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# A report of the AGCPD Task Force to Evaluate Associations between Select Admissions Requirements, Demographics, and Performance on ABGC Certification examination

Authors

Melanie F. Myers[1,2]

Amanda Bergner[3]

Laura Conway[4]

Debra Duquette[5]

Andrea L. Durst[6]

Beverly M. Yashar[7]

Xue Zhang[1]

MaryAnn Campion[8]

[1]Division of Human Genetics, Cincinnati Children's Hospital Medical Center, Cincinnati, OH.

[2]College of Medicine, University of Cincinnati, Cincinnati, OH.

[3]Department of Genetics & Development, Vagelos College of Physicians and Surgeons, Columbia University, New York, NY

[4]Department of Genetics, Perelman School of Medicine, University of Pennsylvania, Philadelphia, PA

[5]Feinberg School of Medicine, Northwestern University, Chicago, IL.

[6] Department of Human Genetics, University of Pittsburgh, Pittsburgh, PA

[7] Department of Human Genetics, University of Michigan, Ann Arbor, MI

[8]Department of Genetics, Stanford University, Stanford, CA.

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Corresponding author:
Melanie Myers
Email: Melanie.Myers@cchmc.org
Phone: 513-636-8195

Suggested running head: Factors associated with outcomes on the ABGC certification exam

**Abstract:**

Graduation from a genetic counseling graduate program accredited by the Accreditation Council of Genetic Counseling (ACGC) and certification obtained by passing the American Board of Genetic Counseling (ABGC) certification examination are increasingly required to practice as a genetic counselor in the United States. Despite the ABGC certification examination serving as a gateway to the genetic counseling career, there have been no research studies to date that have examined what variables are associated with examination performance. Therefore, the Association of Genetic Counseling Program Directors (AGCPD) established a Task Force to assess whether trainee demographics, GPA and GRE® percentile scores are associated with passing the ABGC certification examination on the first attempt. We surveyed accredited genetic counseling graduate programs in North America and gathered demographic data, admissions variables, and certification examination outcome data for 1,494 trainees from 24 training programs, representing approximately 60.5% of matriculants between 2007-2016. Univariable analysis was performed to assess associations between admissions variables and categorical outcome (pass vs. fail) on the certification examination using Wilcoxon rank sum or Fisher's exact test. Variables significantly associated with the categorical board outcome were then entered in a stepwise model selection procedure. In stepwise logistic regression, trainees with higher GPA (OR=3.41; 95% CI=1.99, 5.83), higher verbal (OR=1.02; 95% CI=1.01, 1.03) and quantitative (OR= 1.02; 95% CI-1.01, 1.03) GRE® scores, female trainees (OR=2.95;

95%CI=1.70, 5.12), and White trainees (OR 3.37; 95%CI=2.14, 5.30) had higher odds of passing the certification examination on the first attempt. As programs move to a holistic approach to graduate admissions in order to improve access to the genetic counseling profession, our results may influence programs to provide additional preparation for the certification examination for all trainees. In addition, genetic counseling professional organizations should continue to work together to assess and eliminate outcome disparities in admissions, training, and certification processes.

**Keywords:** Genetic counseling, ABGC certification exam, Graduate Record Examination, admissions, education, standardized testing disparities

**What is known about this topic** (1-2 sentences)

To practice as a genetic counselor in the United States, one must increasingly graduate from a genetic counseling master's program that is accredited by the ACGC and, for many employers and states, must pass the certification examination administered by the ABGC. As part of the admissions process, genetic counseling graduate programs consider undergraduate major, courses, GPA, letters of recommendation, and personal statements. Most also consider English language fluency scores for non-native English speakers, advocacy experience, efforts to explore the profession, and research/laboratory experience. Historically, most programs have required scores from the Graduate Record Exam (GRE®) as well.

**What this paper adds to the topic** (1-2 sentences).

This paper is the first to explore whether demographic and admissions factors considered by genetic counseling graduate programs are associated with performance on the certification examination administered by the ABGC. Results of our study may lead programs to integrate training in standardized test taking as they prepare students for the certification exam, and may guide other professional organizations as they consider exam development and accreditation policies.

**Introduction:**

To practice as a genetic counselor in the United States, graduation from a genetic counseling graduate program accredited by the Accreditation Council of Genetic Counseling (ACGC) and certification obtained by passing the American Board of Genetic Counseling (ABGC) certification examination are increasingly required. Due to state licensure laws and employer requirements, genetic counseling graduates who fail the ABGC certification examination may face various restrictions on their ability to practice, including job loss, change of job title, limitation of roles, and/or decrease in salary, as well as increased pressure and anxiety as they wait to retake the examination. In addition, genetic counselor training programs may find their accreditation status and/or their applicant pool in jeopardy if their first-time pass rate falls below an acceptable threshold. Therefore, genetic counseling applicants, students, and training programs could benefit from understanding what variables are associated with performance on the ABGC certification examination.

*History of genetic counseling admissions requirements:*

The genetic counseling profession continues to grow rapidly since its inception 50 years ago, with more than 5,000 Certified Genetic Counselors (CGCs) in North America (American Board of Genetic Counseling, 2020b) and 54 accredited genetic counseling graduate programs as of November, 2020. Each program typically admits between 4-25 students per year, with 494 training positions available in the spring 2020 admissions cycle (AGCPD internal data). Although individual programs develop their own processes for admission, there are similarities regarding the information collected to evaluate applicants. Programs typically require that applicants have a baccalaureate degree and academic preparation in specific subjects such as biology, chemistry, biochemistry, genetics, statistics, and psychology. Academic transcripts with grade point average (GPA), letters of recommendation, and personal statements are also required, often along with English language fluency scores for non-native English speakers, advocacy experience (e.g., crisis counseling, working with individuals with disabilities), efforts to explore the profession (e.g., job shadowing, genetic counseling assistant experience, online courses and webinars), and research/laboratory experience. Historically, most programs have required scores from the Graduate Record Exam (GRE®) General Test as well. The GRE

General Test measures verbal reasoning, quantitative reasoning, and analytical writing (https://www.ets.org/gre/revised_general/about/).

*Which admissions variables are associated with graduate school success?*

Undergraduate GPA has been positively correlated with graduate school success across many disciplines. Specifically, undergraduate science GPA was a strong predictor of success in nursing graduate school (Patzer et al., 2017), and undergraduate GPA was a significant predictor of performance in master's in business administration (MBA) programs (Graham, 1991; Hammond, Cook-Wallace, Moser, & Harrigan, 2015).

