

Predictors of Student Success on the National Board of Dental Hygiene Examinations, Inc. (NBDHE) For a Dental Hygiene Program in Southern Illinois

Prof. Dr. Jennifer S. Sherry 

Article Info

Article History

Received:
27 March 2024
Accepted:
18 June 2024

Keywords

Student success
Dental hygiene education
Grade point average

Abstract

Grade Point Average (GPA) is often utilized when predicting success in any higher education program. The primary focus of this research was to determine if any link exists between pre-entry GPA, science-based didactic dental hygiene courses GPA, and graduation GPA to success on the National Board of Dental Hygiene Examinations, Inc. (NBDHE). Results were gathered through a myriad of reports such as NBDHE score reports from Southern Illinois University Carbondale's (SIUC) dental hygiene program, GPA, and course grades from the SIUC's Registrar's office for graduates from the Class of 2012-2022. Pre-entry GPA (2.75 or higher on a 4.0 scale), graduation GPA, and individual science-based didactic dental hygiene courses were evaluated using the letter grades "A, B, C" as "pass" and "D, F" as "fail" based on the curriculum requirements of the SIUC dental hygiene program. Specific dental hygiene didactic course grades and how these affected pass rates on the NBDHE will be discussed. Recommendations for the SIUC dental hygiene program from this research will be shared and how instituting a Health Education Systems, Inc. (HESI) exam during the last two years has proven successful in predicting the overall success of dental hygiene students at SIUC.

Introduction

Dental hygiene is an evolving profession that has many facets of training and expertise. Most dental hygienists earn an associate or bachelor's degree in the field. Across the United States, there are over 400 degree programs in dental hygiene: 330 associate or bachelor's degree programs, 60 degree completion programs (where a dental hygienist is licensed and decides to complete a bachelor's degree in dental hygiene), and 18 master's degree programs (ADHA, n.d.). Of the 330 associate/bachelor's degree programs, 12 are in Illinois (American Dental Education Association, 2022), and Southern Illinois University Carbondale (SIUC) is the only bachelor's degree program in the state. It is important to understand that one day, the entry level degree in dental hygiene may be a bachelor's degree and SIUC is positioned to have a vital role in not only training dental hygienists with more clinical training and expertise, but to consider mid-level provider program training.

Prior to dental hygiene licensure, students must pass a clinical exam (depending on state licensure requirements) and a computerized exam (NBDHE) before they are able to apply for licensure in an individual

state. The clinical exam that SIUC offers to students is the Central Regional Dental Testing Service, or CRDTS exam. The exam composition is an Objective Structured Clinical Examination (OSCE) and a patient treatment examination. The student has the option to utilize a “real” patient or a simulated patient, or mannequin. The OSCE exam is given prior to the clinical examination and is comprised of 16 multiple-choice computerized questions. The CRDTS clinical examination is approved for licensure by at least 40 states in the United States (Central Regional Dental Testing Service, 2022). Students must pass the two-part exam with a score of 75 or higher. Based on a ten-year time frame (2012-2022), the mean pass rate of the clinical examination for the SIUC Dental Hygiene Program was 96.9%. The national mean pass rate for the CRDTS exam from 2016 to 2021 was 91.22% (Central Regional Dental Testing Service, 2022). Years 2022 through 2024 have not been added to this data as part of this paper.

The nine-hour computerized examination (NBDHE) tests a myriad of content areas and critical-thinking modes of training and is two sections – discipline-based (200 questions) and case-based (150 items) – and given through Pearson VUE, an independent testing center across the United States and Canada (Joint Commission on National Dental Examinations, 2022). To prepare for the computerized examination, students use course content and materials such as notes, handouts, images, textbooks, and some students take a formal board review course that is independent of their board review course administered by a faculty member at SIUC. In the past, the student’s score would be posted on the American Dental Association student account and must be a passing score of 75%, but in 2012, the Joint Commission on National Dental Hygiene Examinations moved to a pass/fail reporting system (Joint Commission on National Dental Examinations, 2022). For remediation purposes, if a student failed the NBDHE, they would receive a specific topical list of areas to focus on prior to retesting.

