Are Undergraduates Familiar with Nephrology as a Medical Specialty? A Single Site Survey of Undergraduate Students

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Key Points
- There is a discrepancy in the undergraduate population’s ability to recognize the word “nephrology” compared with other medical specialties.
- The number of US fellowship applicants in 2020 was related to medical specialty name recognition in the undergraduate population.

Abstract
Background Over the past decade, nephrology has experienced a 43% decline in the number of fellowship applicants. Previous studies examining why residents choose a fellowship program cite lack of exposure as a main factor having an effect against a career in nephrology; however, no studies have surveyed the undergraduate population to inquire whether they recognize nephrology as a medical specialty compared with other medical specialties. We conducted a survey at a primarily undergraduate institution in the Southeast United States to test whether undergraduate students identified the word “nephrology.”

Methods A total of 274 undergraduates responded to a survey that requested them to select every medical specialty that they recognized by name (15 real specialties and one fictitious specialty). Demographics regarding sex, race, collegiate level, high school location, premedical track, and household income were collected. Correlations between survey findings and rates of application and average salary per specialty were assessed.

Results Out of 15 medical specialties, nephrology (29%) and pulmonology (40%) were the least recognized. Pediatrics (97%) and surgery (97%) ranked highest. Sex, race, collegiate level, and household income were not different between those students who recognized “nephrology” and those who did not. Premedical students were about twice as likely to have recognized nephrology versus nonpremedical students (49% versus 22%, respectively; \(P<0.001\)). STEM majors were about twice as likely to identify nephrology versus non-STEM majors (40% versus 20%, respectively; \(P<0.001\)). The proportion of undergraduate students who recognized a specific medical specialty significantly correlated only with the number of US applicants per fellowship position across different medical specialties in 2020 (\(P<0.05\)).

Conclusions On the basis of word association alone, nephrology is the one of the least recognized specialties by undergraduates. The discrepancy between nephrology and other specialties highlights a gap in name recognition at an early career stage, even among premedical students.

Introduction Over the last decade, nephrology has experienced a 43% decline in fellowship applicants according to data within the National Resident Matching Program (1). The applicant per position ratio for this fellowship program has dropped from 1.6 applicants per fellowship position in 2009 to 0.7 applicants per fellowship position in 2020. In the 2020 appointment year, 291 individuals matched with a position in a nephrology fellowship program, leaving 38% of the available positions unfilled. The decline of applicants for adult and pediatric nephrology fellowships has led to concerns regarding shortages of nephrologists in the future (2–5).

In order to understand the lack of medical graduates pursuing a career in nephrology, perceptions of the field have been examined. In a 2020 focus group study, Beck et al. determined that the six main barriers to medical residents choosing to pursue a career in nephrology were: lack of exposure, low monetary

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compensation, low prestige, lack of advances in the field, high complexity, and lack of role models (6). Results from this study emphasized lack of exposure as one of the more significant barriers to choosing a career in nephrology. Internal medicine residents are reportedly only exposed to limited aspects of the whole spectrum of inpatient and outpatient practices that falls within the scope of a nephrology career.

Whereas numerous studies have been conducted regarding the reasons why medical students and residents choose to enter a specific fellowship program (2,4–12), very few studies have focused on the premedical undergraduate student cohort. Many students spend their formative undergraduate years exploring career interests and developing opinions that are shaped by a combination of premedical advising, professionally moderated Internet content (e.g., Association of American Medical Colleges), job shadowing opportunities with practicing physicians, peers, popular media, and even high school programs (13). Somewhat surprising, very strong opinions are developed early among the premedical cohort, which are based on misconception (14) and can lead to a lasting negative perception of specific careers.

Although scientifically unexplored, if a student has never been exposed to a field of study or even the term used to describe the field of study, the chances of that student developing an early interest in the field is probably very low. Early exposure to fields of study can affect career choices later in life (12,15–17).

The purpose of this study was to determine whether the term “nephrology” is a recognizable medical specialty compared with other medical specialties among an undergraduate student population from a mid-sized, primarily undergraduate institution. We tested two hypotheses on the basis of declining nephrology fellowship applications: (1) nephrology will be the least recognized specialty in an undergraduate student population, and (2) early career recognition will correlate with the number of applicants per position ranking.

### Materials and Methods

This study was approved by the Institutional Review Board at the College of Charleston. Survey responses were anonymous.