The use of GRE® scores as an admissions metric has also been a common practice of graduate schools and programs in many academic disciplines (Posselt, 2014). However, there is conflicting evidence about the correlation between GRE® scores and academic success. A multi-disciplinary study investigated undergraduate GPA and GRE scores as predictors of long-term graduate school success, as measured by graduate GPA and faculty ratings on mastery of the discipline, professional productivity, and communication skills (Burton & Wang, 2005). This study included masters and doctoral students from seven graduate institutions and 21 departments, including biology, chemistry, education, English, and psychology. Findings indicate that the combination of GRE scores and undergraduate GPA is a strong predictor of graduate GPA and faculty ratings across disciplines. A meta-analysis including more than 85,000 graduate students representing humanities, social sciences, life sciences, and math-physical sciences found that GRE® scores were correlated with comprehensive exam scores, graduate GPA, and research productivity and that subject tests tended to be better predictors than any of the general GRE subsections (Kuncel, Hezlett, & Ones, 2001). More supporting evidence comes from a study aimed at predicting student success in nurse practitioner graduate programs, which found that GRE® verbal, quantitative, and total scores were strongly correlated with decreased time to graduate (Richard-Eaglin, 2017).

In contrast, several other studies show small or no correlations between GRE® scores and graduate school success. A study of PhD programs in physics found a positive correlation with a

small effect between scores on the GRE® quantitative subsection and degree completion (C. W. Miller, Zwickl, Posselt, Silvestrini, & Hodapp, 2019). Specifically, the completion rate for US women scoring in the 90th percentile on the GRE® quantitative subsection was 12% higher than US women scoring in the 10th percentile; the difference for US men was smaller, at 9%. A 2017 Vanderbilt University study found that GRE® scores were only a moderate predictor of first semester GPA (quantitative and verbal subsections) and a weak to moderate predictor of overall GPA (verbal subsection only) for matriculants in their biomedical PhD programs. They found no correlation between GRE® scores and progress in the program, research productivity, passing the qualifying exam, and other indicators of success in graduate school (Moneta-Koehler, Brown, Petrie, Evans, & Chalkley, 2017). However, the authors note that their sample was limited to admitted and enrolled students (with GRE® verbal and quantitative subsection scores ~100 points higher than the national average) and thus can't be used to predict outcomes based on the entire range of GRE® scores. Similarly, Hall et al. (Hall, O'Connell, & Cook, 2017) found no correlation between GRE® scores, grades, amount of previous research, or faculty ratings with high/low productivity among applicants admitted to their biomedical PhD program, while Hulse et al. (Hulse et al., 2007) found that GRE® scores were not a predictor of success in certified registered nursing anesthetist programs. Meanwhile, a meta-analysis found that only 6.3% of the variance in graduate GPA was accounted for by performance on the quantitative and verbal sections of the GRE. This analysis included a wide variety of disciplines, including humanities, math, science, education, and psychology, as well as representation from both master's and doctoral students (Morrison & Morrison, 1995).

*Which admissions variables are associated with performance on certification/licensing exams?*

Several studies have investigated the relationship between admissions variables, including GRE® scores and undergraduate GPA, and success on professional entrance examinations for various health and medical fields. Roush et al. (2014) found a low positive correlation between the NAVLE (North American Veterinary Licensing Exam) and the total GRE® score, the GRE® verbal subsection, and the mean GPA of pre-professional science courses. Sharpless and Barber (2013) found that performance on the EPPP (Examination for Professional Practice in Psychology) was significantly correlated with program prestige (e.g. better *US News and World*

*Report* scores and greater research emphasis), program selectivity, GRE® scores, and GPA (Sharpless & Barber, 2013). In the physical therapy field, Hollman et al. (2008) found that outcomes on the NPTE (National Physical Therapy Examination) were significantly correlated with the GRE® verbal subsection and behavioral interview scores (Hollman et al., 2008).

*Which demographic variables are associated with performance on certification/licensing exams?* To investigate potential correlations between race, ethnicity and gender with certification exam pass rates, Dawson et al (1994) performed a retrospective analysis of the performance of men and women from various racial and ethnic backgrounds on the National Board of Medical Examiners Part I examination. In their study population, White students had the highest scores, followed by Asian/Pacific Islander students, Hispanic students, and Black students, and men scored higher than women across all racial and ethnic categories. Subsequent analyses suggested that prior academic performance may explain a large part of the variance among ethnic groups but does not explain the gender differences. In turn, the authors called for continued validity research to investigate the differences (Dawson et al., 1994). Another study by Dewhurst et al (2007) examined whether self-declared ethnicity and gender were associated with pass rates among UK medical graduates taking the Membership of the Royal Colleges of Physicians in the United Kingdom examination. Their analyses found that White candidates performed better than other ethnic groups in both the written and clinical skills portions of the exam. There were no differences between male and female candidates on the written portions, but the female candidates performed significantly better on the clinical skills assessment (Dewhurst, McManus, Mollon, Dacre, & Vale, 2007).

*Use of the ABGC Certification examination as the gateway to genetic counseling practice:*

The CGC® credential is granted to genetic counselors who pass the ABGC certification examination (American Board of Genetic Counseling, 2020c) and is essential in states that require genetic counselor licensure. While licensure requirements vary by state, all states that issue genetic counseling licenses require applicants for licensure to have passed the ABGC certification exam and received a master's degree from an ACGC-accredited program. The ABGC certification examination is a 200 question multiple choice, computer-based standardized

exam whose content is developed from a practice-based analysis of current knowledge, skills and competencies required to practice at the entry level skills as defined by practicing certified genetic counselors (Hampel et al., 2009). Currently, the minimum passing score is determined before an exam is administered by a criterion-referenced methodology, which uses each item's statistical performance characteristics to project results and determine an equitable passing score. The minimum passing score changes when a new form of the exam is created, an event that is often tied to the administration of a new practice analysis. Two exams are in circulation for each examination window (American Board of Genetic Counseling, 2020a). The first-time pass rate between 2013 and 2018 ranged from 79-90%. To date, ABGC has not collected demographic data on examinees. For more information on the ABGC certification exam development process, please see https://www.abgc.net/becoming-certified/certification-exam-faqs/.

Individual and aggregate performance on the ABGC certification exam impacts both graduate training programs and students. In Fall 2019, ACGC introduced revised Standards requiring programs to publish on their websites aggregated first-time certification examination pass rates for recent cohorts of graduating students (Accreditation Council for Genetic Counseling, 2019). Programs would be at risk of probation if their average first-time pass rate over three years falls below 80%. This requirement aligns with the Council for Higher Education Administration (CHEA) best practices regarding transparency for applicants as they evaluate potential graduate programs (Council for Higher Education Accreditation, 2019). Meanwhile, students and recent graduates may grapple with financial and logistic barriers related to the certification exam. In 2020-2021, the certification examination fee was $900 for first-time applicants and $800 for repeat applicants. The examination can only be taken in the months of August or February and until recently, had a limited number of attempts to pass. However, in November 2020, the ABGC announced that there would no longer be a restriction on the number of attempts allowed. Individuals wanting to gain additional preparation may elect to take a certification examination prep course, which can add more significant costs.

