




Undergraduate Student Perceptions and Awareness of Genetic Counseling

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Abstract

Genetic counseling is a rapidly expanding field, and the supply of certified genetic counselors is currently unable to keep up with job demand. Research is fairly limited regarding the awareness and perceptions that prospective genetic counseling students have on the field and what factors most influence their interest. The current study includes data collected from 1389 undergraduate students in the sciences at 23 universities across the United States who were surveyed regarding information related to their awareness, perceptions, knowledge, and interest in genetic counseling. The majority of participants had heard of genetic counseling (78.0%), many from a high school course (37.3%), college course (28.1%), or online (11.5%). Familiarity was associated with factors such as female gender ($p = 0.003$) and length of time in school ($p < 0.001$). After taking the survey, participant interest was positively associated with several factors including female gender ($p < 0.001$) and Asian and Hispanic ethnicity ($p = 0.012$). Factors commonly reported as attractive about the field included direct patient care, the variety of roles available, cultural competency and psychosocial training, and helping others. Discussion elaborates upon specific factors related to student awareness and interest in genetic counseling and potential ways to tailor recruitment strategies for maximum benefit to the field.

Keywords Genetic counseling · Recruitment · Awareness · Perceptions · Undergraduate · Students · College · Interest · Familiarity · Diversity

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Introduction

Advances in genetics have resulted in rapid expansion of the genetic counseling profession, with the number of jobs generally expanding faster than the number of counselors available to fill them. In response, genetic counseling programs are accepting more graduate students and several new genetic counseling programs are opening (ACGC n.d.). This expansion highlights the need to understand factors influencing undergraduate students' familiarity with genetic counseling and what impacts students' interest in the field. With the relatively small size of the field, it is plausible that a number of individuals well-suited for the career miss an opportunity due to lack of awareness or lack of accurate information. Assessing undergraduate student awareness and perceptions of the field of genetic counseling both in general and among various demographic groups is crucial to successfully recruit talented students to genetic counseling graduate training programs and thus, the workforce. Studies addressing issues associated with awareness have found that only 60% of college students sampled had heard of genetic counseling. This increased with length of time in school, such that 75% of seniors reported that they were aware of the field (Schneider et al. 2009).

As the field expands, genetic counseling programs will be challenged with providing a diverse supply of qualified counselors for the workforce. There are many demographic factors that are important when considering awareness and perceptions of genetic counseling. While the clients who genetic counselors serve are of all races and ethnicities, the demographics of genetic counselor providers do not reflect a similar diversity. The majority of genetic counselors are Caucasian females (National Society of Genetic Counselors 2016), and while the lack of diversity in the field has been an area of discussion for many years, no major changes to the field's demographic profile have occurred over this time span (Mittman and Downs 2008). A previous study found that while minority students tend to be less aware of genetic counseling, they are just as likely to consider it once they are made aware of the field (Oh and Lewis 2005). A previous study also showed that what most interests students about careers can differ by ethnicity (Schneider et al. 2009). In terms of gender, studies differ regarding whether males are as likely as females to consider a career in the field (Kopesky et al. 2011; Oh and Lewis 2005). To have a large and diverse workforce, it is important to further address unique factors that could play a role in the awareness and perceptions that students of different backgrounds have of genetic counseling as a potential career path.

To date, few studies have closely examined factors influencing awareness and perceptions of genetic counseling. Studies that have examined these issues include those mentioned previously. As there are likely complex ways that demographics and other factors interact, further research is needed. Limited information is known about student perceptions of genetic counseling. Some characteristics such as salary and job responsibilities have been

reported as both positive and negative aspects of the field (Kopesky et al. 2011; Oh and Lewis 2005; Schoonveld et al. 2007). A study of students enrolled in a genetic counseling program found that common reasons for entering the field included an interest in science, helping others, and intellectual stimulation (Lega et al. 2005). Information about students who consider genetic counseling but do not end up in the field is more limited. Further investigation could identify more effective ways of presenting genetic counseling to potential applicants.

The goal of this study was to provide genetic counseling programs and professional organizations with information to improve recruitment strategies and identify ways that genetic counselors can impact student interest in the field. These strategies can help ensure that as the field expands, qualified students will be aware of the field and genetic counseling programs will have a diverse set of applicants. Because many students are introduced to genetic counseling in college (Kumaravel et al. 2011; Kopesky et al. 2011), this study was targeted at undergraduate students to examine a population that may be considering health-related careers. As program applicants commonly have science backgrounds (Lega et al. 2005; Oh and Lewis 2005), our study recruitment focused on students in the sciences. The study aimed to describe the familiarity and perceptions undergraduate students involved in the sciences have of genetic counseling, determine how they prefer to learn information about genetic counseling, and determine what factors impact their interest in genetic counseling as a potential career.

Methods

Procedures

Approval was obtained from the Committee for the Protection of Human Subjects at the University of Texas Health Science Center at Houston (HSC-MS-16-0440). Biology department heads or other senior biology department faculty members at 183 United States doctoral universities classified as having "highest" or "higher" research activity under the Carnegie Classification of Institutions of Higher Education (Indiana University Center for Postsecondary Research 2015) were contacted via email. This criterion was chosen to provide a consistent means of choosing universities with established strength in the sciences across the United States. All 115 universities with "highest" research activity were contacted, and universities from the list of 107 "higher" research activity institutions were contacted as needed to ensure universities across the USA were included. Primary contact information was obtained through university public websites. Email recipients were asked to forward the survey invitation link to department faculty for distribution to students. Some initial points of contact chose to distribute the survey directly to students through department listservs, while others chose to forward the survey to department professors for

distribution to students enrolled in fall courses. This allowed for a sample of students who came from a wide variety of majors, but who had a potential interest in the sciences because of their enrollment in a biology-related course or listserv. A formal response rate could not be calculated because data was unavailable regarding the exact number of students who received the survey. Undergraduates were eligible to take the survey. The survey was only available in English. There were no other inclusion restrictions. A map demonstrating the geographic representation of participating institutions can be found in Online Resource 2.

