

Retrospective Evaluation of the Status of Advanced Dental Education in Prosthodontics from 2006 to 2016

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Abstract: The aim of this study was to analyze information about advanced education programs in prosthodontics (AEPPs) collected in American Dental Association (ADA) surveys on advanced dental education from 2006-07 to 2016-17. Data recorded included number of AEPPs and information on program directors, applicants, and enrollees in AEPPs. The results showed that, from 2006 to 2016, there was an increase in the number of AEPPs and enrollment of prosthodontic residents, and the number of applicants per program more than doubled. Despite these increases, steps are needed to increase the number of underrepresented minority residents in prosthodontics. Also, a periodic survey of prosthodontic residents to identify their goals, experiences during training, and career plans could benefit the specialty by providing more insight into the future prosthodontic workforce.

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Past studies have reported on factors that attract dental school graduates to specialty training, including enjoyment of providing specialty care and salary potential.^{1,2} Specifically for prosthodontics, residents have highlighted the reputation of the program, the use of digital technology, and the opportunity for implant placement as key factors for choosing a program.³ Each year, the American Dental Education Association (ADEA) and American Dental Association (ADA) conduct surveys to collect data on dental school applicants and enrollees, dental students, and graduates as well as advanced dental education programs—including the years 2006-07 to 2016-17 that are covered in our study.⁴⁻⁸ Recently, the American College of Prosthodontists (ACP) conducted a survey of prosthodontists in private practice.⁹ However, assessment of trends in advanced education programs in prosthodontics is needed to provide a picture of the specialty and its development.

The aim of our study was to analyze information about advanced education programs in

prosthodontics (AEPPs) collected in ADA surveys on advanced dental education from 2006-07 to 2016-17. Interpretation of this data can help with strategic planning of the prosthodontic specialty as part of the assessments of future oral health care needs.¹⁰ Trends in application rates, diversity of residents, and educational cost effects on graduates of AEPPs should be examined to ensure that the specialty will be able to support the needs of the population in the years to come.

Methods

The ADA Health Policy Institute conducts annual surveys of advanced dental education, including both dental school and non-dental school-based specialty and postgraduate general dentistry programs.⁸ The data collected include demographic information, enrollments, graduate statistics, and financial information. Advanced dental education programs must

participate in these surveys to retain accreditation status by the Commission on Dental Accreditation (CODA), the organization responsible for accrediting and monitoring the quality of all dental education programs in the U.S.¹¹

For this study, we retrieved and analyzed data on AEPPs that were collected in 2006-16 in the ADA surveys of advanced dental education. Our study focused on the number and duration of AEPPs and basic information on their directors; number of applicants and enrollees in AEPPs; demographic characteristics of enrolled residents in AEPPs; financial information on AEPPs' first-year residents; and enrollment of international dental school graduates in AEPPs. Descriptive analysis of the data was conducted to identify trends and patterns.

Results

The results showed an increase in the number of advanced dental education programs in the decade 2006-16, except in maxillofacial prosthetics (Table 1). The number of AEPPs increased from 44 in 2006 to 48 in 2016. In 2006 and 2007, there were nine maxillofacial prosthetic programs accepting applicants; however, the number of those programs fell to six or seven after that. AEPPs are, on average, the specialist programs that are the third longest in duration (34.9 months), after oral and maxillofacial surgery (54.5 months) and periodontics (35.2 months). According to the most recent CODA standards for the specialty, an AEPP must be at least 34 months to be accredited.¹²

According to the CODA standards, AEPP program directors appointed after January 1, 1997, must be board-certified by the American Board of Prosthodontics.¹² In 2016, only two of the 48 (4.2%)

AEPP directors were not board-certified, and nearly all (n=46, 95.8%) were employed full-time in their institutions.⁸ A similar distribution was found for directors of maxillofacial prosthetics and combined prosthodontics and maxillofacial prosthetics programs. By comparison, in endodontics, 55 of 56 program directors were full-time, and 54 were board-certified; in oral and maxillofacial surgery, all 102 program directors were full-time, and 101 were board-certified; in orthodontics, 63 of 68 were full-time, and 66 were board-certified; in pediatric dentistry, 71 of 78 were full-time, and 76 were board-certified; and in periodontics, 57 of 58 were full-time, and 57 were board-certified.