Despite the ABGC certification examination serving as a gateway to the genetic counseling career, there have been no research studies to date that have examined which admissions or

demographic variables may be associated with examination performance. Therefore, the AGCPD established a Task Force (TF) to determine to what extent select factors, in particular trainee demographics, GPA and GRE® percentile scores, are associated with passing the ABGC certification examination on the first attempt. Results of this study may inform programs as they prepare students for the certification exam, and may guide other professional organizations as they consider exam development and accreditation policies.

## Methods

This study was reviewed and granted an exemption by the Cincinnati Children's Hospital Medical Center Institutional Review Board in July 2019 (Study #2019-0798). Members of the study team included graduate program leadership from seven different institutions, all of whom are CGCs®.

### Instrumentation

An online survey was designed by the study team and administered through Cincinnati Children's Hospital Medical Center's REDCap. REDCap (Research Electronic Data Capture) is a secure, web-based application designed to support data capture for research studies, providing: 1) an intuitive interface for validated data entry; 2) audit trails for tracking data manipulation and export procedures; 3) automated export procedures for seamless data downloads to common statistical packages; and 4) procedures for importing data from external sources (Harris et al., 2009).

The survey consisted of two components. The first component of the survey included program-level questions about: 1) the responding program's GRE® requirements (i.e. whether the GRE® is waived for all or some applicants and if applicable, under what circumstances is the GRE® waived); 2) trainee matriculation information (i.e. the first year the responding program matriculated trainees and the number of trainees matriculated between 2007-2016); and 3) an open-ended text box asking programs to describe any certification examination preparation provided to trainees as part of the curriculum.

The second component of the survey included trainee-level questions and was collected through a Microsoft® Excel® spreadsheet that respondents could download from the REDCap survey, complete, and upload back to REDCap (online supplemental material). REDCap automatically generated a study ID number which respondents were asked to include in the Excel® spreadsheet as a validity check when merging data into the REDCap survey. Of note, all trainees had graduated at the time of data collection, however, the word "trainee" is used throughout for ease of reference. Six survey subsections captured the following trainee-level data: 1) demographic data of trainees who sat for the ABGC certification examination between January 2009 - February 2019 (i.e. sex, race, ethnicity, citizen of the U.S./Canada vs other, year matriculated and year graduated from genetic counseling training. We use the term sex rather than gender in reporting results because the survey instrument asked for trainees' sex.); 2) certification examination outcomes, specifically number of known times the trainee took the certification examination, date of each examination (month and year), qualitative outcome (pass/fail) and quantitative outcome (total raw score) each time the trainee took the examination; 3) GRE® measures, specifically the number of times and year(s) the trainee took the general GRE® exam as well as verbal, quantitative, and analytical percentile scores received on each GRE®; 4) undergraduate degree information, specifically each trainee's undergraduate major(s) as defined by Education Testing Services (the organization which administers the GRE®), GPA on a four-point scale, whether undergraduate degree was obtained at a U.S. or Canadian institution, and year(s) of graduation); 5) graduate degree information, if applicable, which captured the same information regarding graduate degree(s) as that described for undergraduate degree; and 6) information on trainee progress during their genetic counseling training (i.e. unanticipated delays in graduation and whether any clinical, professional or academic remediation was needed for each trainee). No personal identifiers were collected about trainees.

The survey was pretested by three TF members and the 2018-2019 AGCPD chair. Based on the pretest, changes included: clarification on question wording (e.g. "your program" instead of "you" when asking program-level questions), incorporation of forced response options from drop down menus for certain questions (e.g. choices of February or August for month of certification examination as these are the only months the examination is offered), creation of rules for data

entry (e.g. four digit entry for dates), and correction of grammatical errors. In addition, detailed data entry instructions were provided for respondents in a separate tab of the Excel document, as were definitions for undergraduate and graduate majors.

**Participants**

All genetic counseling graduate programs in the U.S. and Canada that were fully or newly accredited by the ACGC as of July 1, 2019 (n= 49) were eligible to participate in the survey's first component. Programs that had one or more graduate(s) sit for the ABGC certification examination by February 2019 (n=36 based on the ACGC directory of "accredited" programs at the time of study initiation) were eligible to participate in the survey's second component (Figure 1). Programs eligible to participate in the second component of the survey were asked to provide data on trainees who matriculated between 2007-2016 to capture outcomes of those eligible to take the certification exam since 2009, the year that ABGC changed testing vendors to Applied Measurement Professionals (AMP).

**Procedures**

Prior to initiating this study, the AGCPD Task Force discussed the design and goals of the study with AGCPD members via the listserv and annual business meeting, as it was felt that transparency and buy-in were important for the integrity of the project. NSGC, ABGC, and ACGC were also made aware of the study through joint leadership meetings. Subsequently, an invitation to participate, along with an explanation of the study and a link to the REDCap survey, was emailed to all members of the AGCPD listserv in July 2019. Reminder emails were sent to all AGCPD members through the listserv two weeks after the initial email, one month later, and two months later. TF members also sent email reminders to individual programs in September 2019 requesting their participation while remaining blinded as to whether or not the program had already participated. Contact information was requested as part of the REDCap survey should there be questions about the data. However, AGCPD members were informed that only the first author would have access to this field and that only de-identified data would be shared with the remainder of the study team. Several programs requested extensions for data submission and, therefore, the survey remained open through January 2020.

**Data Analysis**

Data were analyzed using SAS® software, version 9.4 (SAS, Cary, NC). Descriptive statistics were used to characterize responses. Frequency and percentage were reported for categorical variables. Median and interquartile range (IQR) were used to describe continuous variables. . Two open-ended responses (situations in which programs waived GRE® scores and descriptions about certification examination preparation integrated into the programs' curriculums) were post-coded after all responses were reviewed by two members of the study team. All open-ended responses were discussed iteratively by members of the study team until consensus was reached.

