A Study of Statistics Anxiety Levels of Graduate Dental Hygiene Students

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Introduction

Dental hygienists pursuing advanced degrees face a multitude of challenges. Those seeking a Master of Science in Dental Hygiene from programs in the U.S. must complete at least one research methods course.[1] Research methods courses necessitate that students develop skills in understanding the application of statistical methodology.[2] These skills are an important component of graduate dental hygiene education as they are essential for effective engagement in evidence-based practice, the art of integrating clinical research into decision-making about patient care.[3,4] However, for many graduate students, statistical concepts are confusing and anxiety provoking.[5-8] Onwuegbuzie and Wilson suggested that from 67 to 80% of graduate students in the behavior and social sciences experience statistics-related anxiety when confronted with statistical content, when interpreting and applying statistics in problem situations, or when evaluating statistics in contexts.[7]

Statistics Anxiety

Statistics Anxiety has been defined as an unpleasant cognitive and psychological reaction that manifests itself "when an individual experiences anxiety as a result of encountering statistics in any form, at any level."[8] Statistics Anxiety is a situation-specific temporary feeling "characterized by worry, intrusive thoughts, mental disorganization, tension, and physiological arousal"[9] that has a debilitating effect on learning and achievement in statistics courses and in research methodology.[2,10-14] Six Statistics Anxiety factors were identified in a seminal study by Cruise et al:[5]

Abstract

Purpose: In light of increased emphasis on evidence-based practice in the profession of dental hygiene, it is important that today's dental hygienist comprehend statistical measures to fully understand research articles, and thereby apply scientific evidence to practice. Therefore, the purpose of this study was to investigate statistics anxiety among graduate dental hygiene students in the U.S.

Methods: A web-based self-report, anonymous survey was emailed to directors of 17 MSDH programs in the U.S. with a request to distribute to graduate students. The survey collected data on statistics anxiety, sociodemographic characteristics and evidence-based practice. Statistic anxiety was assessed using the Statistical Anxiety Rating Scale. Study significance level was α=0.05.

Results: Only 8 of the 17 invited programs participated in the study. Statistical Anxiety Rating Scale data revealed graduate dental hygiene students experience low to moderate levels of statistics anxiety. Specifically, the level of anxiety on the Interpretation Anxiety factor indicated this population could struggle with making sense of scientific research. A decisive majority (92%) of students indicated statistics is essential for evidence-based practice and should be a required course for all dental hygienists.

Conclusion: This study served to identify statistics anxiety in a previously unexplored population. The findings should be useful in both theory building and in practical applications. Furthermore, the results can be used to direct future research.

Keywords: dental hygienists, statistics, anxiety, evidence-based practice, graduate education

This study supports the NDHRA priority area, **Professional Education and Development:** Assess how educators are socializing students to research.

1. Worth of statistics
2. Interpretation anxiety
3. Test and class anxiety
4. Computational self-concept
5. Fear of asking for help
6. Fear of statistics teachers

Prior to the Cruise et al. study, researchers looked at Statistics Anxiety as being synonymous with mathematics anxiety.[5,10,15] Studies have found that Statistics Anxiety has a connection with mathematics preparation and background.[7,10,15,16] None-

theless, scholars have come to the conclusion that it is a related, yet distinctly different concept from mathematics anxiety.[5,10,15]

A number of studies have looked at Statistics Anxiety in certain populations. Onwuegbuzie reported African-American graduate students have higher levels of Statistics Anxiety than do their Caucasian counterparts.[17] Some studies reported women have higher Statistics Anxiety than do men,[18,19] yet other studies have failed to support these findings.[20] Also, the age of students has been reported as having an association, with older students experiencing more Statistics Anxiety than younger students.[21]

Appropriately, adult learning theory supports the idea that instructional practices that actively engage learners while taking into account affective environmental factors can mitigate statistics anxiety.[22] Among pedagogical factors shown to influence Statistics Anxiety are timed versus untimed exams,[23] on-campus versus online courses[6] and shorter versus longer courses,[24] wherein the latter resulted in lower levels of Statistics Anxiety in each case. Other research indicated using computers in teaching statistics lessens anxiety and promotes positive attitudes toward statistics.[25] Further, inclusive teaching strategies designed around sensitivity to Statistics Anxiety, instructor attentiveness in combination with real-life applications, and instructor immediacy with feedback were shown to reduce Statistics Anxiety.[26-28] Conversely, insensitive instructor behavior and harsh grading practices increased Statistics Anxiety.[6]

