dental hygiene programs in the United States, 34 of which offered the baccalaureate degree as the entry-level credential. While accrediting agencies and institutional requirements direct that certain variables be utilized to select incoming applicants, there remains a need for each institution to be cognizant of research that will help the admissions committee make selections that benefit the institution and the community it serves as well as the prospective student.

The purpose of this study was to measure the utility of a variety of predictors that can be used to assist Old Dominion University, Gene W. Hirschfeld School of Dental Hygiene and possibly other baccalaureate dental hygiene programs in selecting dental hygiene students who are most likely to graduate within the expected time frame and pass the NBDHE. Specifically, this study sought to determine whether or not overall grade point average (GPA) at the time of application for admission; GPA in prerequisite science courses; individual final grade in prerequisite science courses, chemistry I and II, human anatomy and physiology I and II, and microbiology; individual final grade in first year dental hygiene courses, oral anatomy and histology and oral pathology, academic setting where prerequisite science courses were completed; multiple attempts to achieve a passing final grade in prerequisite science courses; and ranking score produced by a custom-designed program called admissions criteria points (ACP), are reliable predictors of success in an entry-level dental hygiene program as evidenced by graduation, and are reliable predictors of entry into the profession as evidenced by passing the NBDHE.

## **Review of the literature**

### ***Grade point average***

The study of grade point average (GPA) as a predictor variable appears often in the literature. Researchers have studied high school GPA, college course preprofessional program GPA, science and other prerequisite course GPA, and dental hygiene GPA at specified intervals and at graduation. Incoming GPA, cumulative GPA, early course average, and interim course average, are among the names that researchers use to refer to the different calculations. While the literature supports a strong correlation between GPA and success in a given dental hygiene program, the exact definition of GPA varies widely.

Thirty years ago, Rowe et al found, among other variables, that overall high school GPA and high school science GPA were significant predictors of performance in a dental hygiene certificate program.<sup>12</sup> Since that time, changes in program admissions requirements and the applicant pool have produced potential students who present with a variety of college credit.

In 1989, Shannon investigated the predictive reliability of American College Test score, high school GPA, dental hygiene GPA, college cumulative GPA, and individual college course grades. A regression equation analysis found that cumulative dental hygiene GPA was the best predictor of success on the National Board Dental Hygiene Examination (NBDHE) and that neither high school nor college cumulative GPA was a significant predictor of NBDHE success.<sup>13</sup> However, Shannon's

parameters for dental hygiene GPA included college chemistry, anatomy, physiology, nutrition, and sociology, 13 courses that another researcher might define as prerequisite or science or overall GPA.

Metzger et al examined the admissions criteria used to select students for the dental hygiene program at the University of Maryland at Baltimore to determine if a relationship existed between 4 variables and success on the NBDHE and Northeast Regional Board clinical test scores.<sup>8</sup> Total college GPA and college science GPA (both defined as the GPA for the first 2 years of undergraduate education prior to admission to the program) were analyzed along with scores on the Dental Hygiene Aptitude Test science section and a score from a 25-question personal interview. Results of the study indicate that college science GPA was the most important determinate of admissions into the program. The researchers point out that the usefulness of what they called the total college GPA may be limited, since the number of credits and types of courses that a student may have taken can vary considerably.<sup>8</sup> One high or low grade may be more likely to significantly affect the overall GPA for a student with a limited number of college courses, versus a student who has accumulated more college credits, possibly allowing the GPA to inaccurately represent student academic abilities.<sup>8</sup>

Downey et al examined the predictive reliability of GPA and Scholastic Aptitude Test scores in predicting dental hygiene program success and NBDHE score.<sup>1</sup> A retrospective review of 134 dental hygiene graduates of the Medical College of Georgia from 1996-2001 revealed that incoming overall college GPA at the time of admission was a significant predictor of a student's dental hygiene GPA, and the only variable tested that was significant at predicting NBDHE scores. Incoming overall college GPA at the time of admission to the dental hygiene program was found to be more accurate at predicting dental hygiene program success than incoming math and science GPA. The researchers did not define how many or what specific courses made up the overall GPA, incoming college GPA, or incoming math and science GPA.