The number of applications to each AEPP saw a more than twofold increase from 2006 to 2016 (Figure 1). The only exception to this upward trend was in 2013, when there was a slight drop. The greatest increase in the number of applications per program was in 2010: from 29 in 2009 to 34.7 applications per program. A similar but less dramatic increase was seen in the total number of first-year enrollees in AEPPs: that number in 2006 was 157, and it rose to 172 in 2016. Small variations were seen between consecutive years. The total number of residents in all AEPPs increased from 2006 to 2016: from 436 to 480 (Figure 2). The only deviations were in 2010 and 2013, which had slight decreases in number of residents compared to the previous year. The total number of graduates fluctuated slightly from 2006 to 2016.

In 2016, women constituted 37.8% (n=176) of the residents in AEPPs (Figure 3). In comparison, in 2006, the percentage of women residents in AEPPs was 33.2% (n=140). In the years in which data on gender distribution are available, there has been a slight upward trend in the total number of women

Table 1. Number of selected specialty advanced dental education programs, 2006-07 to 2016-17

Specialty	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17
Endodontics	53	53	53	54	54	55	55	56	56	56	56
Oral and maxillofacial surgery	100	100	100	102	103	102	102	101	101	101	102
Orthodontics and dentofacial orthopedics	62	63	63	64	65	66	66	66	66	67	68
Pediatric dentistry	69	73	74	74	76	77	77	77	77	77	78
Periodontics	53	54	54	54	54	54	55	55	56	57	58
Prosthodontics	44	45	45	45	45	45	46	47	47	47	48
Combined prosthodontics-maxillofacial prosthetics	2	2	2	2	2	2	2	2	2	2	1
Maxillofacial prosthetics	9	9	7	6	6	6	6	6	6	6	7
Total	392	399	398	401	405	407	409	410	411	413	418

Source: American Dental Association, Health Policy Institute. Surveys of advanced dental education. Chicago: American Dental Association, 2006-07 through 2016-17.

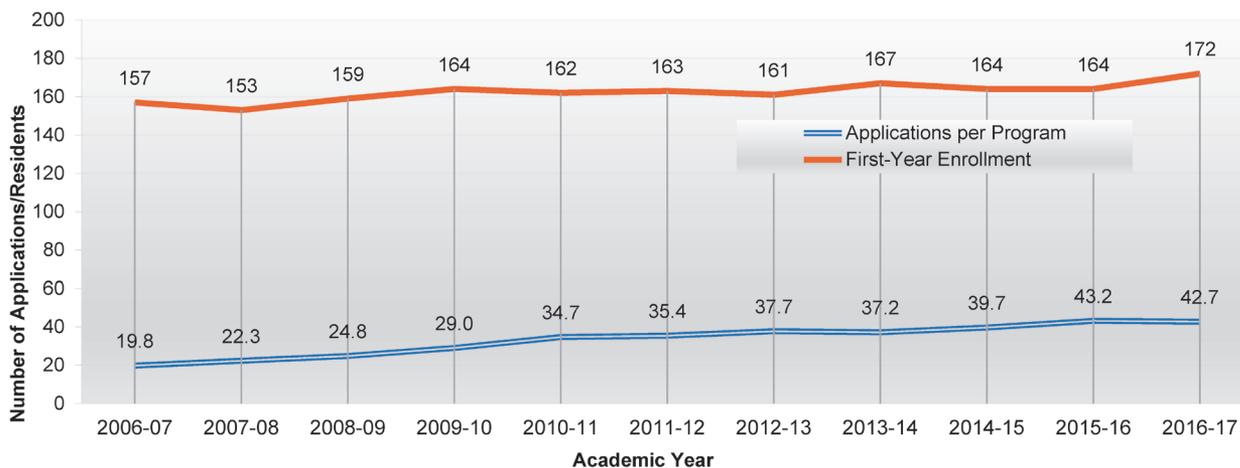


Figure 1. Applications per program and total first-year enrollments in advanced education programs in prosthodontics from 2006-07 to 2016-17 (includes maxillofacial prosthetics and combined prosthodontics-maxillofacial prosthetics programs)

Source: American Dental Association, Health Policy Institute. Surveys of advanced dental education. Chicago: American Dental Association, 2006-07 through 2016-17.



