The Relationship Between ACT Composite and Subcomponent Scores and Dental Hygiene Program Outcomes

THESIS

Presented in Partial Fulfillment of the Requirements for the Degree Master of Science in the Graduate School of The Ohio State University

By

Jamie Marie Beale

Graduate Program in Allied Medicine

The Ohio State University

2013

Master's Examination Committee:

Jill Clutter, PhD, MCHES, Advisor
Georgianna Sergakis, PhD, RRT
Michele Carr, RDH, MA
Abstract

**Purpose:** The purpose of this study was to determine if there are significant correlations between specific admissions criteria and students’ grade point averages (GPA), National Board Dental Hygiene Exam (NBDHE) overall scores and NBDHE case-based question scores. In addition, the study examined differences in NBDHE overall score and GPA for students that made repeated attempts at required science courses to achieve an acceptable grade, versus those students who received an acceptable grade on the first attempt. Due to the historically selective and competitive nature of dental hygiene admissions, it is imperative to select applicants who possess the ability to be successful both in the program of study and the NBDHE.

**Methods:** Composite, reading, science, math, English and science ACT scores of 124 students who anticipated graduating from the Kellogg Community College Dental Hygiene Program from 2005-2011 were examined. For each student, the overall NBDHE score, NBDHE case-based question score, and final dental hygiene GPA were examined to determine if any significant correlations existed. The NBDHE overall scores, NBDHE case-based questions scores and dental hygiene GPA of students who made repeated attempts at required science courses were compared to those who received acceptable grades on the first attempt. In addition, grades of required
science courses (anatomy, chemistry, microbiology and physiology) were examined for correlation with NBDHE scores and final dental hygiene GPA.

**Results:** The results of this study revealed the composite ACT score to have the strongest correlation to composite NBDHE scores, though it showed only a moderate relationship ($r=.394$, $p=<.001$). The strongest relationship between the ACT scores and NBDHE case-based question scores was the ACT science score, which only had a weak relationship ($r=.221$, $p=.014$). The ACT math score was moderately correlated to the final dental hygiene GPA ($r=.322$, $p=<.001$), as was the composite ACT score ($r=.302$, $p=.001$). The ACT reading score revealed only a weak relationship with overall NBDHE scores ($r=.211$, $p=.020$) and no significant relationship with NBDHE case-based question scores or final dental hygiene GPA.

Results of this study also revealed those students who made repeated attempts at science courses had significantly lower final dental hygiene GPA when compared to students who did not require repeated attempts ($t=-4.002$, $df=133$, sig.=.001). Likewise, students requiring repeated attempts at science courses had significantly lower overall NBDHE scores than those who did not require repeated attempts ($t=-3.24$, $df=133$, sig.=.001). Microbiology grades were strongly correlated to final dental hygiene GPA ($r=.698$, $p=<.01$) and overall NBDHE score ($r=.609$, $p=<.001$).

**Conclusion:** Composite ACT scores revealed weak to moderate correlations to NBDHE scores. The subcomponent ACT scores did not provide stronger results in this study. Significant differences found among students repeating science courses
with those who were successful on the first attempt was identified in this population. Researchers should consider further studies in this area. Additional findings suggest microbiology is a strong predictor of success in the dental hygiene curriculum and on the NBDHE.
This document is dedicated to my family, for all of their encouragement, support and understanding.
Acknowledgments

In expression of deepest gratitude for her unending patience and positive attitude, I would like to acknowledge Jill Clutter for her significant role in the process of creating this document.
Vita

June 1990 .................................................. Galion High School

1994.......................................................... B.S. Dental Hygiene, The Ohio State University

1994-Present ........................................... Registered Dental Hygienist

2009-2012 ................................................ Adjunct Dental Hygiene Faculty, Kellogg Community College

2012-Present ........................................... Director, Dental Hygiene Education, Kellogg Community College

Fields of Study

Major Field: Allied Medicine
# Table of Contents

Abstract ........................................................................................................................................ ii

Dedication ...................................................................................................................................... v

Acknowledgments .......................................................................................................................... vi

Vita ............................................................................................................................................... vii

List of Tables ................................................................................................................................. ix

List of Figures ............................................................................................................................... x

Chapter 1: Introduction ................................................................................................................ 1

Chapter 2: Review of Literature ..................................................................................................... 8

Chapter 3: Methodology ............................................................................................................... 19

Chapter 4: Results and Discussion .............................................................................................. 23

Chapter 5: Article .......................................................................................................................... 32

References ..................................................................................................................................... 45

Appendix A: Data Collection Table .............................................................................................. 49

Appendix B: Figures ........................................................................................................................ 50
List of Tables

Table 1. ACT Score and Overall NBDHE.................................................................24
Table 2. ACT Score and NBDHE Case-Based Question Score............................24
Table 3. ACT Score and Final Dental Hygiene GPA..........................................25
Table 4. Repeated Science Course and Overall NBDHE Score............................26
Table 5. Repeated Science Course and Overall Final Dental Hygiene GPA..........26
Table 6. Science Course Grades and Overall NBDHE........................................27
Table 7. Science Course Grades and NBDHE Case-based Question Score...........27
Table 8. Science Course Grades and Final Dental Hygiene GPA........................28
Table 9. Data Collection Instrument...................................................................49
List of Figures

Figure 1: Repeat Science Courses and Overall NBDHE Score..............................50
Figure 2: Repeat Science Courses and Final Dental Hygiene GPA.......................51
Chapter 1
Introduction

Background of the Problem

Dental hygiene is one of the fastest growing occupations in the United States, according to the Bureau of Labor and Statistics (Bureau of Labor and Statistics, 2012). In fact, the Bureau of Labor and Statistics reports dental hygiene employment is projected to increase an astounding 38% between 2010 and 2020. There are 335 entry-level dental hygiene programs across the nation, increasing from 286 in 2006-2007 (American Dental Hygienists’ Association, 2013). Of the 335 programs, 245 offer a two year program, leading to an Associate’s degree, while 90 offer a Bachelor’s degree. Each school’s goal is preparing the students for dental hygiene licensure. Dental hygiene licensure is granted only after successful completion of an accredited dental hygiene program and the passing of the national, regional and state board examinations (American Dental Hygienists’ Association, 2013). While regional and state exams vary among locations, all students must pass the National Board of Dental Hygiene Examination (NBDHE) in order to practice dental hygiene in the United States, with the exception of Alabama.

Admission into dental hygiene education is traditionally highly competitive. With 5,953 students accepted into accredited dental hygiene programs in 2012, admissions
committees are generally faced with a significant challenge in selecting the candidates most likely to be successful in the programs (American Dental Hygienists’ Association, 2013). Critically important as this task may be, each educational institution has its own unique strategy in admissions decisions. There are many criteria weighted in differing formulas among institutions.

Criteria commonly used by dental hygiene admissions committees include such items as prerequisite GPA, prerequisite science course GPA, personal interview scores, college entrance exam scores, dexterity testing, essay evaluation and/or previous dental assisting experience (American Dental Hygienists’ Association, 2013). In 2010, 101 programs reported using ACT scores as a factor in admissions decisions (ADA Survey of Allied Dental Programs, 2011).