Bauchmoyer et al obtained data on 173 graduates of the dental hygiene program at The Ohio State University from 1998-2002 to examine the relationship between pre-admission requirements, site of academic preparation, cumulative dental hygiene GPA, and NBDHE scores.<sup>2</sup> The purpose of this study was to investigate traditional variables such as GPA and individual course grades used by admissions committees to select applicants that had not been studied since the NBDHE format changed in 1998 to include case-based questions. Using Pearson's *r* correlations, regression analysis, and analysis of variance (ANOVA) the authors concluded that entering cumulative GPA had the strongest correlation with program success as defined as cumulative dental hygiene GPA and was closely followed by science GPA (made up of course grades in biology, chemistry I and chemistry II). NBDHE success was strongly predicted by the cumulative dental hygiene GPA, followed by the science GPA and the entering cumulative GPA.

DeWald et al analyzed the records of a sample of dental hygiene students (n=168) at Caruth School of Dental Hygiene, Baylor College of Dentistry from 1998-2003 to determine if enrolling in a board review course affected performance on the NBDHE and to confirm or reject the hypothesis that entering and/or existing GPA can be used to predict performance on the NBDHE.<sup>14</sup> Pearson's correlation coefficient was used to find the relationship between both entering and exiting GPA and NBDHE. Entering GPA was not found to be a predictor of NBDHE performance, while exiting dental hygiene GPA was found to be a strong predictor of performance on the NBDHE.

Edenfield and Hansen sought to determine if a relationship exists between dental hygiene GPA made up of different core dental hygiene course grades and scores on a mock national dental hygiene board examination and the NBDHE.<sup>15</sup> The researchers sampled 130 dental hygiene student records at Armstrong Atlantic State University between and among the years 1989 and 1995 to obtain grades in clinical dental hygiene I, II, III, and IV, periodontics, dental materials, dental anatomy and oral histology, general and oral pathology, and preventive periodontics. An early dental hygiene course average was determined from these grades. Grades were also obtained for clinical dental hygiene V and dental public health, courses taken by the students after taking a mock national dental hygiene board examination, but before taking the NBDHE. Multiple linear regression techniques were utilized to determine that the early dental hygiene course average, the interim dental hygiene course average, and the mock national dental hygiene board examination score can not predict NBDHE scores, but may play a role in estimating the probability of achieving a passing score. There was a 98% NBDHE pass rate by those students in the top 75% of high early dental hygiene course average, while those students in the bottom 25% exhibited a 62% pass rate.

Schutte and Smith investigated the predictive reliability of the American College Test score, high school GPA, first-year dental hygiene GPA, age, and dental assisting experience.<sup>3</sup> Following statistical analysis utilizing Pearson's *r* correlation coefficients and coefficients of determination, P-values were calculated and a regression equation was developed to analyze the variance associated with each predictor variable. All of the variables, including both the high school GPA and first-year dental hygiene GPA were determined to be weak predictors of NBDHE success.

### ***College Course Grades***

In addition to examining the predictive ability of (grade point average) GPA, researchers have indicated that individual course grades may have predictive ability when examined as single variables. Studies of individual course grades have included final course grades for high school courses, pre-professional college courses, college science courses, performance in online courses and performance in dental hygiene courses.<sup>2,3,11,13</sup>

Along with GPA, Shannon examined college courses in the behavioral, biological, and physical sciences for predictability.<sup>13</sup> Data were collected from 219 dental hygiene student records at 3 associate degree programs from 1983-1986 on individual course grades in human anatomy, physiology, chemistry, microbiology, psychology, pharmacology, nutrition, and sociology to determine possible predictive ability of individual courses. A stepwise multiple regression analysis demonstrated positive correlations for predicting success in the dental hygiene program for human anatomy, nutrition, sociology, chemistry, and physiology, while grades in sociology, psychology, and anatomy were most likely to predict NBDHE success.