Figure 2. Total enrollment in and graduates of advanced education programs in prosthodontics from 2006-07 to 2016-17 (includes maxillofacial prosthetics and combined prosthodontics/maxillofacial prosthetics programs)

Source: American Dental Association, Health Policy Institute. Surveys of advanced dental education. Chicago: American Dental Association, 2006-07 through 2016-17.

residents. Nevertheless, their percentage of the total has remained below 40%.

In 2016, a significant majority of residents in AEPPs were white, with only eight African American residents (Figure 4). Residents who self-identified as Hispanic/Latino were 43 of 465 residents. Asians were the second most represented race, with 97 (20.8%) residents. Six residents indicated that they

belonged to other ethnic minorities. When we assessed percentages by race/ethnicity over the years, we found the percentage of U.S. residents from other than white racial groups had been decreasing. There were a few exceptions, but they did not affect the overall trend. There were 69 men and 36 women residents who reported they were non-resident aliens in 2016. The percentage of residents who self-identified

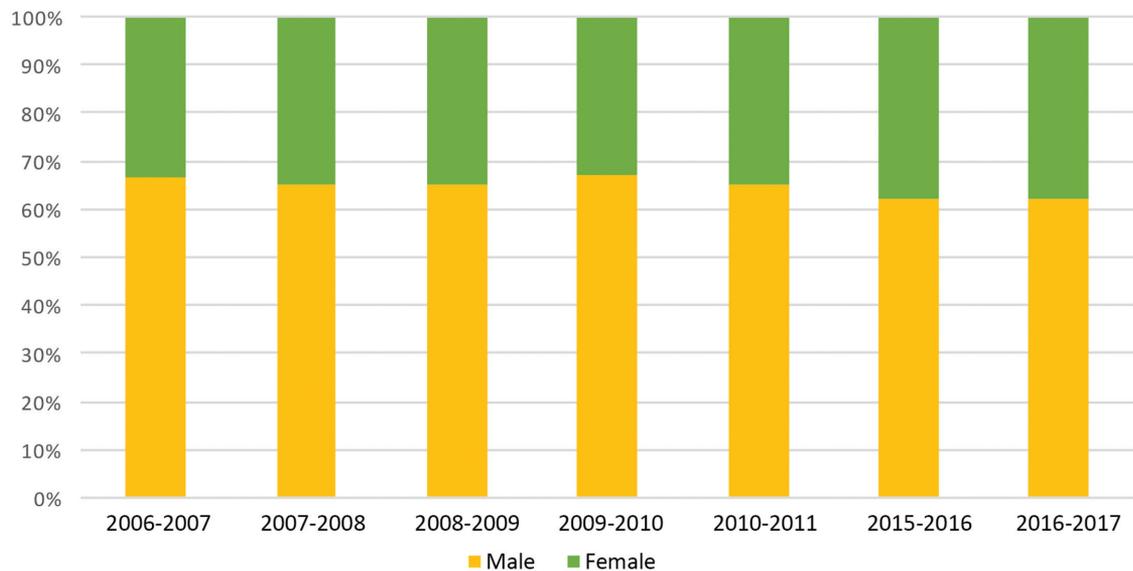


Figure 3. Enrollment in advanced education programs in prosthodontics by gender from 2006-07 to 2010-11, 2015-16, and 2016-17

Source: American Dental Association, Health Policy Institute. Surveys of advanced dental education. Chicago: American Dental Association, 2006-07 through 2016-17. No data are available for 2011-15.

