Is the GRE a Predictor of Student Success Outcomes? An Analysis of the University of Minnesota’s School of Public Health’s Community Health Promotion Program.

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BY

Marlin Farley Jr

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Dr. Michael Stebleton

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Abstract

The Graduate Record Exam is a standardized test commonly used by graduate and professional admissions programs that have recently been disputed as ineffective in evaluating candidates for graduate programs (Miller & Stassun, 2014). To address this issue, this case study is designed to address the central research question, “what is the predictive ability of the Graduate Record Exam of student outcomes within the Community Health Promotion program?” A series of generalized linear models testing pre-admission indicators of undergraduate GPA and GRE scores and their ability to predict various student success measures (GPA Metrics) were used. The sample (n=613) included matriculated student data in the Community Health Promotion program dating from 1964. The results of the tests shown in all three SPH-specific models, the only indicator, undergraduate GPA, significantly and positively predicted performance in SPH coursework. Of the tests, there are no significant effects of either verbal or quantitative GRE scores in the results. Various generalized linear models testing dichotomous groups, including White and Students of Color and identified gender-based on gendered options in previous application modules reflect similar results that undergraduate GPA being the only positive and significant predictor of student success. The implications suggest GRE scores lack positive association or correlation with student success outcomes and the ability of the GRE scores to predict student success outcomes are minimal and unreliable for the Community Health Promotion program. This case study contributes to current research regarding the predictive ability of the graduate record exam of student outcomes in the Public Health field.

Keywords: predictive ability, predictive reliability, student success measures, student success outcomes, GRE verbal, GRE quantitative, Cumulative GPA, Undergraduate GPA, Community Health Promotion (CHP) core, School of Public Health (SPH) core
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Is the GRE a Predictor of Student Success Outcomes? An Analysis of the University of Minnesota’s School of Public Health’s Community Health Promotion Program.

The Education Testing Service identifies the Graduate Record Examination as supportive criteria for admissions committees while choosing applicants. The ETS also stated using the GRE scores as sole or primary criteria in making admissions decisions is considered misuse (ETS, 2017). Yet graduate and professional programs continue to misuse the GRE in this way, which results in limiting diversity of applicants and matriculations due to low GRE scores and enabling bias in graduate and professional programs (Cunningham-Williams, Wideman, Fields, Jones, 2018; Miller & Stassun, 2014). Even with such research questioning the predictive ability of the GRE scores of student success, admissions committees continue to rely on the GRE to filter applications (Jaschik, 2019).

Evidence suggests the issue with admission committee’s reliance on standardized testing in admissions decisions is the lack of supportive evidence for the GRE scores predictive ability of student success outcomes in graduate and professional programs (Cunningham-Williams, Wideman, Fields, Jones, 2018; Miller & Stassun, 2014). Historically, through the usage of standardized tests, admission committees determine the ability of a student to perform in an academic program (Burton & Wang, 2005). Standardized tests’ influence on graduate and professional school admission processes is a highly researched and debated topic (Cunningham-Williams, 2018; Kuncel, 2017; Miller & Stassun, 2014; Moneta-Koehler et al., 2017; Wiener, 2014). Research on the reliability and predictive ability of standardized tests such as the GRE has been conducted in relation to predicting student success in graduate and professional programs with varying results (Cunningham-Williams, 2018; Hall, 2017; Kuncel & Hezlet 2007; Miller & Stassun, 2014). Of the studies examined, it is evident that each discipline has varying statistical significance in the research that has been conducted (Cunningham-Williams et al., 2018; Kuncel
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& Hezlett, 2007; Miller & Stassun, 2014; Wiener, 2014). Although, separate studies conducted by Cunningham-Williams et al., (2018) and Kuncel and Hezlett (2007) linked minor associations to GRE scores to student success measures in some disciplines, a direct correlation between GRE scores and student success measures has yet to be documented.

Furthermore, the testing disparities influenced by socioeconomic access creates disadvantages for underrepresented groups (e.g. ethnic, racial, gender, and socioeconomic) creates unfair conditions in relation to admission policies (Cunningham-Williams et al., 2018; Miller & Stassun, 2014; Moneta-Koehler et al, 2017). Literature suggests the Graduate Record Exam creates disadvantages for underrepresented populations applying for graduate and professional programs (Hall, 2017; Miller & Stassun, 2014). The disadvantages seen within underrepresented populations is present in this case study. The lack of diversity limits the ability to represent perspectives, in this case, the public health field.

Statement of Issue

Current research of GRE scores predicting student success measures have resulted in failed attempts of providing significant correlation between GRE scores and student outcomes in graduate and professional programs (Cunningham-Williams et al., 2018; Kuncel, 2017; Pesta et al., 2019). In addition, research on undergraduate GPA and other variables have proven to show significant positive correlation with student success measures, which includes graduation rates, cumulative grade point average, and time to program completion, which are metrics used in systems ratings of U.S. colleges (Hall, 2017; Petersen, Erenrich, Levine, Vigoreaux, Gile, 2018; Weiner, 2014). However, graduate and professional schools continue to require the GRE in their admissions process without addressing systemic barriers faced by underrepresented student groups including but not limited: low socioeconomic status; first-generation college student;
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underserved geographic area; educationally underserved backgrounds (e.g., no/limited guidance
counselor, no/limited college preparation and advance placement opportunities, school districts
with low graduation rates); and ethnic and/or racial underrepresented communities (Burney &
Beilke, 2008; Harackiewicz & Priniski, 2018; Wise, Dominguez, Kapasi, Williams-York,
Bernadette, Moerchen, 2017). Admission committees who too heavily rely on one component of
an application material such as the GRE and overlook non-cognitive skills, characteristics, and
population insights, which could also effectively determine the ability to perform in graduate and
professional programs may be turning away valuable candidates (Burney & Beilke, 2008;
Harackiewicz & Priniski, 2018; Wise et al., 2017).

Testing Bias

The main issues with standardized tests are the disparities between scores within ethnic
and demographic groups. Current literature suggests certain groups of test takers statistically
score lower when taking standardized tests as it relates to socioeconomic status, race and gender
(Miller & Stassun, 2014). Applicants with access to up-to-date testing materials and GRE
preparation classes have an advantage over other applicants, even if these classes are only
preparing applicants on how to take one test. For some admissions committees, slight differences
in scores can determine admission approvals or declined applications. As shown in: “The exams
‘quantitative score’—the portion measuring math’s acumen, which is most commonly scrutinized
in admissions to STEM PhD programs—correlates closely with gender and ethnicity.”, (Miller &
Stassun, 2014, p. 304). According to ETS report, as stated previously, women score on average
80 points less in physical sciences, and African Americans score on average 200 points below
White people (Miller & Stassun, 2014, p. 304). With inconsistent data regarding the validity and
reliability of the predictive abilities of the GRE, this standardized test works to limit admissions
to certain demographics. With literature suggesting inconsistent evidence of the Graduate Record
Exam ability to predict student performance and success outcomes in graduate and professional schools, the GRE is unreliable indicator. In the “GRE Guidelines for the Use of Scores”, the ETS company intended the GRE to be used as supportive criteria for graduate and professional admissions committees (ETS, 2017). Miller and Stassun (2014) cited another issue of some admissions committees rapidly filtering applications based solely on GRE scores. While GRE scores are misused by creating cutoffs for candidates in graduate and professional programs, gender and ethnicity applicants are affected negatively, as women earn only 20 percent of the US physical-sciences PhD spots and underrepresented minorities earn just 6 percent (Miller and Stassun, 2014). Miller and Stassun (2014) acknowledge the predictive ability of the GRE quantitative score in predicting first-term GPA; however, these results are based on a small effect size and non-generalizable for other student success measures.

In order to innovate and create meaningful change for underrepresented populations, representatives from these populations must be able to pursue an education. The evidence in the literature suggests the misuse of standardized test scores are a barrier to certain demographics in graduate and professional programs. Diversity in perspectives, experiences and backgrounds all allow for unique and innovative changes suited meeting the needs of different populations. It is clear that a more critical and holistic review is needed of graduate admissions. A change in admission policy may allow capable candidates from diverse population’s access into Public Health programs.

**Research Questions**

To test the validity and reliability of the GRE scores, a series of research questions were developed for this case study:
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- Do GRE scores significantly predict student success measures in a graduate level Public Health program (e.g. Cumulative grade point average, first term GPA, School of Public Health core gpa, Community Health Promotion core gpa)?
- Does undergraduate GPA significantly predict student success measures in a graduate level Public Health program?
- Do individuals from different demographics perform differently on the GRE?
- Do genders (as indicated in application eg. Male, Female) perform differently on the GRE?

**Contribution to Research**

Recent research (Cunningham-Williams et al., 2018; Hall, 2017; Kuncel, 2007; Miller & Stassun, 2014) surrounding standardized testing reveals mixed results of the ability of the GRE as a pre-admission indicator of success and student outcomes. Previous literature on the Graduate Record Examination (GRE) have produced mixed results under analysis of the predictive ability of the test in relation to “student success” measures (Cunningham-Williams et al., 2018; Miller & Stassun, 2014; Moneta-Koehler et al., 2017). The variance in studies suggest the GRE may have higher statistical significance in certain disciplines, but the majority of research has been unable to prove the GRE as a sole significant predictor. Of the studies examining the use of the GRE in admissions, studies of public health programs are extremely limited. This case study is among the first to examine public health programs’ use of the Graduate Record Exam in admissions decisions. The Educational Testing Service attributes the GRE scores as a contributor to a holistic review process in predicting student success in graduate and professional programs. Yet as most standardized tests, the GRE is a barrier for underrepresented groups, and the performance on the GRE creates a bias in admissions for programs who rely heavily on the GRE scores (Cunningham-Williams et al., 2018; Hall, 2017; Miller & Stassun, 2014). As past studies have
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shown a variance in statistical significance, and the lack of research in Public Health programs, this case study provides a seminal study for future research.

