Journal of Dental Sciences 20 (2025) 971–979

Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.e-jds.com

Original Article

Overview of the education system for dental technicians in Taiwan

Yung-Hsun Shih [a†], Feng-Chou Cheng [b,c,d†], Yu-Chieh Lin [e,f], Wei-Chun Lin [a,g**], Chun-Pin Chiang [h,i,j,k*]

[a] *Department of Dentistry, Wan-Fang Hospital, Taipei Medical University, Taipei, Taiwan*
[b] *Chia-Te Dental Clinic, New Taipei City, Taiwan*
[c] *School of Life Science, College of Science, National Taiwan Normal University, Taipei, Taiwan*
[d] *Science Education Center, National Taiwan Normal University, Taipei, Taiwan*
[e] *Digital Medicine Center, Translational Health Research Institute, Vilnius University, Vilnius, Lithuania*
[f] *Institute of Research, Development and Innovation, IMU University, Kuala Lumpur, Malaysia*
[g] *School of Dental Technology, College of Oral Medicine, Taipei Medical University, Taipei, Taiwan*
[h] *Department of Dentistry, National Taiwan University Hospital, College of Medicine, National Taiwan University, Taipei, Taiwan*
[i] *Graduate Institute of Oral Biology, School of Dentistry, National Taiwan University, Taipei, Taiwan*
[j] *Department of Dentistry, Hualien Tzu Chi Hospital, Buddhist Tzu Chi Medical Foundation, Hualien, Taiwan*
[k] *Institute of Dental Medicine and Materials, College of Medicine, Tzu Chi University, Hualien, Taiwan*

Received 11 November 2024
Available online 25 November 2024

KEYWORDS
Education;
Dental technology;
Certified dental technician;
Dental technology school;
Dental team

Abstract *Background/purpose:* Currently, the education and examination system for dental technicians in Taiwan is gradually maturing. This study primarily explored the overview of the Taiwan's dental technology education system and the student numbers from 2017 to 2023.
Materials and methods: This study employed the literature and secondary data analysis to investigate the development of the Taiwan's dental technology education system from 2017 to 2023 and the changes in the number of dental technology students.
Results: Currently, Taiwan had five dental technology schools offering the associate, bachelor's, and master's degrees in the dental technology. The enrollment quotas for the dental technology students determined by the Ministry of Education was reduced from 400 students in 2017 to 387 students in 2023. The number of dental technology students with the official enrollment decreased from 2196 in 2017 to 1720 in 2023 with a reduction rate of 21.68 %.

* Corresponding author. Department of Dentistry, Hualien Tzu Chi Hospital, Buddhist Tzu Chi Medical Foundation, and Institute of Dental Medicine and Materials, College of Medicine, Tzu Chi University, No. 707, Section 3, Chung-Yang Road, Hualien 970. Taiwan.
** Corresponding author. School of Dental Technology, College of Oral Medicine, Taipei Medical University, No. 250, Wu-Xing Street, Taipei, 11031, Taiwan.
E-mail addresses: weichun1253@tmu.edu.tw (W.-C. Lin), cpchiang@ntu.edu.tw (C.-P. Chiang).
† These two authors contributed equally to this work.

https://doi.org/10.1016/j.jds.2024.11.015

Comparing the distribution of the officially enrolled dental technology students in 2023 by the gender, school location, and academic program showed significant differences ($P < 0.001$). Overall, the 46 dental technology-related programs had produced a total of 3330 dental technology graduates (1354 male graduates and 1488 female graduates) over the past seven years. *Conclusion:* The dental technicians, who are primarily responsible for the fabrication and maintenance of the dental prostheses, play an indispensable role in the dental healthcare. However, the number of dental technology students decrease year by year. Therefore, attracting more students to join the dental technology education is a great challenge in Taiwan.