There have been many studies that have examined relationships between various admissions criteria, course grades and dental hygiene program success. “Success” in a dental hygiene program may be defined as completing dental hygiene coursework with a “C” or better in a pre-determined time frame, passing the NBDHE, or both (Alzahrani, Thomson, and Blythe Bauman, 2007). The NBDHE is an exam developed by the Joint Commission on National Dental Examinations that is used for the purpose of assisting state boards in evaluating qualifications of dental hygienists seeking licensure. Many previous studies have found academic performance in oral pathology, oral anatomy and histology courses to be predictive of both completing dental hygiene coursework with a passing grade and passing NBDHE scores (Alzahrani et al, 2009; Austin, 2011). Because these performances occur after a candidate is accepted in the dental hygiene program,
such data is not useful in the applicant selection process. Similarly, biomedical science courses such as general chemistry and biology have been shown to be predictors of success in dental hygiene coursework (Bauchmoyer et al, 2004). While this data may be useful for some programs, those not requiring prerequisite courses do not benefit from such data.

Several studies have examined relationships between college entrance examinations and NBDHE success or failure. Although many programs utilize composite ACT scores as a part of selective admissions, the scores have been shown to be only weak predictors in regards to success on the NBDHE (Vitasek and Parker, 1991; Shannon 1989). When subcomponents of the ACT are examined, however, relationships have been found. In a study by Susan Shannon (1989), ACT social studies scores were predictive of pass/fail scores on the NBDHE. In addition, recent research conducted by Austin (2011) at Western Kentucky University studied specific factors to determine correlations to NBDHE scores. Among the factors studied were subcomponent ACT scores; math, reading, English and science. In this study, Austin found both the reading portion of the ACT score and microbiology grades to be the strongest predictors of NBDHE scores.

Significance of the Problem

A very important challenge among college and university selection committees is to matriculate students into the program who have the ability to successfully complete not only the program, but the board exams that must be passed to obtain dental hygiene licensure. By obtaining dental hygiene licensure, that individual becomes an asset to the
community through possessing the ability to provide competent dental hygiene services. Selecting students with the ability to be successful in the program and on licensing examinations benefits the institution, the community and the student. Dental hygiene curricula are lock-step in nature, meaning the courses are sequential and fixed, often times making it impossible to replace students who fail or drop out after partial completion of the program. Students who are admitted into a dental hygiene program and fail to complete the coursework create a burden on resources, both human and financial.

There are numerous studies which have found dental hygiene GPA, specific dental hygiene course grades and/or first-year dental hygiene GPA to be strong predictors of success on the NBDHE (Alzahrani et al, 2007; Austin, 2011; Bauchmoyer, Carr, Clutter and Hoberty, 2004; Tucker Ward, Downey, Thompson, and Collins, 2010; DeWald, Gutmann, and Solomon, 2004; Shannon, 1989). This information is quite useful in regards to recognizing a need for and implementation of remediation efforts with dental hygiene students. However, such information does not aid admissions committees in student selection. In fact, an important goal of researching and improving admissions criteria is to alleviate the strain remediation and board exam failures place on program administrators, faculty and students.

Purpose of the Study

The purpose of this study is to analyze admissions criteria in order to maintain or improve dental hygiene program success, thereby decreasing attrition and undue taxing of resources, and increase the frequency of NBDHE passing scores. This process will
include evaluating data not currently utilized in the admissions process for many colleges. This will provide dental hygiene educators and admissions committees with additional data on which to base admissions decisions. Many studies relate dental hygiene GPA and/or coursework to NBDHE scores, but this does not help with the critical piece of admission selection. This information also comes at a significant time, as 2012 was the first year NBDHE discontinued the reporting of subcomponent scores for passing NBDHE examinees. Historically, program faculty and administrators have been able to study the results and implement program modifications if patterns of weakness were detected in content areas, based on the NBDHE results. Beginning in 2012, the only scores with subcomponent information will be NBDHE failures, making it more difficult to identify general trends and relationships between admissions criteria and program outcomes.

**Research Questions**

Is there a correlation between ACT scores (composite, reading, math, English, science) and:

a. Overall NBDHE scores, first attempt  
b. Case-based question scores, first attempt  
c. Final dental hygiene GPA  
d. Final overall college GPA
Is there a difference in final dental hygiene GPA between students who made repeated attempts of required science courses and those who received acceptable grades on the first attempt?

Is there a difference in NBDHE scores between students who made repeated attempts of required science courses and those who received acceptable grades on the first attempt? **Operational Definition of Terms**

1. **Required Science Courses:** BIOL 201 (Human Anatomy), BIOL 202 (Human Physiology), BIOL 205 (Microbiology), CHEM 100 (General Chemistry).

2. **Repeated Attempts:** retaking a required science course due to failure to achieve a grade of “C” or higher the first attempt.

3. **Final Dental Hygiene GPA:** the GPA calculated by including only dental hygiene courses.

4. **Overall GPA:** the GPA calculated by including all college courses.

5. **First Attempt:** the first time taking an examination or course.

6. **Overall NBDHE Score:** the composite score of the entire NBDHE, passing \( \geq 75 \) percent.
7. Case-Based Question Score: the score on the “Case Study” portion of the exam only.
Traditionally, educational programs in the allied health professions have and continue to implement a selective admissions process. Programs including, but not limited to, medical laboratory technology, radiologic technology, respiratory therapy, occupational therapy, physical therapy, and dental hygiene have all been utilizing some form of selective admissions for their respective programs. In fact, a study in 1982 by Deitrich and Crowley (1982) provided insight into admissions trends across the nation in the aforementioned allied health programs. During this era, it was felt that rigorous admissions processes were imperative, as the future of the individual profession depended on admitting and graduating qualified practitioners into the workforce. The study revealed that programs used academic records, letters of recommendation, interviews, essays, standardized testing and demographic/biographic data as sources of information for applicant selection. Years later, researchers continue to search for key data in determining which applicants are most likely to be successful in a particular allied health program.

Dental hygiene admissions criteria have been a focus of much research and review over the past several decades. Due to the nature of the profession, dental hygiene students must not only pass the coursework from an accredited institution, but also successfully pass the National Board Dental Hygiene Exam (NBDHE) in order to be
granted licensure and, thus, the ability to practice as a dental hygienist (Joint Commission on National Dental Examinations, 2013). With this high degree of importance placed on program course grades and board examination scores, dental hygiene educators have long been searching for factors which can predict the success of students in both the dental hygiene coursework and on the NBDHE. Additionally, the majority of accredited dental hygiene programs utilize selective admissions procedures. In 2006, it was reported that only 25% of those who applied for an associate-level dental hygiene program were offered admissions, while 33% of the applicants to baccalaureate programs were offered admissions. (American Dental Hygienists’ Association, 2013).

According to the 2011-2012 survey of accredited dental hygiene programs, admissions criteria varies widely from institution to institution, but most often includes a high school diploma or GED, high school math, biology and chemistry, a “C” or better overall high school GPA, college entrance exam(s), college prerequisite courses, a personal interview, dexterity test and a personal essay. Chemistry, English, psychology, communications and sociology are reported as common prerequisites courses (Commission On Dental Accreditation, 2012).

Historically, ACT scores, incoming GPA, college GPA, science GPA and dental hygiene program success have been studied for their ability to predict NBDHE performance. Success in the dental hygiene program is considered completion of the sequence of dental hygiene courses with acceptable grades in the prescribed amount of time for the specific program. Several studies have also examined many of the same variables in relationship to student performance within the dental hygiene program itself.
(Bauchmoyer, Carr, Clutter, Hoberty 2004; Tucker-Ward, Downey, Luz Thompson, Collins, 2010; Alzahrani Thomson, Blythe, 2007; Shannon, 1989; DeAngelis, 2003; DeAngelis and Goral, 1995; Vitasek and Parker, 1991; Downey, Collins, Browning, 2002; Austin 2011). Dental hygiene programs have adopted individual methods, strategies, and criteria regarding applicant selection for admissions, and the research studies are reflective of this wide variation.