**Review of Literature**

Previous research suggests GRE scores and undergraduate GPA (UGPA) do predict a variance of student success outcomes in graduate and professional school. However, recently in Higher Education Institutions, programs are advocating for the removal of the GRE, or making this test optional in the United States Higher Education system. Higher Education institutions have cited graduate and professional programs moving towards a more holistic review of applications (Hall, 2017; Jaschik, 2019). A study conducted by Kuncel et al., (2007) found a correlation between first year GPA and GRE scores exists; however, the distinction between whether UGPA was an equal predictor is not made. In Moneta-Koehler’s (2017) study in the Biomedical PhD. program, similarly to Kuncel’s study, the GRE scores (gre_q, gre_v) moderately predicted first semester grades and GRE verbal scores minimally predicted cumulative GPA. This study also challenges the predictive ability of progress in the program or in research productivity. GRE scores did not predict student measures of performance on the qualifying exam, program completion, time to defense, number of presentations, number of first author publications, or individual grants or fellowships (Kuncel, 2017). Interestingly, neither Moneta-Kohlers (2017), nor the Community Health Promotion Program show a similar predictive nature of GRE score and first year cumulative GPA, while showing minimal residual (effect on same population). The inconsistent and minimal residual data advocating for correlations of GRE and student outcomes have led researchers to explore alternative methods to evaluating student potential for success in graduate and professional school programs. Studies such as Moenta-Koehlers (2017) provide positive outcomes for removing standardized testing from admissions,
advocating that for the increase in applicant and admitted student diversity, retain the student success outcomes.

Accurately predicting student success within graduate programs creates beneficial outcomes, both for the student and the graduate program through graduation rates and student performance (Cunningham-Williams et al., 2018). Studies conducted on the reliability and predictive ability of standardized tests in relation to student outcomes vary depending on the research question being asked (Hall, 2017). A study conducted by Kuncel and Hezlett (2007) suggest the GRE’s predictive validity in various disciplines, mainly STEM fields. The study analyzed results from 3 to 1231 studies across 244 to 259,640 students, including programs represented by humanities, social sciences, biological sciences, physical sciences, mathematics, and professional graduate programs in management, law, pharmacy, and medicine (2007, p.1080). The analysis of these studies suggested positive correlation to subsequent measures of student success. However, the actual applied utility of predictors are not easily inferred from the correlations found from the research studies due to the generally high performance of graduate students. The finding suggests that while a statistical association between higher GRE test scores and student performance may exist, there is no clear distinction of GRE score to be the sole contributor to student success. Furthermore, Kuncel and Hezlett (2007) examined the bias which standardized testing creates for marginalized groups. The effects of coaching in testing are also examined in this article. Those with access to coaching resources creates an advantage over those who do not have access to such testing preparations, enabling the bias in testing scores.

In a related study conducted by researchers Hall, O’Connell, and Cook (2017) tested the components, which are predictive of student productivity in the biomedical PhD program at the University of North Carolina’s School of Medicine. The testing components included GRE scores, GPA, previous research experience, faculty interview ratings and recommendations. The
particular cohort indicated in this study included 280 graduate students who entered the biomedical program at North Carolina Chapel Hill between the years of 2008 and 2010. All application metrics were included from these students of which, 195 had graduated with a PhD at the time of this study in July 2016, 45 were still enrolled, and 40 graduated with a Master’s degree or withdrew (Hall, O’Connell & Cook 2017, p. 3). Predictive variables are defined in this study as GRE Scores and UGPA; previous research experience; recommendation letter ratings; interview scores; and student publications. The predictive variables were tested in relation to student productivity, student productivity being defined in this study as research progress and course progress in the PhD program. Through the analyses of this study, Hall et al determined no correlation of metrics between GRE test scores and GPA student productivity in the PhD program.

It is important to note that the mean of undergraduate GPA scores were (3.52 +/- 0.34), above average, and there was a variance and medium standard deviation in the GRE testing scores ranging from high to low (Hall et al., 2017). ETS claims “GRE scores are a proven measure of an applicant’s readiness for graduate level work—and of their potential for success,” though this study strongly debunks this statement and suggests the GRE’s ability to predict student success and outcomes varies among disciplines (ETS, 2017). This study, however, did suggest an alternative predictor of student productivity within the biomedical program. High scores in recommendations from past employers, professors, and advisers within previous academic settings, correlated strongly to student success from the sampled population.

Through a similar study conducted by Moneta-Koehler, Brown, Petrie, Evans and Chalkey (2017), a variety of predictive measures examined in relation to the GRE testing scores. The data consisted of 683 students who matriculated to Vanderbilt University from 2003 to 2011 with a confirmed availability of GRE scores at the time of the study (Moneta-Koehler et al.,
Is the GRE a Predictor of Student Success Outcomes? 2017). The components tested in relation to student productivity were program progression, grades and research productivity. The findings stated that GRE scores did not accurately predict progress in the program in relation to time of completion. The findings also failed to predict an association in research productivity or progress in research progress with the sample population. The study does suggest a moderate correlation of GRE scores and grades within the first semester. The data also suggests students with higher GRE scores statistically performed better within their first semester in the program. The data also shows a decrease in standard deviation (0.29) and in means of GPA in later semesters. Overall, this study was designed to assist in admission committee decisions and evaluations in potential candidates for the biomedical program at Vanderbilt University. The findings from this study suggest little to no association between GRE scores and components of student productivity. The only known association between the GRE scores is a moderate connection between first semesters GPA. The overall analyses of this study suggest GRE should not be the sole arbiter of admissions to graduate programs. Moneta-Koehler et al asserts, “GRE scores are unlikely to provide the important information needed to determine success in graduate school” (2017).

Cunningham-Williams et al., Wideman, Fields and Jones (2018) examined the possible indicators of research productivity in a social work doctorate program at a Midwestern, medium size private research institution. The sample population included doctoral students (n=56) admitted to the social work doctoral program. This 9-year study aimed to identify effective indicators of research productivity, in hopes of promoting a holistic admission review process. Researchers determined overall research productivity, including publications and presentations conducted as a primary investigator, was the strongest predictive indicator of research productivity and time-to-degree completion. The GRE analytical score had moderate correlation
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with post-admission grant production. However, GRE verbal and quantitative were not associated with, nor had strong correlations with, research productivity or time-to-degree completion.

Standardized testing creates bias and disparities among certain groups, along with inconsistency in proving association or correlations of GRE scores and components of student success or progress within graduate and professional programs (Miller & Stassun, 2014). As most standardized tests reflect certain demographic characteristics of test takers, disadvantages arise for groups including those of families with lower socioeconomic status, ethnic backgrounds, racial groups, and gender. The effects of the bias in testing create powerful disparities in testing, specifically on the quantitative exam. Women and people of color, on average, score 80 to 200 points below White males of medium to high socio-economic status. This gap in testing is the result of advantageous backgrounds and the accommodation of standardized testing to meet the expectations of knowledge for a particular group, predominately-White males. With the support of testing debunking GRE predictability of student performance based on GRE testing scores, alternative selection methods are recommended to increase diversity in student populations as well as innovate disciplines with those of different world perspectives. In “A test that fails”, a study conducted by Miller & Stassun, alternative methods of selection were explored (2014). By using alternative admissions criteria based on skills and character attributes that are more predictive of student performance in certain disciplines, such as STEM, these universities altered the traditional admission requirements. Through this alteration of admission requirements, an increase in diversity of admitted students in STEM programs from these universities occurred, and the results are positive. Of the 67 students who have entered the PhD program in Fisk-Vanderbilt, 81% have earned their degree or are making good progress towards their PhD requirements; these students include 56 underrepresented minorities and 35 women (Miller & Stassun, 2014, p. 304). Miller and Stassun report the only downside to the alternative admissions
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process is that interviews take a considerable amount of time, which slows the admission process. A quote by authors contribute insight into the alternative admissions method:

“This is not a call to admit unqualified students in the name of social good. This is a call to acknowledge that the typical weight given to the GRE scores in admissions is disproportionate. If we diminish reliance on GRE and instead augment current admission practices within proven markers of achievement, such as grit and diligence, we will make our programmes more inclusive and will more efficiently identify applicants with potential for long-term success as researchers. Isn’t that what graduate school is about? (Miller and Stassun, 2017, p.304)”

Admission policies and requirements for graduate programs are in need of revaluation. Measuring the potential of applicants, students, and researchers cannot be determined by one method, as previous admission requirements suggests. Furthermore, institutions who have adapted to holistic admission review processes in graduate and professional programs have reported increased diversity of applications, reduced bias in admissions without determinants in student performance in graduate and professional programs (Hall, 2017). Past studies examined graduate and professional programs to answer the question “Is the GRE a valid and reliable predictor of student success?” (Weiner, 2014). This research question leads to the investigation of associations or correlations of the GRE with cumulative grade point average, student research progress, program completion rate and other measures of student success within graduate and professional programs. An additional research question examined through this study is, “Are particular groups disadvantaged by the weight admissions committees put on the GRE?” As more
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and more programs in various disciplines disprove the predictive ability of the GRE, institutions are adapting to a holistic approach to admissions.

This case study contributes to current research by testing the predictive ability of the GRE in an unexplored discipline of Public Health. Hall’s (2017) study reported no adverse effects in performance from doctorate students admitted to the biomedical program without the use of the GRE in admissions. Hall’s study also reported an increase in overall applications to the PhD program, increase in the diversity of applicants, and overall increase in diversity of matriculated students. This research serves to examine the Public Health discipline, with the potential to influence other public health programs to conduct research in their own institutions and reevaluate their current admissions policy.

Method

Institutional Practice

The Community Health Promotion admissions committee consists of the program director, faculty, and administrative representatives. Committee members are responsible for examining applications and assigning a designation. The policy for an express admit to the Community Health Promotion program is an overall GRE score over 300 and in the 60th percentile in verbal, quantitative and writing analytical scores. The undergraduate GPA must also be above 3.4 and for international students, the TOEFL above 100. The express deny requirements are a GRE under 300, and under the 60th percentile for verbal, quantitative and writing analytical scores as well as a GPA under 3.0. Applicants are assessed and assigned a “benchmark” of 1) express admit, 2) committee review and 3) express deny. Applicants who do not qualify for express admit nor express deny are assessed and receive a score between 1-10 based on GRE, UPGA, and TOEFL scores by the admissions committee. Students who are
approved by the committee but have below the required qualifications then need additional approval by the dean of the college.

Many graduate and professional programs use the GRE in a similar way. GRE scores are a way to differentiate students, create variability, and allow for express admits and express deny decisions. Assigning numerical rankings to applications is a time effective method, which allows admissions committees to quickly filter applications of students. This misuse of GRE scores as a sole pre-admission indicator of applicant's ability to perform and succeed in academia limits diversity in graduate and professional. Admission committees may rely on GRE scores to assist with applications, “Yet research by the ETS indicates that the predictive validity of the GRE tests is limited to first-year graduate-course grades, and even that correlation is meagre in math-intensive STEM fields.” (Miller & Stassun, 2014). With the ETS reporting vast differences in mean scores related to gender and ethnicity, the use of the GRE in filtering of applicants creates a major bias in admittance to graduate and professional programs.