Of the universities that were contacted, 26 universities participated by distributing the link. Students who completed the survey had the option to enter their email address into a raffle to win one of four \$50 Visa gift cards. Out of a total of 1712 survey responses, 1389 responses from 23 universities were included in data analysis (Fig. 1). For increased uniformity of sampling methods, three universities that informed the first author they recruited students solely in departments outside of the biology department, which was the desired initial point of contact, were excluded from analysis.

Instrumentation

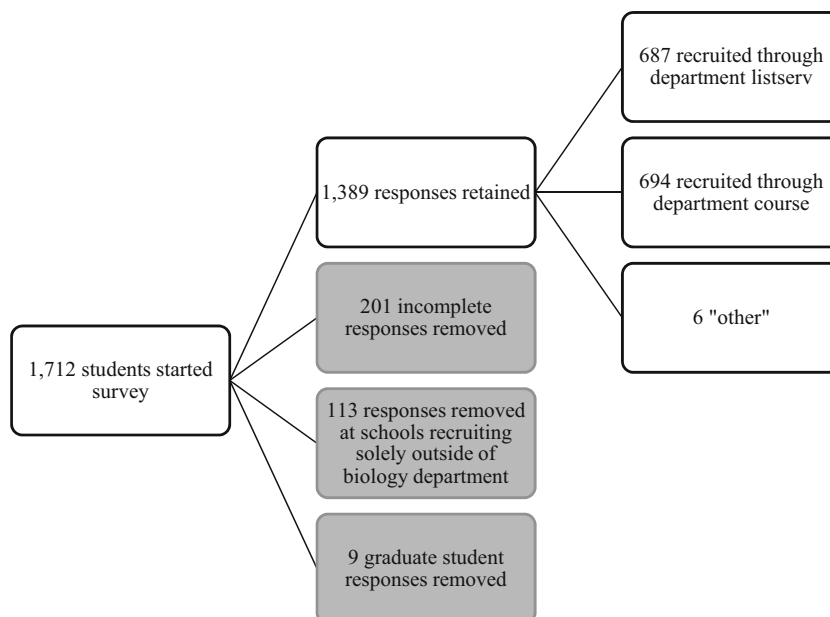
The survey was distributed using an anonymous link through Qualtrics online survey software (v. May 2016, Qualtrics, Provo, UT). The number of questions varied depending on whether participants reported prior familiarity with genetic counseling. Individuals who had never heard of genetic counseling were provided fewer questions about their understanding of genetic counseling and how they learned about the field. The maximum number of questions was 35. Question types included multiple choice, rating scales, checklists, and free responses. Details regarding question types and scoring

can be found in the survey, available in Online Resource 1. The survey was designed to ascertain general demographic information of the respondent and to assess familiarity with genetic counseling, attitudes regarding aspects of a genetic counseling career, and preferences for obtaining information about the career. In an effort to decrease sample bias, no references were made to genetic counseling until a participant clicked the survey link. Survey questions were created by the authors, based on the expertise of the authors and targeted aims based on literature review. Socioeconomic status was self-reported and did not include an indication of household income. Individuals were asked to select their religion from a list of common religions or to enter their religion as a text response if it was not present on the list. A copy of the survey and information about which questions were displayed to different participants can be found in Online Resource 1.

Participants who reported previous familiarity with genetic counseling were provided with seven true statements and five false statements and asked to mark all statements that they believed were part of a genetic counselor's job responsibilities. Participants were scored on how many statements they answered correctly, and scores were stratified and compared using the criteria of less than or equal to 50% correct, 51–75% correct, and greater than 75% correct.

Participants were also asked to indicate their level of interest in pursuing a genetic counseling career. Participants were then shown a brief explanation of genetic counseling in addition to several statements about a career in genetic counseling. Participants were asked to rate each statement from one to five according to how much it increased or decreased their interest in the field, with a score of one indicating a significant decrease in interest and a score of five indicating a significant increase in interest. After reading the summary and rating

Fig 1 Study recruitment and inclusion methods



these statements, participants were asked again to indicate their interest level in genetic counseling. Individual pre-survey and post-survey interest levels in genetic counseling were also compared to determine the extent to which participants individually increased or decreased in their interest level after learning more about genetic counseling. Responses regarding interest were coded on a 1–4 scale, with “highly interested” as a one and “not at all interested” as a four. Thus, a negative value reflects a decrease in interest pre-survey to post-survey, while a positive value reflects an increase in interest pre-survey to post-survey.

Data Analysis

Data collection occurred from September 2016 through December 2016. Data was analyzed using STATA statistical software (v. 13.1. StataCorp LP, College Station, TX). A *p* value of < 0.05 was considered statistically significant. Comparison of continuous variables across groups was performed using independent-samples *t* tests and ANOVA (with post hoc Tukey’s HSD test) for normally distributed data, or Wilcoxon-Mann-Whitney tests and Kruskal-Wallis (with post hoc Dunn’s) tests for non-normally distributed data. These were primarily used in the analyses involving student ratings of various aspects of the genetic counseling field, which utilized a continuous 1–5 scale. The majority of the remaining analyses involved categorical variables, which were compared using contingency tests (chi-square or Fisher exact). For free-response questions, emergent themes were identified by the first author to allow for quantitative data analysis examining the number of students who endorsed various themes. Responses were categorized according to the themes they fit with, and each response could be categorized into multiple themes if indicated. To account for possible confounding, multivariable ordinal logistic models were run to assess the influence of various factors on students’ interest in genetic counseling.