**Cumulative GPA and Individual Course Grades as Predictors of Success**

Though many dental hygiene programs report using applicants’ high school GPA as admission criteria, there is little current research available to identify a relationship between High School GPA and program or NBDHE success. High School GPA was not found to be a useful predictor of NBDHE performance in a study by Shannon (1989), which examined student records from three community college programs. However, this same study did find a positive correlation between High School GPA and dental hygiene GPA.

According to the American Dental Association 2010-2011 Survey of Allied Health Education, 76.2% of accredited dental hygiene programs require prerequisite college courses prior to application and/or admission to the program (Commission on Dental Accreditation, 2012). Requiring such courses allows admissions committees the opportunity to examine and compare the college GPA of students, either in cumulative form or for individual courses. However, schools vary in which courses are prerequisites, though many cite requiring prior coursework in sciences such as chemistry,
microbiology, physiology and anatomy. Other common prerequisite courses include psychology, sociology and English. With data on such courses, studies have identified correlations of course scores to program and NBDHE success. (Austin, 2011; Alzahrani et al, 2007; Bauchmoyer et al, 2004; Shannon, 1989; Downey et al, 2002; Lee, 1983). In a study of 3 associate degree programs, common dental hygiene prerequisite courses were examined to identify correlations between grades in such courses and overall performance in the dental hygiene program and on the NBDHE. Nutrition, sociology, chemistry and physiology were found to be strong predictors of dental hygiene GPA. The same study found sociology, general psychology and anatomy to be strong predictors of NBDHE performance (Shannon, 1989).

Many studies have been conducted which examine various dental hygiene course grades and their ability to predict success on the NBDHE and successful completion of the dental hygiene program. Those studied within the dental hygiene curriculum, while useful for remediation and retention purposes, are not useful in predicting future program outcomes success when considering admissions criteria of program applicants.(Alzahrani et al, 2007; Edenfield et al, 2000; DeWald, Gutmann, Solomon, 2004). Not surprisingly, multiple studies found exiting dental hygiene GPA to be a strong predictor of NBDHE performance (DeWald et al, 2004; Bauchmoyer et al, 2004; Shannon, 1989).

In the study by Alzahrani et al, published in 2006, final course grades in oral pathology and oral anatomy and histology were found to be significant predictors of success on the NBDHE, while oral pathology was also found to be a significant predictor of success in the dental hygiene program. A study by Shannon (1989) found that all
college course grades (biological, physical and behavioral sciences) had a positive correlation to dental hygiene GPA.

Tucker-Ward et al (2010) found a significant relationship between both first year dental hygiene GPA and final dental hygiene GPA when comparing them to NBDHE scores. Both of these variables proved stronger predictors of NBDHE performance than incoming GPA. Similarly, in a study of dental hygiene students at Baylor University College of Dentistry, researchers found no significant relationship between incoming GPA and NBDHE performance (DeWald et al, 2004).

**College Entrance Exam Scores as Predictors of Success**

In contrast to the dental hygiene programs utilizing prerequisites for admissions, nearly 24% of accredited dental hygiene programs responding to the mandatory ADA survey require no prerequisite college coursework prior to application to the program (CODA 2012). Such schools rely on other admissions criteria to determine which candidates to offer admissions into the program. American College Test (ACT) scores are often utilized as admissions criteria. A study of dental hygiene students who graduated in 2002-2010 from Western Kentucky University’s Program of Dental Hygiene included examining the relationship between ACT scores and NBDHE scores. The ACT scores were studied as a composite score as well as scores on the individual sections of the exam; math, reading, English and science. The results of this study found the reading portion of the ACT to be a strong predictor of the total NBDHE scores. In addition, the
reading portion of the ACT was a strong predictor of the performance on the case-based portion of the NBDHE (Austin, 2011).

In a much earlier study by Shannon (1989), student records from three separate community college dental hygiene programs in the Midwest were examined. The results of the NBDHE and dental hygiene GPA were compared to composite ACT and ACT subcomponent scores, as well as many different course grades. While this study found the ACT social studies score to be the most effective of all admissions criteria examined in predicting NBDHE success, the math, science, reading, English and composite ACT scores were not significant predictors of NBDHE performance. In this study, however, the ACT English score was the portion of the ACT most predictive of success in the dental hygiene program.

A research study examining the relationship between NBDHE and ACT scores reviewed the records of 209 dental hygiene graduates from Baylor College of Dentistry’s dental hygiene program (Vitasek and Parker, 1991). The study spanned 11 years and found the ACT scores to be only weak to moderate predictors of NBDHE performance in only 5 of the years studied. It showed no correlation the other six years. The researchers of this study concluded the ACT could not be considered a strong or dependable predictor of NBDHE performance. However, this study did not investigate the subcomponents of the ACT score, only the composite score.

A second standardized test utilized by colleges and universities for admissions purposes is the Scholastic Aptitude Test (SAT). In a study by Downey et al (2002) dental hygiene graduate SAT scores were compared to final dental hygiene GPA and NBDHE
performance at the Medical College of Georgia. While the SAT scores were not significant in predicting NBDHE scores, they were significant predictors of dental hygiene GPA or success in the program. Similarly, a study by Tucker-Ward et al (2010) revealed no statistically significant relationship between SAT scores and NBDHE performance.

Demographic and Other Variables as Predictors of Success

Though not exclusively, demographic variables have been studied as potential predictors of dental hygiene student success and NBDHE performance. Age did not have a significant correlation with NBDHE score among Western Kentucky University’s dental hygiene students between 2002 and 2010 (Austin, 2011). Neither age nor marital status showed a significant relationship with NBDHE performance in the study by Shannon (1989).

A study at the University of Arkansas for Medical Sciences, Department of Dental Hygiene examined records of 132 program graduates. The study compared two cohorts of students; those with prior dental assisting experience and those with no dental assisting experience. Data examined included prerequisite science GPA, dental hygiene GPA at the end of the first year, dental hygiene GPA at the end of the second year, total clinical dental hygiene GPA, preclinical dental hygiene grade, dental hygiene clinic I grade, dental anatomy grade, dental materials grade, NBDHE performance, and Southern Regional Board performance. Results of this study found dental assisting experience to be positively correlated with initial clinical performance and the cumulative clinic GPA.
There were no significant correlations found with the other variables measured, including NBDHE performance (DeAngelis and Goral, 1995).

While the majority of research involving admissions criteria evaluates cognitive variables, a pilot study by Lee et al (1983) at the Louisiana State University Dental School examined student’s attitudes as well as cognitive variables. The non-cognitive variables included student attitudes at the beginning of the program toward “Oral Hygiene”, “Myself” and “Dental Hygiene Education”, measured by the Semantic Differential Method. The Study of Values measured student values on theoretical, economic, aesthetic, social, political and religious scales. The study also examined the traditional cognitive variables of Dental Hygiene Aptitude Test score, ACT score, entering GPA, and science GPA. Results found the use of non-cognitive factors increased the predictive reliability of the cognitive variables, when predicting success in didactic and clinical dental hygiene courses.

Another non-traditional approach to predicting student success involves the evaluation of critical thinking skills. Critical thinking skills have a broad implication in clinical dental hygiene, including the clinician’s ability to process, sort and identify pertinent information when gathering patient data and developing a comprehensive treatment plan. In a study of three baccalaureate programs, students were given the California Critical Thinking Skills Test (CCTST) and California Critical Thinking Disposition Inventory (CCTDI) during the first week of the dental hygiene program and again upon completion of the program. The primary purpose of this study was to identify if a correlation existed between preexisting critical thinking skills and performance on the
NBDHE. Results found a significant relationship between CCTST and NBDHE performance. While the study found other predictors in age, GPA and number of college hours completed, the uniqueness of this study is in the examination of critical thinking skills (Williams, Schmidt, Tillis, Wilkins, Glasnapp, 2006).