Sample

This research is strictly about the reliability of GRE’s predictability of student success measures in the Community Health Promotion program at the School of Public Health at the University of Minnesota. The data provided by the School of Public Health’s Data Council was used to test the correlation of the GRE in the Community Health Promotion program. Criteria for the sample population included: a) enrolled in the Community Health Promotion Program and b) successful attainment of MPH. As the data had a minimal population of non-completers (>4%) and the data did not indicate reason for non-completion of the program, this subset was not included in the data analysis. Data were de-identified and assigned a random identification number to ensure the protection of personal student identification. With the de-identification of
the data, the University of Minnesota Human Subjects Committee deemed the study exempt from review. Of the data provided dating back to 1964, over 680 rows of participant data was collected, though samples with incomplete data was excluded from the analysis (n=67). The provided data includes GRE Quantitative, Verbal, Analytical Writing scores; undergraduate GPA; first term and cumulative GPA MPH; GPA for SPH core courses; admission semester; and length of program completion for the adjusted sample population (n=613). An additional analysis was run for students who matriculated from the Community Health Promotion program at the University of Minnesota, School of Public Health from 2012-2016 (n=396) as this period of time provided a strong sample size with the largest population of complete data. This study reviewed and approved by the University of Minnesota’s Institutional Review Board deemed the study “Not Human Research.”

Design

The School of Public Health’s Data Council provided the de-identified data. The independent or predictor variables used in this research are the quantitative scores from the graduate record exam (GRE_Q) and the verbal scores (GRE_V) along with undergraduate grade point average (UGPA). The dependent or student success variables (Cumulative GPA; Term 1 GPA; CHP Core; SPH Core; SPH+CHP Core) were developed based off previous research conducted, with an emphasis on program performance in the Community Health Promotion program. Generalized linear models or multiple linear regressions were conducted using independent and dependent variables to test for association. Bi-variate test analyses were conducted to explore for differences in groups including gender as indicated upon admission (male, female) and ethnicity.

Measures
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The data used in the analysis is secondary data. The following potential predictors of student success were assessed:

- Undergraduate GPA;
- GRE Quantitative Score;
- GRE Verbal Score;
- Gender;
- Ethnicity.

Student success measures are defined in this study as:

- Term 1 GPA;
- Cumulative GPA;
- Core course School of Public Health GPA (PubH 6414- Biostatistical Literacy, PubH 6450- Biostatistics I, PubH 6320- Fundamental of Epidemiology, PubH 6341- Epidemiologic Methods I);
- CHP core course GPA (PubH 6050- Community Health Theory and Practice I, PubH 6051- Community Health Theory and Practice II) core+CHP core course GPA.

Changes in Measures

In 2011, the Education Testing Service revised the scoring of the Graduate Record Exam. The prior scale ranged from 200-800 in verbal, and quantitative scores increase by increments of 10 points. The new and current scale ranges from 130-170 for verbal and quantitative scores, increasing by increments of one. For this study, using the GRE concordance table, the GRE scores recorded prior to 2011 were converted to the current scale. Though this conversion reduced the possible score possibilities by 20, the ETS reported that the new scoring allowed for more distinguishability between “higher ability test takers”. Using the ETS concordance tables,
converting the old scales into the current had very minimal, if any, effect on the testing conducted in this study (ETS, 2012).

**Data Collection**

The School of Public Health’s Data Council provided the following secondary data associated with de-identified assigned IDs, which was aggregated to perform the analysis. With the approval of the University of Minnesota’s IRB, this case study is considered non-human research and no further approvals were needed. The following is a summary of the data provided by the SPH Data Council:

- **Degree Information**: Degree Description, College, Completion Date, GPA in Degree, Degree Awarded;
- **Demographic**: Identified Gender, Ethnicity, Citizenship, Country of Origin;
- **GPA_GRE**: GRE Verbal, GRE Quantitative, GRE Analytical, GPA Undergraduate, GPA Graduate, SPH Core, SPH CHP Core;
- **Student Enrollment**: Enrollment Term, Grade Points, Enrollment Status, Institution, College, Major, Sub-Plan; and
- **Program Details**: Current Record, Academic Plan, Sub plan, Admit Date, Admit Term, Completion Term.

**Statistical Analysis**

A series of generalized linear models using statistical programs (RStudio, Statscrunch) were used to test whether UPGA and/or GRE scores predict various GPA metrics. Multiple linear and nonlinear regression tests were conducted to test dependent variable relationships with more than one independent variable, as it is rare a dependent variable is explained by a single variable. Statisticians commonly use these programs, as they are widely trusted quality of software, with
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RStudio being cited as the statistical program used in previous studies (Kuncel, 2007). Although the sample size (n=613) has various portions of data missing, 557 students had complete UGPA and quantitative and verbal GRE data.

Table 4 Matriculate Data from 2006-2016

<table>
<thead>
<tr>
<th>Y Axis (GPA Scores)</th>
<th>β0(Intercept)</th>
<th>1(X1=UGPA)</th>
<th>β2(X2=GREV)</th>
<th>β3(X3=GREQ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Term1 GPA</td>
<td>(0.86, 2.76)***</td>
<td>-0.007</td>
<td>(0.008, 0.02)***</td>
<td>△&lt;0.001</td>
</tr>
<tr>
<td>Cumulative GPA</td>
<td>(1.84, 3.05)***</td>
<td>(0.007, 0.05)*</td>
<td>(0.003, 0.007)*</td>
<td>(0.001, 0.008)*</td>
</tr>
<tr>
<td>Core GPA</td>
<td>1.8</td>
<td>(0.14, 0.25)***</td>
<td>-0.0003</td>
<td>0.008</td>
</tr>
<tr>
<td>CHP GPA</td>
<td>(0.45, 4.07)*</td>
<td>(0.24, 0.34)***</td>
<td>0.008</td>
<td>-0.004</td>
</tr>
</tbody>
</table>

An additional sample population (n=396) was identified (Table 4). This sample population contained complete data (GRE_V, GRE_Q, GRE_A). Single linear regressions (X-axis) were conducted using predictor data to determine association with student outcomes (Y-axis) with varying significance (Appendix D). Of these single linear regressions, UGPA, GRE_V and GRE_Q showed significance in p-values in some areas of student outcomes, but the effect size, or R², in these models was insignificant. Generalized linear models tested all predictor data for associations with the identified student outcomes relating to GPA. In all three SPH-specific models, only undergraduate GPA significantly and positively predicted performance in SPH coursework according to the linear regression tests. Neither GRE score, quantitative or verbal, held significant effect to student success outcomes data. Though there may be evidence which suggests portions of the GRE (verbal) predict overall GPA scores in term 1 and full transcript
(quantitative) models, these effect sizes are remarkably small compared to what we find in the SPH-specific models. Bi-variate analyses were applied to the demographic data to test for differences in performance in SPH models, specifically in the Core+CHP Core model.

**Results**

The first notable finding is the low variance in cumulative GPA and 1st semester GPA (0.033, 0.139). However, SPH core and Core+CHP GPA have a substantially higher variance (0.361, 0.301) which can help inform how reliable these are as measures when correlated with student success. Table 1 (below) includes undergraduate GPA and GRE as predictors of student success. With alpha 0.05, the summary table provided below highlights significance in results in the conducted tests.

**Table 1 Summary: UPGA & GRE Predictor Data for GPA Among All MPH Students**

<table>
<thead>
<tr>
<th>Y (GPA Scores)</th>
<th>$\beta_0$ (Intercept)</th>
<th>$\beta_1$ (X1=UGPA)</th>
<th>$\beta_2$(X2=GRE_V)</th>
<th>$\beta_3$(X3=GRE_Q)</th>
<th>R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Term 1</td>
<td>(0.49, 2.80)**</td>
<td>0.01</td>
<td>(0.004, 0.02)**</td>
<td>0.003</td>
<td>0.045</td>
</tr>
<tr>
<td>Cumulative GPA</td>
<td>(1.62, 2.69)***</td>
<td>(0.02, 0.06)***</td>
<td>0.003</td>
<td>(0.004,0.01)**</td>
<td>0.1093</td>
</tr>
<tr>
<td>Core GPA</td>
<td>(0.16, 3.91)*</td>
<td>(0.15, 0.25)***</td>
<td>-0.002</td>
<td>0.01</td>
<td>0.155</td>
</tr>
<tr>
<td>CHP GPA</td>
<td>(0.43, 3.88)*</td>
<td>(0.24, 0.33)***</td>
<td>0.007</td>
<td>-0.002</td>
<td>0.324</td>
</tr>
<tr>
<td>Core+ CHP</td>
<td>(0.29, 3.53)*</td>
<td>(0.19, 0.28)***</td>
<td>0.004</td>
<td>0.003</td>
<td>0.2672</td>
</tr>
</tbody>
</table>

Table 1 displays the predictor data (X Axis) and student GPA outcomes (Y Axis). Focusing on the distributions of scatterplots, the variance, and skewedness of the predictor UGPA and the lack of variance of the GRE scores, both verbal and quantitative, in relation to student outcomes
indicates the ability to predict outcomes. We see in the scatterplot (Figure 1) that higher UGPA generally indicates a higher GPA in student outcomes in the Community Health Promotion master’s program. Analyzing the same scatter plot, the GRE scores are inconsistently distributed, indicating variance of predictive ability.

**Figure 1 Scatterplot Summary**

Of the three SPH-specific models, only undergraduate GPA significantly positively predicts performance in SPH coursework. It is important to note no significant effect of either section of the GRE score indicated. Although there is evidence to suggest the GRE_V predicts overall GPA in 1st year and GRE_Q predicts cumulative GPA, the $R^2$ effect sizes are incredibly small compared to what we find in our SPH-specific models. Additionally, the data re-stresses
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that the variance in 1st year and cumulative GPA is quite low, especially in comparison to variance among SPH GPA scores. Standardization of measures allows data to be better compared with different sets of data using, by using a standardized measure. To run a standardized generalized linear model, we found the relative cumulative GPA (3.85) and relative predictor data indicated in the graph below. By standardizing the data, we are able to compare the data by equal measures.

*Figure 2 Standardized GLM*

The ranges in figure 2 (above) of 0.25, 1.25 with the value 1.00 representing the mean of each predictor (UGPA, GRE_V, GRE_Q) were determined as part of the representation of the
standardization of scores. As seen in figure 2 through the distributions, only Relative UGPA shows significant variance in scores when testing for relative cumulative GPA in the Community Health Promotion Program. Both GRE quantitative and verbal scores have a clustered distribution centered on the mean, with very low significance of variability, which shows the lack of predictive ability in this model.