Bauchmoyer, Carr, Clutter, and Hoberty studied 10 individual courses that comprise the preadmissions requirements and basic college science requirements for the dental hygiene program at The Ohio State University to determine whether or not a correlation existed between course grades and program and NBDHE success.<sup>2</sup> Pearson's *r* correlation was used to analyze individual course grades in program-required courses, including, biology, chemistry I and II, English, math, and psychology. The strongest correlation with program success was demonstrated by course grades in biology and chemistry and the strongest correlation with NBDHE success was demonstrated by course grades in biology and psychology. Additionally, the researchers sought to determine whether or not a correlation existed between grades in courses required after matriculation, including, anatomy, nutrition, microbiology, and physiology. Among these courses, the course grade in nutrition was found to have the strongest correlation with program success, followed in decreasing order of correlation, by anatomy, physiology, and microbiology. The course grade in physiology demonstrated the strongest correlation with NBDHE success followed in strength by anatomy, microbiology, and nutrition.

### ***Academic Setting and Multiple Attempts***

Inconclusive evidence regarding what predicts success prompts admissions committees to look beyond traditional variables used to select students who are most likely to graduate and pass the National Board Dental Hygiene Examination (NBDHE). One of the variables Bauchmoyer et al examined in their study at The Ohio State University, was the possible affect the academic setting where the prerequisite science courses were completed (4-year university or 2-year community college) had on academic achievement.<sup>2</sup> The researchers grouped students into 3 categories: those who completed all prerequisite science courses at a 4-year university; those who completed a fairly equal number of courses at both a 4-year university and a 2-year community college; and those who completed all or almost all of the prerequisite science courses at a 2-year community college. Results of analysis of variance (ANOVA) comparison revealed no significant difference in success rates for NBDHE for the 3 groups. A post-hoc Scheffé comparison indicated a significant difference for dental hygiene program success between the group who completed all prerequisite science courses at a 4-year university and the group who completed a fairly equal number of courses at both settings. The researchers suggest that consistency in site where prerequisite science courses were taken was significant to predict program success.

There is no evidence in the literature of an investigation into the possibility that passing the prerequisite science courses the first time is predictive of success. For the purpose of this study, it was hypothesized that students who needed to repeat any of the prerequisite science courses to achieve a passing grade might take longer to successfully master the dental hygiene curriculum. To efficiently educate a student and prepare him/her for success on the NBDHE, admissions committees

would like to admit individuals who will be successful in achieving the goal of entering the dental hygiene profession with the minimum resource expenditure.

### ***Custom-Designed Admissions Rating Tools***

Observation suggests that individual dental hygiene programs have developed their own rating or point system to assist in ranking applicants to determine those who will be most likely to succeed. However, limited publications are found that discuss the use of an institution's custom-designed rating system. In 1981, Metzger et al combined 4 variables: Dental Hygiene Aptitude Test science section score, science grade point average (GPA), total (GPA), and score assigned on a personal interview, into a total admission score to rank applicants for acceptance into the Dental Hygiene Program at the University of Maryland at Baltimore. The researchers sought to determine what role the total point score obtained from the 4 variables plays in selecting applicants for admission and whether or not this score predicts dental hygiene program success.<sup>8</sup> However, the statistical analysis, Pearson product-moment correlation and stepwise multiple regression routine, were performed on each of the 4 variables separately, negating the ability to confirm or reject the rating system as a predictor of success.

Edenfield and Tanenbaum sought through an ex post facto study to determine if the Admission Point Index rating system used for selection of applicants to Armstrong Atlantic State University could be used as a reliable predictor of dental hygiene program success and success on the NBDHE.<sup>10</sup> The researchers gathered data on student applications for the years 1995 through 1997, and noted the retention and graduation rates and NBDHE scores. While the custom-developed index was determined to be a reliable predictor of success, the abstract does not fully describe what variables make up this custom-designed rating system.