Resources available to many students prior to taking the NBDHE are mock board classes and mock board exams. At Baylor College of Dentistry, a study was conducted to determine if taking a dental hygiene board review course significantly affected NBDHE performance. The study found no significant difference between the group of students who took the review course and those who had not taken the course relative to NBDHE scores (DeWald et al, 2004).

In a similar study at Armstrong Atlantic State University, researchers examined mock dental hygiene examination scores Early Course Average (ECA) and Interim Course Average (ICA) in relationship to NBDHE performance. Although ECA showed a strong relationship to NBDHE performance, a significant correlation was not found between mock dental hygiene exam scores and NBDHE performance or ICA and NBDHE performance (Edenfield and Hansen, 2000).

Personal interviews are commonplace among dental hygiene application and admission procedures. Literature studying the effectiveness of the interview process is sparse. In a study of allied health program selection practices, 59% of the dental hygiene programs studied utilized the interview as a portion of the interview process. Among the schools utilizing the interviewing process, the interview was weighted an average of 14% of the total application points (Dietrich and Crowley, 1982).
While studies specific to dental hygiene and the effectiveness of the interview portion of the admissions process in predicting future program and board success is not available, a study examining the correlation between the admissions interview and academic performance was conducted among the dental students at the University of Florida College of Dentistry (UCFD). Interview scores were determined by professional demeanor, maturity, dental-related experience, clarity of expression, and motivation for choosing to study dentistry, among other factors. Researchers discovered a statistically significant correlation among interview scores and the yearly dental school GPA, thereby also making it correlated with the final dental school GPA. The study also found the interview score to be positively correlated to National Board Dental Exam Scores (Sandow, Jones, Peek, Courts and Watson, 2002). This result contradicts other earlier research of the interview score and dental school performance, all which found no correlation or only a weak correlation between interview scores and academic performance (Staat and Yancey, 2002; Houston and Mensh, 1975; Walker, Killip and Fuller, 1985; Graham and Boyd, 1982; Killip, Fuller and Kerber, 1979; Boyd, Graham, Teteruck and Krupka, 1983).

In 1998, the NBDHE format was changed, designating 150 of the 350 questions on the test based on twelve to fifteen patient cases, interdisciplinary in nature. Since that time, several research studies have been conducted to determine if relationships exist between academic factors and success on the NBDHE. In a study published in 2004 by Bauchmoyer et al, examining data after the case-based questions had been included in the NBDHE, the research showed that cumulative dental hygiene GPA and the three science
prerequisite GPA (biology, chemistry I and chemistry II) remained the strong predictors of NBDHE performance at The Ohio State University. Interestingly, the study also found that cumulative dental hygiene GPA, one of the strong predictors of NBDHE performance, was strongly correlated with students’ human nutrition grade, and consistency of location of prerequisite course completion.

Similar to the study at The Ohio State University, Austin (2011) researched academic variables, searching for correlations with performance on the case-based portion of the NBDHE among dental hygiene graduates from data obtained at Western Kentucky University. The results of this study found a relationship between ACT reading scores and both the case-based portion and overall score on the NBDHE. Also noted in this study was a strong correlation between microbiology grades and the case-based NBDHE performance.

Beginning in 2012, NBDHE scores are provided to dental hygiene program administrators with a different degree of detail. If less than 10 students from an individual dental hygiene program sit for the exam in a one month reporting period, the program director will only be notified of the pass/fail status of each student. If ten or more students take the exam during a reporting period, the school will be provided with an aggregate standard deviation score in subject areas, in comparison to the national average. Therefore, dental hygiene program administrators no longer have access to scores of individual student performance on specific portions of the test, like the case-based question section. Due to this fact, the limited research in this area will not be likely to proliferate.
Chapter 3
Methodology

This chapter outlines the specific steps utilized to gather and analyze data to determine if relationships exist among the admission variable of ACT scores and dental hygiene program outcomes including NBDHE performance and final dental hygiene GPA. The research investigates ACT composite scores as well as the subcomponent scores. In addition, students requiring repeated attempts to successfully complete required science courses and those who successfully completed those courses on the first attempt were compared in regards to the final dental hygiene GPA and NBDHE scores. The research design, sampling and subject selection, data collection and data analysis are addressed in this chapter.

Research Design

The design of this study is ex-post facto, correlational research. A review of dental hygiene admissions applications, academic records and NBDHE performance was conducted. Student records from those who anticipated completion of the dental hygiene program at Kellogg Community College from 2005-2011 were included in the study. Admissions applications were utilized to obtain ACT composite scores, as well as the subcomponent scores of English, reading, social studies, math and science. The academic records of the same cohort of students were examined. The final dental hygiene GPA and
final overall GPA for each of the students was recorded, those with repeated attempts at required science courses were identified. Finally, the NBDHE scores, which are provided to the college’s dental hygiene department by the Joint Commission of Dental Examiners, were examined for the same cohort of students.

Research Questions

Is there a correlation between ACT scores (composite, reading, math, English, science) and:

a. Overall NBDHE scores
b. Case-based Question scores
c. Final dental hygiene GPA
d. Final overall college GPA

Is there a difference in final dental hygiene GPA between students who made repeated attempts of required science courses and those who received acceptable grades on the first attempt?

Is there a difference in NBDHE scores between students who made repeated attempts of required science courses and those who received acceptable grades on the first attempt?

Subject Selection

A complete list of dental hygiene students in each of the graduating classes from 2005-2011 at Kellogg Community College was obtained. Data from this group of
students was utilized for the purposes of this study. Each matriculating class began with twenty students in the original cohort, but due to student circumstances, minor deviation can occur, causing the graduating class to be slightly above or below twenty students. In total, 138 student records were examined in this study. Prior to reviewing student records and recording data, the research proposal was approved as Exempt Research by The Ohio State University Institutional Review Board and the Kellogg Community College Institutional Review Board.

Data Collection

Data from students having an anticipated graduation from the Kellogg Community College dental hygiene program between 2005 and 2011 was utilized. A complete list of these cohorts of students was compiled by the researcher. The student academic record data and ACT scores were then requested through the Kellogg Community College Institutional Review Board. The Final dental hygiene GPA was calculated and recorded on the data collection sheet for each student record in the study group. Students requiring repeated attempts to successfully pass a required science course were also recorded on the data collection sheet, as well as students who were academically dismissed from the program.

The Joint Commission of Dental Examiners (JCNDE) sends NBDHE scores to the Kellogg Community College Dental Hygiene Program each year, and the scores from the aforementioned groups of students were obtained from the records on file in the dental hygiene department. Due to the JCNDE change in score reporting, the class of
2012 and 2013 NBDHE scores are only available in pass/fail data, rather than a numerical score as in the previous years. This explains why the study does not include 2012 or 2013 cohorts of students. The data was compiled on individual data collection sheets. Each subject was assigned an identification number and data was transferred from the data collection sheets into an Excel spreadsheet for analyses. All data was de-identified, containing no personally identifiable information, to insure the privacy and confidentiality of the student records. The original data sheets are being stored in a locked cabinet in the researcher’s office, and will destroyed five years following the completion of the research project.