Admissions variables included trainee demographics, GRE® percentile scores, overall undergraduate GPA, undergraduate major, whether or not the trainee had an additional graduate degree prior to their genetic counseling training, and whether or not the trainee entered their genetic counseling program in the fall after completing their undergraduate degree. Undergraduate major was collapsed into life sciences, social behavioral, and other. We collected the number of times trainees took the GRE® exam and the verbal, quantitative, and analytical percentile scores for each time a trainee took the GRE®s. However, some programs only require submission of the highest score attained for each section so we looked at both first-time GRE® percentile scores and highest attained GRE® percentile scores. If trainees matriculated into a genetic counseling training program in the same calendar year that they attained their undergraduate degree, they were categorized as not having taken time off between undergraduate and graduate education.

To assess associations between admissions variables and categorical outcome (pass vs. fail) on the certification examination, univariable analysis was performed. Our analysis was limited to outcome on the first certification examination attempt since ACGC standards stipulate that a program will be at risk of probation if their average first-time pass rate over three years falls below 80% (Accreditation Council for Genetic Counseling, 2019).Furthermore, it is not possible to calculate an "overall pass rate" within the constraints of the current study design because trainees who did not pass on the first or subsequent attempt(s) may plan to take the exam again. Associations were tested using Wilcoxon rank sum or Fisher's exact test. Admissions variables significantly associated with the categorical board outcome were then entered in a stepwise

model selection with SAS procedure HPGENSELECT, a recently introduced module that incorporates a wider range of variable-selection options than were previously available; binary distribution of the dependent variable and logit link function were used. The Bayesian information criterion (*BIC*), which includes an offset to the maximized log-likelihood statistic as a penalty to models with more predictor variables, was used as the criterion for model selection. Variables selected by BIC were included in a final multiple logistic model. A p value less than 0.05 was used to indicate statistical significance. Significance tests were based on cases that had all variables available for the given analysis. Not all significance tests were based on the same set of individuals given that different variables were missing for different trainees.

Associations between categorical certification examination outcomes and variables related to the trainee's progress in their program were examined in univariable analysis. However, since these variables were collected retrospectively and are subject to recall bias, we did not include these variables in model selection and multiple logistic regression analysis. "Trainee progress" variables included whether the trainee graduated on time, whether they were part-time at any point during their training, and whether they needed any academic, clinical or professional remediation during training.

## Results

A total of 41 programs completed the program-level questions (response rate 86%). Five of these programs indicated they waived GRE® scores as part of their admissions requirements for all applicants, and 26 of 41 indicated they waived GREs® for some applicants (e.g. if the applicant already had an advanced degree or on a case-by-case basis). Already having an advanced degree was the main reason programs reported for waiving the GRE® requirement (n=24 of 26).

Thirty-six programs reported providing some ABGC certification examination preparation for trainees. Reported preparation included comprehensive written exams generated by the program, the ABGC practice exam, shorter written board style assessments, and oral exams. Many respondents relied on more than one approach to these assessments and reported varied formats

(e.g. focused lectures, workshops, and self-study) to help trainees prepare for subsequent evaluations.

Of 36 North American programs that matriculated trainees between 2007-2016 and had trainees sit by February 2019 for the ABGC certification examination, 30 provided program-level data and 24 submitted trainee-level data (Figure 1). Of these 24 programs, 18 matriculated their first class of trainees prior to 2007 and were therefore eligible to contribute certification outcomes for all years of data collection (January 2009 - February 2019). Most programs provided certification examination outcome data for 51 to 75 trainees (Online Supplemental Figure). The numbers of individuals in our data set who took the examination annually between 2010 and 2018 ranged from 108 to 199. Only 56 individuals took the certification examination in 2019, reflecting that we were only able to collect data from one of the two examination opportunities (February) that year (Table 1).

Overall, certification examination outcome data was provided for 1,494 trainees, representing approximately 60.5% of matriculants between 2007-2016 (AGCPD, personal communication). Roughly 93% of the 1,494 trainees were female, 89% were White, slightly more than 3% were Hispanic, and slightly less than 3% were not U.S. or Canadian citizens. An estimated 10% of trainees received some type of remediation (clinical, professional, and/or academic). Overall, the first-time pass rate was 87.5% (n=1,308). We compared first-time pass rates from 2013 through 2018 to those reported by the ABGC (www.abgc.net) to assess whether or not the current study sample was representative of all exam takers. With the exception of 2014, there were no statistically significant differences in first-time pass rates between trainees in our sample and those reported by the ABGC. For 2014, 86% of trainees in our sample passed the certification examination on the first attempt compared to 79% reported by the ABGC (Table 1).

**Associations with Outcomes on First Certification Examination Attempt**

*Univariable Analysis:* In univariable analysis, admissions variables associated with categorical first-time certification examination performance (pass/fail) included first-time and highest median verbal, quantitative, and analytical GRE® scores, median undergraduate GPA, sex, race (Asian, Black, Other, White) , U.S. or Canadian citizen (yes/no), and whether the trainee

graduated from a U.S. or Canadian undergraduate institution (Table 2). We found no significant difference in first-time pass rate between trainees who were Asian, Black, and Other (p=0.84). When these three groups were combined, 76% (n=123) of trainees who were Asian, Black or Other passed on the first attempt compared to 89% (n=1153) of trainees who were White (p<.0001).

All trainee progress variables were associated with categorical first-time certification examination performance in univariable analysis. However, since the same trainee may have needed academic and/or clinical and/or professional remediation, we also report whether trainees needed "any" type of remediation (Table 3).

*Logistic Regression:* Variables significant in univariable analysis were entered into a stepwise model selection. Only highest GRE® scores were entered into the model selection since reported first-time and highest GRE® scores were similar (Table 2). Likewise, due to comparable pass rates among trainees in the Asian, Black, and Other race categories, we collapsed these categories into "Racial Minority Groups" in regression analysis. Admissions variables selected by the stepwise model included median GPA, median highest verbal GRE® score, median highest quantitative GRE® score, sex, and race (White vs. Racial Minority Groups). Trainees with higher GPA, higher verbal and quantitative GRE® scores, female trainees, and White trainees had higher odds of passing the certification examination on the first attempt (Table 4). Collectively, the Area under the Curve (AUC) for the Receiver Operating Characteristic (ROC) for all variables in the model was 0.739 (data not shown). The significant admissions variables were tested in a generalized linear mixed model in which random effects of different programs were considered. The conclusion remained unchanged (data not shown).

## Discussion

This is the first study to examine associations between admissions factors and performance on the certification examination in the genetic counseling profession. Our findings suggest that there is an association between GRE® score, GPA, sex, and race and outcomes on the first certification examination attempt.