(Figures 3-5) To test whether the predictor’s undergraduate GPA and GRE affects Students of Color differently, we ran an additional analysis on the relationship between Core+CHP GPA, undergraduate GPA, and GRE scores for Students of Color (128) vs White students (485) pursuing an MPH denoted in figures 3-5. (Note: Due to the low samples for each ethnic group, we unfortunately aggregated the data into one group).
Figure 3 Demographic: Predictor UGPA-> GPA Summary Scatterplots
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Figure 4 Predictor: GRE Q -> Cumulative GPA
Again, we see only undergraduate GPA positively and significantly predicts GPA in Core Community Health Promotion coursework. A similar test was conducted to analyze whether dichotomous differences in identified gender will have similar results to that of the Students of Color vs White comparison. In table 4 (appendix) we see only the matriculated students from 2006-2016, with a sample population of 396 MPH students. This data has similar results and supports other tests, indicating the strongest predictor of success in core SPH coursework being undergraduate GPA. This variable of range was examined due to it containing the highest amount of complete data used in the SPH specific models created for this research.
This case study examined the predictive ability of GRE scores concerning “student success outcomes”. Through multiple generalized linear models, predictive indicators, which included graduate record exam scores and undergraduate grade point averages, were tested for association and correlation with student success measures. The student success measures identified as performance in: term 1 GPA; cumulative GPA; School of Public Health core course GPA; Community Health Promotion core course GPA; and School of Public Health core and Community Health Promotion core GPA. The results ranged from minimal to zero positive “correlation” (e.g., relationships between two random variables which are statistically dependent or correlated) to strong correlations between predictor measures and student success measures in the Community Health Promotion program.

The significant results from the study are the positive correlations between the predictor indicator UGPA and the student success outcomes SPH core course GPA; CHP core course GPA; and SPH+CHP core GPA. The student success outcomes developed to address the research questions listed previously in this study, specifically “is the GRE a reliable predictor of student success in the Community Health Promotion program?” The results from this study suggest that the GRE is not a significant predictor of student success outcomes. Of the results showing significant association with student success outcomes, there is minimal evidence which suggests portions of the GRE predict overall GPA in term 1, and cumulative GPA, though the effect sizes were remarkably small, especially when compared to the SPH-specific models. This study also tested whether results varied among White students and Students of Color as well as identified gender listed on admissions applications (eg. male, female). Among both Students of Color and White students, only UGPA positively and significantly predicted GPA in SPH+CHP core coursework. Similarly, of the tests conducted on the identified gender, the results were very
Is the GRE a Predictor of Student Success Outcomes? 26

similar to the UGPA positively and significantly correlating UGPA with SPH+CHP core course GPA.

The Educational Testing Service (ETS) released the statement stating, “a cutoff score based only on GRE scores should never be used as a sole criterion for denial of admission” (ETS, 2017, pg.2). Yet, nationwide academic institutions place a strong emphasis on GRE scores when considering applicants for admission to graduate and professional programs. The issue in emphasizing the GRE in graduate and professional applications are the barriers the test creates for marginalized groups, as study materials and class resources often come at high expenses (Miller & Stassun, 2014). Those with higher access and economic stability have greater access to resources when preparing for the GRE, thus creating the bias in testing to those who do not have access to updated testing materials. The analysis of the data in this case study examining the Community Health Promotion program suggests the GRE is an ineffective predictor of student outcomes defined previously in the study. Though there is minimal evidence suggesting that portions of the GRE predict overall GPA in term 1 (GRE verbal) and cumulative GPA (GRE quantitative), the effect size or residuals are remarkably small. Overall, though the low p-value or correlation strength of the GRE verbal and quantitative scores suggest predictive ability within certain student outcomes, these claims are limited to a very small population size. Importantly, through the generalized linear model tests in all three SPH-specific models, only the undergraduate GPA significantly and positively predicts performance in School of Public Health required coursework. Additionally, when examining dichotomous groups including identified gender (Table 3) and White students and students of color (Table 2) to see if there is a variance in results, UGPA was again the only significant predictor of student outcomes.
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**Holistic Admissions Approach**

This analysis was designed to assist admission committees responsible for evaluating and admitting applicants to the Community Health Promotion program. Using quantitative research methods to challenge the predictive ability of the graduate record examination is a step towards creating a holistic review model as it discourages the misuse of a sole application component. The study by Moneta-Koehler, Brown, Petrie, Evans, and Chakely (2014) provided insight into the benefits of programs who have removed the GRE from admissions requirements and replaced the quantitative measure with experience in the field, recommendation letters, undergraduate GPA, and an interview process. The benefits of this study included an increase in overall applications, the diversity in applicants and reported no decline in student performance in the program. Although this method is more time consuming, it reduces the misuse of GRE scores in admission decisions, which has led to increases in the diversity of students in graduate and professional programs (Hall, 2017).

To individually, holistically review applications is to allow admission committees to examine the non-standardized quantitative values assigned to applicants and allow the exploration of an individual navigating through the higher education system. For many underrepresented students facing barriers and individual challenges within the education system, their abilities may not be properly displayed in their testing scores. Some admission committees do not hear applicant’s stories of overcoming education disparities, poverty and other life events the average advantaged student does not ever encounter. Testing scores do not have the opportunity to examine the non-cognitive skills, characteristics, point of views, and the grit and determination that some applicants bring to their field and they may value their education. Holistic review processes including personal statements, interviews, and recommendation letters are crucial for
underrepresented populations to be competitive in graduate and professional programs in comparison to applicants who come from a privileged background (Wise et al., 2018).

The findings of this case study influenced the Community Health Promotion program to remove the graduate record exam and move towards holistic review processes. The new model of admissions includes having more emphasis on personal statements, reference letters, undergraduate GPA, and previous experience in the field. Based on the work from Halls (2017), reforms in admission requirements yielded results of overall application increases, increases in the diversity of applicants and increases in admitted student diversity. This study also did not report decreases in performances in student research progress in the Ph.D. program, or time-to-dissertation (Hall, 2017).

Limitations

Though certain findings of this study proved significant, there are limitations of this study that need consideration. Of the data included in the dataset, a significantly low number of GRE Analytical scores were reported in the applicant data. This restricted the ability to run linear regression analyses using all components of the Graduate Record Exam. Additionally, as stated in the methods section, portions of the sample data were limited, which affected the sample population. Term start or matriculation dates and term completion or degree conferral data is also minimally limited by the available applicant data. Another limitation is the low number of non-White students in the data, which led to unfortunately aggregating the data of all non-White students into the “Students of Color” grouping. Additionally, the identified gender in the application was dichotomous, which limited the tests for identified gender in the data. Overall, minimal tests were restricted by the lack of available applicant data, which does not affect the overall results or implications, as the sample size was strong enough to make statistical claims.
Another limitation was the pre-admission data available. Such pre-admission indicators include personal statements and reference letters, which some admission committees utilize in admission decisions. The review of personal statements and recommendation letters is another pre-admission or application material component that was unexplored.

**Implications**

By focusing on a particular graduate program context, Community Health Promotion admissions, testing for specific outcomes using predictors of GRE and UGPA scores was possible. As anticipated, the pre-admissions variable of the GRE (GRE_V, GRE_Q) did not prove significant as a predictor of student success measures. The supporting evidence of the GRE variable’s predictive ability in student success outcomes of the first-term GPA by the verbal score (0.004-0.02) and cumulative GPA by the quantitative scores (0.004-0.01) are remarkably small effect sizes, especially when compared to School of Public Health specific models. Upon examining UGPA’s predictive ability, significant findings particular to the SPH-specific models found. The results proved undergraduate GPA significantly predicts performance in the School of Public Health and program courses. This study provides a basis for future studies examining the predictive ability of GRE and UPGA in other institutions of Public Health as well as supports past research negating the predictive ability of the GRE test to student outcomes. As a result, this study and those like it may be used as seminal research for Public Health institutions conducting similar studies.

**Policy & Practice**

The analysis of this data influenced the decision for division programs to temporarily waive the graduate record exam scores from admissions requirements in the University of Minnesota’s Division of Epidemiology in the School of Public Health. This evaluation of policy
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regarding the use of the Graduate Record Exam in the Division of Epidemiology and Community Health influenced by the results of this case study. The process to waive the GRE from admissions requirements required a faculty vote from each program. The secondary data analysis was distributed to stakeholders along with supporting literature documenting past studies both supporting and disproving the predictive ability of the GRE in relation to student success measures, similar measures used within this analysis. Primary program faculty were allowed one vote for each division program. The removal of the GRE requirement will be present in admissions policy for two years, at which point an additional analysis will be conducted from the first cohort of students to test for any possible changes in performance from previous cohorts.

The potential implications of this study as it relates to admissions in the Community Health Promotion program are the increase in overall applications, an increase in the diversity of applicants, and furthering of the holistic admission process all due to the removal of the graduate record exam. Removing the filtering of student applications by GRE scores allows admissions committees to conduct a critical review of each student. Increasing the diversity of students, meaning the diversity of backgrounds, perspectives and experiences, is a key component of innovation and problem solving. In a field such as public health, identifying threats and epidemics, which affect a certain population’s health, requires knowledge of the community and culture. Understanding the population, that public health professionals seek to treat can only benefit underrepresented communities, underserved populations, and bring new perspectives to create solutions to address public health needs.

Additionally, this case study may serve to influence other public health institutions to conduct similar studies of the predictive ability of the graduate record exam, whether correlations between the GRE and student outcomes exist, and to what extent. Influencing other public health programs and institutions to critically evaluate their reliance on GRE scores in making
admissions decisions, particularly examining the association and correlation of GRE scores as a predictor of student performance will promote a holistic assessment of students. Research can influence institutional policies, as reflected in this study. Moreover, increasing the diversity of students and future practitioners in the public health field can lead to improvements in public health, as populations are better able to identify gaps in services in an increased variety of communities.

Research

With inconsistencies in research and the variance in data among disciplines, an opportunity to continue examination of GRE scores predictive ability in Public Health Master’s programs. As this research is among the first conducted in the Public Health spectrum, further research is needed to support the findings of this this study, to further the evidence of disproving the predictive ability of the graduate record examination. However, this case study contributes to recent literature examining the predictive ability of the GRE on student outcomes in public health programs. Furthermore, the results of the study support current research conducted proving non-associations between GRE verbal and quantitative scores and student outcomes (Cunningham-Williams et al., 2018). As this is secondary data, the implications are limited to Community Health Promotion program and not representative of the wider population in the School of Public Health or other public health higher education institutions. However, the findings of this study may provide a foundation for other public health institutions to conduct similar research in the predictive indicators of student success outcomes. Such studies could serve to influence public health institutions to review admissions policies and to adopt holistic review methods in place of standardized testing scores. Shifting towards a holistic review process (e.g., reference letters, content analysis of personal statement, etc.) will allow future studies to be conducted relating to positive significant indicators of pre-admission indicators. Further research is needed on
Conclusion

This case study examined the predictive ability of undergraduate GPA and graduate record exam scores to student outcomes in the Community Health Promotion Program at the University of Minnesota’s School of Public Health. Current research on graduate record exam’s ability to predict student outcomes suggests a variance of results within different institutions and disciplines. The GRE is a controversial method of evaluating potential student’s ability to perform in graduate and professional programs due to the inconsistencies in the data that currently exists. With the bias in testing results from the variety of applicant groups and the variance in the predictive ability of the GRE, this test creates barriers for capable students applying for graduate and professional programs. The findings of this case study suggest a lack of predictive ability of the GRE, and supports the other commonly used pre-admission predictor UGPA as being the more reliable and effective measure of student outcomes. As research is limited on the predictive ability of the GRE in relation to student outcomes in the public health field, this study may serve to promote similar studies of other public health institutions.