### Survey

A QualtricsXM survey containing 11 questions was created and sent to professors from multiple departments at the College of Charleston—a public liberal arts and sciences university. Professors in biology, chemistry, art history, economics, geology, public health, and communications were requested to distribute the survey in their class between November 15, 2020, and December 14, 2020. This included a potential 3892 enrollees as determined by course enrollment quantities provided in enrollment records. It was not possible to determine enrollment redundancy (one student enrolled in multiple courses) due to the anonymous nature of the survey. No personal identifying information was collected. Within the survey, participants were asked to select every medical specialty they recognized by name from a list of 15 real specialties: anesthesiology, cardiology, dermatology, endocrinology, gastroenterology, gynecology, hematology/oncology, pediatrics, pulmonology, radiology, rheumatology, surgery, nephrology, neurology,

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| Characteristic | n   | %  | Characteristic | n   | %  |
|---------------|-----|----|---------------|-----|----|
| **Sex**       |     |    |               |     |    |
| Men           | 53  | 19 | Stem major    |     |    |
| Women         | 220 | 81 | STEM          | 124 | 46 |
| No response   | 1   |    | Non-STEM      | 144 | 54 |
|               |     |    | No response   | 6   |    |
| **Race and ethnicity** |     |    | Household income, $ |     |    |
| Asian         | 10  | 4  | <50,000       | 46  | 20 |
| Black         | 18  | 7  | 50,000–100,000| 66  | 29 |
| White         | 213 | 79 | 100,000–150,000| 46  | 20 |
| Hispanic or Latino | 15 | 6  | >150,000      | 69  | 30 |
| Native American| 3  | 1  | No response   | 47  |    |
| Other         | 12  | 4  |               |     |    |
| No response   | 3   |    |               |     |    |
| **Collegiate level** |     |    | High school location |     |    |
| Freshman      | 114 | 42 | South Carolina| 56  | 70 |
| Sophomore     | 82  | 30 | North Carolina| 3   | 4  |
| Junior        | 56  | 21 | Georgia       | 1   | 1  |
| Senior        | 19  | 7  | Florida       | 2   | 3  |
| No response   | 3   |    | New Jersey    | 3   | 4  |
| **Premedical track** |     |    | New York      | 1   | 1  |
| Premedical    | 72  | 26 | Virginia      | 3   | 4  |
| Nonpremedial  | 202 | 74 | Connecticut   | 1   | 1  |
| No response   | 0   |    | Tennessee     | 2   | 3  |
|               |     |    | Ohio          | 1   | 1  |
|               |     |    | Other         | 7   | 9  |
|               |     |    | No response   | 194 |    |

**Table 1. Self-identified demographics of survey respondents**

Absolute number of respondents (n) and percent distribution (%) of responses, excluding nonresponses, is displayed for each category. STEM, science, technology, engineering, and math.
urology, and one fictitious specialty (diasymptomology). The fictitious specialty was included to estimate response error.

Demographic questions regarding sex, race and ethnicity, collegiate level, high school location, and household income were included. Respondents were asked to self-identify as belonging to the premedical track or not. At the conclusion of the study, data were manually inspected for duplicate responses on the basis of the last four digits of the respondents’ phone number. When two or more responses contained the same four digits, all but one response was removed. After this inspection, 274 out of 287 responses were kept for statistical analyses.

Statistical Analyses

Minitab statistical software was used to conduct all statistical analyses. For each medical specialty, 95% confidence intervals were calculated for one proportion using the exact method, and differences between specialties were assumed when confidence intervals did not overlap. The chi-squared test was used to conduct subgroup analyses. These analyses examined differences between premedical and nonpremedical students; science, technology, engineering, and math (STEM) versus non-STEM majors; and sex, race and ethnicity, collegiate level high school location, and household income for each specialty. A significant chi-squared value was considered when $P<0.05$. Data regarding the number of applicants per specialty fellowship program were extracted from the National Resident Matching Program, Results and Data: Specialties Matching Service 2019 and 2020 appointment year. Data regarding US fellowship applicants per position were extracted from the National Resident Matching Program (1). Dermatology, neurology, and urology were excluded from the correlations because data for the specialties could not be gathered from the National Resident Matching Program. For noninternal medicine specialties listed within the National Resident Matching Program classification (1), subspecialties were grouped together under a single classification (e.g., gynecology included all subspecialties under the category “Obstetrics & Gynecology”). Tests for correlation were made using Spearman’s rank correlation test. Correlations were considered significant when $P<0.05$. The following comparisons were made: (1) number of positive responses per specialty versus the number of applicants per specialty (year 2019 or 2020), (2) number of positive responses per specialty versus the number of US applicants per specialty (year 2019 or 2020), and (3) number of positive responses per specialty versus the average salary for each specialty. Data for salaries in the year 2020 for each specialty were gathered from Medscape (18).