Statistics Anxiety Measures

An extensive literature review on Statistics Anxiety assessment discovered 4 main instruments that have been developed specifically to measure Statistics Anxiety. They are the Statistical Anxiety Rating Scale,[5] the Statistics Anxiety Inventory,[10] the Statistics Anxiety Scale[29] and the Statistics Anxiety Measure.[11] The most widely used is the Statistical Anxiety Rating Scale because it is an instrument with documented validity and reliability.[7,30]

Statistics Anxiety and Graduate Dental Hygiene Students

To date, there are no published studies that have explored the levels of Statistics Anxiety in graduate dental hygiene students. Only one investigation involving health professionals was found in the literature. In a 1978 study, Wolfe examined anxiety toward statistics and stereotypical beliefs about statistics among nursing students.[31] Therefore, the present study examining levels of Statistics Anxiety among graduate dental hygiene students was warranted.

In light of increased emphasis on evidence-based practice in the profession of dental hygiene, it is important that today's dental hygienist comprehend statistical measures to fully understand research articles and, thereby, apply scientific evidence to practice.[3,32-35] Accordingly, this study sought to determine the state of knowledge regarding Statistics Anxiety in graduate dental hygiene students in the U.S.

Methods and Materials

The study was an exploratory, cross-sectional survey of Statistics Anxiety levels among dental hygiene graduate students in the U.S. using the Statistical Anxiety Rating Scale instrument. Of 22 graduate dental hygiene programs listed in the American Dental Hygienists' Association (ADHA) website, 17 offered a Master of Science degree in dental hygiene (MSDH).[36] Students in these programs constituted the target group for this study.

Data Collection Procedure

Prior to initiation of the study, an exempt status application was approved by the institutional review board of The University of Texas Health Science Center at San Antonio. An invitation to participate in the research study was emailed to the directors of the 17 MSDH programs. The invitation explained the purpose of the study and requested program directors to forward the electronic link to the web-based survey and consent form to students enrolled in Fall 2013 MSDH programs. The program directors were further asked to send an email reply to the recruitment letter stating the number of students to whom they sent the survey link for response rate calculations. Three weeks after the initial email solicitation, a second email recruitment letter was sent to non-responding program directors. No identifiable information about the program directors' universities or colleges was used in the study.

The emailed recruitment letter provided instructions to access the online cover letter and consent form and to complete the survey. Students were informed that participation in the study was voluntary and anonymous, they could skip items, and they could decline to participate or stop responding at any time without penalty. The survey was distributed using SurveyMonkey®

Table I: Statistical Anxiety Rating Scale Factors, Number of Items, Score Ranges and Corresponding Sample Items

Factor	Number of Items	Score Range	Description and Sample Item
Worth of Statistics	16	16 to 80	A person scoring high on this factor sees no value in learning statistics. "I feel statistics is a waste."
Interpretation Anxiety	11	11 to 55	A person scoring high on this factor has difficulty interpreting statistical data. For instance, when "Making an objective decision based on empirical data."
Test and Class Anxiety	8	8 to 40	A person scoring high on this factor is very anxious about being in a statistics course and taking exams. For instance, when "Studying for an examination in a statistics course."
Computation Self-Concept	7	7 to 35	A person scoring high on this factor has anxiety about statistics because it involves mathematical calculations. "I could enjoy statistics if it weren't so mathematical."
Fear of Asking for Help	4	4 to 20	A person scoring high on this factor experiences anxiety when seeking help from the professor or other students. For instance, when "Asking my statistics teacher for individual help with material I am having difficulty understanding."
Fear of Statistics Teachers	5	5 to 25	A person scoring high on this factor sees statistics teachers as impersonal and intimidating. "Statistics teachers are so abstract they seem inhuman."

software and was available for completion online for approximately 4 weeks. Secure Sockets Layer encryption was used to provide encrypted survey links and survey pages. Students' responses were encrypted, stored in a SurveyMonkey® account and downloaded through an encrypted format.

Data Collection Instrument

The web-based survey collected data on Statistics Anxiety, sociodemographic features and evidence-based practice (EBP). The survey was uploaded to SurveyMonkey® and accessed by students through the emailed URL link.