Introduction

In addition to the dentists, the dental healthcare team includes the dental technicians, the dental nurses, the dental hygienists, the dental assistants, the dental office managers, and the community dental health coordinators.[1–4] They have primary responsibilities and are indispensable to the dental healthcare process.[5] Clinically, the fabrication of the dental prostheses is mostly undertaken by the dental technicians.[6,7] Due to the varying needs of each dental patient, the duties of the dental technicians are comprehensive and diverse.[8] Currently, the dental technicians primarily follow the detailed prescriptions from the dentists and use the models of patients' teeth or oral soft tissues to create the dental prostheses.[9] Because there are many types of the dental restorations, the clinical work of the dental technicians is quite complex, requiring the extensive practical teaching experience and certification.[10] The American Dental Association (ADA) indicates that the dental technicians must pass the relevant certification examinations to become the certified dental technicians (CDTs).[11] Taiwan has a comprehensive dental technology education system and licensure policy. In Taiwan, the dental technicians must complete the educational dental technology programs and the clinical internships and pass the national examinations to serve as the CDTs.[8]

The human teeth are unique and require the specially crafted and personalized dental prostheses, such as the crowns, bridges, veneers, removable full dentures, and orthodontic devices.[12–14] The dental technology is both a science and an art. The dental technology education covers the oral histology, biomechanics, art, precision manufacturing, and materials science.[15,16] The dental technicians must be proficient in using the precision instruments and equipment.[17–19] The digital transformation has especially brought changes to the profession of the dental technicians.[20] More importantly, they need to gain the extensive experience through the clinical internships.[21]

Although Taiwan only enacted the Dental Technicians Act in 2009,[8] as early as 1981, the first dental technology educational institution was established with the aim of cultivating professional practice and research talent related to the dental technology. Currently, Taiwan has five schools offering the dental technology education. These dental technology programs offer four-year, five-year, or two-year training options and are distributed across the northern, central, and southern regions of Taiwan. Among them, there are two universities awarding degrees of Master of Science and Bachelor of Science, and three junior colleges granting associate degrees. Therefore, Taiwan currently possesses a very comprehensive dental technology education system. However, analyses of the registration rates, and the numbers of dental technology students and graduates in Taiwan have not yet to be explored.

This study collected the educational data on the dental technicians through the literature review and secondary data analysis. It evaluated the educational systems for the dental technicians in Taiwan, the gender ratio of dental technology students, and the distribution of the talent cultivation. We also tried to evaluate whether there were significant differences in the student registration rates among different dental technology education systems in Taiwan and whether there were significant differences among the student gender ratios, the different academic programs, and the different regions of Taiwan. The results of this study will contribute to the planning and development of the dental technicians within the dental healthcare system.

Materials and methods

This study utilized the literature analysis and secondary data analysis methods to examine the status of Taiwan's dental technician education system. The public information from the Taiwan's Ministry of Education was used to collect the data related to the dental technology schools' enrollment quotas, the number of completed registrations, the total number of the officially enrolled students, and the number of graduates from 2017 to 2023. Through the analyses of the above data, we assessed the changes in dental technology students over the past seven years. The selected data were stored in an excel file and used for the statistical analysis.[22] The collected data were analyzed using JMP 16 software (Statistical Analysis System, Charlotte, NC, USA). The distribution and trends of dental technology students were analyzed across all groups. One-way analysis of variance (ANOVA) and chi-square test were used to evaluate the significance, followed by Tukey's honestly significant difference (HSD) post-hoc test. The *P*-value of less than 0.05 was considered statistically significant.

Results

The educational goals of dental technology school in Taiwan

Currently, Taiwan had five dental technology schools, and all of them were private institutions (Table 1). Among these, there were one medical university, one technological university, and three junior colleges of medical management. The Taipei Medical University and the Central Taiwan University of Science and Technology offered postgraduate programs and awarded the master's degrees in the dental technology field. These universities also provided four-year undergraduate programs and awarded bachelor's degrees in the dental technology. The three dental technology departments within the junior colleges offered five-year and two-year training programs and awarded associate degrees in the dental technology. The four-year undergraduate and two-year training programs recruited the high school graduates, while the five-year training programs recruited the junior high school graduates. In addition, the two-year undergraduate programs (on-the-job) recruited the students with an associate degree or above. Of these five dental technology schools, two were located in the northern Taiwan, one in the central Taiwan, and two in the southern Taiwan. There were no dental technology schools in the eastern Taiwan (Table 1).