**Statistical Analysis**

Data analysis was completed using the Statistical Package for Social Sciences (SPSS19). Data was organized using descriptive statistics (means, standard deviations, percentages). Pearson’s correlations were calculated to answer the research questions searching for relationships. Independent t-tests were performed for the questions searching for differences in outcomes for students who made repeated attempts at science courses, versus those students who passed the science courses successfully the first time.
This study was developed to search for relationships among composite ACT scores, subcomponent ACT scores and overall NBDHE scores, NBDHE case-based scores and final dental hygiene GPA. A total of 138 records were studied, however 14 of the students had previously earned a college degree, and therefore were not required to provide ACT scores to the college. Consequently, for all of the calculations involving ACT scores, n=124. An exception is with the reading portion of the ACT where n=121. This discrepancy is due to a change in the ACT format. Three students with older ACT scores had social studies scores in place of reading scores.

Results

As shown in Table 1, results of this study found that of the ACT scores, the strongest correlation with overall NBDHE score was the composite ACT score (r=.394, p=<.001). However, both the ACT composite score and the subcomponent scores of math (r=.360, p=<.001), English (r=.337, p=<.001) and science (r=.334, p=<.001) show only moderate correlation to the overall NBDHE score. A weaker correlation was found between the overall NBDHE score and the reading portion of the ACT (r=.211, p=.020).
ACT scores, both overall and all subcomponent scores proved to have a weaker correlation with NBDHE case-based question scores, as shown in Table 2. A weak correlation was found between NBDHE case-based scores and overall ACT scores (r=.215, p=.016), ACT math scores (r=.214, p=.0178), ACT English scores (r=.212, p=.018), and ACT science scores (r=.221, p=.014). There was no significant correlation found with the ACT reading subcomponent score and the NBDHE case-based question score.

<table>
<thead>
<tr>
<th>Exam</th>
<th>r value</th>
<th>p value</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Composite ACT</td>
<td>.394</td>
<td>&lt;.001</td>
<td>124</td>
</tr>
<tr>
<td>Reading ACT</td>
<td>.211</td>
<td>.020</td>
<td>121</td>
</tr>
<tr>
<td>Math ACT</td>
<td>.360</td>
<td>&lt;.001</td>
<td>124</td>
</tr>
<tr>
<td>English</td>
<td>.337</td>
<td>&lt;.001</td>
<td>124</td>
</tr>
<tr>
<td>Science</td>
<td>.334</td>
<td>&lt;.001</td>
<td>124</td>
</tr>
</tbody>
</table>

Table 1: ACT Scores and Overall NBDHE Score

<table>
<thead>
<tr>
<th>Exam</th>
<th>r value</th>
<th>p value</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Composite ACT</td>
<td>.215</td>
<td>.016</td>
<td>124</td>
</tr>
<tr>
<td>Reading ACT</td>
<td>.041</td>
<td>.652</td>
<td>121</td>
</tr>
<tr>
<td>Math ACT</td>
<td>.214</td>
<td>.0178</td>
<td>124</td>
</tr>
<tr>
<td>English</td>
<td>.212</td>
<td>.018</td>
<td>124</td>
</tr>
<tr>
<td>Science</td>
<td>.221</td>
<td>.014</td>
<td>124</td>
</tr>
</tbody>
</table>

Table 2: ACT Scores and NBDHE Case-based Question Score
ACT score and final dental hygiene correlations are shown in Table 3. Although all were moderate or weak at best, ACT correlation with final dental hygiene GPA revealed the strongest relationship was the ACT math score ($r=.302$, $p=<.001$). The ACT composite score also showed a significant moderate relationship to final dental hygiene GPA ($r=.302$, $p=.001$), while the English ACT ($r=.255$, $p=.004$) and science ACT scores ($r=.239$, $p=.007$) revealed a weak correlation. The reading ACT subcomponent score showed no significant relationship to the final dental hygiene GPA.

<table>
<thead>
<tr>
<th>Exam</th>
<th>r value</th>
<th>p value</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Composite ACT</td>
<td>.302</td>
<td>.001</td>
<td>124</td>
</tr>
<tr>
<td>Reading ACT</td>
<td>.126</td>
<td>.170</td>
<td>121</td>
</tr>
<tr>
<td>Math ACT</td>
<td>.322</td>
<td>&lt;.001</td>
<td>124</td>
</tr>
<tr>
<td>English ACT</td>
<td>.255</td>
<td>.004</td>
<td>124</td>
</tr>
<tr>
<td>Science ACT</td>
<td>.239</td>
<td>.007</td>
<td>124</td>
</tr>
</tbody>
</table>

Table 3: ACT Scores and Final Dental Hygiene GPA

In a separate analysis, differences in overall NBDHE scores and final dental hygiene GPA between those who made repeated attempts to receive acceptable grades in required science courses and those who did not was examined. The results are located in Table 4 and Table 5. The t-test yielded results indicating those students who made repeated attempts at science courses had significantly lower final dental hygiene GPA when compared to students who did not require repeated attempts ($t=-4.002$, df=133, sig.=.001). Likewise, students requiring repeated attempts at science courses had
significantly lower overall NBDHE scores than those who did not require repeated attempts ($t=-3.24$, $df=133$, sig.=.001).

<table>
<thead>
<tr>
<th>Students Repeating Required Science Courses</th>
<th>n</th>
<th>Mean NBDHE Score</th>
<th>Standard Deviation</th>
<th>t-test Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>14</td>
<td>78.93</td>
<td>5.269</td>
<td>$t$ value = -3.24</td>
</tr>
<tr>
<td>No</td>
<td>121</td>
<td>83.3</td>
<td>4.715</td>
<td>$df = 133$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>sig.= .001</td>
</tr>
</tbody>
</table>

Table 4: Repeated Science Course and Overall NBDHE Score

<table>
<thead>
<tr>
<th>Students Repeating Required Science Course</th>
<th>n</th>
<th>Mean Dental Hygiene GPA</th>
<th>Standard Deviation</th>
<th>t-test Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>14</td>
<td>3.107</td>
<td>.3185</td>
<td>$t$ = -4.002</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$df = 133$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>sig.= .001</td>
</tr>
<tr>
<td>No</td>
<td>121</td>
<td>3.457</td>
<td>.3083</td>
<td></td>
</tr>
</tbody>
</table>

Table 5: Repeated Science Course and Final Dental Hygiene GPA

Relationships were also revealed among specific required science course grades and final dental hygiene GPA, overall NBDHE scores and NBDHE case-based question scores. Microbiology grades (n=91) were strongly correlated to final dental hygiene GPA ($r=.698$, $p<.001$) and overall NBDHE scores ($r=.609$, $p<.001$), and moderately
correlated to NBDHE case-based question scores ($r=.479$, $p<.001$). A strong correlation was revealed between Human Anatomy grades (n=102) and final dental hygiene GPA ($r=.628$, $p=.001$), while they were moderately correlated with overall NBDHE scores ($r=.474$, $p<.001$) and NBDHE case-based question scores ($r=.355$, $p<.001$). Physiology grades (n=114) showed moderate correlations with final dental hygiene GPA ($r=.460$, $p<.001$) and overall NBDHE scores ($r=.369$, $p<.001$), while revealing only a weak relationship with NBDHE case-based question scores ($r=.274$, $p=.003$). General chemistry grades (n=82) were moderately correlated with final dental hygiene GPA ($r=.454$, $p<.001$) and overall NBDHE scores ($r=.301$, $p=.006$). No significant relationship was found between General chemistry grades and NBDHE case-based question scores. Refer to Tables 6, 7 and 8.