Results

Sample Characteristics

A summary of demographics can be found in Table 1. The average age of participants was 20 years (range of 16–44 years). Participants were majority non-Hispanic White (NHW) and majority female (72%). Data was not available for comparison regarding the demographic breakdowns of the specific courses and listservs in which the survey was distributed, but demographic information was compared to data from the National Science Foundation (NSF) in 2014 for students earning science and engineering bachelor’s degrees. In general, the current sample appears to have more females

Table 1 Demographic information

	<i>n</i>	%
Race/ethnicity		
Non-Hispanic White	827	59.6
Asian	294	21.2
Multiracial	126	9.1
Black/African American	55	4.0
Latino/Hispanic	59	4.3
Other	27	2.0
Number of languages		
One	938	67.5
Two	386	27.8
Three or more	63	4.5
Language (other than English)		
Other	212	15.3
Spanish	158	11.4
Chinese	75	5.4
Hindi	40	2.9
French	38	2.7
Socioeconomic status		
Poor	56	4.1
Working class	130	9.4
Lower-middle class	201	14.6
Middle class	545	39.5
Upper-middle class	414	30.0
Upper class or wealthy	34	2.5
Year in college		
First year	322	23.2
Second year	20	30.2
Third year	322	23.2
Fourth year	273	19.7
Fifth year or higher	52	3.7

(72% current sample vs. 50% NSF sample), more multiracial and Asian individuals (9% multiracial and 21% Asian current sample vs. 3% multiracial, and 9% Asian NSF sample), and fewer Hispanic and African American individuals than those reported in the NSF data (4% Hispanic and 4% African American current sample vs. 12% Hispanic and 8% African American NSF sample).

The majority of participants (67.5%) spoke only English. Participants came from a variety of self-reported socioeconomic backgrounds but were most commonly middle or upper-middle class. Participants were well-distributed regarding their year in school. The most commonly reported major was a single major in biology (34%), but a variety of science and non-science related majors were reported.

Participants were recruited using different methods according to the preference of their university, with some being recruited through department listservs (*n* = 687) and others being recruited through department professors

($n = 694$). There were some differences between students recruited from these different groups. These included differences in gender ($p < 0.001$) and ethnic breakdown ($p < 0.001$) between groups, with more males present in the group who received the survey through a course professor (33.0%) versus a listserv (21.5%). More NHW and fewer Asian students were also present in the group who received the survey through a course professor (68.6% NHW, 16.1% Asian) versus a listserv (53.3% NHW, 26.6% Asian).

Familiarity with Genetic Counseling

Slightly more than three-quarters of the students had heard of genetic counseling, reporting that they were either very familiar (4.8%), mildly familiar (31.5%), or had heard of genetic counseling but were not at all familiar with it (41.6%, Table 2). Students who reported more familiarity with genetic counseling were more likely to correctly answer statements about job responsibilities of genetic counselors ($p = 0.011$) and were less likely to change their interest levels in genetic counseling after taking the survey ($p < 0.001$). Females reported higher levels of familiarity than males ($p = 0.003$). Reported familiarity increased with a participant's year in school ($p < 0.001$), with 68.3% of freshmen reporting that they had heard of genetic counseling in some capacity compared to 86.8% of seniors. Individuals in biology-related majors reported more familiarity, while individuals in non-biology related majors reported less familiarity ($p = 0.018$). Students who received the survey through a department listserv reported more familiarity ($p < 0.001$), with 26.8% of participants who received the survey through a professor reporting that they had never heard of genetic counseling compared to 17.2% of participants who received the survey through a department listserv. There was no significant association between whether a participant graduated from a rural or urban high school and their reported familiarity with genetic counseling ($p = 0.215$). There were also no significant differences in familiarity with genetic counseling by ethnicity ($p = 0.097$) or socioeconomic status ($p = 0.053$).

Methods of Learning About Genetic Counseling

Participants reported that the most helpful resources when learning about a new career were hands-on opportunities such as shadowing (88.9%), finding a part-time job or internship (87.1%), and interviewing people in the field (48.8%). Factors reported as most important to a participant when considering a new career included personal satisfaction (80.0%), helping others (58.3%), salary (53.8%), and job outlook (48.0%). Factors reported as least important included the amount of postgraduate education required (56.8%), job prestige (54.6%), research opportunities (48.7%), and a flexible location (45.4%).

Of students who reported some degree of prior familiarity with the field ($n = 1083$), the most commonly reported settings of first hearing about genetic counseling were a high school class (37.3%), college class (28.1%), online (11.5%), in the media (7.6%), or through a family member/friend (6.4%) (Table 2). Only four students (0.4%) reported first hearing about it at a career fair. Among those who had heard of genetic counseling, the level of familiarity varied with where the student had first heard of it ($p < 0.001$). This statistical significance was present even after collapsing the source into K-12 school, college, online, personal/family/friend, media, extracurricular activities, career fair and others, as well as collapsing familiarity into those that were "very to mildly" familiar compared to those that were "not familiar" ($p < 0.001$). Students who heard about the field in elementary/middle/high school or from someone they knew (or personal experience), reported higher levels of familiarity than those that first heard from online sources. Additionally, a greater proportion of respondents who first heard of genetic counseling in college or from online resources reported being not familiar with genetic counseling. Although the sample sizes were small, students who first heard from a school or college advisor were also more likely to report lack of familiarity.

Most participants who reported some degree of familiarity with the field had never researched genetic counseling (80.7%). However, 8.1% of individuals reporting prior familiarity indicated that they had researched the field through a genetic counseling program website or social media page, the National Society of Genetic Counselors (NSGC) website or social media (4.4%), genetic counseling blogs (3.9%), communication with a genetic counselor in person or through email/telephone (3.6%), the American College of Medical Genetics and Genomics (ACMG) website or social media (3.3%), other resources (3.1%), and shadowing a genetic counselor (1.4%).