Results

Among 3892 course enrollees who were targeted, 274 (7%) students responded to the online survey. Of these 274 students, 72 (26%) identified as belonging to the premedical track, and 124 (46%) identified as being a STEM major (Table 1). The majority of respondents were women (81%) and White (79%). The largest survey population were freshmen (42%) followed by sophomores (30%), juniors (21%), and seniors (7%). Of the 15 medical specialties, pediatrics and surgery had the highest student recognition rate at 97%±0.02% (Figure 1). Nephrology had the lowest student recognition rate at 29%±0.05%. The second lowest
recognized specialty, pulmonology (40%±0.06%), had a 95% confidence interval that overlapped with nephrology.

**Subgroup Analysis**

For the 72 self-identified premedical students, pediatrics, surgery, and cardiology had the highest student recognition rate at 94%±0.06% (Figure 2). Rheumatology had the lowest student recognition rate among the premedical cohort at 43%±0.06%, followed by nephrology at 47%±0.06%. Rheumatology and nephrology had overlapping 95% confidence intervals, and response rates were not different from each other. Premedical students were about twice as likely (P<0.001, chi-squared test) to recognize nephrology versus nonpremedical students (49% versus 22%, respectively; Figure 3A). STEM majors were about twice as likely (P<0.001, chi-squared test) to recognize nephrology versus non-STEM majors (40% versus 20%, respectively; Figure 3B). Sex, race, collegiate level, and household income were not found to be different between students who recognized nephrology versus those who did not (Figure 3, C–E).

**Correlation with Applicant Rate**

There was no correlation between student recognition for a specific specialty and the overall number of applicants (i.e., US and international medical graduates) per fellowship position in both 2019 (R²=0.02, P=0.66, Spearman’s rank correlation; Supplemental Figure 1A) and 2020 (R²=0.02, P=0.65, Spearman’s rank correlation; Figure 4A). When only US applicants were examined, there was no correlation between student recognition for a specific specialty and the number of US applicants per fellowship position in 2019 (R²=0.23, P=0.12, Spearman’s rank correlation; Supplemental Figure 1B), but data from 2020 were correlated (R²=0.38, P=0.03, Spearman’s rank correlation; Figure 4B). When the average salary for each specialty was examined, there was no correlation between student recognition for a specific specialty and the average salary in 2020 for each specialty (R²=0.05, P=0.43, Spearman’s rank correlation; Figure 5).

**Discussion**

Our study revealed that the majority of undergraduates do not recognize the word “nephrology.” Eight out of 15 medical specialties were recognized by >80% of the undergraduates, with only four out of 15 specialties being recognized by <70% of students. Not surprisingly, most students recognize words such as “pediatrics,” “surgery,” and “gynecology”; however, these specialties are not suffering a major decline in fellowship applicants.

Realizing that most undergraduates will not choose a career in medicine, a subgroup analysis was conducted for those students who self-identified as being premedical. Even for the premedical group, only half of respondents recognized the word “nephrology,” which was also the least recognized of the 15 specialties included in the survey. These results are alarming because the pool of future physicians for the US nephrology workforce appears to be blunted to nephrology at the entry-level portion of their career path. Over the past decade, the number of applicants to medical schools has steadily increased (19). In 2020 alone, there were approximately 47,920 undergraduate students who applied to medical school in the United States (20). Despite the rise in medical school applicants, nephrology fellowship program fill rates have declined and