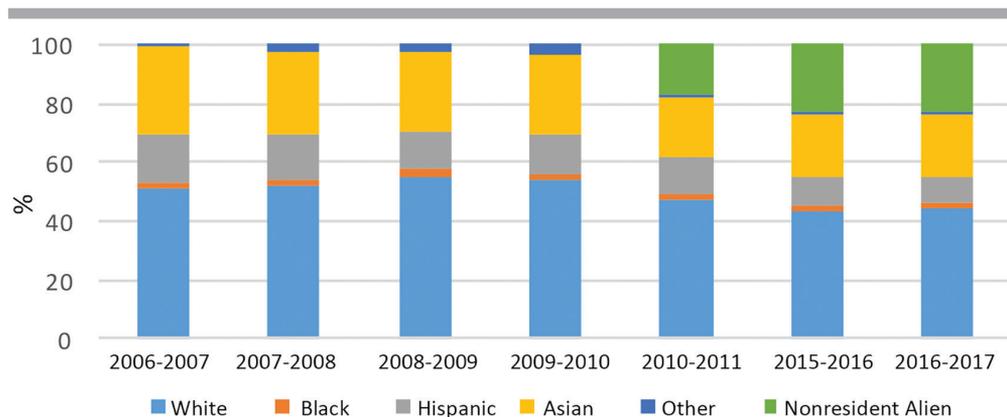


Figure 4. Enrollment in advanced education programs in prosthodontics by race/ethnicity from 2006-07 to 2010-11, 2015-16, and 2016-17

Source: American Dental Association, Health Policy Institute. Surveys of advanced dental education. Chicago: American Dental Association, 2006-07 through 2016-17. No data are available for 2011-15. The category “nonresident alien” was added to the response options in 2010.

as non-resident aliens—a category documented starting in 2010—increased from 17.3% in 2010 to 22.6% in 2016-17.

Average first-year tuition and stipends of AEPPs and other selected specialty programs are shown in Table 2. The program with the highest tuition and fees was the combined prosthodontic and maxillofacial program. However, the stipend outweighed those costs. Twenty-three of 48 (47.9%)

AEPPs had an average tuition of \$31,281 and provided that amount as a stipend to their residents. Sixteen of 48 AEPPs did not provide stipends, and eight offered stipends with no payment of tuition or fees.

AEPPs have traditionally accepted graduates of international dental schools. In 2016, 40 of the 48 programs accepted foreign-trained dentists. AEPPs enrolled the second largest number of foreign-trained dentists (196 out of 465) in 2016 (periodontics had 199).

Table 2. Average first-year resident tuition and fees and stipends, along with number of programs that provide them, by selected specialty program type, 2016-17

Specialty	Tuition & Fees (Excluding \$0 Values)	N	Stipend (Excluding \$0 Values)	N	Both Tuition & Fees and Stipends	Tuition & Fees Only	Stipends Only	Neither Tuition & Fees nor Stipends	Total Programs in Discipline
Endodontics	\$40,988	46	\$26,021	21	16	30	5	5	56
Oral and maxillofacial surgery	\$23,587	22	\$50,732	89	19	3	70	10	102
Orthodontics and dentofacial orthopedics	\$40,892	61	\$22,567	35	29	32	6	1	68
Pediatric dentistry	\$27,854	32	\$47,646	71	25	7	46	0	78
Periodontics	\$33,163	51	\$24,064	27	23	28	4	3	58
Prosthodontics	\$31,281	37	\$28,837	29	21	16	8	3	48
Combined prosthodontics- maxillofacial prosthetics	\$49,083	1	\$54,584	1	1	0	0	0	1
Maxillofacial prosthetics	N/A	0	\$60,061	5	0	0	5	2	7

Source: American Dental Association, Health Policy Institute. Survey of advanced dental education, 2016-17. Chicago: American Dental Association, 2017.