The numbers of enrollment quotas of dental technology schools and new dental technology enrollees who completed registration and their registration rate from 2017 to 2023

Over the past seven years (from 2017 to 2023), the enrollment quotas for the dental technology programs determined by the Ministry of Education decreased from 400

Table 1 The education system of dental technology in Taiwan.

Item	School name	School category	Department name	Academic program	Graduation conferring degree	Established time	Location	Region of Taiwan
1	Taipei medical university	Medical university	School of dental technology	Graduate program	Master of science (M.S.)	2017	Taipei city	Northern
2				Undergraduate program	Bachelor of science (B.S.)	2007		
3	Central Taiwan university of science and technology[a]	Technological university	Department of dental technology and materials science	Graduate program	Master of science (M.S.)	2013	Taichung city	Central
4				Undergraduate program	Bachelor of science (B.S.)	1998		
5				Two-year undergraduate program	Bachelor of science (B.S.)	1998		
6	Shu-Zen junior college of medicine and management	Technological college	Department of dental technology	Five-year training program	Associate bachelor of science (A.B.S.)	2006	Kaohsiung city	Southern
7				Two-year training program (on-the-job)	Associate bachelor of science (A.B.S.)	2006		
8	Min-Hwei junior college of health care management	Technological college	Department of dental laboratory technology	Five-year training program	Associate degree of dental technology (A.D.D.T)	2007	Tainan city	Southern
9	St. Mary's junior college of medicine, nursing and management	Technological college	Department of dental technology and digital applications	Five-year training program	Associate bachelor of science (A.B.S.)	2023	Yilan city	Northern

[a] Its five-year training program was established in 1981. It was the first dental technology school in Taiwan. Due to the upgrade, the five-year training program stopped enrolling new students in 1998.

students across 8 programs in 2017 to 387 students across 9 programs in 2023, and the number of newly registered dental technology students also declined from 373 in 2017 to 320 in 2023 (Table 2). Additionally, the registration rate dropped from 93.25 % in 2017 to 82.69 % in 2023, with a significant decrease observed in 2022, when the registration rate was only 71.14 %. The two-year training program (on-the-job) at the junior colleges consistently exhibited the highest registration rates each year. The registration rates for the other programs fluctuated non-linearly, generally ranging between 70 % and 100 %. Notably, the two-year undergraduate program had its lowest registration rates in 2018 (54 %) and 2020 (56 %). The number of the newly registered students showed that the five-year training

Table 2 The numbers of enrollment quotas of dental technology schools and new dental technology enrollees who completed registration and their registration rate from 2017 to 2023.

Years	Program	Number of programs	Number of enrollment quotas	Number of registered students	Registration rate (%)
2017	A	2	10	9	90
	B	2	135	128	94.81
	C	1	50	44	88
	D	2	255	236	92.55
	E	1	110	110	100
	Overall	8	400	373	93.25
2018	A	2	10	7	70
	B	2	135	129	95.56
	C	1	50	27	54
	D	2	255	209	81.96
	E	1	110	110	100
	Overall	8	400	345	86.25
2019	A	2	10	8	80
	B	2	137	126	91.97
	C	1	50	36	72
	D	2	255	234	91.76
	E	1	110	110	100
	Overall	8	402	368	91.54
2020	A	2	10	9	90
	B	2	137	120	87.59
	C	1	50	28	56
	D	2	255	230	90.20
	E	1	100	100	100
	Overall	8	402	359	89.30
2021	A	2	10	10	100
	B	2	137	123	89.78
	C	1	50	44	88
	D	2	255	216	84.71
	E	1	100	100	100
	Overall	8	402	349	86.82
2022	A	2	10	9	90
	B	2	137	95	69.34
	C	1	50	32	64
	D	2	255	182	71.37
	E	1	100	87	87
	Overall	8	402	286	71.14
2023	A	2	10	8	80
	B	2	127	113	88.98
	C	1	50	49	98
	D	3	250	199	79.6
	E	1	100	89	89
	Overall	9	387	320	82.69

A: Graduate program.
B: Four-year undergraduate program.
C: Two-year undergraduate program.
D: Five-year training program of the junior college.
E: Two-year training program (on-the-job) of the junior college.

program at the junior colleges served as the primary source of the dental technology students, followed by the four-year undergraduate program, the two-year training program (on-the-job) at the junior colleges, the two-year undergraduate program, and the graduate program (Table 2).