![Figure 2](image-url)  
**Figure 2.** Percentage of premedical students (n=72) who indicated recognizing a specific medical specialty. Collated responses are expressed as a percentage on the y axis and exact percentage displayed above each bar. Specialty order was maintained from Figure 1. Nephrology is indicated as a gray bar. Error bars indicate 95% confidence interval for the one-proportion test. Diasymptomology was included as the fictitious specialty to estimate the size of respondent measurement error.
Figure 3. | Survey subgroup comparisons for nephrology. (A) Premedical versus nonpremedical. Premedical students were about twice as likely to have recognized nephrology compared with nonpremedical students ($P<0.001$, chi-squared test). (B) STEM versus non-STEM. STEM majors were about twice as likely to have recognized nephrology compared with non-STEM majors ($P<0.001$, chi-squared test). (C) Ethnicity. (D) Collegiate level. (E) Household income. No differences in medical specialty recognition were detected between respondents grouped by ethnicity, collegiate level, or household income. Error bars represent the 95% confidence interval (one-proportion test, exact method). STEM, science, technology, engineering, and math.
Figure 4. | Correlation between student recognition and number of applicants to fellowship positions. Spearman’s rank correlation analysis between the fraction of undergraduate students (percent recognition) who recognized a medical specialty and (A) the total number of US and international applicants per fellowship position across all medical specialties included in the survey and (B) only US applicants for the year 2020. Nephrology is indicated by a light gray marker. Data regarding US fellowship applicants per position were extracted from the National Resident Matching Program. Dermatology, neurology, and urology were excluded from the correlations because data for the specialties could not be gathered from the National Resident Matching Program.
The number of nephrology fellowship programs with unfilled positions continues to this day and cannot simply be explained by the addition of newly created fellowship positions outpacing applicants.

Concerns regarding the nephrology workforce were voiced more than a decade ago, leading to the development of the American Society of Nephrology Task Force to address a foreseen shortage in the nephrology workforce (4). Focus was placed on strategies to enhance mentorship, educational rotations, and social media awareness as a means of publicizing to internal medicine graduates, to name a few. Nine years later, in a survey of internal medicine residents at the University of Colorado, medical residents continued to highlight lack of mentorship and exposure as reasons negatively affecting their choice to enter a nephrology fellowship program (6).

High school and undergraduate students who are exposed to a profession or career field may spend more time researching and connecting with a specific field (15–17). Early exposure can provide an individual with additional time to seek immersion experiences such as job shadowing and volunteering. These experiences allow an individual to witness and gain a greater understanding of their field of interest. Many undergraduates are in the exploration stage of their career development, making early exposure a crucial factor for which careers they decide to pursue (21). For the medical field, early exposure to mentors and the experiences of medical professionals can give undergraduates insight into the responsibilities of a career in the field (15).

Although not formally studied, one can assume that students who cannot even recognize the name of a job or career are probably not likely to make an early connection with that career. This idea is somewhat supported in this study where a weak correlation between the number of US applicants per fellowship position was related to the ability of the students to recognize a medical specialty (Figure 3). It is highly likely that additional factors play major roles in final career training decisions for medical residents as previously described (4,6), but these data support the idea that prestige is an important factor to consider when introducing a medical specialty to early career students. Prestige was previously identified in a smaller survey of undergraduate students conducted to assess their view of primary care physicians (14). Negative perceptions had a significant influence on early career decisions on whether to pursue a given area of medicine well before students were accepted to medical school.

Financial compensation is recognized as a driver of specialty competitiveness for the National Medical Residency Match Program (22), and it was identified as a factor affecting the decision of internal medicine residents to choose a nephrology fellowship (6). However, the ability to recognize a medical specialty did not correlate with annual salary, suggesting college students are less focused on future

Figure 5. | Spearman’s rank correlation analysis between the fraction of undergraduate students (percent recognition) who recognized a medical specialty and the average salary per specialty in 2020. Nephrology is indicated by a light gray marker. Data regarding physician compensation were extracted from the Medscape Physician Compensation Report 2020.
income with regards to medical specialty (Figure 5). These findings are in opposition to those from undergraduate students’ perceptions of primary care, which cited compensation with respect to student debt as a negative influence on perception of primary care (14).

Social media presence was one target area identified in the 2011 American Society of Nephrology Task Force (4). Social media is one form of exposure that is gaining popularity among many fellowship programs to improve their online presence and send information to a wide range of individuals in a short amount of time. Nephrology fellowship programs with social media are four times as likely to fill than those without (23), further suggesting exposure is a critical factor in program selection for those who have already chosen nephrology as a specialty. However, these data were collected from nephrology fellowship programs and did not include cohorts of students at an early point in their career training. Social media platforms that are targeted to medical students and residents may not reach the premedical cohort, especially if the premedical cohort does not recognize the word “nephrology.” There has been much attention given to developing social media presence in nephrology (24) for the purposes of developing resources for physicians, fellows, residents, and medical students, but there exists an unrecognized terminus between the premedical student pool and medical student pool.