In 2020, the SIUC Dental Hygiene Program began utilizing a dental hygiene Health Education Systems, Inc., or HESI exam administered through Elsevier. The primary purpose of this was to have a standardized mode of testing to simulate a mock board examination for our senior dental hygiene students. Many of the students retook the HESI several times to learn from the process and test their knowledge of valuable dental hygiene content. Again, a passing score was 75% and to sit for the NBDHE prior to graduation, they must score a 75% or higher on the first attempt. If they are unsuccessful, they must delay signing up for the NBDHE until after graduation to give them more time to prepare and become successful.

It is imperative to review the time frame when evaluating test scores and results for the NBDHE computerized examination. Table 1 displays the overall national pass rates and compares them to the SIUC overall pass rates for the NBDHE computerized examination. One important point within NBDHE scoring was in 2020 when COVID-19 changed the format of the exam to three categories – Scientific Basis for Dental Hygiene Practice, Provision of Clinical Dental Hygiene Services, and Community Health/Research Principles (Joint Commission on National Dental Examinations, 2022).

Steady declines in mean pass rates for SIUC began in 2016 and majorly declined until 2019 and may have occurred due to a limitation of the study where many seasoned faculty retired or left the university that were major content experts. New faculty or current faculty began teaching new courses and this could have

influenced learning for students. SIUC faculty noticed the trends in the NBDHE data and wanted to investigate potential causes for the decline. The priority was to evaluate factors such as SIUC's student pre-entry grade point average (GPA), grades in science-based didactic dental hygiene courses such as Oral Pathology, Microbiology, Oral Anatomy, Head and Neck Anatomy, and Dental Radiology I and II., and graduation GPA at the end of the dental hygiene coursework and how these factors could affect performance on the NBDHE.

Table 1. SIUC Pass Rates (%) and National Pass Rates (%) on the NBDHE (2012-2022)

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
SIUC	96.3	93.1	97.1	100	84	78.8	76.7	68.9	84.3	96.3	95.2*
Pass											
Rates											
on											
NBDHE											
(%)											
National	96	95.5	95.5	95.7	95	93.9	94.3	92.2	90.7	96	N/A**
Pass											
Rates											
on											
NBDHE											
(%)											

*In 2022, 95.2% was the pass rates as of March 12, 2023. ** In 2022, the national pass rate was not known at the time of study; Yellow shading on the year 2012 reflects with the Joint Commission on National Dental Examinations approved the pass/fail scoring system; The gray italics area on the table reflects when SIUC dropped the ACT/SAT entrance requirement (began in 2019); HESI exam began for the SIUC Class of 2021 (SIUC Dental Hygiene Program, 2023)

Literature Review

The review of the literature included peer-reviewed articles and a master's thesis that were retrieved from Google Scholar, PubMed, Wiley Online Library, Sage Pub Journals, Springer, and website information from the American Dental Hygienists' Association.

A review of the literature determines the various relationships between a student's grades and standardized tests to successful results on the NBDHE. In addition, multiple research studies concluded that GPA does affect student success on the NBDHE (Alzahrani et al., 2007; Downey et al., 2002; Ward et al., 2010). Trends within research determine that some examples of standardized tests such as the American College Test (ACT), Scholastic Achievement Test (SAT), Dental Hygiene Aptitude Test (DHAT), or Admission Test for Dental Hygiene (ATDH) may show a positive association to student success.

According to a 2008 article by Aikens and Barbarin, many areas throughout the United States have students who have family struggles with low socioeconomic status, which in turn, may affect technological advances and learning capability. Lack of access to learning materials, practical learning strategies, and/or tutoring

opportunities may negatively impact students' learning environment (Bradley et al., 2001; Orr, 2003).

In a 2019 article by Jenkins and Boyd, if faculty and students have similar multicultural backgrounds, this would enhance their learning experiences. Most international students struggle daily with feelings of alienation, anxiety, cultural discrimination, and sense of belonging due to faculty members not having similar cultural and familial experiences. In the profession of dental hygiene, it is imperative to embrace the cultural "melting pot" in student experiences and build upon their experiences to share and learn about one another.