Levels of Statistics Anxiety were assessed using a web-based version of the Statistical Anxiety Rating Scale. The Statistical Anxiety Rating Scale was developed in 1980 by Cruise and Wilkins.[5] It consists of 51 self-report items with responses gathered on a 5-point Likert scale (from none to high) for the 6 factors described in Table I. The first 23 items indicate how much anxiety a respondent would experience in each situation. The remaining 28 items indicate level of agreement with statements related to statistics. In either instance, higher scores indicated higher Statistics Anxiety.

The validity of the Statistical Anxiety Rating

Scale was determined in 2 ways. Face validity was obtained by presenting the 6 factors and their items for review to a group consisting of 5 statistics professors and 5 doctoral students. Construct validity was obtained through principal component factor analysis with varimax rotation. Reliability was assessed using Cronbach's alpha, point multi-serial correlations, and test-retest estimates. Cronbach's alpha coefficients ranged from 0.65 to 0.96. Multi-serial correlations fell between 0.59 and 0.91. Test-retest estimates ranged from 0.67 to 0.83.

Each factor, composed of a subset of items, measured a distinct aspect of Statistics Anxiety. The Statistical Anxiety Rating Scale total score was calculated as the sum of the responses on the 51 items. Each factor score was calculated as the sum of the responses to items composing that factor. Cruise et al provided percentile rank charts for the factor scores.[5]

Sociodemographic data included personal characteristics as well as enrollment status, program delivery method and previous experience with mathematics and statistics courses. Additionally, students were asked to indicate their degree of agreement with 5 statements on EBP on a 5-point Likert scale, with 5 showing the strongest level of agreement. The sociodemographic survey items

and the EBP statements were developed by one of the researchers specifically for this study.

Data Analysis

Survey responses and frequency summaries for sociodemographic and EBP data were extracted from SurveyMonkey®. Statistical Anxiety Rating Scale data were summarized and analyzed using Microsoft Excel 2010; incomplete data were excluded. The statistical significance level was set at α=0.05. Bonferroni corrections were used to adjust for multiple comparisons.[37]

Cronbach's alpha, a measure of internal consistency reliability, was computed for each of the factor scores.[38] Descriptive statistics for the Statistical Anxiety Rating Scale total and factor scores were calculated. Median percentile rank equivalent scores[39] were calculated by comparing the median factor scores in the present study to the percentile rankings given in the graduate percentile chart in the Cruise et al study.[5] The median percentile rank equivalent scores provided a means to assess students' levels of Statistics Anxiety, as measured by the Statistical Anxiety Rating Scale factor scores.[39] For instance, a median percentile rank equivalent score of 60 would indicate that at least half of the graduate dental hygiene students in the present study scored higher than 60 percent of the graduate students in the norm group on that dimension of statistics anxiety. Pearson's correlation coefficients were used to determine whether relationships existed between the Statistical Anxiety Rating Scale total score and continuous demographic variables.

Results

Sample

The response rate for the survey could not be determined with certainty because only 8 of the 17 program directors sent back email replies to the recruitment letter. Of those, only 7 provided the number of students who received the survey link. The link was sent to 80 students from those 7 programs. Seventy-eight students submitted the online survey. One survey contained incomplete Statistical Anxiety Rating Scale data and was eliminated, resulting in 77 usable surveys.

Sociodemographic Data

The sociodemographic data showed that the students were 97.4% female, 88.3% non-Hispanic, 92.1% White and 61.3% married. Further, 52.6% of the students were working full-time, 79.0% were

Table II: Internal Consistency Coefficients for Statistical Anxiety Rating Scale Factor Scores in the Present Study

Factor	Number of Items	Cronbach's Alpha
Worth of Statistics	16	0.90
Interpretation Anxiety	11	0.84
Test and Class Anxiety	8	0.76
Computation Self-Concept	7	0.76
Fear of Asking for Help	4	0.66
Fear of Statistics Teachers	5	0.64

enrolled in graduate school part-time and 84.4% were enrolled in predominantly online MSDH programs.

The mean age was 36.4 years and ranged from 23 to 58 years for the 54 students who responded to the age question. Statistical Anxiety Rating Scale total and factor scores were not statistically different between students who reported their ages and those who did not (p>0.05). Therefore, all analyses were performed on the combined sample.