While the odds ratios of 1.02 associated with GRE variables appear small, it is worth noting that the unit of measurement is 1 percentile point. Thus with every 1 percentile point increase in Verbal or Quantitative GRE scores, the odds of passing the certification exam on the first attempt increased by 1.02 fold when holding all other variables constant. If we extrapolate to a 5 percentile point increase in Verbal or Quantitative GRE scores, then the odds of passing the ABGC certification exam would increase by 1.1 fold, and for a 10 percentile point increase, the odds ratio would be 1.2. An odds ratio of 1.2 means there is a 20% increase in the odds of passing the certification exam with each 10 percentile point increase. The unit of measurement for GPA was one point on a scale from 0 to 4. Thus with every 1 point increase in GPA (for example from a 3.0 to a 4.0), the odds of passing the certification exam on the first attempt increased by 3.4 fold when holding all other variables constant in the model. If we extrapolate to a 0.1 point increase in GPA (for example from 3.1 to 3.2), the odds of passing the certification exam on the first attempt would increase by 1.13 fold.

The positive correlation between undergraduate GPA and performance on the ABGC certification exam aligns with results from similar studies in other graduate professions (Roush, Rush, White, & Wilkerson, 2014; Sharpless & Barber, 2013; Utzman, Riddle, & Jewell, 2007). While undergraduate GPA is an important component of genetic counseling program admissions it is critical to recognize that it is an intricate construct that does not account for the wide variability of rigor, field of study, and GPA distributions between institutions. Furthermore, several studies have shown associations between lower undergraduate GPA and non-academic factors including socio-economic status, exposure to violence, and stereotype threat (Kallsen SR, Alwood MA, Adams SW, & CP., 2020; Massey, 2006; Massey & Fischer, 2005; Massey & Probasco, 2010). These findings highlight the importance of a nuanced review of GPA in the context of the full application package.

Our findings that female sex and White race are predictive of passing the certification examination on the first attempt do not, in the absence of further assumptions, prove the existence of sex bias or racial bias (Bickel, Hammel, & O'Connell J, 1975; Dempster, 1988), as it is possible that other variables not measured could account for such differences. Still, it might be deemed desirable to guard against possible bias by adoption of anti-racist and anti-sexist perspectives in evaluating and modifying curricula, seeking and including educators and

committee members with multicultural perspectives, and maintaining diversity among ABGC examination writers. The fact that our current practice, and therefore practice analysis, relies on a relatively homogenous White female work force could result in the creation of an exam that fails to account for cultural and social differences and variations in practice. This concern was expressed in a recent report to address the status of NSGC's DEI efforts. Some genetic counselor survey participants expressed concern that the certification exams are written for the perspectives of White genetic counselors (The Exeter Group, 2021). Additionally, the majority of textbooks (which may inform certification exam questions) in our field to date appear to have been authored primarily by White females. Such homogeneity has the potential to uphold systems of inequity and reinforce structural racism.

Success in identifying, evaluating and creating change in the education of and professional practice of genetic counselors requires efforts by individuals, local and national professional organizations. Recent efforts by NSGC, ABGC, ACGC, and AGCPD have focused on identifying implicit biases in the profession, the development, implementation and evaluation of the certification exam and the ways in which diversity, equity, and inclusion can be applied to graduate education and the pathway for entry to the profession through graduate school. We implore all individuals and groups to continue to explore and address these areas.

The interpretation of our GRE® findings is more complex. Our logistic regression results suggest that trainees' highest GRE® verbal and quantitative subsection scores are associated with passing the certification examination on the first attempt. While we found that first-time and highest scores were similar, it is possible that programs or trainees only reported highest scores, which could result in misclassification. While our positive correlation between GRE® scores and board certification outcomes align with some similar studies from other graduate professions, the use of the GRE® as an admissions metric remains a contentious topic in higher education due to an increasing body of evidence that GRE® scores do not predict academic or professional success. In other words, the correlation between higher GRE® scores and passing the ABGC certification examination does not mean that either GRE® scores or passing the ABGC certification examination is associated with professional success. Additionally, requiring GRE® scores could be a barrier to racial and ethnic minority applicants due to demographic differences

in the distribution of GRE® scores. For example, White and Asian-American males on average score higher than males from underrepresented backgrounds, as well as females from all ethnic groups (Educational Testing Service, 2019; C. Miller & Stassun, 2014).

A model for holistic review in graduate admissions was proposed by Wilson et al. in 2019 after finding that a metrics-based review of applicants (including cutoffs of 3.0 for GPA and 50$^{th}$ percentile or higher for each section of the GRE) excluded twice the number of applicants who identified as a historically underrepresented minority compared with their peers (Wilson, Odem, Walters, DePass, & Bean, 2019). Similarly, Bleske-Rechek and Brown (2014) studied the evolution of GRE scores and enrollment patterns over time, broken down by gender and ethnicity. They found little change from 1982-1996 in the gender gap (GRE quantitative reasoning scores specifically) and the ethnic gap (for GRE scores overall). However, they found an increase in the representation of females and disadvantaged ethnic groups in STEM graduate programs during that time, suggesting that the use of GRE scores in admissions decisions has not impeded other efforts to diversify and equalize graduate education (Bleske-Rechek & Browne, 2014). A summary of the growing movement within bioscience Ph.D. programs to drop the GRE requirement discusses a variety of potential contributors to the differences in GRE scores, including unequal access to education and support, financial barriers to preparing for and taking the test, and challenges with time limitations for students who don't speak English as a first language (Langin, 2019). These issues are a concern for the genetic counseling workforce, which is lacking in diversity across multiple axes of identity. For example, while racial minority populations currently account for over one-third of Americans, results from the NSGC 2020 Professional Status Survey (PSS) indicate that they represent less than 10% of the genetic counseling profession. In addition, 95% of NSGC PSS respondents were female and 93% identified as straight or heterosexual, while only 2% identified themselves as part of a disability community. The demographic data from the PSS indicate that despite decades of efforts to increase diversity among genetic counselors, only minimal gains have been realized (Channaoui, Bui, & Mittman, 2020; National Society of Genetic Counselors, 2020; United States Census, 2019).