The mean registration rate was highest for the two-year training program (on-the-job) at the junior colleges (96.57 ± 5.88 %), followed by the four-year undergraduate program (88.29 ± 8.86 %), the graduate program (85.71 ± 9.75 %), the five-year training program at the junior colleges (84.59 ± 7.66 %), and the two-year undergraduate program (74.51 ± 17.11 %) ($P = 0.0112$) (Table 3). The *P*-value for the mean registration rate across the different programs from 2017 to 2023 indicated significant differences between the two-year undergraduate program and the four-year undergraduate program ($P = 0.0210$) as well as between the two-year undergraduate program and the two-year training program (on-the-job) at the junior colleges ($P = 0.0005$) (Table 4). Additionally, there was a significant difference between the five-year training program at the junior colleges and the two-year training program (on-the-job) at the junior colleges ($P = 0.0426$) (Table 4).

The numbers of dental technology students with official enrollment by the gender, school location, and academic program from 2017 to 2023

The number of officially enrolled dental technology students decreased from 2196 in 2017 to 1720 in 2023. By the gender, the number of male students declined from 1040 in 2017 to 630 in 2023, while the number of female students decreased from 1156 in 2017 to 1090 in 2023. The total change rate was −39.42 % and −5.71 % for male students and female students, respectively. The total student number decreased by 476, with a total change rate of −21.68 %, indicating a trend of a negative growth in the dental technology student numbers (Table 5).

Dividing the number of dental technology students by the region, the student enrollment in the northern Taiwan decreased from 177 in 2017 to 158 in 2023. In the central Taiwan, the number of students fell from 600 in 2017 to 405 in 2023, while the southern Taiwan showed a decline from 1417 in 2017 to 1157 in 2023. The total change rate in the student numbers was −11.73 %, −32.50 %, and −18.35 % for the northern, central, and southern regions of Taiwan, respectively. Each region showed a decrease in the student numbers, with the largest decline in the central region of Taiwan (Table 5).

Based on the academic programs offered by the dental technology schools, the number of students in the graduate program (including on-the-job) increased from 14 in 2017 to 18 in 2023. The enrollment in the four-year and two-year undergraduate programs decreased from 765 in 2017 to 545 in 2023. The five-year training program at the junior colleges revealed a reduction from 1200 students in 2017 to 988 students in 2023, while the two-year training program (on-the-job) at the junior colleges dropped from 217 students in 2017 to 169 students in 2023. The total change rate was 28.57 %, −28.76 %, −17.67 %, and −22.12 % for the graduate program, the four-year and two-year undergraduate programs, the five-year junior college program, and the two-year junior college on-the-job program, respectively. Only the graduate program experienced a positive growth, while all the other programs showed a negative growth (Table 5).

Comparing the distribution of officially enrolled dental technology students in 2023 by the gender, school location, and academic program showed that, regardless of location or academic program, the number of female students was significantly higher than male students ($P < 0.001$) (Table 6). Additionally, the number of students in the southern Taiwan was significantly higher than that in the other regions of Taiwan, and the enrollment in the five-year training program at the junior colleges was significantly higher than that in the other programs ($P < 0.001$) (Table 6). Proportionally, the dental technology students were mainly concentrated in the four-year and two-year undergraduate programs and the five-year junior college training program.

The number of dental technology graduates by the gender from 2017 to 2023

Over the past seven years (from 2017 to 2023), the number of dental technology graduates decreased from 488

Table 3 The mean registration rate of dental technology schools by the programs from 2017 to 2023 and their comparison.

Program	Mean ± SD (%)	Lower 95 %	Upper 95 %	F Ratio	*P*-value
A	85.71 ± 9.75	76.68	94.74	3.9210	0.0112[a]
B	88.29 ± 8.86	80.09	96.49		
C	74.51 ± 17.11	58.68	90.34		
D	84.59 ± 7.66	77.50	91.68		
E	96.57 ± 5.88	91.13	102.01		

A: Graduate program.
B: Four-year undergraduate program.
C: Two-year undergraduate program.
D: Five-year training program of the junior college.
E: Two-year training program (on-the-job) of the junior college.
SD: standard deviation.
[a] The significant difference ($P < 0.05$) was determined by one-way analysis of variance (ANOVA).