The goal of dental hygiene educators is to prepare competent oral health care professionals who can contribute to the profession; thus, determining what predicts success has been a persistent goal among dental hygiene admission committees. Success is achieved most efficiently when students enter the program and progress through the sequence of classes to achieve clinical competencies, and satisfy accreditation and university credit requirements within a specified time frame. Students who stop-out of the program because of a failed course, the need for extra time to complete clinical requirements, or require remediation to bring skills to a competency level, tax resources and may prevent another candidate from entering the program.

Additionally, in most all licensing jurisdictions in the United States, successful graduates must then achieve a passing score on the NBDHE as a step to becoming a licensed dental hygienist. Educators want to know whether or not certain variables that predict academic success as defined as graduation are the same as those that predict NBDHE success. Valid and reliable methods for selecting potential students who are most likely to succeed in both graduating and passing the NBDHE are sought.

## **Methods and Materials**

The variables under investigation were chosen based on the following: their prevalence as traditionally collected data on dental hygiene program applications; the evidence in the literature regarding their importance to academicians and institutions; the reported conflicting results of studies found in the literature; and the special interest of the faculty at this institution. A convenience sample was chosen using the academic records for all students admitted to Old Dominion University, Gene W. Hirschfeld School of Dental Hygiene, for the academic years 1998 through 2002 (n=235). Students are admitted to this entry-level baccalaureate degree program after having completed 2 years of prerequisite and general education courses. Students admitted to the dental hygiene program would be expected to be become eligible to take the National Board Dental Hygiene Examination (NBDHE) 2 years after admission.

Prior to initiation of the study, an exempt status proposal was submitted to the Old Dominion University, Institutional Review Board, and was approved. The following variables were extracted from admissions applications and transcripts and placed into a custom-designed spreadsheet: incoming college grade point average (I-GPA), defined as GPA at the time of application submission; grade point average in prerequisite college science courses (S-GPA), defined as chemistry

I, chemistry II, human anatomy and physiology I, human anatomy and physiology II, and microbiology; individual final course grade in college chemistry I, chemistry II, human anatomy and physiology I, human anatomy and physiology II, and microbiology; individual final course grade in first-year dental hygiene courses oral anatomy and histology and oral pathology; academic setting where prerequisite science courses were completed (4-year university or 2-year community college); multiple attempts to achieve a passing final grade in prerequisite science courses (chemistry I, chemistry II, human anatomy and physiology I, human anatomy and physiology II, and microbiology); admissions criteria points (ACP) generated by a custom-designed applicant ranking system used by the admissions committee; graduation or non-graduation within 2 years of enrollment; and NBDHE score.

The ACP combines an applicant's I-GPA, S-GPA, grades in prerequisite and general education required courses, significant educational achievements, oral health care experience, and quality and completeness of application, and ranks each applicant with an ordinal score. This instrument assigns quantitative numbers to the required admissions data and tallies the numbers into a total score. This total score is utilized to assist the admissions committee with selecting applications.

Students who completed 3 or more of the 5 prerequisite science courses at a 4-year university were categorized as 4-year university students. Students who completed 3 or more of the five prerequisite science courses at a 2-year community college were categorized as 2-year community college students. Data were extracted from student transcripts regarding science courses that were repeated to achieve a passing grade. Students who did not qualify for graduation within 2 academic years from the time of admission into the program were non-graduates and students who did not pass the NBDHE on the first try were considered to have failed.