Knowledge of Genetic Counseling

Most true/false statements regarding job responsibilities of genetic counselors were answered correctly by the majority of respondents (> 74%). However, three statements were answered incorrectly by approximately half of respondents. These were false statements indicating that genetic counselors recommend cancer treatments based on a patient's genetic information (47.2% incorrect), perform gene therapy for patients who are good candidates (47.3% incorrect), and recommend reproductive options such as pregnancy termination based on a couple's chances of having a child affected with a genetic condition (55.5% incorrect). As stated above, students reporting familiarity with genetic counseling were more likely to answer questions correctly (Table 2, $p = 0.011$). However, there were no significant differences in pre-survey or post-survey interest in genetic counseling ($p = 0.538$ and

Table 2 Factors significantly associated with reported familiarity with genetic counseling

	Very familiar <i>n</i> (%)	Mildly familiar <i>n</i> (%)	Heard of GC, but not familiar <i>n</i> (%)	Never heard of GC <i>n</i> (%)	<i>p</i> value
Knowledge Questions Score ^a					0.011*
<= 50%	2 (3)	37 (8)	32 (6)		
51–75%	27 (40)	161 (37)	269 (47)		
> 75%	38 (57)	240 (55)	277 (48)		
Pre-survey to post-survey change in interest ^a					0.035***
–3	3 (5)	0 (0)	0 (0)	0 (0)	
–2	1 (1)	20 (5)	19 (3)	11 (4)	
–1	7 (10)	42 (10)	94 (16)	68 (22)	
0	50 (75)	297 (68)	279 (48)	121 (40)	
1	5 (7)	49 (11)	154 (27)	86 (28)	
2	1 (1)	30 (7)	29 (5)	20 (7)	
3	0 (0)	0 (0)	2 (< 1)	0 (0)	
Gender					0.003**
Female	55 (5)	323 (32)	430 (43)	198 (20)	
Male	12 (3)	109 (29)	147 (39)	106 (28)	
Year in school					< 0.001*
First year	12 (4)	71 (22)	137 (43)	102 (32)	
Second year	13 (3)	112 (27)	186 (44)	109 (26)	
Third year	16 (5)	113 (35)	140 (43)	53 (16)	
Fourth year	25 (9)	119 (44)	93 (34)	36 (13)	
Fifth year or higher	1 (2)	23 (44)	22 (42)	6 (12)	
Where participant first heard of GC					< 0.001*
Elementary/middle school	5 (19)	12 (46)	9 (35)		
High school class	24 (6)	203 (50)	177 (44)		
College class	19 (6)	112 (37)	173 (57)		
Career fair	0 (0)	2 (50)	2 (50)		
Extracurricular activity	1 (10)	6 (60)	3 (30)		
High school advisor	0 (0)	2 (33)	4 (67)		
Online	6 (5)	36 (29)	82 (66)		
Family member/friend	3 (4)	26 (38)	40 (58)		
Personal/family experience	6 (75)	2 (25)	0 (0)		
In the media	0 (0)	22 (27)	60 (73)		
Other	2 (7)	10 (34)	17 (59)		
College advisor	1 (6)	5 (31)	10 (63)		
Major					< 0.001**
Non-biology majors	5 (3)	28 (17)	70 (42)	63 (38)	
Biology-related majors	42 (5)	269 (35)	312 (41)	146 (19)	
Multiple or “other” majors	20 (5)	138 (31)	190 (43)	95 (21)	

* Fisher exact test, ** Chi-square test, *** Kruskal-Wallis with post hoc Dunn’s test

GC genetic counseling

^a Percentages organized by column rather than row

$p = 0.117$, respectively) based on whether participants answered questions correctly or incorrectly, indicating that these misperceptions were unlikely to influence overall interest in the field. The number of correct responses to knowledge statements about genetic counseling was not significantly different between individuals who were recruited through a department course versus a department listserv ($p = 0.522$).

Aspects of Genetic Counseling and Student Interest

Individual pre-survey and post-survey interest levels in genetic counseling were compared to determine the extent to which participants individually increased or decreased in their interest level after learning more about genetic counseling (Fig. 2). Overall, 53.8% of individuals did not change in their interest levels, 27.1% of individuals increased in interest, and 19.1% of individuals decreased in interest. Approximately 30% of individuals unsure of their interest prior to taking the survey stated that their interest had decreased after the survey, and approximately 53% of individuals unsure of their interest stated that their interest had increased after taking the survey. Viewing more information about genetic counseling during the survey facilitated a change in interest levels for approximately half of participants overall (46.2%).

For participants who reported that they were highly or somewhat interested in genetic counseling after taking the survey, scores rating each statement about the career were averaged and compared to determine what aspects of the career were most appealing overall. Scores were also averaged for students who were not interested in genetic counseling. These students rated all aspects lower on average than did students who were highly or somewhat interested (Fig. 3). Scores were not examined for students reporting they were not sure of their interest in genetic counseling.

Participants were also asked to answer free response questions regarding why they would ($n = 582$) or would not ($n = 766$) consider a genetic counseling career, and common themes were elucidated. Commonly reported reasons for considering the field included helping others (29.2%), interest in genetics (26.8%), patient contact (21.3%), a general interest in the field (20.3%), an interest in healthcare (13.6%), and constant learning/evolving field (10.8%). Commonly reported reasons for not considering the field included a prior preference for another career (36.3%), a general lack of interest (16.1%), program acceptance rate (8.6%), salary (6.8%), no interest in genetics (5.4%), and no interest in patient interaction (5.0%).

Demographic Factors and Student Interest

Interest levels in genetic counseling (highly interested, somewhat interested, not sure, and not at all interested) were also examined in association with various demographic factors for

all students. There were no significant differences in pre-survey interest in genetic counseling by gender, but there were significant differences post-survey with females reporting higher levels of interest overall (Table 3). Differences in ratings between genders of the specific aspects of a career in genetic counseling are shown in Fig. 4. Several aspects of the career were rated significantly lower by males than females, with the number of women working in the field having the largest difference in average rating between males and females. The only finding rated significantly higher by males than females was a statement regarding the use of calculations and statistics to convey risk information.