Seven students reported they had not taken any, while 90.9% had taken at least 1 college-level statistics course and, on average, in the previous 2.5 years. Fifty percent had taken 2 college-level math or statistics courses.

Statistical Anxiety Rating Scale Data

As reported in Table II, Cronbach's alpha for the 6 Statistical Anxiety Rating Scale factors in this study ranged from 0.64 to 0.90. The value 0.64 for the factor Fear of Statistics Teachers and 0.66 for the factor Fear of Asking for Help are based on 5 and 4 items, respectively. Nunnally pointed out that the value of Cronbach's alpha is "a direct function of the number of test items," with fewer items yielding lower coefficients.[38]

Table III displays descriptive statistics for the Statistical Anxiety Rating Scale total and factor scores and the mean percentile rank equivalent median percentile rank equivalent scores. The median percentile rank equivalent scores ranged from 45 to 69. The scores indicated students' median

Table III: Descriptive Statistics and median percentile rank equivalent scores for the Statistical Anxiety Rating Scale Factors in the Present Study

Factor	Mean	SD	Median	Minimum	Maximum	Median Percentile Rank Equivalent Score
Worth of Statistics	32.9	13.0	31	16	72	60
Interpretation Anxiety	28.5	9.1	29	11	48	69
Test and Class Anxiety	25.9	6.6	26	9	39	61
Computation Self-Concept	15.0	5.9	15	7	30	55
Fear of Asking for Help	8.6	4.0	8	4	18	66
Fear of Statistics Teachers	10.3	3.8	10	5	23	45
Total	121.1	33.0	119	60	194	N/A*

*Cruise et al. does not provide percentile values for Statistical Anxiety Rating Scale total scores[5]

Table IV: Summary of Responses to EBP Statements

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Question	Number (Percent)*				
I am learning about evidence-based practice in my MSDH program. (n=77)	1 (1.3%)	0 (0.0%)	5 (6.5%)	7 (9.1%)	64 (83.1%)
Knowledge and skills of statistics are essential to evidence-based practice. (n=77)	1 (1.3%)	1 (1.3%)	4 (5.2%)	13 (16.9%)	58 (75.3%)
Evidence-based practice will be useful in my profession as a dental hygienist. (n=77)	1 (1.3%)	2 (2.6%)	3 (3.9%)	12 (15.6%)	59 (76.6%)
Statistics will be useful in my profession as a dental hygienist. (n=76)	2 (2.6%)	7 (9.2%)	9 (11.8%)	19 (25.0%)	39 (51.3%)
Statistics should be a required course for all dental hygienists. (n=76)	4 (5.3%)	6 (7.9%)	10 (13.2%)	19 (25.0%)	37 (48.7%)

*Percents might not sum to 100% due to rounding

score for Fear of Statistics Teachers was at the 45th percentile and Interpretation Anxiety was at the 69th percentile when compared to graduate students in the Cruise et al study.[5]

No significant correlations were found between the Statistical Anxiety Rating Scale total score and age of students, number of college-level math or statistics courses taken, or number of years since college-level statistics was last taken (p>0.05).

EBP Data

The summary of EBP data in Table IV shows

92.2% of the students agreed statistical knowledge and skills are essential to evidence-based practice, and 73.6% agreed statistics should be a required course for all dental hygienists.

Discussion

Representativeness of Sample

The sample of 77 dental hygiene graduate students in this study represented 8 of the 17 MSDH programs in the U.S. The students are predominantly non-Hispanic, White and female, characteristics that mirror the national distribution of

ethnicity, race and gender of dental hygiene students as given in the 2013 ADHA fact sheet.[1]

Statistics Anxiety

The study findings indicated that Statistics Anxiety exists in graduate dental hygiene students. Median percentile rank equivalent scores for the Statistical Anxiety Rating Scale data revealed that this population has low to moderate Statistics Anxiety.[39] On 5 of the 6 Statistical Anxiety Rating Scale factors (Worth of Statistics, Interpretation Anxiety, Test and Class Anxiety, Computation Self-Concept and Fear of Asking for Help), the median percentile rank equivalent scores of graduate dental hygiene students in this study indicated their statistical anxiety levels exceeded those of graduate students in the Cruise et al study.[5] However, no Statistical Anxiety Rating Scale factor reached a median percentile rank equivalent score above the 69th percentile. Most of the students having had one or more statistics courses, fairly recently, might account for this finding. Research has shown that previous experience with statistics reduces statistics anxiety.[13]