Discussion

In its 2010-11 survey, the ADA noted that it has been conducting the survey of advanced dental education for over 40 years to collect data that are utilized during the accreditation process by CODA.¹³ The information collected provides for a better understanding of characteristics of the applicant pool, enrollees, and current state of the programs that produce future prosthodontists. These data also allow for identifying trends by comparisons over time.

As the number of dental school graduates has steadily increased in the last decade,¹⁴ the number of graduating students interested in pursuing advanced dental education has also grown.¹⁵ This expansion could potentially explain the more than twofold increase in the average number of applications per AEPP from 2006 to 2016. While the number of AEPPs and the number of enrollees in those programs also increased over that decade, those increases are small compared to that of the applicant numbers. In those years, while the number of prosthodontic programs increased from 44 to 48, there was a decrease in the number of combined prosthodontic-maxillofacial programs (from two to one) and maxillofacial prosthetics programs (from nine to seven). In 2016, the four-year combined prosthodontic-maxillofacial prosthetics residency in the Mayo Clinic became three years (AEPP only), and subsequently, the maxillofacial part of the training became a separate one-year fellowship.¹⁶ Since then, the only combined program

in prosthodontics and maxillofacial prosthetics in the U.S. is at the Indiana University School of Dentistry. The number of maxillofacial prosthetics programs decreased from nine in 2006 to seven in 2007. The following year the number decreased to six, which remained the same until 2016 when the opening of a program brought the number back to seven. The reason for this decrease may be changes in leadership or limited financial benefits for the home institutions. Most maxillofacial prosthodontists' practice is focused on general prosthodontic procedures, with only 25% focused on maxillofacial procedures unless their practice is affiliated with the hospital.¹⁷ As a result, potentially reduced interest from prosthodontists to pursue the additional one-year training might have led to a reduced number of programs.

All current program directors in all AEPPs except for two were board-certified in 2016. It could be that those two were in the process of becoming board-certified since program directors are expected to encourage their residents to pursue board certification, as clearly outlined in the CODA accreditation standards.¹² However, there is currently no specific requirement defining the time commitment expected by the director of an AEPP.

An increase in the number of applicants and matriculated residents in AEPPs also occurred from 2006 to 2016. Potential reasons for growing interest in the specialty could be the advances in digital technology and implant prosthodontics, higher income potential than that for a general dentist, and the inspiration of gifted mentors or instructors in predoctoral

education.^{15,18,19} Munoz et al. suggested that job security was another reason based on future projections of increased need for prosthodontists.²⁰ The current interest in prosthodontic advanced training is starkly different from the years before 2001, which saw a consistent decline in the number of applicants pursuing postgraduate studies in prosthodontics.²⁰⁻²² This reversal may be due to the ADA-imposed changes in AEPPs, including that residents be trained in both fixed and removable prosthodontics, leading to an increase in duration of programs from two to three years. Despite the general upward trend in the last decade, the interest of applicants in the specialty needs to be carefully assessed in the changing dental economy environment.¹⁰ Nash and Benting recently reported trends in the income of prosthodontists in private practice that should be considered.⁹

Although the number of women residents in AEPPs increased from 2006 to 2016, their percentage of enrollees is still below 40% (Figure 3). In 2016, women and men graduated from dental school in almost equal proportions.⁵ Among those graduating seniors, 6% more women than men reported that they were pursuing advanced dental education, but that gender proportion was not seen in AEPP enrollments for that year. One study in medical education found that pregnancy and marriage had a greater impact on women residents than men.²³ Showcasing women's success stories in leadership, clinical care, and research in our specialty may attract more women to AEPPs. Initiatives taken in 2016 by ACP celebrating women's contributions to the specialty could help advance this goal.^{24,25}

Racial and ethnic minority enrollment in AEPPs during the decade 2006-16 has been documented with a lapse for 2011 to 2014. During the years for which we have data, there has been a decrease in the percentage of white residents enrolled in AEPPs. Asians were the most represented race after white throughout this decade. However, starting in 2010, the information on race/ethnicity of AEPP residents includes the option "nonresident alien," a term for those who are not U.S. citizens. Nonresident aliens are in the U.S. on a student visa or temporary basis and do not have the right to remain in the U.S. indefinitely. Since the beginning of documenting this category, the number of AEPP residents who are nonresident aliens has been increasing. However, no information about their race/ethnicity is available, so it is impossible to include them in the race/ethnicity percentages.