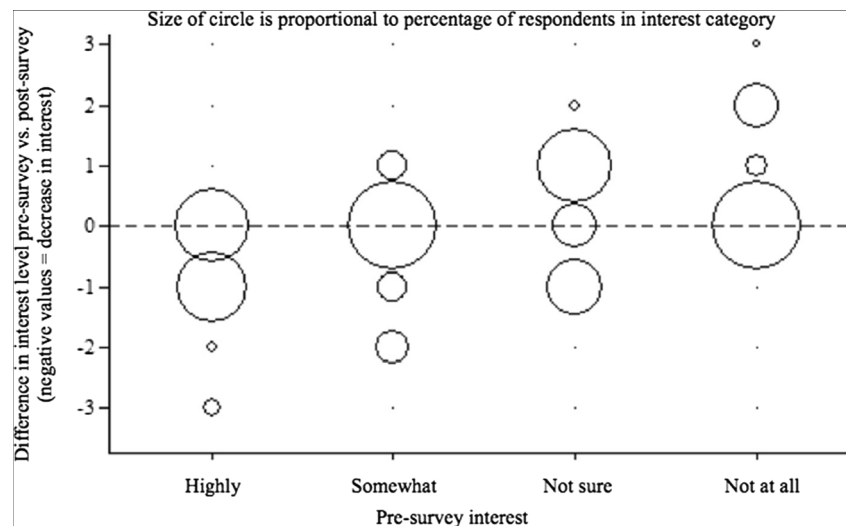
In addition, there were no significant differences in pre-survey interest by self-reported socioeconomic status, but there were significant differences post-survey with individuals who were upper class or wealthy reporting lower levels of interest (Table 3). Regarding socioeconomic status, the average salary ($p < 0.001$) and the 96% female field ($p < 0.001$) statements were rated significantly lower by respondents from the upper class than by respondents from other socioeconomic groups, indicating that these statements were more negatively received by individuals from the upper class. Being a first-generation college student was also associated with interest, with individuals whose parents had not received a degree beyond a high school diploma reporting higher levels of interest both pre-survey ($p < 0.001$) and post-survey ($p < 0.001$).

Similarly, there were no significant differences in pre-survey interest by ethnicity, but there were significant differences post-survey. Specifically, Hispanic and Asian individuals were more likely to be interested in genetic counseling than were NHW, African American, and multiracial individuals. No significant differences were identified regarding how individuals of different ethnicities rated statements regarding different aspects of a career in genetic counseling.

Conversely, religion was significantly associated with pre-survey interest ($p < 0.001$), but not post-survey interest ($p = 0.156$). Pre-survey, Islam and Buddhist individuals appeared more likely to report interest in the field, while Mormon individuals appeared less likely to report interest. These associations were not significant in the post-survey interest for any religious group.

Finally, the student's major was significantly associated with both pre-survey interest ($p < 0.001$) and post-survey interest ($p < 0.001$). Majors indicating highest levels of interest post-survey included public health, genetics, microbiology, neuroscience, biochemistry, and exercise science. Majors indicating lowest levels of interest post-survey included human physiology, pharmacy, environmental studies, premed, engineering, and "other" majors, which included less commonly reported science and non-science majors. Individuals who received the survey through a department listserv versus a course professor also had higher levels of interest pre-survey (44.2% highly/somewhat interested vs. 34.3%) and post-

Fig 2 Difference in interest level pre-survey versus post-survey



survey (58.4% highly/somewhat interested vs. 53.0%) ($p < 0.001$).

Multi-variable models containing ethnicity, gender, socioeconomic status, and first-generation vs. non-first-generation college student were also evaluated. Respondents were more likely to report being interested in genetic counseling if they were first-generation college students than if they were not (OR 1.60 (95% CI: 1.22–2.11)). Although this effect was independent of ethnicity, this generational difference was more evident in Asians and African Americans compared to NHWs or Hispanics. Conversely, Asian individuals demonstrated a significantly higher likelihood of interest in genetic counseling compared to NHWs (OR 1.49 (95% CI: 1.15–1.93)). Although this trend of higher interest levels compared to NHWs was also observed for Hispanics (OR: 1.54 (95% CI: 0.92–2.60)) and African Americans (OR: 1.09 (95% CI: 0.64–

1.84)), it failed to reach statistical significance. Males were less likely to be interested in genetic counseling (OR 0.57 (95% CI: 0.45–0.72)). However, self-reported socioeconomic status did not yield any statistically significant trends. This is likely due to the high level of correlation between socioeconomic status and first-generation college students (35% of first-generation students were middle class or higher compared to 80% of non-first-generation students, $p < 0.001$).

Discussion

This study contributes important findings to a body of literature exploring the awareness and perceptions that undergraduate students have of the field of genetic counseling in addition to factors that could influence student interest. Findings

Fig. 3 Average ratings of genetic counseling aspects by post-survey interest levels in genetic counseling