Some students may transfer from community colleges and have a sense of "transfer shock" because the university setting is different in many ways (Tucker, 2018). Secondly, if students are residing on or off campus for the first time, this is a huge adjustment and takes a strong foundation to be successful. Rudy et al. (2017) stated that if ACT scores are exemplary, students do succeed more readily on the NBDHE, but some dental hygiene programs no longer use this type of standardized exam to determine program acceptance. Other articles stated the Dental Hygiene Aptitude Test (DHAT) was another excellent method to gauge success on the NBDHE (Longenbecker & Wood, 1984; Tucker, 2018).

Many science-based courses also measure success on the NBDHE such as histology, radiology, oral anatomy, and oral pathology (Liang et al., 2018). However, Sanderson and Lorentzen (2015) found that dental hygiene programs did not positively correlate pre-requisite courses and the potential skills of future dental hygiene students. Dental hygiene curriculum may be affected by the way courses are delivered and how critical-thinking, evidence-based decision-making activities maintain student engagement and increase learning (Alzahrani et al., 2007).

Another type of assessment exam that could positively affect student engagement and outcomes was the Objective Structured Clinical Examinations (OSCE). In 2017, Terry et al. stated that several programs use OSCE's for gauging clinical competency and local anesthesia competency. In addition, the OSCE could be used as a tracking mechanism to teach dental hygiene content in a more engaging way using critical-thinking exercises and using technological advances with online or hybrid course design.

Research Design

Quantitative research methods were used to evaluate SIUC's dental hygiene students' NBDHE scores from a ten-year period starting in 2012 and ending in 2022. Frequencies and percentages evaluated student pre-entry GPA, dental hygiene science-based didactic course GPA, and graduation GPA to investigate whether these scores can predict student success on the NBDHE. A cluster population was used since the researcher used student data from place of employment.

Significance of Study

The study's significance was to broadly review the different types of GPA and how these records may affect

NBDHE results of SIUC's dental hygiene students. The program's faculty could reflect upon many possibilities that could improve scores such as increasing pre-entry GPA, student interviews, improved student selection strategies, more diverse student population pool of applicants, and instituting an earlier HESI testing cycle to effectively gauge student's success.

Limitations and Delimitations

Faculty turnover and faculty retirements have already been discussed as a limitation in this study. The SIUC's Registrar had some missing data for pre-entry GPA as well as some Microbiology and Pathology course grades. If students transferred to SIUC, grades may be there in the Registrar's system, but this was not a strategy of the researcher's data search. Microbiology may have been taken as a transfer course or assigned a different course number than the search parameters allowed. The SIUC dental hygiene program's Pathology course was assigned a different course number during the ten-year data span, so this data could have been missing from the original data sets. The researcher has been in the program for many years and was able to obtain some missing data from program historical grade reports—another possible effect of course grade changes. In addition, the SIUC dental hygiene program does not perform any part of the selection process of students because it is handled by academic advisors and other staff members. A ranking system was designed based on point of entry and acceptance into the program.

Delimitations of this study are as follows:

1. The researcher only compared the mean NBDHE scores in the United States to SIUC's dental hygiene program.
2. Score reporting during the 10-year span of time (2012-2022) was affected due to COVID-19. Students would not receive detailed reports as in the past, so this would hamper follow-up preparation on weak areas within the NBDHE.
3. The researcher was involved in teaching many science-based courses in the SIUC dental hygiene curriculum.
4. Students only pass with grades of "A, B, or C". The grades "D, F" are failing grades and this is different than SIUC's standard in other courses across campus.

Methodology

Correlational methods were used to determine if various aspects of GPA affect student outcomes on the NBDHE. Factors that were utilized were student pre-entry GPA; GPA in science-based didactic dental hygiene courses such as Oral Pathology, Microbiology, Oral Anatomy, Head and Neck Anatomy, and Dental Radiology I and II; and graduating GPA at the conclusion of the SIUC dental hygiene program and how these variables correlate to student scores on the NBDHE.

Data Collection

The researcher gathered information prior to data collection about how scores were calculated on the NBDHE.

During the 2012–2019-time frame, data were reported to SIUC by a raw score and standard deviation on each topic area. From 2020 to 2022 and currently, only a “pass” or “fail” report was given for each SIUC dental hygiene student. “Pass” is 75 or higher and “fail” is 74 or below. Remediation comments on weak topical areas on the NBDHE are provided to each student who is unsuccessful (Joint Commission on National Dental Examinations, 2022).