In general, there is still progress to be made in attracting racial minorities to AEPPs and advanced

dental education in general.²⁶ In predoctoral dental education, there have been initiatives to improve the racial diversity of dental students, including as one part of the Pipeline, Profession, and Practice: Community-Based Dental Education program.²⁷ In 2016, the graduating dental class showed an improvement in racial minority representation although still at a lower level than their representation in the general population.⁵ Over a decade ago, one study noted that availability of financial aid and lower tuition costs were factors that could help certain minorities to pursue dental education.²⁸ More recently, increasing enrollments in postbaccalaureate science programs has been found to help underrepresented minority students gain acceptance to and success in dental school.²⁹ Prosthodontic specialty organizations should invest in innovative ways to improve enrollment in AEPPs for dental graduates from diverse racial groups to ensure that the prosthodontic needs of all members of the population are served.

The cost of dental education has increased steadily from 2006 to 2016 for various reasons.²⁶ As a consequence, the amount of students' debt at graduation or the incentive of a stipend has the potential to be a determining factor for future career choices.^{1,3,30} It is currently unknown to what extent the amount of debt that residents accrue during their advanced prosthodontic training dictates their next career steps. In one of the few studies on this topic, Nazarova et al. reported that the level of debt and reduced financial benefits of academic careers were negative factors for residents of AEPPs contemplating an academic position.³¹ Identifying the importance of the cost of prosthodontic advanced education on the employment choices made by newly graduated prosthodontists is crucial for the future practice of the specialty.

Increased enrollment of foreign-trained dentists in advanced dental education programs coincides with insufficient numbers of U.S. applicants as programs seek to sustain their revenue.³² Munoz et al. reported that, for 1994 to 2002, there were fewer graduates of U.S. dental schools applying to AEPPs than international graduates.²⁰ Al-Sowygh and Sukotjo reported that the number of foreign-trained dentists enrolled in prosthodontic specialty programs was almost 50%, based on an ACP survey in 2002-03.³³ Since then, there has been an increase in the interest of U.S. graduates in pursuing prosthodontic specialty training.³² This increase may be attributable to the wider application of dental implants and digital technology that has regenerated interest in AEPPs. Despite this renewed interest among U.S.

dental school graduates, since the ADA has requested prosthodontic residents to report their immigration status since 2011, the number of residents self-identifying as non-resident aliens has increased steadily. This number most likely correlates with graduates of foreign dental schools who are not permanent residents in the U.S. The evolution of this trend needs to be monitored to ensure that the graduates of AEPPs who stay in the U.S. after graduation will be sufficient to serve the population.

There are some limitations of the data presented in our study. The surveys conducted by the ADA are completed by administrators of the CODA-accredited advanced dental education programs, which raises the possibility of inconsistencies or omissions among the data reported. Another limitation of this type of survey is that no specific information on individual applicants or enrollees was collected. This absence means we cannot draw conclusions about the reasons of non-selection of a specific applicant or failure to enroll in an AEPP. Finally, demographic data on residents for 2011-12 through 2014-15 were not available, leaving a gap in the trends reported.

Conclusion

Our study found that, in the decade 2006 to 2016, the number of applicants per AEPP more than doubled. Despite this positive trend, a careful projection of the future need for prosthodontists in the U.S. should be conducted to ensure there is no excess in graduating prosthodontists and, even more importantly, no shortage in access to care, especially in underserved groups. New strategies need to be implemented to increase the number of underrepresented minority residents. Additionally, the factors that may deter women from pursuing a career in prosthodontics should be examined and addressed. A periodic survey of all prosthodontic residents could provide insights that would allow the specialty to plan for its future in the evolving health care environment.

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