The finding that the area under the ROC curve was 0.739 reflects the extent to which other factors not measured in the analysis also contribute to certification examination outcomes. Examples of factors not collected that may be considered in future studies include prospective and standardized collection of whether trainees needed remediation during graduate school and why, as well as other socio-economic data, such as first-generation college identity, English proficiency, household income, country of birth, and years lived in North America. While most programs reported providing some ABGC certification examination preparation for trainees, we were not able to standardize such preparation to measure the impact of program examination preparation on board certification outcomes. Other program-specific variables, such as size and whether there is a link between variables assessed in this study and the graduate program to which admissions is sought and/or acceptance is obtained (Bickel et al., 1975), should also be considered in future studies. We also recognize that non-cognitive variables may also contribute to success in graduate school and could impact performance on standardized tests such as the GRE® and certification exams. For example, Sampson and Boyer (2001) aimed to assess the accuracy of the GRE® and select demographic variables in predicting first year GPAs among minority graduate students at 'Research I' institutions. They found that GRE® verbal scores, age, major, and undergraduate GPA significantly correlated with first year graduate GPAs, but that these variables only accounted for 25% of the variance. The authors concluded that other factors, such as Sedlacek's non-cognitive variables (e.g. self-confidence, realistic self-appraisal, leadership, community service, access to support, and long-range goals), as well as other variables such as persistence, critical thinking skills, interpersonal skills, writing skills, and motivation should be more strongly considered in the admissions process. Of course, many of these variables cannot be measured by standardized tests or other validated measures and are harder to incorporate into scoring systems (Sampson & Boyer, 2001). Moneta-Koehler et al. (2017) expanded on this mindset by hypothesizing that the GRE® measures characteristics such as test taking skills and attention, as well as stress management and time management, which overlap with but are also distinct from qualities needed for success in graduate training (Moneta-Koehler et al., 2017). Therefore, future research in genetic counseling, as well as other healthcare fields, should focus on how best to assess for non-cognitive variables and how they impact success in genetic counseling.

A variety of complementary considerations favor a holistic approach to graduate admissions and not overweighting standardized test requirements, such as the GRE®, as they may serve as a barrier to applicants and diversity in health professions. A study of nursing graduate school admissions at the University of Washington School of Nursing found that the GRE® predicted only 5-8% of variance in cumulative GPA (Katz, Chow, Motzer, & Woods, 2009; Wolf, 2014). Another study reported a 44% decrease in the percent of Black/African American applicants when they added the GRE® as an admissions requirement for the New York Institute of Technology's Physician Assistant Program (Wolf, 2014). The potential impacts of both these findings are poignantly captured by Moneta-Kohler et al. (2017): "The limited benefits of the GRE® do not outweigh the potential costs of excluding minority and low socioeconomic status applicants."

The Educational Testing Service provides guidelines regarding fair and appropriate use of GRE® scores, including the importance of supplementing GRE® scores with other admissions criteria, especially when it comes to assessing the abilities of historically educationally disadvantaged students, students for whom English is a second language, and non-traditional students (Educational Testing Service, 2016). Although these ETS guidelines have been in place since 2004, there is evidence that not all health profession programs adhere to these recommendations (Hocking & Piepenbrock, 2010). In a study of physician assistant (PA) program applicants, Yuen and Honda (2019) found that both minority applicants (Hispanic, Black, Native American, and Pacific Islander) and older applicants had lower matriculation odds if they didn't submit GRE® scores. In addition, being male was associated with lower odds of matriculation, which is consistent with the preponderance of female PAs in the US. Taken together, these findings suggest that the odds of matriculation by minority status, age, and sex/gender are significantly affected by traditional measures of academic achievement, suggesting that requiring GRE® scores could be a barrier to diversifying the healthcare workforce. In turn, programs using the GRE® as an integral part of their admissions process may be unintentionally selecting against marginalized groups, given lower average GRE® scores in underrepresented groups (Educational Testing Service, 2019; C. Miller & Stassun, 2014; Posselt, 2014). GRE® scores, with or without the use of strict cutoffs or even preferences, may reinforce marginalization of specific groups based on race, age, and sex/gender in graduate admissions and

contribute to negative consequences for healthcare diversity. In a growing trend suggesting agreement with the points above, more genetic counseling graduate programs are removing the GRE® requirement and/or making it optional (AGCPD, personal communication).

Genetic counseling graduate programs are accredited by the ACGC, which maintains both the Standards of Accreditation (Standards) and the Practice-Based Competencies for Genetic Counselors (PBCs). Accredited programs must adhere to the ACGC Standards and PBCs (Doyle et al., 2016; Riconda, Grubs, Campion, & Cragun, 2018), though programs differ in how they meet these guidelines through their curriculum and program operations. As mentioned above, the 2020 ACGC Standards require programs to publish aggregated first-time certification examination pass rates on their websites for recent cohorts of graduating students (Accreditation Council for Genetic Counseling, 2019), and programs would be at risk of probation if their average first-time pass rate over three years falls below 80%. Concerns have been raised regarding the impact that this new requirement could have on programs' willingness to accept a broader range of applicants with different and unique strengths in order to support diversity within the profession. In addition, evidence is lacking to suggest that first-time pass rate is the best measure of genetic counseling competency or skills. One might expect that those with good test-taking skills are the most likely to pass on the first attempt. Publishing an overall pass rate for a cohort, rather than first-time pass rate, could reduce these concerns. Similar concerns have been expressed for graduates of psychology programs. Sharpless and Barber (2013) found that psychology graduate programs with higher numbers of ethnic minority students have lower pass rates on the EPPP compared to programs with lower numbers of minorities. They noted that the EPPP has never undergone empirical testing to determine whether or not it possesses incremental, criterion, or predictive validity; therefore, it is uncertain whether or not this exam is an effective instrument for their field. Given that the EPPP is the most commonly used gatekeeper among state licensing boards, it may create inequity among individuals from minority groups trying to gain entry into the practice of professional psychology.

Finally, as we think about our results within the context of graduate training pipeline, it is critical to also consider evaluating alternate mechanisms to assess entry-level competence of genetic counselors, such as using a written or oral portfolio. While programs in medicine and optometry

do require high-stake examinations, they also include a direct assessment of clinical skills using real or simulated patients. The psychology field has discussed replacing or augmenting the EPPP, but changes have not yet been made (Sharpless & Barber, 2013). When examining credentialing, licensing, and/or registration of genetic counselors in other countries, there is great variation in regulation by the government (at the state, province, or country-level) versus professional organizations. In addition, some governmental regulations have strict statutory requirements, while others are voluntary. Furthermore, some countries determine eligibility for credentialing/licensure via a written examination similar to the US (e.g. Canada, Israel), while others use an oral exam (e.g. Saudi Arabia), both a written and oral exam (e.g. India, Japan, Taiwan), a portfolio of submitted work (e.g. the United Kingdom, the European Union, and Australia) or rely on the attainment of a master's degree in genetic counseling plus a subsequent internship (e.g. South Africa) (Abacan et al., 2019; Ormond et al., 2018). Although some healthcare professions have begun incorporating alternative methods of demonstrating entry-level competence, there is no evidence that these methods are superior in assessing competence without bias. Therefore, determination of the degree to which the different assessment practices reflect entry-level competence of genetic counselors, as well as whether alternative assessments may help ameliorate bias, are possible areas of future research.