Students sign the application, and this allows score release to the dental hygiene program for accreditation purposes as well as institutional and program assessment. Students also receive NBDHE scores once they have been approved for validity and reliability via their secure PIN (DENTPIN) through the Commission on Dental Accreditation (CODA) website.

Institutional Review Board (IRB) and Study’s Data Transfer

The researcher completed an IRB Form A, B1, and E since personal data was going to be shared. Permission was granted by the Interim Director of the SIUC’s Registrar’s Office to gather SIUC dental hygiene graduates’ GPA information from existing SIUC transcripts as well as permission from the current SIUC dental hygiene program director to access NBDHE score reports. IRB approved the study.

The data from the SIUC Registrar was transferred via Microsoft Excel file. No survey data was gathered, and all data was existing data sets and the researcher de-identified and coded data after it was secured. Storage of the data was on a separate One Drive file that was on the researcher’s office computer which is locked and secure. The NBDHE data was secured on the program’s database that only dental hygiene faculty have access to the S-Drive. A statistician was utilized to assist in the correlational data calculations.

Independent variables were pre-entry GPA (2.75 or higher); SIUC’s dental hygiene GPA in science-based didactic dental hygiene courses (Oral Pathology, Microbiology, Oral Anatomy, Head and Neck Anatomy, and Dental Radiology I and II); graduation GPA at the conclusion of the dental hygiene program. The dependent variable was the dental hygiene student pass rates on the NBDHE. SAS version 9 was used by the statistician to calculate the means within various groups and frequency distributions and utilized for Chi-Square analysis.

Presentation of the Research

The population for this study was a total of 334 SIUC dental hygiene graduates from years 2012-2022. Some data was missing such as select pre-dental hygiene GPA from 2012 to 2022 graduates, select Oral Pathology course letter grades (from 2013 and 2017), in addition to Microbiology course grades from 2012-2022. The remaining dental hygiene didactic courses (Oral Anatomy, Radiology I/II, Head and Neck Anatomy) had complete data compilation. In addition, NBDHE pass/fail rates were complete data sets for years 2012-2022. Moving forward, the data was reported as first time pass rates and not overall pass rates.

Table 2 displays the totals for NBDHE first attempt pass rates by year of graduation. The “0” column is SIUC

dental hygiene graduates who failed the first attempt of the NBDHE; and “1” column refers to graduates who passed the first attempt of the NBDHE. The “All” column reflects the total number of SIUC dental hygiene students who took the NBDHE based on graduation year.

Table 2. Total Breakout of NBDHE First Attempt Pass Rates by Year of Graduation

	0 (Fail)	1 (Pass)	All
	N (%)	N (%)	N
Graduation Year			
2012	1 (3.6%)	27 (96.4%)	28
2013	1 (3.33%)	29 (96.7%)	30
2014	1 (2.9%)	34 (97.1%)	35
2015	1 (3.3%)	29 (96.7%)	30
2016	5 (15.2%)	28 (84.8%)	33
2017	7 (21.2%)	26 (78.8%)	33
2018	7 (21.9%)	25 (78.1%)	32
2019	8 (27.6%)	21 (72.4%)	29
2020	11 (33.3%)	22 (66.7%)	33
2021	6 (20%)	24 (80%)	30
2022	4 (19%)	17 (81%)	21
TOTAL	52	282	334

The year that reflected the beginning of significant changes is 2016 as well as the four following years (2017-2020) where percentages of first-time NBDHE pass rates severely declined.

Table 3 evaluated the pre-entry and graduation GPA by NBDHE pass rates using the MEANS procedure which produces data summaries for the calculation of descriptive statistics for variables across observation and within groups of variables. In all subsequent tables, passing grades are based on a 4.0 GPA and “A, B, C” are “passing”; “D, F” are “failing”. Standard deviations for all columns and variables display a weak or very weak association (0.25-0.41 standard deviation).

Table 3. Pre-entry and Graduating GPA by NBDHE Pass Rates using the MEANS Procedure

NBDHE First Attempt Pass Rates	N Obs	Variable	N	Mean	Std Dev
0 (Fail)	52	Pre-Entry GPA	13	3.15	0.37
		Graduating GPA	52	3.45	0.25
1 (Pass)	282	Pre-Entry GPA	63	3.27	0.41
		Graduating GPA	282	3.65	0.27

Table 4 presents the NBDHE first attempt pass rates compared to the Microbiology course pass rate. Students usually take Microbiology as part of a transferring institution’s course or at SIUC. If students pass

Microbiology, this is a good indicator of success on the NBDHE.