Table 4 The *P*-value outcome by the comparison of the mean registration rate among the different programs of dental technology from 2017 to 2023.

Program	A	B	C	D
B	0.6521	—	—	—
C	0.0570	0.0210[a]	—	—
D	0.8442	0.5183	0.0849	—
E	0.0645	0.1536	0.0005[a]	0.0426[a]

A: Graduate program.
B: Four-year undergraduate program.
C: Two-year undergraduate program.
D: Five-year training program of the junior college.
E: Two-year training program (on-the-job) of the junior college.
[a] The significant difference ($P < 0.05$) was determined by Tukey's honestly significant difference (HSD) post hoc test.

Table 5 The numbers of dental technology students with the official enrollment by the gender, school location, and academic program from 2017 to 2023.

Year	Number (proportion) of dental technology students				
Gender	Male	Female	—	—	Total
Location	Northern	Central	Southern	—	
Program	A	B And C	D	E	
2017					
Gender	1040 (47.36 %)	1156 (52.64 %)	—	—	2196
Location	177 (8.15 %)	600 (27.32 %)	1417 (64.53 %)	—	
Program	14 (0.64 %)	765 (34.84 %)	1200 (54.64 %)	217 (9.88 %)	
2018					
Gender	981 (46.38 %)	1134 (53.62 %)	—	—	2115
Location	185 (8.75 %)	562 (26.57 %)	1368 (64.68 %)	—	
Program	14 (0.66 %)	733 (34.66 %)	1200 (54.64 %)	221 (10.45 %)	14 (0.66 %)
2019					
Gender	920 (44.77 %)	1135 (55.23 %)	—	—	2055
Location	168 (8.18 %)	537 (26.13 %)	1350 (65.69 %)	—	
Program	13 (0.63 %)	692 (33.67 %)	1126 (54.79 %)	224 (10.90 %)	
2020					
Gender	851 (43.02 %)	1127 (56.98 %)	—	—	1978
Location	171 (8.65 %)	507 (25.63 %)	1300 (65.72)	—	
Program	19 (0.96 %)	659 (33.32 %)	1099 (55.56 %)	201 (10.16 %)	
2021					
Gender	788 (40.74 %)	1146 (59.26 %)	—	—	1934
Location	175 (9.05 %)	491 (25.39 %)	1268 (65.56 %)	—	
Program	23 (1.19 %)	643 (33.25 %)	1076 (55.17 %)	201 (10.39 %)	
2022					
Gender	706 (39.57 %)	1078 (60.43 %)	—	—	1784
Location	166 (9.30 %)	420 (23.54 %)	1198 (67.15 %)	—	
Program	18 (1.01 %)	568 (31.84 %)	1023 (57.34 %)	175 (9.81 %)	
2023					
Gender	630 (36.63 %)	1090 (63.37 %)	—	—	1720
Location	158 (9.19 %)	405 (23.55 %)	1157 (67.27 %)	—	
Program	18 (1.05 %)	545 (31.69 %)	988 (57.44 %)	169 (9.83 %)	
Total change					
Gender	−410	−66	—	—	−476
Location	−21	−195	−260	—	
Program	4	−220	−212	−48	
Total change rate (%)					
Gender	−39.42	−5.71	—	—	−21.68
Location	−11.73	−32.50	−18.35	—	
Program	28.57	−28.76	−17.67	−22.12	

A: Graduate program.
B and C: Four-year undergraduate program and two-year undergraduate program.
D: Five-year training program of the junior college.
E: Two-year training program (on-the-job) of the junior college.

graduates across 6 programs in 2017 to 426 graduates across 7 programs in 2023 (Table 7). The number of male graduates declined from 235 in 2017 to 177 in 2023, while the number of female graduates remained relatively stable, decreasing only slightly from 253 in 2017 to 249 in 2023. Overall, in the past seven years, there were a total of 3330 dental technology graduates across 46 programs, consisting of 1589 male graduates and 1741 female graduates. These results indicated that the five-year training program at the junior colleges produced the highest number of graduates, followed by the four-year and two-year undergraduate programs, the two-year training program (on-the-job) at the junior colleges, and the graduate program.