Of serious concern is that the level of Interpretation Anxiety in dental hygiene graduate indicates this population could struggle with making sense of scientific research. This finding's direct relation to EBP underscores its importance.[3,34] Interpretation Anxiety could hinder the use of statistics in one's professional career.[3]

The Statistics Anxiety results for dental hygiene graduate students are similar to those found in other studies that included a combination of graduate students in education, nursing, personal financial planning, exercise sports sciences, mass communications and forensic science,[28] and in education only.[40] Other researchers have reported moderate to high levels of Statistics Anxiety in graduate students from the social and behavioral sciences.[2,41-43] Future empirical studies might be undertaken to compare Statistics Anxiety levels between dental hygiene graduate students and graduate students from other disciplines.

Unlike results in previous studies, neither age, math and statistics background, time since last statistics class or program delivery method (online, campus-based) emerged as significantly related to Statistics Anxiety in this study.[7,21] No statistically significant relationships between Statistics Anxiety and employment status (full-time, part-time) or enrollment status (full-time, part-time) were found. Gender differences were not investigated. Future studies could examine these variables in the context of a broader sample.

Evidence-Based Practice

Over 90% of students surveyed agreed that statistical knowledge and skills are essential to evidence-based practice and should be a required course for all dental hygienists. The responses indicated that participants recognized the vital role statistics plays in their profession, particularly its relevance to evidence-based practice.

Implications

The study has a number of implications. Statistics Anxiety is a potential barrier to professional growth for dental hygiene graduate students after program completion. To critically appraise scientific research, dental hygienists need to feel comfortable delving into the statistical aspects of studies.[3,34] Working with other health professionals also could be hindered by Statistics Anxiety. "Understanding the language of statistics gives all health care providers a common language despite the differences between the professions."[34]

For administrators and faculty in MSDH programs, the findings suggest course content and teaching practices should reflect awareness that some students in the program might be dealing with Statistics Anxiety. Faculty who teach research methods or statistics courses could use the Statistical Anxiety Rating Scale at the beginning of the semester to assess graduate students' Statistics Anxiety levels, and then work closely with students identified as having elevated statistics anxiety.[39]

This study attempted to gather information about an understudied population. While some research has been done on dental hygiene graduate students on local levels, studies at the national level are scarce. This population is important to the profession as its members most likely will become the future faculty that will teach and influence undergraduates and graduates thereby shaping the profession.

Finally, most of the students surveyed were in programs delivered primarily online.[36] Intervention studies that seek to identify ways to develop statistical proficiency in online environments without triggering statistics anxiety are warranted. In addition, an empirical study investigating statistics anxiety in health professionals could generate a larger sample to conduct more sophisticated analyses.

Limitations

By design, this study was an exploratory investigation, so causative factors could not be determined. One limitation of the study is that it relied on information reported on the ADHA website. The programs that were explicitly MSDH programs were not easily discernible. Therefore, students who accessed the survey were instructed to exit the survey if they were not in an MSDH program.

The researchers assumed that students comprehended the survey items and answered accurately and truthfully, to the best of their ability. However, because the study used a self-report survey with Likert-type choices, the responses were vulnerable to undesirable respondent behaviors. Such behaviors include giving socially-desirable responses, tending to select similar options, tending to agree with statements, giving random responses, and not completing the survey.[38,45]

To enhance response quality, the survey was disseminated through program directors and presented as a voluntary, anonymous online survey, in which students could skip items.[46-48]

Conclusion

This study served to identify Statistics Anxiety in a previously unexplored population. The purpose of the study was to measure Statistics Anxiety in dental hygiene graduate students and thereby increase Statistics Anxiety awareness for stakeholders. Knowledge of dental hygiene graduate students' Statistics Anxiety could be used by MSDH program directors and faculty to assess the need for tailored courses and teaching methods that promote student success with statistical concepts and thus enhance their abilities to comprehend and engage in scholarly research. Students could use the information to manage personal graduate experiences that require the understanding and application of statistics and to seek out helpful resources and extra assistance as needed.

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