<table>
<thead>
<tr>
<th>Science Course</th>
<th>r value</th>
<th>p value</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anatomy</td>
<td>.474</td>
<td>&lt;.001</td>
<td>114</td>
</tr>
<tr>
<td>Physiology</td>
<td>.369</td>
<td>&lt;.001</td>
<td>114</td>
</tr>
<tr>
<td>Microbiology</td>
<td>.609</td>
<td>&lt;.001</td>
<td>91</td>
</tr>
<tr>
<td>Chemistry</td>
<td>.301</td>
<td>.006</td>
<td>82</td>
</tr>
</tbody>
</table>

Table 6: Science Grade and Overall NBDHE Score

<table>
<thead>
<tr>
<th>Science Course</th>
<th>r value</th>
<th>p value</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anatomy</td>
<td>.355</td>
<td>&lt;.001</td>
<td>102</td>
</tr>
<tr>
<td>Physiology</td>
<td>.274</td>
<td>.003</td>
<td>114</td>
</tr>
<tr>
<td>Microbiology</td>
<td>.479</td>
<td>&lt;.001</td>
<td>91</td>
</tr>
<tr>
<td>Chemistry</td>
<td>.159</td>
<td>.155</td>
<td>82</td>
</tr>
</tbody>
</table>

Table 7: Science Grade and Case-based NBDHE Score
Discussion

Results from this study suggest that composite ACT scores are moderately correlated to both overall NBDHE scores and final dental hygiene GPA. Previous studies have examined composite ACT scores, with fewer studies examining the subcomponent ACT scores in relationship to dental hygiene program outcomes. Findings have produced conflicting results (Austin, 2011; Shannon, 1989; Vitasek et al, 1991; Lee et al, 1983). The relationship between the ACT scores and final dental hygiene GPA from the current study are consistent with that of Vitasek, when she found the ACT English and composite scores to be moderately correlated to the final dental hygiene GPA. In the same study, Vitasek found ACT scores to have weak to moderate correlations to NBDHE performance, which is also consistent with the current study.

Required science courses, often prerequisites for entry into dental hygiene programs, have also been studied and compared to dental hygiene program outcomes. Many of these studies have found specific courses and/or combined science GPA to be more strongly correlated with specific program outcomes (Austin, 2011; Tucker-Ward et al, 2010; Alzahrani et al, 2007; Shannon, 1989; Lee et al, 1983; Downey et al, 2002).
Additional findings in this study involving specific science course grades revealed relationships previously observed in other research studies. Students’ first attempt science course grades were observed in comparison to NBDHE scores, NBDHE case-based question scores and final dental hygiene GPA. Microbiology grades were found to be strongly correlated to final dental hygiene GPA and composite NBDHE scores in the current study. These are similar to the findings observed by Austin, where microbiology grades were among the strongest predictors of NBDHE performance in her 2011 study of dental hygiene students at Western Kentucky University. Microbiology grades were found to be moderately correlated to the both the final dental hygiene GPA and NBDHE score among students at The Ohio State University, in the 2004 study by Bauchmoyer, et al.

Chemistry and physiology were both found to have moderate correlations with final dental hygiene GPA and overall NBDHE scores in the current study. This is similar to the study by Shannon in 1989, where the researcher found relationships between physiology and dental hygiene GPA, and chemistry and dental hygiene GPA among students at Baylor University. Bauchmoyer, et al found the physiology grade to be strongly correlated to dental hygiene GPA, while it was moderately correlated with NBDHE scores, in the 2004 study at The Ohio State University.

In the current study, anatomy grades were found to be strongly correlated with final dental hygiene GPA. The anatomy grades were moderately correlated with overall NBDHE scores and case-based question scores. Austin had a similar finding in her 2011 study, where anatomy grades were moderately correlated with overall NBDHE scores.
Likewise, Bauchmoyer et al, 2004, found the anatomy grade to be strongly correlated to final dental hygiene GPA and moderately correlated to NBDHE score. The anatomy grade was also found to have a strong correlation to dental hygiene GPA in the study by Shannon in 1989.

Results of this study revealed statistically significant differences in outcomes for students who made repeated attempts at required science courses versus those who received an acceptable grade on the first attempt. Both the final dental hygiene grade point averages and overall NBDHE scores were significantly higher for those who received acceptable grades on the first attempt of required science courses when compared with those who required a repeated attempt.

The results of the current study may not be a complete representation of the sample, as some students may have repeated attempts at another institution that were not made available in the data for this study. These results conflict with the findings of Alzharani et al, who found no relationship between multiple attempts at science courses and success in the program or on the NBDHE.

The overall college GPA of the cohort of students was not able to be studied in comparison to the final dental hygiene GPA or performance on the NBDHE, as many students had taken college courses at a different institution, and GPA information for transferred credit was not included in the data provided for this study.

As the results of the current study and many previous studies have found, the ACT score, composite and subcomponent, have only weak or moderate correlations with NBDHE scores and final dental hygiene GPA. Therefore, it may be prudent to place less
weight on ACT scores when considering applications for admissions into dental hygiene programs. Rather, based on the results of this study in addition to previous research, it may be beneficial for those making program admissions decisions to place more consideration on applicants’ core science course grades in anatomy, physiology, chemistry and microbiology.

Further research involving academic records of students who made repeated attempts of required science courses is suggested, as what little research has been done in this area has produced conflicting results. With more research, admissions criteria may need to be adjusted, so students with a stronger ability to be successful in the program and on the boards are accepted into dental hygiene programs.

With nearly 24% of all accredited dental hygiene programs not mandating prerequisite coursework prior to acceptance, consideration of pre-dental hygiene science coursework would be a consideration that would involve major changes to the program and admissions policies. Success in the program and on the licensure examinations is the ultimate goal of a dental hygiene educational program. Adopting and maintaining admissions criteria which are designed to admit those applicants more likely to be successful, based on research, is an important tool to utilize resources most efficiently. As the current study concurs with previous research in the lack of strength in relationship between ACT scores and dental hygiene program outcomes, schools may be wise to be cautious of placing significant importance on ACT scores.
Introduction

Dental hygiene is one of the fastest growing occupations in the United States, according to the Bureau of Labor and Statistics (Bureau of Labor and Statistics, 2011). In fact, dental hygiene employment is projected to increase an astounding 36% between 2008 and 2018 Bureau of Labor and Statistics, 2011). Each school’s goal is preparing the students for dental hygiene licensure. Dental hygiene licensure is granted only after successful completion of an accredited dental hygiene program and the passing of the national, regional and state board examinations (American Dental Hygienists’ Association, 2009). While regional and state exams vary among locations, all students must pass the same National Board of Dental Hygiene Examination(NBDHE) in order to practice dental hygiene in the United States.

The NBDHE is an exam developed by the Joint Commission on National Dental Examinations that is used for the purpose of assisting state boards in evaluating qualifications of dental hygienists seeking licensure (Joint Commission on National Dental Examinations, 2013). Since it has been administered beginning in 1962, the NBDHE has undergone many revisions and alterations, the most recent being the addition of case-based questions in 1998. These 150 questions are based on 15 cases,
which involve more reading than the traditional exam questions. It is possible that success on these questions may require a slightly different set of abilities than the traditional questions.

With 34,117 applicants and 9,821 students accepted into accredited dental hygiene programs in 2010, admissions committees are faced with a significant challenge in selecting the candidates most likely to be successful in the programs (American Dental Association Survey of Allied Dental Education, 2012). Each educational institution has its own unique strategy in making admissions decisions. There are many criteria weighted in differing formulas among institutions. Criteria used by dental hygiene admissions committees include such items as prerequisite GPAs, grades received in various prerequisite science courses, personal interview scores, ACT scores, SAT scores or previous dental assisting experience (American Dental Hygienists’ Association, 2013).