This study investigated the relationship among quantitative variables; therefore, a regression approach was used to determine whether admission variables are reliable predictors of success in an entry-level baccalaureate dental hygiene program as evidenced by graduation from the program and reliable predictors of successful entry into the profession as evidenced by the NBDHE. Means, percentages, and frequencies were used to analyze the data. Multiple logistic regression analysis was used to determine the relationship between variables and graduation. Multiple linear regression analysis was used to determine the relationship between variables and NBDHE. In all cases of analysis, a p-value of less than or equal to 0.05 level was tested to determine significance. To confirm the results of the initial regression analysis, the following additional approaches were employed: backward elimination method of selection of variables and R-square method, residual analysis, and analysis of variance.

## **Results**

Following data collection, frequency tables were examined to determine sample sizes of complete records for statistical treatment. Multiple logistic regression to determine success as measured by graduation was performed on a sample size of 146 complete records and multiple linear regression to determine NBDHE success was performed on a sample size of 130 complete records. The frequency tables revealed that a significant number of missing data values occurred for individual final course grades in chemistry II and human anatomy and physiology II. At the time of application submission, many candidates are enrolled in these courses, making final grades unavailable at the time of data collection. Therefore, these 2 variables were omitted from analysis to avoid further reducing the sample sizes.

Because the dependant variable, graduating within 2 years of beginning the program or not graduating within 2 years of beginning the program, is a dichotomous variable, a multiple logistic regression model was used to analyze the variables. The variable, academic setting where prerequisite science courses were completed (4-year university or 2-year community college) was analyzed independently from the other 9 variables because this data set had 2 relating or complimenting values, 4-year university and 2-year community college. Regression analysis performed on this separate data set (n=235) revealed no statistically significant relationship between the academic settings and graduation or NBDHE success.

Multiple logistic regression analysis of the other 9 variables indicated that all but one, individual final course grade in oral pathology, were not significant at 0.05 (Table I). A backward elimination of selection of variables approach was applied to determine a smaller set of variables. Table II displays the variables removed from the data set during backward elimination analysis, indicating the removal of 8 of the 9 variables until the remaining variable, individual final course grade in oral pathology, was significant at the 0.05 level of significance (p-value 0.0008) (Table III).

**Table I. Results of multiple logistic regression: variables associated with graduation**  
 (n = 146; df = 1)

Variable	Estimate	Standard Error	Wald chi-square	Pr > ChiSq
API	0.0253	0.0572	0.1962	0.6578
I-GPA	0.4957	1.1356	0.1905	0.6625
S-GPA	-0.6177	1.4897	0.1719	0.6784
Multiple Attempt	-.0606	0.3864	0.0246	0.8753
Chemistry I	-0.4975	0.6298	0.6240	0.4296
Microbiology	-0.5773	0.5521	1.0932	0.2958
Anatomy I	-0.3987	0.6398	0.3882	0.5332
Oral Anatomy	0.7684	0.4938	2.4221	0.1196
Pathology	1.6491	0.5013	10.8226	0.0010*

\*significant at the 0.05 alpha level

**Table II. Results of chi-square for cross tabulation between variables and graduation**

Step	Variable removed	Number In	Wald chi-square	Pr > ChiSq
1	Multiple Attempt	8	0.0246	0.8753
2	S-GPA	7	0.1712	0.6790
3	ACP	6	0.1361	0.7122
4	I-GPA	5	1.3493	0.2454
5	Anatomy I	4	1.3527	0.2448
6	Oral Anatomy	3	2.3890	0.1222
7	Chemistry I	2	1.8452	0.1743
8	Microbiology	1	3.2298	0.0723



**Table III. Final results of multiple logistic regression: variables associated with graduation**

Variable	DF	Parameter Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Pathology	1	1.0967	0.3285	11.1492	0.0008*

\*significant at the 0.05 alpha level

The dependent variable, NBDHE score, was measured in ratio scale, prompting the use of multiple linear regression analysis, which revealed that 2 variables, individual final course grade in oral pathology and individual final course grade in oral anatomy and histology, are significant predictors (Table IV). A backward elimination method of selection of variables yielded 3 significant variables with an R-square value equal to 0.5581 (See Table V). Additional analysis utilizing the backward elimination method indicated the removal of 5 variables until the 3 variables remaining were significant. A selection of variables R-square test confirmed this selection as appropriate on which to perform further analysis. Multiple linear regression testing was run a second time to determine the most significant predictors of the 4 variables selected by backward elimination. The second multiple linear regression analysis yielded the variables, individual final course grade in oral pathology, individual final course grade in oral anatomy and histology, and ACP, as statistically significant predictors of NBDHE success (Table VI).