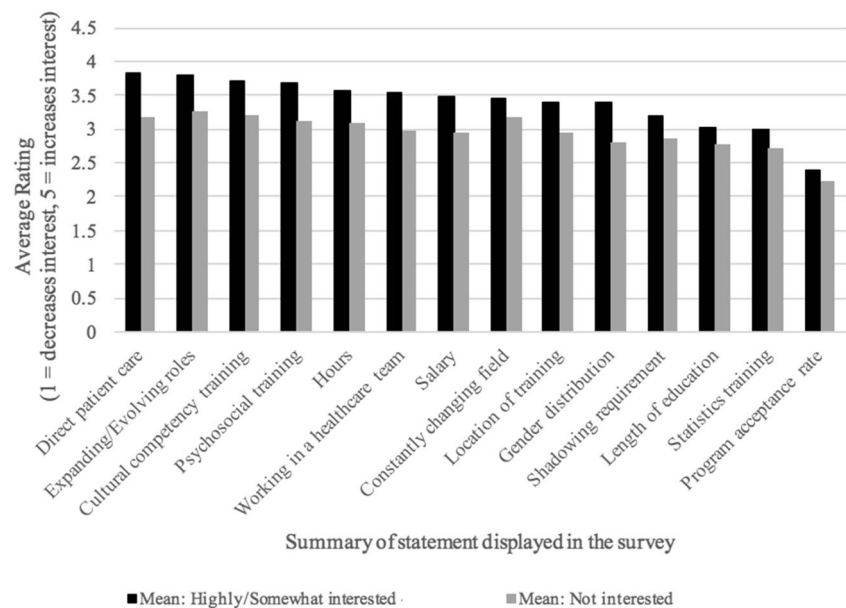


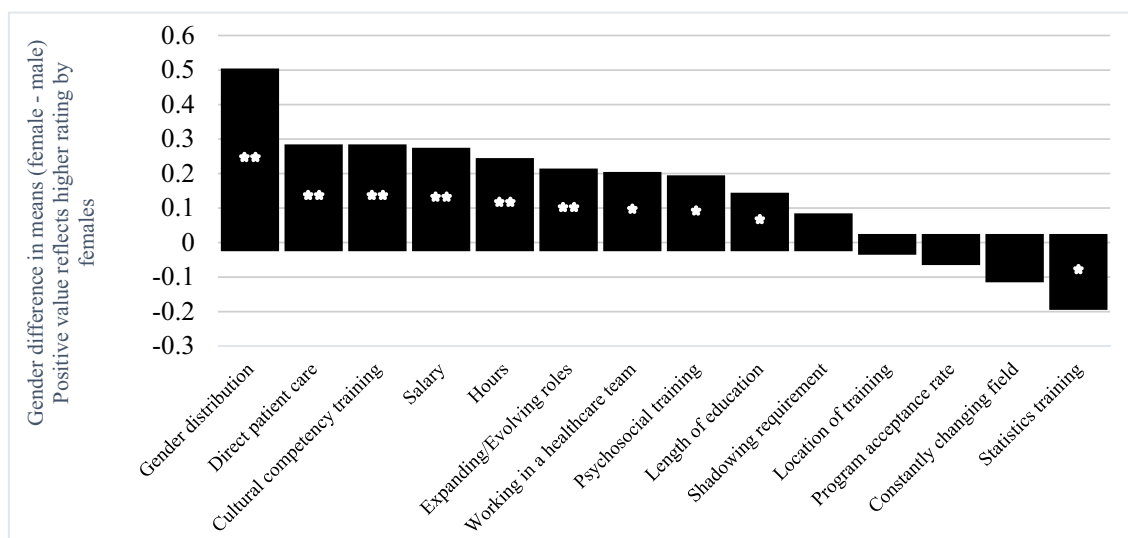
Table 3 Factors significantly associated with interest in genetic counseling

	Highly interested <i>n</i> (%)	Somewhat interested <i>n</i> (%)	Not sure, need more information <i>n</i> (%)	Not at all interested <i>n</i> (%)	<i>p</i> value
Factors significant pre-survey					
Religion					< 0.001*
Protestant	23 (8)	94 (33)	79 (28)	88 (31)	
Catholic	12 (4)	91 (33)	95 (35)	75 (27)	
Mormon	1 (1)	31 (19)	80 (49)	52 (32)	
Jewish	3 (8)	12 (32)	10 (27)	12 (32)	
Islam	5 (9)	25 (46)	17 (31)	7 (13)	
Hindu	4 (8)	15 (29)	21 (40)	12 (23)	
Buddhist	2 (7)	11 (41)	9 (33)	5 (19)	
Unaffiliated	19 (8)	84 (34)	80 (32)	64 (26)	
Atheist	5 (3)	65 (42)	41 (26)	44 (28)	
Other	5 (6)	32 (39)	30 (37)	15 (18)	
Major					< 0.001**
Non-biology majors	9 (5)	31 (19)	81 (49)	45 (27)	
Biology-related majors	49 (6)	305 (40)	235 (31)	179 (23)	
Multiple or “other” majors	21 (5)	126 (28)	146 (33)	150 (34)	
First-generation college student					< 0.001**
First-generation student	19 (8)	138 (58)	33 (14)	49 (21)	
Non-first-generation student	65 (6)	551 (48)	103 (9)	429 (37)	
Factors significant post-survey					
Race/ethnicity					0.012*
White	50 (6)	380 (46)	81 (10)	316 (38)	
African American	4 (7)	27 (49)	5 (9)	19 (35)	
Hispanic	6 (10)	32 (54)	9 (15)	12 (20)	
Asian	18 (6)	173 (59)	24 (8)	79 (27)	
Multiracial	4 (3)	64 (51)	14 (11)	44 (35)	
Gender					< 0.001**
Female	69 (7)	528 (52)	104 (10)	305 (30)	
Male	15 (4)	159 (43)	31 (8)	169 (45)	
Socioeconomic status (when student was a child)					0.013*
Poor	3 (5)	29 (52)	10 (18)	14 (25)	
Working class	8 (6)	67 (52)	15 (12)	40 (31)	
Lower-middle class	10 (5)	114 (57)	21 (10)	56 (28)	
Middle class	33 (6)	271 (50)	57 (10)	184 (34)	
Upper-middle class	27 (7)	195 (47)	27 (7)	165 (40)	
Upper class or wealthy	3 (9)	8 (24)	5 (15)	18 (53)	
Major					< 0.001**
Non-biology majors	8 (5)	75 (45)	18 (11)	65 (39)	
Biology-related majors	54 (7)	408 (53)	84 (11)	223 (29)	
Multiple or “other” majors	22 (5)	201 (45)	33 (7)	187 (42)	
First-generation college student					< 0.001**
First-generation student	21 (9)	89 (37)	89 (37)	40 (17)	
Non-first-generation student	58 (5)	374 (33)	377 (33)	338 (29)	

* Fisher exact test, ** Chi-square test

provide information regarding how students are currently learning about the field and support several recommendations

regarding ways to consider improving recruitment efforts for the field and addressing diversity-associated issues, some of



* = significant difference at $p < 0.01$

** = significant difference at $p < 0.001$

Fig. 4 Average ratings of genetic counseling aspects by gender

which are supported by data from previous studies. In general, students of many different backgrounds appear to have interest in genetic counseling, and students prefer hands-on, interactive experiences to learn about the field. Students have interest in many aspects of the career such as helping others, working directly with people, and training in genetics, cultural competency, and psychosocial issues.