Considerations

The School of Public Health’s Data Council provided the de-identified data used for this case study. Proper measures had been taken to secure the applicant data. The findings of this case study are limited to Community Health Promotion program at the University of Minnesota’s School of Public Health.
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Bibliography


Appendix A

Note: P-Values and Confidence Intervals for slope terms significant at Alpha= 0.05* appear in bold.

Additional asterisks refer to a decreasing orders of magnitude in the p-value estimates. 95% CIs are presented for significant β estimates.

Data notes:

Descriptions of datasets:

- gpa_gre: applicant-level data- GRE scores, undergraduate GPA (UGPA), first term, and anticipated program. (Only GRE Quantitative and GRE verbal scores are used in analysis testing.

- degrees: SPH student IDs that have completed the MPH. NOTE: Some students completed multiple degrees (present in data)

- demog: basic demographic data for all students with SPH IDs and sufficient data (gpa_gre). Groupings included female and male identified students, White and non-white students, students who matriculated from 2006-2016, students who completed vs not completed the MPH.

Summary Data Key:

X Axis: Predictor Data

UGPA: Undergraduate GPA

GREV: GRE Verbal Scores

GREQ= GRE Quantitative Scores
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R² = Coefficient of Determination (Strength of Relationship)

Y Axis: Student Outcomes

Term 1 GPA: Cumulative GPA after first term

Cumulative GPA: Final GPA upon program completion

Core GPA: School of Public Health Core Course GPA; (PubH 6414, PubH 6450, PubH 6320, PubH 6341)

CHP GPA: Community Health Promotion Core Course GPA; (PubH 6050, PubH 6051)

Core+CHP: Combined GPA for Core and CHP Course GPA

Summary Data:

Table 1: UPGA and GRE predictors of GPA among All MPH students

<table>
<thead>
<tr>
<th>Summary: UPGA &amp; GRE Predictor Data for GPA Among All MPH Students</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Y (GPA Scores)</th>
<th>β0 (Intercept)</th>
<th>β1 (X1=UGPA)</th>
<th>β2 (X2=GREV)</th>
<th>β3 (X3=GREQ)</th>
<th>R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Term 1 GPA</td>
<td>(0.49, 2.80)**</td>
<td>0.01</td>
<td>(0.004, 0.02)***</td>
<td>0.003</td>
<td>0.045</td>
</tr>
<tr>
<td>Cumulative GPA</td>
<td>(1.62, 2.69)***</td>
<td>(0.02, 0.06)***</td>
<td>0.003</td>
<td>(0.004, 0.01)***</td>
<td>0.109</td>
</tr>
<tr>
<td>Core GPA</td>
<td>(0.16, 3.91)*</td>
<td>(0.15, 0.25)***</td>
<td>-0.002</td>
<td>0.01</td>
<td>0.155</td>
</tr>
<tr>
<td>CHP GPA</td>
<td>(0.43, 3.88)*</td>
<td>(0.24, 0.33)***</td>
<td>0.007</td>
<td>-0.002</td>
<td>0.324</td>
</tr>
<tr>
<td>Core+CHP</td>
<td>(0.29, 3.53)*</td>
<td>(0.19, 0.28)***</td>
<td>0.004</td>
<td>0.003</td>
<td>0.267</td>
</tr>
</tbody>
</table>

Summary of results from the series of generalized linear models testing independent and dependent variables. Confidence intervals with significant findings are presented. Out of the 613
students with variable admissions data present, only 557 have complete UGPA and GRE data. The three additional models were customized to test performance in School of Public Health core course and program courses.

**Table 2: UGPA and GRE predictors of core+CHP GPA among MPH student of Color**

**Table 1 Demographic Data: Predictors of Core+CHP GPA among Dichotomist group**

<table>
<thead>
<tr>
<th>Demographic</th>
<th>$\beta_0$ (Intercept)</th>
<th>$\beta_1$ (X1=UGPA)</th>
<th>$\beta_2$ (X2=GREV)</th>
<th>$\beta_3$ (X3=GREQ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students of Color</td>
<td>-0.96</td>
<td>(0.15,0.033)***</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>White Students</td>
<td>(1.51,5.1)***</td>
<td>(0.17,0.28)***</td>
<td>-0.01</td>
<td>-0.01</td>
</tr>
</tbody>
</table>

Demographic data was tested to determine if predictor variables affected groups differently. Due to the relatively small group sizes, two demographic groups were created, white student and students of color. Among both demographic groups in the CHP program, UGPA positively and significantly predicted GPA in SPH specific models of SPH core and CHP core coursework.

**Table 3: UGPA and GRE predictors among MPH student, female vs. male**

**Table 3 Demographic Data: Female & Male comparison**

<table>
<thead>
<tr>
<th>Demographic</th>
<th>$\beta_0$ (Intercept)</th>
<th>$\beta_1$ (X1=UGPA)</th>
<th>$\beta_2$ (X2=GREV)</th>
<th>$\beta_3$ (X3=GREQ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>(1.40,3.69)*</td>
<td>(0.21,0.31)***</td>
<td>0.004</td>
<td>0.002</td>
</tr>
<tr>
<td>Male</td>
<td>3.15</td>
<td>(0.04,0.23)***</td>
<td>-0.003</td>
<td>0.004</td>
</tr>
</tbody>
</table>

Similarly to Table 2, UGPA significantly and positively predicts performance in SPH and CHP core coursework in this dichotomous group.

**Table 4: UGPA and GRE predictors among MPH students from 2006–2016**
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**Table 4 Matriculate Data from 2006-2016**

<table>
<thead>
<tr>
<th>Y Axis (GPA Scores)</th>
<th>β0 (Intercept)</th>
<th>β1 (X1=UGPA)</th>
<th>β2 (X2=GREV)</th>
<th>β3 (X3=GREQ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Term1 GPA</td>
<td>(0.86, 2.76)***</td>
<td>-0.007</td>
<td>(0.008, 0.02)***</td>
<td>&lt;0.001</td>
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<tr>
<td>Cumulative GPA</td>
<td>(1.84, 3.05)***</td>
<td>(0.007, 0.05)*</td>
<td>(0.003, 0.007)*</td>
<td>(0.001, 0.008)**</td>
</tr>
<tr>
<td>Core GPA</td>
<td>1.8</td>
<td><strong>0.14, 0.25)</strong>***</td>
<td>-0.003</td>
<td>0.008</td>
</tr>
<tr>
<td>CHP GPA</td>
<td>(0.45, 4.07)*</td>
<td><strong>0.24, 0.34)</strong>***</td>
<td>0.008</td>
<td>-0.004</td>
</tr>
</tbody>
</table>

Restricted the data to include 10 years of matriculated applicant data. This range was chosen as this group contained the most complete data among the sample population while retaining a strong sample size (n=396).

**Table 5: UGPA & GRE predictors of completion among all MPH Students**

<table>
<thead>
<tr>
<th>Y Axis (Completion)</th>
<th>β0 (Intercept)</th>
<th>β1 (X1=UGPA)</th>
<th>β2 (X2=GREV)</th>
<th>β3 (X3=GREQ)</th>
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</thead>
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<tr>
<td>Binomial</td>
<td>5.56</td>
<td>0.28</td>
<td>-0.005</td>
<td>-0.024</td>
</tr>
</tbody>
</table>
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Appendix B

Table 1: UGPA and GRE predictors of 1st term GPA among all MPH students

Dependent Variable: gpa_term1

Independent Variable(s): u_gpa, gre_v, gre_q

gpa_term1 = 1.6423542 + 0.009032903 u_gpa + 0.011101205 gre_v + 0.0025781051 gre_q

Parameter estimates:

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<th>Parameter</th>
<th>Estimate</th>
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<th>P Value</th>
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<td>0.48465936</td>
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<td>u_gpa</td>
<td>0.00903290</td>
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<td>-</td>
<td>0.04048796</td>
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<tr>
<td>gre_v</td>
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<tr>
<td>gre_q</td>
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Analysis of variance table for multiple regression model:

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<td>39.426</td>
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</tr>
<tr>
<td>Total</td>
<td>381</td>
<td>41.262</td>
<td></td>
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</table>
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Summary of fit:

Root MSE: 0.32295382
R-squared: 0.0445
R-squared (adjusted): 0.0369
Cohen’s \( f^2 = 0.038 \) Medium correlation

Table 2: UGPA and GRE predictors of cumulative GPA among all MPH students

Dependent Variable: gpa_cumul
Independent Variable(s): u_gpa, gre_v, gre_q

\[
gpa_{cumul} = 2.1575968 + 0.04259766 \times u_{gpa} + 0.0028224985 \times gre_v + 0.0072096976 \times gre_q
\]

Parameter estimates:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Estimate</th>
<th>Std. Err.</th>
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<th>95% L. Limit</th>
<th>95% U. Limit</th>
<th>P Value</th>
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<td>gre_v</td>
<td>0.0028224985</td>
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Is the GRE a Predictor of Student Success Outcomes? 42

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<thead>
<tr>
<th>Parameter</th>
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<th>95% U. Limit</th>
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<td>0.0041422304</td>
<td>0.010277165</td>
<td>0.0001</td>
</tr>
</tbody>
</table>

Analysis of variance table for multiple regression model:

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>SS</th>
<th>MS</th>
<th>F-stat</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>3</td>
<td>1.2399435</td>
<td>0.41331451</td>
<td>17.551519</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Error</td>
<td>429</td>
<td>10.102369</td>
<td>0.023548645</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>432</td>
<td>11.342312</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Summary of fit:

Root MSE: 0.15345568
R-squared: 0.1093
R-squared (adjusted): 0.1031
Cohen’s f2= 0.11 small correlation
Table 3: UGPA and GRE predictors of core+GPA among all MPH students