Television popular culture also plays a major role in framing student opinion with regards to career path choices. As early as junior high school (middle school), students develop aspirations on the basis of role models through media such as television (25). Anecdotally, and perhaps somewhat troubling, undergraduates often mention television programming as a positive influence on their decision to aspire to a medical career. Television dramas do affect health perceptions (26), and many programs are targeted at 18- to 49-year-olds. The media, especially television programs, has been recognized as playing a major role in occupational socialization among younger people (27). In point, popular forensic television series have led to an increase in undergraduate enrollment in forensic science (28); however, nephrologists are rarely portrayed in the media as an important contributor to patient care. In fact, television programming has not been considered as a focus area for promoting nephrology or increasing exposure to a wider audience of students.

Finally, the word “nephrology” may be confusing to patients and the general population according to a recent report from the Kidney Disease: Improving Global Outcomes Consensus Conference (29). On the basis of Google trends comparison (2004–present), the word “kidney” is searched 23 times more than the word “nephrology” and four times more than the word “renal.” The search frequency for the word “kidney” compares closely with the search frequency for the word “pediatrics.” Although not assessed here, the idea that word popularity may influence student recognition is also a reasonable consideration.

This study has some limitations. Results were based on willing participants at a single 4-year primary undergraduate college in the Southeastern United States. The majority of the respondents were women (81%) and White (79%), graduated high school from South Carolina, and were from a middle- to upper middle-class family. This survey utilized “nephrology” as the only term to gauge recognition of the specialty among undergraduate students. Other terms, such as “renal disease” or “kidney disease,” could be included in a subsequent question to gain a greater understanding of undergraduate students’ knowledge of the specialty. Lastly, no questions regarding family history of kidney disease were presented in the survey. Future studies may wish to consider examining whether the percentage of students that were familiar with nephrology were affected or had family members affected by kidney disease to implicate additional correlates for those students who recognized the word “nephrology.”

In conclusion, this is the first study to reveal an unrecognized deficiency in undergraduate word association related to medical specialties. The word “nephrology” appears to be unrecognized by most undergraduate students but significantly more recognized than a fictitious specialty. Future efforts to increase nephrology fellowship applicants may wish to consider addressing this wide gap between nephrology and more popular medical specialties.

Disclosures
J.M. Arthur reports consultancy for Travere; honoraria from Travere; and an advisory or leadership role for Kidney360. J.C.Q. Velez reports consultancy for Bayer, Calliditas, Mallinckrodt Pharmaceuticals, and Travere; honoraria from Bayer, Calliditas, Mallinckrodt Pharmaceuticals, and Travere; and an advisory or leadership role for Bayer, Calliditas, Mallinckrodt Pharmaceuticals, Kidney360, and Travere. All remaining authors have nothing to disclose.

Funding
Funding for this study was provided in part through a grant from the National Institutes of Health/National Institute of Diabetes and Digestive and Kidney Diseases (1R15DK124846-01).

Acknowledgments
This work is in partial fulfillment of the requirements for graduation from the Honors College at the College of Charleston with a Bachelor of Science. We wish to thank the faculty and students at the College of Charleston for their participation in this study. We also wish to thank the two anonymous reviewers for their suggestions and contribution to the discussion. Portions of this work was presented as a poster at Kidney Week, November 2021, and as an oral presentation at the Southern Regional Meeting of the Southern Society of Clinical Investigation, New Orleans, February 2022.

Author Contributions
J.M. Arthur and M.G. Janech were responsible for the conceptualization and supervision; J. Hopkins wrote the original draft of the manuscript; J. Hopkins and M.G. Janech were responsible for data curation and formal analysis; J. Hopkins and J.C.Q. Velez were responsible for the investigation; M.G. Janech and J.C.Q. Velez were responsible for funding acquisition; and all authors were responsible for the methodology and reviewed and edited the manuscript.
Data Sharing Statement

All data are included in the manuscript and/or supporting information.

Supplemental Material

This article contains the following supplemental material online at http://kidney360.asnjournals.org/lookup/suppl doi:10.34067/KID.0002472022/-/DCSupplemental.

Survey Questionnaire

Supplemental Figure 1. Correlation analysis between the fraction of undergraduate students who recognized a medical specialty and applicants per fellowship position across all medical specialties included in the survey.

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Received: May 2, 2022 Accepted: May 25, 2022