Table 4. NBDHE First Pass Attempt by Microbiology Course Pass Rate

NBDHE First Attempt Pass Rates	Microbiology Fail N (%)	Microbiology Pass N (%)	Total
0 (Fail)	3 (1.2%)	38 (14.7%)	41
1 (Pass)	14 (5.4%)	204 (78.7%)	218
TOTAL	17	242	259

Table 5 shows the NBDHE first attempt pass rate in comparison to the Oral Anatomy course pass rate. Out of 334 students in the sample, no students failed the Oral Anatomy course, so no Chi-Square can be calculated for this data set. By viewing Table 5, 84.43% of the students who passed Oral Anatomy also passed the NBDHE on the first attempt.

Table 5. NBDHE First Pass Attempt by Oral Anatomy Course Pass Rate

NBDHE First Attempt Pass Rates	Oral Anatomy Fail N (%)	Oral Anatomy Pass N (%)	Total
0 (Fail)	0 (0%)	52 (15.57%)	52
1 (Pass)	0 (0%)	282 (84.43%)	282
TOTAL	0	334	334

Table 6 displays the NBDHE first attempt pass rates compared to the Dental Radiology I, II, and Head and Neck Anatomy course pass rates. Again, no students failed the Dental Radiology I/II or Head and Neck Anatomy course in a ten-year period, so no Chi-Square was calculated. By viewing Table 6, 84.43% of the students who passed Dental Radiology I and II as well as Head and Neck Anatomy also passed the NBDHE on the first attempt. Another item of interest was all three of these courses had the same professor during the 10-year period, but in the earlier time frame, there was a different professor who taught Head and Neck Anatomy.

Table 6. NBDHE First Pass Attempt by Dental Radiology I, II, and Head and Neck Anatomy Course Pass Rate

NBDHE First Attempt Pass Rates	Dental Radiology I Fail N (%)	Dental Radiology I Pass N (%)	Total
0 (Fail)	0 (0%)	52 (15.57%)	52
1 (Pass)	0 (0%)	282 (84.43%)	282
TOTAL	0	334	334

Table 7 shows the NBDHE first attempt pass rates compared to the Oral Pathology course pass rate. Missing data with a frequency of 63 students was discovered during the data analysis portion of this study, so the total number of students decreased to 271. There were two students during the 10-year span who failed this course, but data shows an 83.02% pass rate of Oral Pathology also pass the NBDHE.

Table 7. NBDHE First Pass Attempt by Oral Pathology Course Pass Rate

NBDHE First Attempt Pass Rates	Oral Pathology Fail N (%)	Oral Pathology Pass N (%)	Total
0 (Fail)	0 (0%)	44 (16.24%)	44
1 (Pass)	2 (.738%)	225 (83.02%)	227
TOTAL	2	269	271

Summary, Conclusion, and Recommendations

The primary purpose of this study was to investigate problems that exist with the NBDHE scores at Southern Illinois University Carbondale (SIUC) and modes of improvement the SIUC dental hygiene program can investigate further. Factors such as pre-entry grade point average (GPA), grades in science-based didactic dental hygiene courses (Oral Pathology, Microbiology, Oral Anatomy, Head and Neck Anatomy, and Dental Radiology I and II), and graduating GPA at the conclusion of the dental hygiene curriculum and how these factors affected student scores. Data analysis was imperative to determine conclusions from the data collected as well as how the SIUC dental hygiene program can make strategic improvements to the NBDHE and how future research can assist in this process.

Dental hygiene pre-entry GPA may have increased the actual GPA scores because many students take pre-requisite courses prior to acceptance into the dental hygiene program. Data displayed that pre-entry GPA were similar in passing and failing the NBDHE, so no significance or correlation was found. This result parallels with the article from Austin (2011) that discovered no correlation between college cumulative GPA, high school GPA, and success on the NBDHE. Microbiology had a lower percentage of pass rate on the NBDHE, but there was some data missing from the original data set from the SIUC Registrar, and some students retook the course, so the updated grade is the grade that remains on the student's record.