Dependent Variable: gpa_core

Independent Variable(s): u_gpa, gre_v, gre_q

\[
gpa_{core} = 2.0334781 + 0.19940553 \times u_{gpa} - 0.0021658544 \times gre_v + 0.0088456676 \times gre_q
\]

Parameter estimates:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Estimate</th>
<th>Std. Err.</th>
<th>DF</th>
<th>95% L. Limit</th>
<th>95% U. Limit</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>2.0334781</td>
<td>0.9551397</td>
<td>35</td>
<td>0.1549982</td>
<td>3.9119581</td>
<td>0.0339</td>
</tr>
<tr>
<td>u_gpa</td>
<td>0.19940553</td>
<td>0.025533968</td>
<td>35</td>
<td>0.1491877</td>
<td>0.24962336</td>
<td>0.0001</td>
</tr>
<tr>
<td>gre_v</td>
<td>-0.0021658544</td>
<td>0.005304659</td>
<td>6</td>
<td>-0.012598566</td>
<td>0.008266856</td>
<td>0.6833</td>
</tr>
<tr>
<td>gre_q</td>
<td>0.0088456676</td>
<td>0.005453084</td>
<td>2</td>
<td>-0.0018789513</td>
<td>0.019570287</td>
<td>0.1057</td>
</tr>
</tbody>
</table>
Analysis of variance table for multiple regression model:

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>SS</th>
<th>MS</th>
<th>F-stat</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>3</td>
<td>16.621936</td>
<td>5.5406452</td>
<td>21.60767</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Error</td>
<td>353</td>
<td>90.516365</td>
<td>0.2564203</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>356</td>
<td>107.1383</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Summary of fit:

Root MSE: 0.5063796

R-squared: 0.1551

R-squared (adjusted): 0.148

Cohen’s f²= .17 small

Table 4: UGPA and GRE predictors of core+CHP GPA

Dependent Variable: gpa_chp

Independent Variable(s): u_gpa, gre_v, gre_q

gpa_chp = 2.1551202 + 0.28249721 u_gpa + 0.0071528397 gre_v + -0.0024651643 gre_q

Parameter estimates:
Is the GRE a Predictor of Student Success Outcomes? 45

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Estimate</th>
<th>Std. Err.</th>
<th>DF</th>
<th>95% L. Limit</th>
<th>95% U. Limit</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>2.1551202</td>
<td>0.87879099</td>
<td>35</td>
<td>0.42676195</td>
<td>3.8834785</td>
<td>0.0147</td>
</tr>
<tr>
<td>u_gpa</td>
<td>0.28249721</td>
<td>0.023561045</td>
<td>35</td>
<td>0.23615863</td>
<td>0.32883579</td>
<td>0.0001</td>
</tr>
<tr>
<td>gre_v</td>
<td>0.0071528397</td>
<td>0.004845180</td>
<td>35</td>
<td>-</td>
<td>0.0023763977</td>
<td>0.016682077</td>
</tr>
<tr>
<td>gre_q</td>
<td>0.0024651643</td>
<td>0.005028308</td>
<td>35</td>
<td>-0.012354567</td>
<td>0.007424238</td>
<td>0.6243</td>
</tr>
</tbody>
</table>

Analysis of variance table for multiple regression model:

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>SS</th>
<th>MS</th>
<th>F-stat</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>3</td>
<td>36.908903</td>
<td>12.302968</td>
<td>56.259693</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Error</td>
<td>351</td>
<td>76.757292</td>
<td>0.21868174</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Is the GRE a Predictor of Student Success Outcomes? 46

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>SS</th>
<th>MS</th>
<th>F-stat</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>354</td>
<td>113.6662</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Summary of fit:

Root MSE: 0.4676342

R-squared: 0.3247

R-squared (adjusted): 0.3189

Cohen’s $f^2 = 0.468$ Large

Table 5: UGPA and GRE predictors of SPH core+CHP core GPA

Dependent Variable: gpa_core_chp

Independent Variable(s): u_gpa, gre_v, gre_q

\[
gpa\_core\_chp = 1.9069555 + 0.23728876 \times u\_gpa + 0.0042527742 \times gre\_v + 0.0026309375 \times gre\_q
\]

Parameter estimates:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Estimate</th>
<th>Std. Err.</th>
<th>DF</th>
<th>95% L. Limit</th>
<th>95% U. Limit</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>1.9069555</td>
<td>0.82555744</td>
<td>35</td>
<td>0.28337298</td>
<td>3.5305381</td>
<td>0.0215</td>
</tr>
<tr>
<td>Parameter</td>
<td>Estimate</td>
<td>Std. Err.</td>
<td>DF</td>
<td>95% L. Limit</td>
<td>95% U. Limit</td>
<td>P Value</td>
</tr>
<tr>
<td>-----------</td>
<td>-----------</td>
<td>------------</td>
<td>-----</td>
<td>--------------</td>
<td>--------------</td>
<td>---------</td>
</tr>
<tr>
<td>u_gpa</td>
<td>0.23728876</td>
<td>0.022181365</td>
<td>35</td>
<td>0.19366578</td>
<td>0.28091174</td>
<td>0.0001</td>
</tr>
<tr>
<td>gre_v</td>
<td>0.0042527742</td>
<td>0.004541569</td>
<td>35</td>
<td>-0.0046789025</td>
<td>0.013184451</td>
<td>0.3497</td>
</tr>
<tr>
<td>gre_q</td>
<td>0.0026309375</td>
<td>0.0047358779</td>
<td>35</td>
<td>-0.0066828768</td>
<td>0.011944752</td>
<td>0.5789</td>
</tr>
</tbody>
</table>

Analysis of variance table for multiple regression model:

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>SS</th>
<th>MS</th>
<th>F-stat</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>3</td>
<td>25.244986</td>
<td>8.4149953</td>
<td>43.272778</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Error</td>
<td>356</td>
<td>69.229166</td>
<td>0.19446395</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>359</td>
<td>94.474152</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Summary of fit:

Root MSE: 0.44098067
R-squared: 0.2672
R-squared (adjusted): 0.261
Cohen’s $f^2= 0.31$ medium

Appendix C

Table 1: Ethnicity and Sex as predictors of core+CHP GP

Two Way Analysis of Variance results:

Responses: gpa_core_chp
Row factor: Recode(ethnicity)
Column factor: sex

ANOVA table, Unbalanced

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>Type III SS</th>
<th>MS</th>
<th>F-Stat</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethnicity</td>
<td>2</td>
<td>0.85298093</td>
<td>0.42649047</td>
<td>1.4403205</td>
<td>0.2381</td>
</tr>
<tr>
<td>sex</td>
<td>1</td>
<td>0.040927236</td>
<td>0.040927236</td>
<td>0.13821724</td>
<td>0.7103</td>
</tr>
<tr>
<td>Interaction</td>
<td>2</td>
<td>0.4387024</td>
<td>0.2193512</td>
<td>0.74078097</td>
<td>0.4774</td>
</tr>
</tbody>
</table>
Is the GRE a Predictor of Student Success Outcomes? 49

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>Type III SS</th>
<th>MS</th>
<th>F-Stat</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>5</td>
<td>4.0708051</td>
<td>0.81416103</td>
<td>2.7495405</td>
<td>0.0186</td>
</tr>
<tr>
<td>Error</td>
<td>394</td>
<td>116.66657</td>
<td>0.29610804</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>399</td>
<td>120.73737</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2: Ethnicity and Sex predictors of # of terms to graduation among all MPH students

Two Way Analysis of Variance results:

Responses: # of terms to Graduation
Row factor: sex
Column factor: Ethnicity

ANOVA table, Unbalanced

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>Type III SS</th>
<th>MS</th>
<th>F-Stat</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>sex</td>
<td>1</td>
<td>14.80499</td>
<td>14.80499</td>
<td>1.1560775</td>
<td>0.283</td>
</tr>
<tr>
<td>Ethnicity</td>
<td>2</td>
<td>3.239283</td>
<td>1.6196415</td>
<td>0.12647298</td>
<td>0.8812</td>
</tr>
</tbody>
</table>
Is the GRE a Predictor of Student Success Outcomes? 50

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>Type III SS</th>
<th>MS</th>
<th>F-Stat</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interaction</td>
<td>2</td>
<td>42.891814</td>
<td>21.445907</td>
<td>1.6746469</td>
<td>0.1888</td>
</tr>
<tr>
<td>Model</td>
<td>5</td>
<td>50.505215</td>
<td>10.101043</td>
<td>0.78876034</td>
<td>0.5583</td>
</tr>
<tr>
<td>Error</td>
<td>375</td>
<td>4802.3347</td>
<td>12.806226</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>380</td>
<td>4852.8399</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Means and counts table

<table>
<thead>
<tr>
<th></th>
<th>NSPEC</th>
<th>Non White</th>
<th>WHITE</th>
</tr>
</thead>
<tbody>
<tr>
<td>F</td>
<td>5 (8)</td>
<td>6.9318182 (44)</td>
<td>6.479021 (286)</td>
</tr>
<tr>
<td>M</td>
<td>8.6666667 (3)</td>
<td>5.8181818 (11)</td>
<td>6.9310345 (29)</td>
</tr>
<tr>
<td></td>
<td>6 (11)</td>
<td>6.7090909 (55)</td>
<td>6.5206349 (315)</td>
</tr>
</tbody>
</table>

Tukey HSD results (95% level) for sex:
Is the GRE a Predictor of Student Success Outcomes? 51

F subtracted from

<table>
<thead>
<tr>
<th>Difference</th>
<th>Lower</th>
<th>Upper</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>M</td>
<td>0.26448328</td>
<td>-0.87480206</td>
<td>1.4037686</td>
</tr>
</tbody>
</table>

Tukey HSD results (95% level) for Ethnicity:

NSPEC subtracted from

<table>
<thead>
<tr>
<th>Difference</th>
<th>Lower</th>
<th>Upper</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non White</td>
<td>0.70909091</td>
<td>-2.0721418</td>
<td>3.4903237</td>
</tr>
<tr>
<td>WHITE</td>
<td>0.52063492</td>
<td>-2.0622213</td>
<td>3.1034912</td>
</tr>
</tbody>
</table>

Non White subtracted from

<table>
<thead>
<tr>
<th>Difference</th>
<th>Lower</th>
<th>Upper</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>WHITE</td>
<td>-0.18845599</td>
<td>-1.4190287</td>
<td>1.0421168</td>
</tr>
</tbody>
</table>
Tukey HSD results (95% level) for sex*Recode(ethnicity):