Recommendations for Targeting Recruitment Efforts

When considering academic factors for recruitment, targeting high school or early college students could have a larger recruitment impact than targeting upperclassmen, as upperclassmen were significantly more likely to be familiar with genetic counseling. Previous research asserts that learning about the field earlier, possibly even before high school, is ideal (Oh and Lewis 2005; Mittman and Downs 2008; Schneider et al. 2009; Owens et al. 2009). In addition, while many genetic counseling students were biology or genetics majors during their undergraduate studies (Lega et al. 2005), it appears that students in other science-related majors may also have interest in the field. Recruiting at science-related events or courses outside of those focused solely in biology or genetics could have potential recruitment benefits and bring students with new perspectives to the field.

As outlined in the results section, students who heard about the field in grades K–12 or from someone they knew (or personal experience) reported higher levels of familiarity than those that first heard from online sources. Also, a greater proportion of respondents who first heard of genetic counseling in college, from online resources, or from a school or college advisor (although the sample sizes were small) were more

likely to report lack of familiarity with the field. This demonstrates specific areas where recruitment strategies could potentially be improved and emphasizes the need for ensuring that individuals who will educate students about genetic counseling have access to accurate and reliable resources to provide to students about the field and how to learn more if they are interested.

Regarding demographic factors, individuals of low-middle socioeconomic status (SES) tended to report more interest in the field than those from the upper class, and this observation appeared to be related to whether an individual was a first-generation college student. It should be noted that SES was a self-reported measure, as authors were unsure of whether college students would know their average household income. It is possible that participants may have had different interpretations of the answer choices for SES that were provided to them. Targeting efforts to schools that are more likely to have students from a variety of backgrounds that includes low-middle SES groups and first-generation college students, for example targeting public schools rather than private schools, could help maximize recruitment efforts.

Our data also indicate that individuals outside of NHW ethnicity, particularly Asian and Hispanic individuals, might have a relatively high level of interest in the field. This demonstrates that recruiting in schools with ethnically diverse populations could be a beneficial endeavor. Factors related to aspects of the field that might have contributed to differences in interest by ethnicity could not be elucidated. Although available literature to compare this to is limited, a previous study comparing African American and Caucasian student interest in genetic counseling found that African American students did tend to place more importance than

Caucasian students on certain career factors such as helping others, flexible working hours, and a high salary (Schneider et al. 2009). It is unclear why such differences were not seen in the current study. There were no significant differences in reported familiarity with genetic counseling across ethnic groups. However, based on reported interest levels, it does appear that recruiting within culturally- or ethnically-based student organizations could have potential benefits for diverse recruitment. Although some religious groups might initially be less open to genetic counseling and report lower interest levels, these differences in interest tend to dissipate once individuals learn more about genetic counseling. Therefore, there may be a benefit to speaking to religious groups that do not initially appear interested in genetic counseling and discussing any misconceptions they might have about the field.

Recommendations for Specific Recruitment Strategies

Findings of the current study support specific types of recruitment strategies that are appealing to students. Because students tend to report the most interest in hands-on exposure to careers of interest, genetic counselors should allow interested students to shadow or interview them whenever possible. Genetic counseling internships, hands-on recruiting events, or similar learning experiences for interested students should also be established at institutions where this is possible and are currently incorporated into some genetic counseling programs. Committees and task forces within NSGC are dedicated to these types of outreach activities and should consider the findings of this study for future outreach efforts.

Although in-person learning experiences are ideal, access to genetic counselors is often limited by the geographic location of practicing counselors and genetic counseling programs. For students who want these learning experiences but do not have direct access to a genetic counselor, there is a Master Genetic Counselor Series through the NSGC that presents simulated genetic counseling sessions from three specialty areas. Expanding upon this series, making it more interactive, and providing examples of more diverse counselors and settings could be beneficial. In addition, online courses could provide hands-on learning experiences that are not limited by location.

A significant number of students reported first hearing of genetic counseling online or in the media, which supports the importance of positive media relations and exposure to genetic counseling. Webinars, chat rooms, or Q&A sessions through social media tools such as Reddit could disseminate information in a relatively hands-on way to potential student populations from a wide variety of geographic, demographic, and educational backgrounds. NSGC has successfully participated in Reddit Q&A sessions in the past. Targeting some of these Q&A sessions specifically to students and including program

directors, current students, and practicing counselors from various specialties could be valuable. Use of similar interactive web tools has also been suggested in previous studies (Kumaravel et al. 2011; Mittman and Downs 2008). These experiences could help students gain more knowledge about the field before deciding if they want to invest resources into seeking out more hands-on experiences and allow students to better determine what types of counselors they would prefer to shadow or interview.

Finally, in accordance with the Accreditation Council for Genetic Counseling (ACGC) Standards of Accreditation for Graduate Programs in Genetic Counseling, training programs should keep their websites up to date and have links or information to learn more about genetic counseling. The ACGC currently has recommendations in place for information that should be included on program websites in addition to suggestions for addressing diversity issues, such as scholarship opportunities and annual recruitment goals for underrepresented populations (ACGC 2013). These standards are important and should continue to be tailored as more research about recruitment issues is published, especially because program websites were the most commonly reported resource used to learn more about the field. NSGC resources are also reported as a common source of information for students, and the NSGC currently has a variety of resources available for patients and students to learn about the field on their website. Consideration of methods to build upon these resources or to tailor them more effectively for different student populations could be beneficial.

Recommendations for Recruitment Talking Points

Based on participant changes in genetic counseling interest before and after taking the survey, it appears that viewing a fairly brief overview of genetic counseling is enough for many individuals to feel that they can make a decision on whether they are interested in the career. Less than 20% of individuals who were unsure about their interest in the field at the beginning of the survey stated that they were still unsure of their interest at the end of the survey, with approximately 30% stating that their interest had decreased and approximately 53% stating that their interest had increased. Similarly, the majority of individuals who had never heard of genetic counseling (60.5%) changed their interest levels in genetic counseling, with 34.6% of individuals increasing their interest. The fact that many individuals changed their interest level in the field after reading approximately 20 explanatory statements demonstrates a need to present some of the most positively-viewed statements first in order to capture the initial interest of as many individuals as possible.