Through the process of selective admissions, dental hygiene program admissions committees attempt to select those students who are most likely to be successful in the dental hygiene program. Success in a dental hygiene program may be defined as completing dental hygiene coursework with a “C” or better in a predetermined time frame and passing the NBDHE by scoring 75% or higher. Beginning in 2012, JCNDE discontinued the reporting of subcomponent scores for passing NBDHE examinees to dental hygiene program directors. Historically, program faculty and administrators have been able to study the results and implement program modifications if patterns of weakness were detected in content areas, based on the NBDHE results.
The purpose of this study was to determine if relationships existed between certain dental hygiene admissions criteria and dental hygiene program outcomes. Specifically, the study sought to find relationships between ACT scores, both composite and subcomponent, and NBDHE scores. Also, the study searched for relationships between ACT scores and final dental hygiene GPA. Lastly, the study was designed to search for differences in outcomes for students who required multiple attempts to successfully complete required science courses, versus those who did not.

….. American College Test (ACT) scores are often utilized as admissions criteria. A study of dental hygiene students who graduated between 2002 and 2010 from Western Kentucky University’s Program of Dental Hygiene included examining the relationship between ACT scores and NBDHE scores. The ACT scores were studied as a composite score as well as scores on the individual sections of the exam; math, reading, English and science. The results of this study found the reading portion of the ACT to be a strong predictor of the total NBDHE scores. In addition, the reading portion of the ACT was a strong predictor of the performance on the case-based portion of the NBDHE (Austin, 2011).

In a much earlier study by Shannon (1989), student records from three separate community college dental hygiene programs in the Midwest were examined. The results of the NBDHE and dental hygiene GPA were compared to total ACT and ACT subcomponent scores, as well as many different course grades. While this study found the ACT social studies score to be the most effective of all admissions criteria examined in predicting NBDHE success, the math, science, reading, English and composite ACT
scores were not significant predictors of NBDHE performance. In this study, however, the ACT English score was the portion of the ACT most predictive of success in the dental hygiene program.

A research study examining the relationship between NBDHE and ACT scores reviewed the records of 209 dental hygiene graduates from Baylor College of Dentistry’s dental hygiene program (Vitasek and Parker, 191). The study spanned 11 years and found the ACT scores to be only weak to moderate predictors of NBDHE performance in only 5 of the years studied. It showed no correlation the other six years. The researchers of this study concluded the ACT could not be considered a strong or dependable predictor of NBDHE performance. However, this study did not investigate the subcomponents of the ACT score, only the composite score.

In a study published in 2004 by Bauchmoyer et al, examining data after the case-based questions had been included in the NBDHE, the research showed that cumulative dental hygiene GPA and the three science prerequisite GPA (biology, chemistry I and chemistry II) remained the strong predictors of NBDHE performance at The Ohio State University. Interestingly, the study also found that cumulative dental hygiene GPA, one of the strong predictors of NBDHE performance, was strongly correlated with students’ human nutrition grade, and consistency of location of prerequisite course completion.

Similar to the study at The Ohio State University, Austin (2011) researched academic variables, searching for correlations with performance on the case-based portion of the NBDHE among dental hygiene graduates from data obtained at Western Kentucky University. The results of this study found a relationship between ACT reading
scores and both the case-based portion and overall score on the NBDHE. Also noted in this study was a strong correlation between microbiology grades and the case-based NBDHE performance.

In a study by Alzahrani, et al in 2007, no correlation was found between students' incoming college grade point average, grades in science prerequisite courses and graduation and NBDHE success. Also, no difference was found in outcomes between students who required multiple attempts to successfully complete required science courses and those who successfully completed the courses on the first attempt.

Methods and Materials

In this ex-post facto, correlational research a review of dental hygiene student ACT scores, academic records and NBDHE performance was conducted. Student records from those who anticipated completion of the dental hygiene program at Kellogg Community College from 2005-2011 were included in the study. ACT composite scores, as well as the subcomponent scores of English, reading, social studies, math and science and the academic records of the same cohort of students were examined. The final dental hygiene GPA and final overall GPA for each of the students was recorded, those with repeated attempts at required science courses were identified. Finally, the NBDHE scores, which are provided to the college’s dental hygiene department by the Joint Commission of Dental Examiners, were examined for the same cohort of students.

Prior to beginning the study, an exempt status proposal was approved by the Human Subject’s Review Board at both The Ohio State University and Kellogg
Community College. A complete list of dental hygiene students in each of the graduating classes from 2005-2011 at Kellogg Community College was obtained. Data from this group of students was utilized for the purposes of this study. In total, 138 student records were examined in this study. Also, not all academic records contained usable data regarding repeating of science courses. The student academic record data and ACT scores were then requested through the Kellogg Community College Institutional Review Board. The Final dental hygiene GPA was calculated and recorded on the data collection sheet for each student record in the study group. Students requiring repeated attempts to successfully pass a required science course were also recorded on the data collection sheet, as well as students who were academically dismissed from the program.

Each subject was assigned an identification number and data was transferred from the data collection sheets into an Excel spreadsheet for analyses. All data was de-identified, containing no personally identifiable information, to insure the privacy and confidentiality of the student records.

ACT composite score, ACT subcomponent scores of math, science, reading and English, final dental hygiene GPA, overall NBDHE score, case-based NBDHE score, science course grades and whether or not repeat attempts for success in science courses was required were all recorded in a spreadsheet. Data analysis was completed using the Statistical Package for Social Sciences (SPSS19). Data was organized using descriptive statistics (means, standard deviations, percentages). Pearson’s correlations were calculated to answer the research questions.
Results

A total of 138 records were studied. However, ACT scores were not available for all students, as those who have previously obtained an associate’s degree of higher are not required to submit ACT scores upon application to the dental hygiene program at Kellogg Community College. Consequently, for all of the calculations involving ACT scores, n=124. An exception is with the reading portion of the ACT where n=121. This discrepancy is due to a change in the ACT format. Three students with older ACT scores had social studies scores in place of reading scores. Results of this study found that of the ACT scores, the strongest correlation with overall NBDHE score was the composite ACT score ($r=.394$, $p<.001$). However, both the ACT composite score and the subcomponent scores of math ($r=.360$, $p<.001$), English ($r=.337$, $p<.001$) and science ($r=.334$, $p<.001$) show only moderate correlation to the overall NBDHE score. A weaker correlation was found between the overall NBDHE score and the reading portion of the ACT ($r=.211$, $p=.020$).

ACT scores, both overall and all subcomponent scores proved to have a weaker correlation with NBDHE case-based question scores. A weak correlation was found between NBDHE case-based scores and overall ACT scores ($r=.215$, $p=.016$), ACT math scores ($r=.214$, $p=.0178$), ACT English scores ($r=.212$, $p=.018$), and ACT science scores ($r=.221$, $p=.014$). There was no significant correlation found with the ACT reading subcomponent score and the NBDHE case-based question score.
Although all were moderate or weak at best, ACT correlation with final dental hygiene GPA revealed the strongest relationship was the ACT math score ($r=.302, p=<.001$). The ACT composite score also showed a significant moderate relationship to final dental hygiene GPA ($r=.302, p=.001$), while the English ACT ($r=.255, p=.004$) and science ACT scores ($r=.239, p=.007$) revealed a weak correlation. The reading ACT subcomponent score showed no significant relationship to the final dental hygiene GPA.