Discussion

According to Taiwan's Ministry of Education, there were a total of 155 colleges and universities (both public and private) nationwide in 2023, with the dental technology programs offered in only five institutions.[23] Despite this limited number, these schools have continued to train a substantial number of the skilled dental technicians who serve the dental healthcare sector. The dental technology primarily involves the fabrication of intraoral prostheses, which requires a comprehensive understanding of the oral structures and dental morphology, as well as the knowledge of equipment operation and maintenance for the dental

Table 6 The distribution of dental technology students with the official enrollment by the gender, school location, and academic program in 2023.

	Location of dental technology school				Chi-square test
Gender	Northern	Central	Southern	Total	*P*-value
Male	54	169	407	630	$P < 0.001$
Female	140	236	714	1090	
Total	194	405	1121	1720	

	Academic program of dental technology school					Chi-square test
Gender	A	B And C	D	E	Total	*P*-value
Male	7	205	333	85	630	$P < 0.001$
Female	11	340	655	84	1090	
Total	18	545	988	169	1720	

	Location of dental technology school				Chi-square test
Program	Northern	Central	Southern	Total	*P*-value
A	11	7	0	18	$P < 0.001$
B And C	147	398	0	545	
D	36	0	952	988	
E	0	0	169	169	
Total	194	405	1121	1720	

A: Graduate program.
B and C: Four-year undergraduate program and two-year undergraduate program.
D: Five-year training program of the junior college.
E: Two-year training program (on-the-job) of the junior college.

prosthesis production process.[24] The advancements in the digital software and the artificial intelligence have also transformed the landscape of the dental technology.[25–27] As such, the dental technology can be considered a diverse and highly specialized discipline. However, the educational system for dental technicians has received a limited attention. The Taiwan's comprehensive environment for the dental healthcare education includes programs in the dentistry, dental technology, and oral hygiene, reflecting the country's commitment to support the dental healthcare.[4,28,29] This emphasis highlights the Taiwan's dedication to the advanced dental care.

The dental technology education in Taiwan was first established in 1981 by the Central Taiwan University of Science and Technology, which founded a department dedicated to the dental technology. It initially enrolled the students in the five-year training programs. In 1998, due to the upgrade, the five-year training program stopped enrolling new students, while the four-year and two-year undergraduate programs were established (Table 1). Between 2006 and 2007, three other institutions subsequently launched the dental technology departments, including the Shu-Zen Junior College of Medicine and Management, the Taipei Medical University, and the Min-Hwei Junior College of Health Care Management. The graduate programs were introduced later, with the Central Taiwan University of Science and Technology initiating its program in 2013 and the Taipei Medical University following in 2017. In 2023, the St. Mary's Junior College of Medicine, Nursing and Management, located in the northern Taiwan, established a dental technology department that primarily offered a five-year training program. Consequently, the dental technology education in Taiwan provided the various options across the different institutions and different regions of Taiwan.

Table 7 The number of dental technology graduates by the gender from 2017 to 2023.

Year	Program	Number of programs	Number of dental technology graduates		
			Male	Female	Total
2017	A	1	0	4	4
	B And C	2	69	104	173
	D	2	79	128	207
	E	1	87	17	104
	Overall	6	235	253	488
2018	A	1	1	4	5
	B And C	2	93	106	199
	D	2	94	116	210
	E	1	74	24	98
	Overall	6	262	250	512
2019	A	2	4	4	8
	B And C	2	90	116	206
	D	2	89	107	196
	E	1	81	26	107
	Overall	7	264	253	517
2020	A	1	0	2	2
	B And C	2	100	90	190
	D	2	63	117	180
	E	1	75	30	105
	Overall	6	238	239	477
2021	A	2	3	5	8
	B And C	2	70	94	164
	D	2	84	112	196
	E	1	66	32	98
	Overall	7	223	243	466
2022	A	2	8	3	11
	B And C	2	60	107	167
	D	2	56	116	172
	E	1	66	28	94
	Overall	7	190	254	444
2023	A	2	4	5	9
	B And C	2	71	102	173
	D	2	55	112	167
	E	1	47	30	77
	Overall	7	177	249	426
Overall	A	11	20	27	47
	B And C	14	553	719	1272
	D	14	520	808	1328
	E	7	496	187	683
	Overall	46	1589	1741	3330