F,NSPEC subtracted from

<table>
<thead>
<tr>
<th></th>
<th>Difference</th>
<th>Lower</th>
<th>Upper</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>F,Non White</td>
<td>1.9318182</td>
<td>-2.008148</td>
<td>5.8717843</td>
<td>0.7243</td>
</tr>
<tr>
<td>F,WHITE</td>
<td>1.479021</td>
<td>-2.195599</td>
<td>5.1536018</td>
<td>0.8586</td>
</tr>
<tr>
<td>M,NSPEC</td>
<td>3.666667</td>
<td>-3.273239</td>
<td>10.606561</td>
<td>0.6558</td>
</tr>
<tr>
<td>M,Non White</td>
<td>0.81818182</td>
<td>-3.945005</td>
<td>5.5813686</td>
<td>0.9964</td>
</tr>
<tr>
<td>M,WHITE</td>
<td>1.9310345</td>
<td>-2.162693</td>
<td>6.0247628</td>
<td>0.756</td>
</tr>
</tbody>
</table>

F,Non White subtracted from

<table>
<thead>
<tr>
<th></th>
<th>Difference</th>
<th>Lower</th>
<th>Upper</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>F,WHITE</td>
<td>-0.4527972</td>
<td>-2.1128036</td>
<td>1.2072092</td>
<td>0.9706</td>
</tr>
<tr>
<td>M,NSPEC</td>
<td>1.7348485</td>
<td>-4.3819492</td>
<td>7.8516461</td>
<td>0.9652</td>
</tr>
</tbody>
</table>
Is the GRE a Predictor of Student Success Outcomes? 53

<table>
<thead>
<tr>
<th></th>
<th>Difference</th>
<th>Lower</th>
<th>Upper</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>M,Non White</td>
<td>-1.1136364</td>
<td>-4.5692153</td>
<td>2.3419425</td>
<td>0.9404</td>
</tr>
<tr>
<td>M,WHITE</td>
<td>-0.00078369906</td>
<td>-2.4526582</td>
<td>2.4510908</td>
<td>1</td>
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</table>

F,WHITE subtracted from

<table>
<thead>
<tr>
<th></th>
<th>Difference</th>
<th>Lower</th>
<th>Upper</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>M,NSPEC</td>
<td>2.1876457</td>
<td>-3.7616757</td>
<td>8.136967</td>
<td>0.8993</td>
</tr>
<tr>
<td>M,Non White</td>
<td>-0.66083916</td>
<td>-3.8104799</td>
<td>2.4888016</td>
<td>0.9909</td>
</tr>
<tr>
<td>M,WHITE</td>
<td>0.4520135</td>
<td>-1.5457101</td>
<td>2.4497372</td>
<td>0.9872</td>
</tr>
</tbody>
</table>

M,NSPEC subtracted from

<table>
<thead>
<tr>
<th></th>
<th>Difference</th>
<th>Lower</th>
<th>Upper</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>M,Non White</td>
<td>-2.8484848</td>
<td>-9.5252976</td>
<td>3.8283279</td>
<td>0.8259</td>
</tr>
<tr>
<td>M,WHITE</td>
<td>-1.7356322</td>
<td>-7.9525842</td>
<td>4.4813198</td>
<td>0.9675</td>
</tr>
</tbody>
</table>

M,Non White subtracted from
Table 3: Difference in variance of GRE_Q scores by Ethnicity

<table>
<thead>
<tr>
<th>Ethnicity</th>
<th>n</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Std. Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>NSPEC</td>
<td>14</td>
<td>152.42857</td>
<td>4.6692824</td>
<td>1.2479182</td>
</tr>
<tr>
<td>Non White</td>
<td>90</td>
<td>149.9</td>
<td>5.4547165</td>
<td>0.57497761</td>
</tr>
<tr>
<td>WHITE</td>
<td>454</td>
<td>150.15198</td>
<td>4.8733435</td>
<td>0.22871735</td>
</tr>
</tbody>
</table>

Residuals stored in new column: Residuals
Is the GRE a Predictor of Student Success Outcomes? 55

ANOVA table

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>SS</th>
<th>MS</th>
<th>F-Stat</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recode(ethnicity)</td>
<td>2</td>
<td>78.123087</td>
<td>39.061544</td>
<td>1.5835713</td>
<td>0.2062</td>
</tr>
<tr>
<td>Error</td>
<td>555</td>
<td>13690.042</td>
<td>24.666742</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>557</td>
<td>13768.165</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4: Difference in variance of GRE_Q scores by Sex

Response statistics by factor

<table>
<thead>
<tr>
<th>sex</th>
<th>n</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Std. Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>F</td>
<td>504</td>
<td>149.85516</td>
<td>4.7465435</td>
<td>0.21142785</td>
</tr>
<tr>
<td>M</td>
<td>55</td>
<td>152.96364</td>
<td>6.0460077</td>
<td>0.81524351</td>
</tr>
</tbody>
</table>
ANOVA table

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>SS</th>
<th>MS</th>
<th>F-Stat</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>sex</td>
<td>1</td>
<td>479.15598</td>
<td>479.15598</td>
<td>20.057326</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Error</td>
<td>557</td>
<td>13306.354</td>
<td>23.889325</td>
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<td></td>
</tr>
<tr>
<td>Total</td>
<td>558</td>
<td>13785.51</td>
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<td></td>
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</tbody>
</table>

Tukey HSD results (95% level)

F subtracted from

<table>
<thead>
<tr>
<th></th>
<th>Difference</th>
<th>Lower</th>
<th>Upper</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>M</td>
<td>3.1084776</td>
<td>1.7451381</td>
<td>4.4718172</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

Appendix D

Table 1: Simple Linear Regression Results of UGPA vs GPA_Term1

Simple linear regression results:

Dependent Variable: gpa_term1

Independent Variable: u_gpa

gpa_term1 = 3.6842198 + 0.033181361 u_gpa
Is the GRE a Predictor of Student Success Outcomes? 57

Sample size: 377

R (correlation coefficient) = 0.074686402

R-sq = 0.0055780586

Estimate of error standard deviation: 0.31744639

Parameter estimates:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Estimate</th>
<th>Std. Err.</th>
<th>D</th>
<th>95% L. Limit</th>
<th>95% U. Limit</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>3.6842198</td>
<td>0.07432077</td>
<td>37</td>
<td>3.5380821</td>
<td>3.8303575</td>
<td>&lt;0.0001</td>
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<tr>
<td>Slope</td>
<td>0.0331814</td>
<td>0.02287822</td>
<td>37</td>
<td>-0.01180433</td>
<td>0.078167051</td>
<td>0.1478</td>
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</table>

Analysis of variance table for regression model:

<table>
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<tr>
<th>Source</th>
<th>DF</th>
<th>SS</th>
<th>MS</th>
<th>F-stat</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>1</td>
<td>0.21197489</td>
<td>0.21197489</td>
<td>2.1035055</td>
<td>0.1478</td>
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<tr>
<td>Error</td>
<td>375</td>
<td>37.789578</td>
<td>0.10077221</td>
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<td></td>
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</tbody>
</table>
Is the GRE a Predictor of Student Success Outcomes?

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>SS</th>
<th>MS</th>
<th>F-stat</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>376</td>
<td>38.001553</td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

95% lower limit for mean response stored in new column: 95% L. Limit Mean
95% upper limit for mean response stored in new column: 95% U. Limit Mean

Appendix E

Figure 2 CHP Core GPA Histogram
Figure 6 CHP Core + SPH Core GPA Histogram
Figure 8 CHP Final Cumulative GPA Histogram
Figure 9 Term 1 GPA Histogram
Figure 10 GRE Quantitative Average Score: Histogram
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Figure 3 GRE Verbal Average Score: Histogram
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**Figure 12 Predictor GRE Quantitative Summary Scatterplots**

<table>
<thead>
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<th>Predictor-GRE Quantitative</th>
<th>gre_nq</th>
<th>gre_qn</th>
<th>gre_qmr</th>
<th>gre_sumq</th>
<th>gre_sent</th>
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<tbody>
<tr>
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</tr>
</tbody>
</table>
Figure 13 Predictor GRE Verbal Summary Scatterplots
Figure 14 Dichotomous (Female vs Male) Comparison: Predictor GRE Quantitative
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Figure 15 Dichotomous (Female vs Male) Comparison: Predictor GRE Verbal
Figure 16 Dichotomous (Female vs Male) Comparison: Predictor UGPA
Figure 17 UPGA Mean Histogram
Figure 18 Predictor UGPA Summary Scatterplots
APPENDIX F

RStudio Code:
#Libraries
library(tidyverse)
library(formattable)
library(gridExtra)
library(grid)

#Data Call
fp<-'C:/Users/malon/Desktop/R Projects/Marlin/'#change to local directory
Marlin.Data<-read.csv(paste(fp,"db Final.csv",sep="")) #data call function

#Add Demog Group Column
Marlin.Data$DemogGroupFLG<-ifelse(Marlin.Data$ethnicity=="WHITE","White Students","Students of Color")

#Select Relevant Fields
Marlin.Data<-select(Marlin.Data,
   id,
   sex,
   ethnicity,
   status,
   degree,
   DemogGroupFLG,
   first_term,
   compl_term,
   gre_v,
   gre_q,
   u_gpa,
   gpa_term1,
   gpa_cumul,
   gpa_core,"
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gpa_chp,
gpa_core_chp
)

# Data Cleaning
Marlin.Data<-Marlin.Data[complete.cases(Marlin.Data),] # Complete Cases
Marlin.Data<-filter(Marlin.Data,u_gpa!=0) # Filter U_GPA, not equal to 0

# Relative Measure Creation
avgGPA<-mean(Marlin.Data$gpa_cumul)
Marlin.Data$Relative_Cumul_GPA<-Marlin.Data$gpa_cumul/avgGPA
avgGRE_Q<-mean(Marlin.Data$gre_q)
Marlin.Data$Relative_GRE_Q<-Marlin.Data$gre_q/avgGRE_Q
avgGRE_V<-mean(Marlin.Data$gre_v)
Marlin.Data$Relative_GRE_V<-Marlin.Data$gre_v/avgGRE_V
avgUGPA<-mean(Marlin.Data$u_gpa)
Marlin.Data$Relative_U_GPA<-Marlin.Data$u_gpa/avgUGPA

# Gather data for facet wrap
GPATerm1<-select(Marlin.Data,
id,
sex,
ethnicity,
DemogGroupFLG,
status,
gpa_term1,
 gre_v,
 gre_q,
 u_gpa)
GPATerm1$GPAType<-'gpa_term1''
colnames(GPATerm1)<-c("id","sex","ethnicity","DemogGroupFLG","status","GraduateGPA","gre_v","gre_q","u_gpa","GPAType")