In a separate analysis, differences in overall NBDHE final dental scores and hygiene GPA between those who made repeated attempts to receive acceptable grades in required science courses and those who did not was examined. The t-test yielded results indicating those students who made repeated attempts at science courses had significantly lower final dental hygiene GPA when compared to students who did not require repeated attempts ($t=-4.002, df=133, sig.=.001$). Likewise, students requiring repeated attempts at science courses had significantly lower overall NBDHE scores than those who did not require repeated attempts ($t=-3.24, df=133, sig.=.001$).

Relationships were also revealed among specific required science course grades and final dental hygiene GPA, overall NBDHE scores and NBDHE case-based question scores. Microbiology grades (n=91) were strongly correlated to final dental hygiene GPA ($r=.698, p=<.001$) and overall NBDHE scores ($r=.609, p=<.001$), and moderately correlated to NBDHE case-based question scores ($r=.479, p=<.001$). A strong correlation was revealed between Human Anatomy grades (n=102) and final dental hygiene GPA ($r=.628, p=.001$), while they were moderately correlated with overall NBDHE scores ($r=.474, p=<.001$) and NBDHE case-based question scores ($r=.355, p=<.001$). Physiology
grades (n=114) showed moderate correlations with final dental hygiene GPA (r=.460, p=<.001) and overall NBDHE scores (r=.369, p=<.001), while revealing only a weak relationship with NBDHE case-based question scores (r=.274, p=.003). General chemistry grades (n=82) were moderately correlated with final dental hygiene GPA (r=.454, p=<.001) and overall NBDHE scores (r=.301, p=.006). No significant relationship was found between General chemistry grades and NBDHE case-based question scores.

Discussion

Results from this study suggest that composite ACT scores are moderately correlated to both overall NBDHE scores and final dental hygiene GPA. Previous studies have examined composite ACT scores, with fewer studies examining the subcomponent ACT scores in relationship to dental hygiene program outcomes. Findings have produced conflicting results (Austin, 2011; Shannon, 1989; Vitasek et al, 1991; Lee et al, 1983). The relationship between the ACT scores and final dental hygiene GPA from the current study are consistent with that of Vitasek, when she found the ACT English and composite scores to be moderately correlated to the final dental hygiene GPA. In the same study, Viastek found ACT scores to have weak to moderate correlations to NBDHE performance, which is also consistent with the current study.

Required science courses, often prerequisites for entry into dental hygiene programs, have also been studied and compared to dental hygiene program outcomes. Additional findings in this study involving specific science course grade revealed
relationships previously observed in other research studies. Students’ first attempt science course grades were observed in comparison to NBDHE scores, NBDHE case-based question scores and final dental hygiene GPA. Many of these studies have found specific courses and/or combined science GPA to be more strongly correlated with specific program outcomes (Austin, 2011; Tucker-Ward et al, 2010; Alzahrani et al, 2007; Shannon, 1989; Lee et al, 1983; Downey et al, 2002). Specific science course grades examined in this study revealed relationships previously observed in other research studies. Microbiology grades were found to be strongly correlated to final dental hygiene GPA and composite NBDHE scores in the current study. These are similar to the findings observed by Austin, where microbiology grades were among the strongest predictors of NBDHE performance in her 2011 study of dental hygiene students at Western Kentucky University. Microbiology grades were found to be moderately correlated to the both the final dental hygiene GPA and NBDHE score among students at The Ohio State University, in the 2004 study by Bauchmoyer, et al.

Chemistry and physiology were both found to have moderate correlations with final dental hygiene GPA and overall NBDHE scores in the current study. This is similar to the study by Shannon in 1989, where the researcher found relationships between physiology and dental hygiene GPA, and chemistry and dental hygiene GPA among students at Baylor University. Bauchmoyer, et al found the physiology grade to be strongly correlated to dental hygiene GPA, while it was moderately correlated with NBDHE scores, in the 2004 study at The Ohio State University.
In the current study, anatomy grades were found to be strongly correlated with final dental hygiene GPA. The anatomy grades were moderately correlated with overall NBDHE scores and case-based question scores. Austin had a similar finding in her 2011 study, where anatomy grades were moderately correlated with overall NBDHE scores. Likewise, Bauchmoyer et al, 2004, found the anatomy grade to be strongly correlated to final dental hygiene GPA and moderately correlated to NBDHE score. The anatomy grade was also found to have a strong correlation to dental hygiene GPA in the study by Shannon in 1989.

Results of this study revealed statistically significant differences in outcomes for students who made repeated attempts at required science courses versus those who received an acceptable grade on the first attempt. Both the final dental hygiene grade point averages and overall NBDHE scores were significantly higher for those who received acceptable grades on the first attempt of required science courses when compared with those who required a repeated attempt. However, the findings are limited due to the possibility of incomplete data.

The results of the current study may not be a complete representation of the sample, as some students may have repeated attempts at another institution that were not made available in the data for this study. These results conflict with the findings of Alzharani et al (2007), who found no relationship between multiple attempts at science courses and success in the program or on the NBDHE.

The overall college GPA of the cohort of students was not able to be studied in comparison to the final dental hygiene GPA or performance on the NBDHE, as many
students had taken college courses at a different institution, and GPA information for transferred credit was not included in the data provided for this study.

**Conclusion**

As the results of the current study and many previous studies have found, the ACT score, composite and subcomponent, have only weak or moderate correlations with NBDHE scores and final dental hygiene GPA. Therefore, it may be prudent to consider placing less weight on ACT scores when considering applications for admissions into dental hygiene programs. Rather, based on the results of this study in addition to previous research, it may be beneficial for those making program admissions decisions to place more consideration on applicants’ core science course grades in anatomy, physiology, chemistry and microbiology.

The results of the current study show no correlation with reading ACT reading scores and NBDHE case-based questions scores. This does not concur with Austin’s findings in 2011, where reading ACT scores were found to have a strong relationship to NBDHE case-based questions score. Austin’s findings suggested a possible link between reading ability and strength in the case-based portion of the exam. As this finding was not consistent with the current study, perhaps other skill sets are more important for success on this portion of the exam.

Further research involving academic records of students who made repeated attempts of required science courses is suggested, as what little research has been done in this area has produced conflicting results. With more research, admissions criteria may
need to be adjusted, so students with a stronger ability to be successful in the program and on the boards are accepted into dental hygiene programs.

With nearly 24% of all accredited dental hygiene programs not mandating prerequisite coursework prior to acceptance, including Kellogg Community College, consideration in requiring pre-dental hygiene science coursework would require major changes to the program and admissions policies. Success in the program and on the licensure examinations is the ultimate goal of a dental hygiene educational program. Adopting and maintaining admissions criteria which are designed to admit those applicants more likely to be successful, based on research, is an important tool to utilize resources most efficiently. As the current study concurs with previous literature in the lack of strength in relationship between ACT scores and dental hygiene program outcomes, schools may be wise to be cautious of placing significant importance on ACT scores.
References


   \textit{adha.org} Retrieved July 11\textsuperscript{th}, 2013.


## Appendix A: Data Collection Table

<table>
<thead>
<tr>
<th>Unique Identifier</th>
<th>Predictors</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ACT Composite Score</td>
<td>ACT Science Score</td>
</tr>
<tr>
<td></td>
<td>49</td>
<td>138</td>
</tr>
</tbody>
</table>

Table 9: Data Collection Instrument
Appendix B: Figures

Figure 1: Repeat Science Courses and NBDHE Score
Figure 2: Repeat Science Courses and Final Dental Hygiene GPA