**Table IV. Results of multiple linear regression: variables associated with NBDHE (n= 130; df = 1 )**

Variable	Parameter Estimate	Standard Error	t-Value	Pr >  t  (P-value)
ACP	0.05874	0.07212	0.81	0.4169
I-GPA	-0.01884	1.51758	-0.01	0.9901
S-GPA	1.32570	1.96683	0.67	0.5016
Multiple Attempt	0.23502	0.48021	0.49	0.6254
Chemistry I	-0.49961	0.79467	-0.63	0.5307
Microbiology	0.25762	0.78067	0.33	0.7420
Anatomy I	-1.40194	0.80624	-1.74	0.0846
Oral Anatomy	3.26012	0.57915	5.63	<.0001*
Pathology	3.21109	0.66405	4.84	<.0001*

\*significant at the 0.05 alpha level

**Table V. Results of chi-square for cross tabulation between variables and NBDHE**

Step	Variable removed	Number In	Partial R-Square	Model R-Square	C(P)	F value	Pr > F
1	I-GPA	8	0.0000	0.5581	8.0002	0.00	0.9901
2	Microbiology	7	0.0004	0.5577	6.1092	0.11	0.7408
3	Multiple Attempt	6	0.0012	0.5565	4.4349	0.33	0.5662
4	Chemistry I	5	0.0037	0.5528	3.4413	1.03	0.3127
5	S-GPA	4	0.0019	0.5509	1.9506	0.52	0.4722

**Table VI. Final results of multiple logistic regression: variables associated with NBDHE**

Variable	Parameter Estimate	Standard Error	t-Value	Pr >  t  (p-value)
ACP	0.07253	0.03197	2.27	0.0245*
Anatomy I	-0.66257	0.43107	-1.54	0.1260
Oral Anatomy	3.31188	0.44447	7.45	<.0001*
Pathology	2.98093	0.49788	5.99	<.0001*

\*significant at the 0.05 alpha level

## Discussion

This study questioned whether or not certain variables have the ability to predict academic success as defined by graduation from the program within a specified time frame and whether these same variables have the ability to predict success on the NBDHE. No statistically significant relationship was found between incoming college grade point average (I-GPA) and grade point average in prerequisite college science courses (S-GPA) and graduation and NBDHE success. These results support findings by Schutte and Smith,<sup>4</sup> Shannon,<sup>13</sup> and DeWald,<sup>14</sup> but do not concur with other researchers,<sup>1-2,8</sup> who found a correlation between GPA and success. Comparing the I-GPA and S-GPA defined in this study with other researchers' definitions of GPA may not lead to accurate conclusions. Additionally, it is possible that incoming GPA extracted from an associate degree program may be based on only a few courses. Theoretically, a student who completes one course with a grade of "A" achieves a high GPA. However, a student who has completed 20 courses with grades of "B" will have a lower GPA. The question becomes, which GPA is a more true reflection of ability to succeed. Studies investigating GPA that are comprised of similar courses may be more likely to produce similar results. For the purpose of this study, I-GPA was defined as all coursework completed at the time the candidate submits an application for admission to the dental hygiene program. However, the number and type of courses making up this GPA were not identified and may have varied significantly between students.