Several aspects of genetic counseling were commonly mentioned as factors that increased an individual's interest in the field. These should be emphasized when discussing the

field with students and include interpersonal aspects such as personal satisfaction, helping others, and working directly with people. Aspects of genetic counseling training that were frequently rated positively included training in genetics, cultural competency, and psychosocial issues. Genetic counseling program directors can integrate these aspects of training in their program's recruitment materials and on their websites.

In addition, approximately half of respondents had a few commonly held misconceptions about the field that would be important to clarify when discussing a career in genetic counseling. These included beliefs held by approximately half of respondents that genetic counselors order genetic testing to determine effective cancer treatments, perform gene therapy, and recommend reproductive options such as pregnancy termination. However, there was some ambiguity in the way the pregnancy termination statement was worded on the survey that may have caused some participants to misinterpret its intent. Although genetic counselors typically take a nondirective approach and do not "recommend" options such as pregnancy termination, they do routinely discuss these options with patients. It is possible that some students may not have made this nuanced distinction when responding to the question.

Assessment of talking points to use when discussing genetic counseling also revealed some less well-received themes that should continue to be objects of troubleshooting for the field. The program acceptance rate, that will likely change as new genetic counseling programs open, was negatively received by participants. In addition, the fact that the field is majority female tended to be less well-received by males than by females. Because males also rated many other aspects of genetic counseling lower on average than did females, it appears that there may be multiple factors contributing to the field's gender discrepancy. These features may include the types of roles available within and outside of patient care, typical hours, and average salary. Previous research asserts that factors outside of gender discrepancy are likely to play a role in male interest and recruitment to the field (Chen et al. 2017; Kopesky et al. 2011). However, the number of females in the field was still the biggest area of discrepancy between male and female ratings, and it appears that this is a deterrent for at least some males.

Study Strengths and Limitations

To our knowledge, the current study is one of the largest studies undertaken to date examining the perceptions and awareness undergraduate students have of the genetic counseling field. The sample used for data analysis includes students from a wide variety of locations, backgrounds, ethnicities, and majors, providing data about many different groups that have not always been well-characterized previously. This study makes beneficial and important contributions to

research regarding ways to improve genetic counseling recruitment strategies.

However, the current study also has limitations that should be considered when interpreting results. First, it is unclear from this study how reflective reported interest is of an individual's likelihood to submit an application or matriculate into a genetic counseling training program. In addition, it is unclear how recruitment influences available training spots, and improved recruitment may be irrelevant if the number of training spots remains constant. The study sample is somewhat different demographically than expected based on NSF data. The varying demographic profiles of the universities surveyed are likely to be contributing to these differences, and it is possible that using different criterion to identify institutions could have resulted in a different demographic profile. There were also differences in survey question responses between students who were recruited through a biology department listserv versus a course professor, but this could be expected considering that these two groups are likely to represent somewhat different majors and interests. Although this indicates that these two groups represent slightly different populations overall and results might have been somewhat different if each group were examined separately, both groups would likely be reached through the same types of recruitment methods and are important to understanding recruitment issues associated with students in the sciences. Thus, both groups were analyzed together to assess overall awareness and perceptions of students in the sciences.

In addition, the large sample size in this study provided power to identify statistically significant differences, even when the actual magnitude of the differences was not very large. The magnitude of differences reported between groups can be further examined in Tables 2 and 3. The results of this study need to be interpreted not only in light of their statistical significance, but also with an appreciation of their potential for real-world recruitment utility or lack thereof. Survey measures were developed by the authors and were not validated. Finally, the current study focused on students in the sciences at high-level research institutions; thus, the findings cannot be applied to all college student populations. It is likely that the population of students surveyed could have had higher levels of awareness and different perceptions of genetic counseling given that the majority of students surveyed had a background in the sciences.

Research Recommendations

The current study includes many findings that could be examined further in future studies. For example, there were several significant findings regarding various demographic factors such as ethnicity, socioeconomic status, and gender in relation to interest in genetic counseling and various perceptions of the field. Under-representation of various minority groups has

been an ongoing issue in the genetic counseling field for many years (Oh and Lewis 2005). It is unclear from the current study whether students from minority groups are applying to genetic counseling programs and are less likely to be accepted, or whether these individuals might be less likely to apply to programs for reasons other than interest alone. The current study also did not directly address financial barriers to genetic counseling awareness. In order to increase access to opportunities for students from lower SES groups or regions that do not have easy access to a genetic counselor, further research to examine the utility of scholarships through NSGC or other organizations can be considered to help students have these experiences.

In addition, the finding regarding first-generation college students having more interest in the field differs from previous research that has found that genetic counseling students are more likely to come from a household where one or both parents hold an advanced degree (Lega et al. 2005). A previous paper asserted that this could be due to first-generation students preferring more well-known careers with higher salaries and/or disadvantages in the application process (Mittman and Downs 2008). Finally, although there were many students whose interest level in genetic counseling decreased after taking the survey, the only career aspect statement that was negatively received by participants overall was the statement regarding program acceptance rates. It is unlikely that acceptance rate alone contributed to this decline in interest, and participants did mention some other contributing factors in the free response questions such as preference for another career, salary, and lack of interest in genetics or patient interaction. Further examination of different factors contributing to interest in the field could elucidate new findings that might have also contributed to these decreases in interest.

Findings of the current study also include suggestions that can be used by genetic counseling programs, NSGC, AGCPD, and other genetic counseling organizations to develop recruitment tools and informational resources about the field of genetic counseling in addition to improving current recruitment strategies. We encourage these organizations to work together by pooling resources and sharing initiatives to more effectively improve recruitment efforts.

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Compliance with Ethical Standards

Conflicts of Interest Andrew Bean, Katie Bergstrom, Amanda Gerard, S. Shahrukh Hashmi, Christina B. Hurst, William Mattox, and Blair Stevens declare that they have no conflict of interest. Sarah Noblin is the Coordinator of Recruitment for the University of Texas Genetic Counseling Program.

Human Studies and Informed Consent 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 (5). Informed consent was obtained from all individual participants included in the study.

No animal studies were carried out by the authors for this article.

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