Limitations

The data collected was self-reported by programs on a voluntary basis, and it is possible that there is an over-representation of data from programs with higher pass rates. We also cannot determine if some certification outcomes were omitted from the data provided by participating programs. However, we only found a statistically significant higher pass rate in our data set when compared to the national pass rate reported by the ABGC for the year 2014. National pass rates on the ABGC certification examination were only available for 2013 through 2018, thus we could not compare pass rates for trainees in our data set to the national pass rates for all years.

As is seen in the profession as a whole, the dataset contained fewer trainees who were identified as Racial Minority Groups, Hispanic, and/or male compared to those who were identified as White, Non-hispanic, and/or female. We also did not ask for trainee's first spoken language and therefore cannot assess the impact of being an English language learner. Due to small numbers

and lack of data, some associations may be unrecognized. Additionally, data about trainees is reported by program leadership, not the trainees themselves. While most programs require this information as part of admissions, it is possible that trainees would respond differently to some of the demographic questions, such as race, sex, and ethnicity, as well as to other questions such as the number of times they took the GREs. We recognize that race and ethnicity are sociopolitical constructs and that any differences attributed to these variables may reflect social, economic and/or other inequities. Going forward, it could be informative to collect measures of racism, discrimination, and other socio-economic factors in addition to race.

Analysis of certification examination outcome focused solely on whether trainees passed or failed. We could not perform regression analysis with quantitative certification examination scores in part because there are two different tests in circulation for each examination cycle, each with a different passing score. As a result, we could not assess whether admissions or demographic variables were associated with certification examination scores in a linear fashion.

Average GRE® scores were above the 50$^{th}$ percentile for all trainees. It's not clear what relationship might exist between lower ranges of GRE® scores and performance on the certification examination. In other words, when GRE® scores are used to determine who is and is not admitted, it is not possible to tell if those with lower scores who were not admitted might be successful on the certification examination. However, a related study examined 32 biomedical PhD students at Vanderbilt with GRE® scores comprising the full range of percentiles (1%-91%) and found no predictive trends between GRE® scores and long-term graduate outcomes (Sealy, Saunders, Blume, & Chalkley, 2019).

Finally, admissions requirements for genetic counseling graduate programs are evolving. For example, some programs no longer require pre-requisites and many no longer require the GRE® exam. Future studies may be able to focus on associations between non-cognitive variables and outcomes on the certification exam.

**Conclusion and Future Research:**

Our study is the first to report that GRE® scores, median GPA, race, and sex are associated with first-time ABGC certification examination outcomes for genetic counselors. Differences in certification exam outcomes are likely impacted by socioeconomic and non-cognitive variables not captured in our study. While our findings that female sex and White race are predictive of passing the certification examination on the first attempt do not prove the existence of sex bias or racial bias, the overrepresentation of White female genetic counselors among graduate instructors, mentors, supervisors, and colleagues (Channaoui et al., 2020; National Society of Genetic Counselors, 2020; The Exeter Group, 2021) could potentially advantage White female trainees. Additionally, while there is substantial data in the literature demonstrating the correlation between standardized test scores and race/ethnicity, our findings regarding sex do not match what is reported in the literature from other disciplines. Future studies are needed to evaluate what variables may be contributing to this discrepancy.

Intentionally evaluating and modifying admissions practices as well as curricula to adopt an anti-racist and anti-sexist perspective, seeking and including educators and admissions committee members with multicultural perspectives, and increasing diversity and training among ABGC certification examination item writers is desirable to guard against possible bias. Alternatives to the certification exam, such as using a written or oral portfolio, could also help decrease barriers presented by standardized testing. Assessment of such alternatives and their associations with entry-level competence presents an opportunity for future research, as does evaluation of the demographics of exam takers to assess any item or exam-level biases in the ABGC certification exam. Genetic counseling professional organizations should continue to work together to assess and eliminate outcome disparities in admissions guidelines, training, and certification processes.

## COI Statement

Melanie Myers, Amanda Bergner, MaryAnn Campion, Andrea Durst, Debra Duquette, Beverly Yashar, and Xue Zhang declare they have no conflict of interest.
Laura Conway is the 2020-2021 President of the Association of Genetic Counseling Program Directors and the Co-Academic Coordinator of the Online Review Course in Medical Genetics and Genetic Counseling.

## Author Contributions

All authors fulfill the International Committee of Medical Journal Editors (ICMJE) criteria for authorship. Melanie Myers had full access to all the data in the study. Xue Zhang had access to de-identified data. They both take responsibility for the integrity of the data and the accuracy of the data analysis. All of the authors gave final approval of this version to be published and agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.


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## Human Studies and Informed Consent

This study was reviewed and granted an exemption by the Cincinnati Children's Hospital Institutional Review Board. All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000. Implied informed consent was obtained for individuals who voluntarily completed the online survey and submitted their responses.

## Animal Studies

No non-human studies were carried out by the authors for this article

## Data Availability

Research data are not shared due to privacy and ethical concerns.

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## Figure Legend

Figure 1. Program Eligibility and Participation

**Table 1. Total Number of Exam Takers and Pass Rates/Year Compared to National Pass Rates**

| Year | Total # Exam Takers | # Fail | # Pass | Pass rate (%) | National rate (%) | *p-value |
|---|---|---|---|---|---|---|
| **2010** | 121 | 23 | 98 | 80.99 | - | |
| **2011** | 135 | 24 | 111 | 82.22 | - | |
| **2012** | 145 | 16 | 129 | 88.97 | - | |
| **2013** | 108 | 7 | 101 | 93.52 | 89 | 0.13 |
| **2014** | 148 | 20 | 128 | 86.49 | 79 | 0.025 |
| **2015** | 196 | 21 | 175 | 89.29 | 87 | 0.34 |
| **2016** | 187 | 16 | 171 | 91.44 | 88 | 0.15 |
| **2017** | 199 | 21 | 178 | 89.45 | 90 | 0.79 |
| **2018** | 198 | 30 | 168 | 84.85 | 85 | 0.95 |
| **2019** | 56 | 8 | 48 | 85.71 | - | |

*one sample proportion test (2-sided)