Science-based didactic courses within the SIU dental hygiene program did not show a correlation to pass rates on the NBDHE. About 84% of all dental hygiene students who passed Oral Anatomy, Dental Radiology I and II, Oral Pathology, and Head and Neck Anatomy also passed the NBDHE. Graduating GPA did not show a significance in pass rates on the NBDHE, but did display that student's GPA did improve during their time in the SIU dental hygiene program. Another issue that could affect this result is the "N" size or missing data and this can affect the GPA ranges for each student or student class.

Many lessons were learned with the study about how missing data does affect what is seen in the results and how SIUC's grading policies or how grades are reported through SIUC's Registrar can impact results. If a student retakes a course, the new course grade trumps the old course grade, hence improving the student's GPA. The new grade improvement policy made a difference in how grades and GPA were not as reflective on actual attainment of course content and predicting success. During COVID-19, grades were also represented in a different way. Passing was "A, B, C, D" and failing was "F". Students could choose to change their grades to "Pass" or "Fail" after faculty posted grades, however, the SIUC dental hygiene program planned to keep the

course letter grade for accreditation reporting purposes.

Many recommendations were discovered throughout the research process. To gain more accurate dental hygiene program assessments, a spreadsheet with all course grades should be maintained for each student. In addition, students may want to take some professionalism building courses or training prior to applying for the program to possibly increase pre-entry GPA's and increase skills that will make them a well-rounded student. The Health Education Systems, Inc. (HESI) exam could be used as a pre-entry assessment exam to gauge complex skills such as problem-solving and critical-thinking activities. Dental hygiene faculty should consider evaluation of the student assessment rubric each year and update accordingly based on the goals and program outcomes desired. Incorporating faculty in the selection process may encourage a more well-rounded student and assessing a writing assignment and interviewing students may help as well.

Once students are accepted in the SIUC dental hygiene program, maintaining an organized and structured remediation process for courses where students struggle is imperative. Increased rigor with testing is also necessary as well as building programmatic engagement within student groups will only help guide them into a successful journey. When students are approaching graduation, maintain an outside entity's board review to gauge learning and maintain SIUC's board review course to build learning and engage students with the type of board questions they will see on the NBDHE. The HESI exam can be used as a baseline to take the NBDHE and maintain the pass rate at 75% or higher to sit for the NBDHE. All dental hygiene faculty must be aware of the trends of pass rates and topical areas of improvement that should be addressed prior to the next cohort's exam. Once the SIUC dental hygiene program initiated the HESI exam for assessing students' readiness to take the NBDHE, we noted some interesting trends within the data. There is a lower predictor of success during 2021 by the equal distribution of pass/fail rates (see Table 8). In comparison, the Class of 2022 results on the HESI showed a strong predictor of success on the NBDHE due to 80% who failed the NBDHE also failed the HESI exam (see Table 9).

Table 8. SIUC Dental Hygiene Class of 2021 Failure Rates on HESI Exam and Failure Rates of NBDHE on First Attempt

Number of Students N	HESI Exam Failures N (%)	HESI Exam Failures and Students Who Failed NBDHE on First Attempt N (%)
28	13 (46.42%)	6 (46.15%)

Table 9. SIUC Dental Hygiene Class of 2022 Failure Rates on HESI Exam and Failure Rates of NBDHE on First Attempt

Number of Students N	HESI Exam Failures N (%)	HESI Exam Failures and Students Who Failed NBDHE on First Attempt N (%)
21	5 (23.8%)	4 (80%)

Many possible future research projects could arise from this study.

- What impact does transfer courses have on NBDHE results?
- How does Microbiology and other pre-requisite courses affect NBDHE results?
- How do other health care professional programs gauge student success and can we adopt some of these ideas to help our program succeed?
- Which topical areas are students consistently failing and are course grades inflated within our program?
- Discuss with former dental hygiene graduates how they prepared for the NBDHE and what strategies would help our students improve performance.

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Author Information

Prof. Dr. Jennifer S. Sherry

 <https://orcid.org/0000-0002-4038-7866>

Southern Illinois University Carbondale

United States of America

Contact e-mail: clnteth@siu.edu