The definition closest to the S-GPA used in this study was the GPA used by Bauchmoyer et al which was based on grades in college biology, chemistry I, and chemistry II, and was found to be a predictor of program and NBDHE success.<sup>2</sup> Factors that might have contributed to these conflicting results include demographic differences between the 2 sample populations and whether the students took the courses on a full-time or part-time basis, which may possibly influence the student's ability to maintain a high GPA. The average age of the undergraduate student population at Old Dominion University at the time of this study was 24 years, suggesting that incoming students may have completed prerequisite coursework on a part-time basis over a longer period of time. It can be hypothesized that taking a difficult science course on a part-time basis may provide a student with extra time needed to achieve success. The part-time student must adjust to a full-time course load once accepted into the dental hygiene program.

It is unknown as to whether or not final course grade in chemistry II and final course grade in human anatomy and physiology II predict success for either graduation or NBDHE. Due to a significant lack of data, these hypotheses could not be tested. The inability to collect this data was unique to this study. The records chosen for review typically would not have this data recorded. This was not identified until data collection had already begun because it was not possible to examine the records

prior to the start of study. Access to these confidential records needed to be approved by the Institutional Review Board, hence the proposal for the study was submitted without knowing that a significant amount of this data would be unavailable. Furthermore, it was determined that applying for access to additional confidential records to look up these grades, and recalculating GPA and S-GPA based on this additional data, would be beyond the scope of this project. Omitting these 2 variables at this time, for this project, was justified by the fact that admissions committees would most likely be making decisions to accept or reject candidates without final course grades in chemistry II and human anatomy and physiology II, possibly increasing the realistic approach of this research.

A statistically significant relationship was found to exist between the dental hygiene core curriculum course oral pathology and both program and NBDHE success, while individual final course grade in oral anatomy and histology was found to be a predictor of NBDHE success. These findings support other researchers,<sup>2,13-15</sup> who have indicated that dental hygiene core courses or dental hygiene GPA are potential predictors of success. Many researchers who study predictor variables have focused on pre-dental hygiene course grades such as those available at the time an application is reviewed for admission. Identifying dental hygiene courses as significant predictors of success lends support to recommendations made by Edenfield and Hansen that performance in significant dental hygiene courses be monitored to assist with student success.<sup>15</sup> While admissions committees' desire to identify pre-dental hygiene program variables that predict success, the importance of performance in dental hygiene courses should not be overlooked.

An important outcome of this study is that oral pathology final course grade was determined to be a significant predictor of both graduation and NBDHE success. One explanation for this outcome may be that the oral pathology course offered at this institution was taught by the same instructor over the course of the study period. Oral pathology was the only course variable that was consistent for all students in the sample. In addition to different instructors, all of the other courses studied, except oral anatomy and histology, could have been taken at other universities or community colleges possibly, introducing other variables not controlled for in this study.

While final course grade in pathology was found to be a significant predictor of both graduation and NBDHE success, oral anatomy and histology was not a significant predictor of NBDHE success. One explanation for this finding might be that oral pathology may require higher level critical thinking skills than oral anatomy and histology, an important skill needed for success on the NBDHE, especially the case-based section. For example, oral pathology requires the use of discrimination, comparison, and contrast in order to evaluate oral findings, while oral anatomy and histology may rely more on the memorization of facts.

The academic setting where prerequisite science courses are completed is a complicated variable. Curriculum, faculty, credit hours, course requirements, physical infrastructure, and conducting methods, such as televised or online courses versus traditional face-to-face on campus classroom, all reflect the nature and mission of the institution. Because of the different missions of 4-year universities and 2-year community colleges, it was hypothesized that where a student completed the required prerequisite coursework may affect the student's ability to be successful in an entry-level baccalaureate dental hygiene program. However, the results of this study support research by Bauchmoyer et al<sup>2</sup> and show no statistically significant relationship between academic settings where prerequisite science courses were completed and success.