**Table 2: Univariable Analysis: Associations between First Time Board Exam Pass Rate (pass/fail) and Admission Variables**

| | FAIL (N=186) | PASS (N=1308) | p Value |
|---|---|---|---|
| Board Score (n=1425), median (IQR) | 119.0 (114.0, 123.0) | 141.0 (135.0, 147.0) | <.001 |
| First Verbal GRE® Percentile (n=1413), median (IQR) | 67.0 (51.0, 78.0) | 75.0 (62.5, 87.0) | <.001 |
| First Quantitative GRE® Percentile (n=1413), median (IQR) | 60.0 (44.0, 72.0) | 68.0 (55.0, 78.0) | <.001 |
| First Analytical GRE® Percentile (n=1402), median (IQR) | 56.0 (45.0, 78.0) | 67.0 (49.0, 80.0) | 0.005 |
| Highest GRE® Verbal Percentile (n=1413), median (IQR) | 69.0 (52.0, 79.0) | 77.0 (64.0, 87.0) | <.001 |
| Highest GRE® Quantitative Percentile (n=1413), median (IQR) | 60.0 (48.0, 73.0) | 69.0 (57.0, 78.0) | <.001 |
| Highest GRE® Analytical Percentile (n=1405), median (IQR) | 57.0 (48.0, 78.0) | 67.0 (52.0, 81.0) | 0.002 |
| Undergrad GPA (n=1427), median (IQR) | 3.42 (3.20, 3.64) | 3.58 (3.35, 3.79) | <.001 |
| Sex | | | <.001 |
| Female (n=1,394) | 160 (11%) | 1234 (89%) | |
| Male (n=99) | 26 (26%) | 73 (74%) | |
| Race | | | <.001 |
| Asian (n=113) | 27 (24%) | 86 (76%) | |
| Black (n=24) | 7 (29%) | 17 (71%) | |
| Other (n=25)** | 5 (20%) | 20 (80%) | |
| White (n=1,296) | 143 (11%) | 1153 (89%) | |
| Hispanic | | | 0.14 |
| No (n=1,206) | 144 (12%) | 1062 (88%) | |

| | | | |
|---|---|---|---|
| Yes (n=40) | 8 (20%) | 32 (80%) | |
| US/Canadian Citizen | | | 0.014 |
| No (n=42) | 11 (26%) | 31 (74%) | |
| Yes (n=1,451)) | 174 (12%) | 1277 (88%) | |
| Number of times took GRE | | | 0.81 |
| 1 (n=938) | 125 (13%) | 813 (87%) | |
| 2+ (n=178) | 25 (14%) | 153 (86%) | |
| Undergrad Degree | | | 0.55 |
| BA (n=279) | 38 (14%) | 241 (86%) | |
| BS (n=931) | 106 (11%) | 825 (89%) | |
| Other (n=9) | 1 (11%) | 8 (89%) | |
| Undergrad Major*** | | | 0.84 |
| Life Sciences (n=1,035) | 124 (12%) | 911 (88%) | |
| Social Behavioral (n=136) | 14 (10%) | 122 (90%) | |
| Other (n=87) | 9 (10%) | 78 (90%) | |
| Second Undergrad Major*** | | | 0.58 |
| Life Sciences (n=11) | 1 (9%) | 10 (91%) | |
| Social Behavioral (n=43) | 5 (12%) | 38 (88%) | |
| Other (n=39) | 2 (5%) | 37 (95%) | |
| Undergrad Canadian/US Institution | | | 0.015 |
| No (n=27) | 8 (30%) | 19 (70%) | |
| Yes (n=1,245) | 153 (12%) | 1092 (88%) | |
| Break Prior to GC Grad School | | | 0.17 |
| Break (n=804) | 106 (13%) | 698 (87%) | |
| New (n=417) | 43 (10%) | 374 (90%) | |
| Have another Graduate Degree | | | 0.07 |
| No (n=1,405) | 169 (12%) | 1236 (88%) | |
| Yes (n=89) | 17 (19%) | 72 (81%) | |

Numeric variables were shown as median (IQR) and compared using Wilcoxon rank sum tests; others were shown as frequency (%) and compared using Fisher's exact tests

*Any academic or professional or clinical remediation;

** Other race includes Asian and White (5), Biracial (3), American Indian (3), Asian and Hispanic (1), Egyptian (1), other not specified (12)

*** Other major includes Business, Education, Engineering, Humanities and Arts, and Physical Sciences (see supplemental material)

**Table 3: Univariable Analysis: Associations between First Time Board Exam Pass Rate (pass/fail) with Trainee Progress in Program**

| | FAIL (N=186) | PASS (N=1308) | p Value |
|---|---|---|---|
| Part-time | | | 0.010 |
| No (n=1,457) | 175 (12%) | 1282 (88%) | |
| Yes (n=21) | 7 (33%) | 14 (67%) | |
| Graduate on time | | | 0.010 |
| No (n=139) | 27 (19%) | 112 (81%) | |
| Yes (n=1,288) | 148 (11%) | 1140 (89%) | |
| Clinical remediation | | | 0.002 |
| No (n=1,356) | 156 (12%) | 1200 (89%) | |
| Yes (n=66) | 17 (26%) | 49 (74%) | |
| Professional remediation | | | <.001 |
| No (n=1,355) | 160 (12%) | 1195 (88%) | |
| Yes (n=36) | 13 (36%) | 23 (64%) | |
| Academic remediation | | | <.001 |
| No (n=1,268) | 140 (11%) | 1128 (89%) | |
| Yes (n=70) | 33 (47%) | 37 (53%) | |
| Any Remediation* | | | <.001 |
| No (n=1,205) | 126 (10%) | 1079 (90%) | |
| Yes (n=136) | 47 (35%) | 89 (65%) | |

Data shown as frequency (%) and compared using Fisher's exact tests

*Any academic or professional or clinical remediation;

** Other includes Business, Education, Engineering, Humanities and Arts, and Physical

Sciences (see supplemental material)

**Table 4: Multiple Logistic Regression: Admission Variables Associated with Passing Board Exam First Time (pass/fail). N=1,278**

| Independent variable | Regression coefficient (95% CL) | p value | OR (95% CL) |
|---|---|---|---|
| GPA | 1.2259 (0.6880, 1.7638) | <0.001 | 3.41 (1.99, 5.83) |
| Highest verbal GRE | 0.0197 (0.0094, 0.0299) | <0.001 | 1.02 (1.01, 1.03) |
| Highest quant GRE | 0.0213 (0.0099, 0.0327) | <0.001 | 1.02 (1.01, 1.03) |
| Female vs. Male | 1.0826 (0.5316,1.6335) | <0.001 | 2.95 (1.70, 5.12) |
| White vs. Racial Minority Groups | 1.2144 (0.7604, 1.6683) | <0.001 | 3.37 (2.14, 5.30) |

**Figure Legend**

Figure 1. Program Eligibility and Participation

**Online Supplemental Figure: Number of Trainees with Board Outcome Data per Program**