GPACumulative<-select(Marlin.Data,
id, 
sex, 
ethnicity, 
DemogGroupFLG, 
status, 
gpa_cumul, 
gre_v, 
gre_q, 
u_gpa)
GPACumulative$GPAType<-'gpa_cumul'
colnames(GPACumulative)<- 
  c('id','sex','ethnicity','DemogGroupFLG','status','GraduateGPA','gre_v','gre_q', 
    'u_gpa','GPAType')

GPACore<-select(Marlin.Data, 
  id, 
  sex, 
  ethnicity, 
  DemogGroupFLG, 
  status, 
  gpa_core, 
  gre_v, 
  gre_q, 
  u_gpa)
GPACore$GPAType<-'gpa_core'
colnames(GPACore)<- 
c('id','sex','ethnicity','DemogGroupFLG','status','GraduateGPA','gre_v','gre_q', 
  'u_gpa','GPAType')

GPACHP<-select(Marlin.Data, 
  id, 
  sex, 
  ethnicity, 
  DemogGroupFLG, 
  status, 
  gpa_chp,
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gre_v,
gre_q,
u_gpa)

GPACHPSGPAType<="gpa_chp"
colnames(GPACHP)<-
c("id","sex","ethnicity","DemogGroupFLG","status","GraduateGPA","gre_v","gre_q",
"u_gpa","GPAType")

GPACORECHP<select(Marlin.Data,
   id,
   sex,
   ethnicity,
   DemogGroupFLG,
   status,
   gpa_core_chp,
   gre_v,
   gre_q,
   u_gpa)

GPACORECHPSGPAType<="gpa_core_chp"
colnames(GPACORECHP)<-
c("id","sex","ethnicity","DemogGroupFLG","status","GraduateGPA","gre_v","gre_q",
"u_gpa","GPAType")

GPAData<-rbind(GPATerm1,
   GPACumulative,
   GPACore,
   GPACHP,
   GPACORECHP)

#Outcome Distributions
GPA_Term1_Histogram<-ggplot(Marlin.Data,aes(x=gpa_term1))+geom_histogram()
GPA_CUMUL_Histogram<-ggplot(Marlin.Data,aes(x=gpa_cumul))+geom_histogram()
GPA_Core_Histogram<-ggplot(Marlin.Data,aes(x=gpa_core))+geom_histogram()
GPA_CHP_Histogram<-ggplot(Marlin.Data,aes(x=gpa_chp))+geom_histogram()
GPA_Core_CHP_Histogram<-
ggplot(Marlin.Data,aes(x=gpa_core_chp))+geom_histogram()

#Predictor Distributions
GRE_V_Histogram<-ggplot(Marlin.Data,aes(x=gre_v))+geom_histogram()
Is the GRE a Predictor of Student Success Outcomes?

```r
GRE_Q_Histogram <- ggplot(Marlin.Data, aes(x = gre_q)) + geom_histogram()
U_GPA_Histogram <- ggplot(Marlin.Data, aes(x = u_gpa)) + geom_histogram()

# Undergraduate GPA and Graduate Cumulative GPA
U_GPA_Scatterplot <- ggplot(GPAData, aes(x = u_gpa, y = GraduateGPA)) +
  geom_point() +
  facet_grid(. ~ GPAType) +
  labs(title = "Predictor - Undergraduate GPA")

# GRE V and Graduate Cumulative GPA
GRE_V_Scatterplot <- ggplot(GPAData, aes(x = gre_v, y = GraduateGPA)) +
  geom_point() +
  facet_grid(. ~ GPAType) +
  labs(title = "Predictor - GRE Verbal")

# GRE Q and Graduate Cumulative GPA
GRE_Q_Scatterplot <- ggplot(GPAData, aes(x = gre_q, y = GraduateGPA)) +
  geom_point() +
  facet_grid(. ~ GPAType) +
  labs(title = "Predictor - GRE Quantitative")

DashboardPredictorScatterplot <-
  gridExtra::grid.arrange(U_GPA_Scatterplot, GRE_V_Scatterplot, GRE_Q_Scatterplot, nrow = 3)

# Relative Predictor Dashboard
Relative.UGPA_CUMULGPA <-
  ggplot(Marlin.Data, aes(x = Relative_U_GPA, y = Relative_Cumul_GPA)) +
  geom_point() +
  geom_hline(yintercept = 1) +
  geom_vline(xintercept = 1) +
  annotate("text", x = 0.6, y = 0.8, label = paste("Avg U_GPA = " , accounting(avgUGPA))) +
  annotate("text", x = 0.6, y = 0.81, label = paste("Avg Cumul_GPA = " , accounting(avgGPA))) +
  labs(title = "Relative Cumulative GPA \n and Undergraduate GPA") +
  xlim(0.25, 1.25)

Relative.GREQ_CUMULGPA <-
  ggplot(Marlin.Data, aes(x = Relative_GRE_Q, y = Relative_Cumul_GPA)) +
  geom_point() +
  geom_hline(yintercept = 1) +
  geom_vline(xintercept = 1) +
  annotate("text", x = 0.6, y = 0.8, label = paste("Avg GRE_Q = " , accounting(avgGRE_Q))) +
  annotate("text", x = 0.6, y = 0.81, label = paste("Avg Cumul_GPA = " , accounting(avgGPA))) +
```
Is the GRE a Predictor of Student Success Outcomes?

```r
labs(title="Relative Cumulative GPA\nand GRE Quantitative")+
xlim(0.25,1.25)
Relative.GREV_CUMULGPA<-
ggplot(Marlin.Data,aes(x=Relative_GRE_V,y=Relative_Cumul_GPA))+
   geom_point()+
   geom_hline(yintercept=1)+
   geom_vline(xintercept=1)+
   annotate("text",x=0.6,y=0.8,label=paste("Avg GRE_V =",accounting(avgGRE_V)))+
   annotate("text",x=0.6,y=0.81,label=paste("Avg Cumul_GPA =",accounting(avgGPA)))+
   labs(title="Relative Cumulative GPA\n and GRE Verbal")+
xlim(0.25,1.25)
DashboardCumulativeGPARelativeOutcomes<-
grid.arrange(Relative.UGPA_CUMULGPA,Relative.GREQ_CUMULGPA,Relative.GREV_CUMULGPA,ncol=3)
#Facet Grid DemogGroupFLG & GPA Type
DemogGroup_GRE_V_Scatterplot<-ggplot(GPAData,aes(x=gre_v,y=GraduateGPA))+
   geom_point()+
   facet_grid(DemogGroupFLG~GPAType)
DemogGroup_GRE_Q_Scatterplot<-ggplot(GPAData,aes(x=gre_q,y=GraduateGPA))+
   geom_point()+
   facet_grid(DemogGroupFLG~GPAType)
DemogGroup_U_GPA_Scatterplot<-ggplot(GPAData,aes(x=u_gpa,y=GraduateGPA))+
   geom_point()+
   facet_grid(DemogGroupFLG~GPAType)
#Facet Grid Sex & GPA Type
Sex_GRE_V_Scatterplot<-ggplot(GPAData,aes(x=gre_v,y=GraduateGPA))+
   geom_point()+
   facet_grid(sex~GPAType)
Sex_GRE_Q_Scatterplot<-ggplot(GPAData,aes(x=gre_q,y=GraduateGPA))+
   geom_point()+
   facet_grid(sex~GPAType)
Sex_U_GPA_Scatterplot<-ggplot(GPAData,aes(x=u_gpa,y=GraduateGPA))+
   geom_point()+
   facet_grid(sex~GPAType)
```
facet_grid(sex~GPAType)

#paste(fp,"GPA_Term1_Histogram",".png",sep="")

#Save Plots
ggsave(paste(fp,"GPA_Term1_Histogram",".png",sep=""),GPA_Term1_Histogram,width =16,height = 12,units="in",device = "png")
ggsave(paste(fp,"GPA_CUMUL_Histogram",".png",sep=""),GPA_CUMUL_Histogram,width =16,height = 12,units="in",device = "png")
ggsave(paste(fp,"GPA_Core_Histogram",".png",sep=""),GPA_Core_Histogram,width=16, height = 12,units="in",device = "png")
ggsave(paste(fp,"GPA_CHP_Histogram",".png",sep=""),GPA_CHP_Histogram,width=16, height = 12,units="in",device = "png")
ggsave(paste(fp,"GRE_V_Histogram",".png",sep=""),GRE_V_Histogram,width=16,height = 12,units="in",device = "png")
ggsave(paste(fp,"GRE_Q_Histogram",".png",sep=""),GRE_Q_Histogram,width=16,height = 12,units="in",device = "png")
ggsave(paste(fp,"U_GPA_Histogram",".png",sep=""),U_GPA_Histogram,width=16,height = 12,units="in",device = "png")
ggsave(paste(fp,"U_GPA_Scatterplot",".png",sep=""),U_GPA_Scatterplot,width=16,height = 12,units="in",device = "png")
ggsave(paste(fp,"GRE_V_Scatterplot",".png",sep=""),GRE_V_Scatterplot,width=16,height = 12,units="in",device = "png")
ggsave(paste(fp,"GRE_Q_Scatterplot",".png",sep=""),GRE_Q_Scatterplot,width=16,height = 12,units="in",device = "png")
ggsave(paste(fp,"DemogGroup_GRE_V_Scatterplot",".png",sep=""),DemogGroup_GRE_V_Scatterplot,width=16,height = 12,units="in",device = "png")
ggsave(paste(fp,"DemogGroup_GRE_Q_Scatterplot",".png",sep=""),DemogGroup_GRE_Q_Scatterplot,width=16,height = 12,units="in",device = "png")
ggsave(paste(fp,"DemogGroup_U_GPA_Scatterplot",".png",sep=""),DemogGroup_U_GPA_Scatterplot,width=16,height = 12,units="in",device = "png")
ggsave(paste(fp,"Sex_GRE_V_Scatterplot",".png",sep=""),Sex_GRE_V_Scatterplot,width =16,height = 12,units="in",device = "png")
ggsave(paste(fp,"Sex_GRE_Q_Scatterplot",".png",sep=""),Sex_GRE_Q_Scatterplot,width =16,height = 12,units="in",device = "png")
ggsave(paste(fp,"Sex_U_GPA_Scatterplot",".png",sep=""),Sex_U_GPA_Scatterplot,width =16,height = 12,units="in",device = "png")
ggsave(paste(fp,"DashboardPredictorScatterplot",".png",sep=""),DashboardPredictorScatterplot,width=16,height = 12,units="in",device = "png")
Is the GRE a Predictor of Student Success Outcomes?

ggsave(paste(fp,"DashboardCumulativeGPARelativeOutcomes",".png",sep=""),DashboardCumulativeGPARelativeOutcomes,width=16,height = 12,units="in",device = "png")