It has been reported that consistency in site where prerequisite science courses were taken was more significant to predict success than dividing the prerequisite science courses between a 2-year community college and a 4-year university.<sup>2</sup> It may be valuable to investigate whether or not students who completed these courses were enrolled part time or full time. Often, students who attend 2-year community colleges do so on a part-time basis, speculating that the difficult science-based prerequisite courses may have been taken alone or with only 1 or 2 other courses in these settings. Enrolling in only one course at a time would allow the student to devote time to the requirements of the course, possibly increasing the likelihood of success. Dental hygiene program attendance is usually on a full-time basis, requiring that students balance the time and resources needed for successful completion of multiple courses.

For the purpose of this study, it was hypothesized that students who had to repeat a prerequisite science course to achieve a passing grade would be less likely to be successful in the dental hygiene program and on the NBDHE. However, the analysis of data collected from student transcripts regarding multiple attempts to achieve a passing course grade revealed no statistically significant relationship between multiple attempts and success. It was not known whether or not the multiple attempts occurred recently or many years ago when the student may not have identified dental hygiene as a major and

may not have been as interested in the coursework or as motivated to succeed. Additionally, multiple attempts were not cross-referenced to see if they occurred when the student was enrolled on a full-time or part-time basis. Both of these parameters might affect a student's true ability to succeed.

While most of the variables under investigation in this study were not found to be predictors of success when tested alone, when these variables were combined into one ACP score they proved significant at predicting NBDHE success. This outcome supports Edenfield and Tanenbaum who found a positive relationship between their custom-developed admission selection rating tool and NBDHE, 10 suggesting that while the study of individual variables tend to produce mixed results, there may be certain combinations of variables that predict success when combined. Success may be better predicted through the use of a cluster of variables instead of relying on performance in only one area. Which individual variables to cluster together remains unknown.

The most basic of clustering variables is GPA, which combines grades for individual courses. Researchers have also combined noncognitive with cognitive variables to determine the predictive value of adding such variables as personality traits and attitudes into a cluster to determine ability to predict success.<sup>5,9</sup> While there is limited research in this area, anecdotally, one would assume that admissions committees utilize a tally sheet or other summary to tabulate information on program applicants. Often collected singularly, this information may be more predictive when clustered together.

The ACP was identified as a predictor variable for NBDHE success. Further investigation is recommended to analyze the criteria used by the ACP to determine if the weights assigned to each variable adequately correspond to their ability to predict success. The findings of such an investigation might enable the admissions committee to modify the ACP point assignments through evidence-based decisions.

While the ACP was determined to be a significant predictor of NBDHE success, it was not found to be a predictor of successful graduation from the program. This outcome is not easily explained. This study purposely posed 2 research questions, each asking whether or not the variables showed predictability for graduation and for NBDHE success. The ACP used by this university to aid the admissions committee in selecting program applications appears to be collecting the appropriate data on an applicant to predict the candidate's ability to succeed on the NBDHE, the ultimate goal of the program. However, some of the individuals were not able to progress through the program in the set time frame, indicated as not successful for the graduation criteria. It is evident from the results of this study that variables that predict success on the NBDHE may not be able to predict which students will require more assistance in achieving that goal.

## **Conclusion**

Attrition encountered in dental hygiene programs impacts the individual, the institution, and the community at large. When a student is not successful, the financial, time, and emotional impact on the individual and his/her family can be enormous. Retention of students is particularly important to institutions whose programs are evaluated and funded based on retention and graduation. When graduation rates decrease, the community's supply of competent oral health care providers decreases, impacting the public's access to care. While the findings of this study may not be generalized to other entry-level accredited baccalaureate programs, the results suggest support for the use of dental hygiene coursework (oral anatomy and histology and oral pathology) after admission to predict graduation and NBDHE success. It may be suggested that educators look to improving student performance after admission to the program to improve the likelihood of success.

Additionally, at this institution, when admission variables were combined into a cluster of variables (ACP), they proved significant at predicting success on the NBDHE. Collecting, analyzing, and utilizing variables that are not predicting success is time consuming and add cost to the program budget, and may inappropriately affect admissions committee decisions. Research shows that the evaluation of admission criteria should be continued in relation to each institution.

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## **Notes**

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