A: Graduate program.
B and C: Four-year undergraduate program and two-year undergraduate program.
D: Five-year training program of the junior college.
E: Two-year training program (on-the-job) of the junior college.

The registration rate for dental technology students in Taiwan indicated that, despite limited slots in the graduate program, the registration rate did not reach 100 %. This

suggested that the demand among dental technology students for the graduate programs was not particularly strong (Table 2). This trend might be related to the clinical employment landscape, as obtaining a master's degree in the dental technology did not necessarily lead to the higher salary prospects. The two-year undergraduate program displayed the relatively unstable registration rates over the seven years, with the significant drops observed in 2018 (54 %) and 2020 (56 %). In contrast, the registration rates for the other programs remained relatively stable over the past seven years. Interestingly, although a new dental technology educational institution was added in Taiwan in 2023, both the number of enrollment quotas and the number of registered students decreased. This trend highlighted the potential impact of the Taiwan's declining birthrate on the dental technology education.[30]

From 2017 to 2023, the mean registration rate demonstrated significant differences among the different programs ($P = 0.0112$), with the two-year undergraduate program showing the lowest registration rate (Table 3). The primary source of the students for the two-year undergraduate program was the graduates from the five-year training program at the junior colleges in the dental technology. After graduation, the students from the five-year program had the option to either enter the clinical work or pursue the advanced education. As a result, each cohort's continuation rate for the further studies could be influenced by the prevailing job market conditions. The students in the two-year programs (both the two-year undergraduate program and two-year training program of the junior college) appeared to face a greater uncertainty compared to those in the other educational paths, leading to a greater variability in the registration rates (Table 4). This discrepancy might suggest that the students placed a higher value on the four-year or five-year dental technology training programs over the shorter two-year training programs, possibly due to the more comprehensive education offered in the longer programs.

The number of enrolled dental technology students showed a yearly declining trend from 2017 to 2023 (Table 5), with an average decrease of 70 students per year, and a notable reduction of 150 students between 2021 and 2022. This decrease was related to the registration rate, as only 286 students registered in 2022. Coupled with the number of graduates, this significantly reduced the overall student population. In terms of the gender, the student ratio over the previous years was 47.36 % for male students to 52.64 % for female students, but by 2023, the student ratio shifted to 36.63 % for male students and 63.37 % for female students, indicating a growing number of women entering the dental technician profession. There was no significant difference in the student numbers based on the location or the program type. Overall, the student numbers in 2023 were significantly lower than those in 2017, influenced by the decreased registration rates as well as the impact of transfers and withdrawals.

In 2023, significant differences were observed in the number of enrolled students across the gender, location, and program ($P < 0.001$) (Table 6). The female enrollment was higher than the male enrollment across all the locations of Taiwan. Interestingly, the gender ratio was nearly equal in the two-year training program (on-the-job) at the junior colleges. Additionally, the number of enrolled students in the southern Taiwan exceeded that of the other regions of Taiwan, primarily due to the five-year training program and the two-year training program (on-the-job) offered at the junior colleges in the southern region of Taiwan. The northern region provided a greater variety of program options, giving students more choices in terms of the educational paths. Over the past seven years, all the dental technology programs had an average of approximately 476 graduates annually, accumulating to over 3330 graduates in total (Table 7). Interestingly, until 2019, the numbers of the male and female graduates were nearly equal. However, from 2019 onward, the number of female graduates significantly exceeded that of male graduates, suggesting a potential increase in the number of women entering the field as the clinical dental technicians. Thus, the findings of this study indicated that there were significant differences in the registration rates among the dental technology education systems, and there were significant gender ratio differences across the different regions of Taiwan.

The training of dental technicians requires not only technical skills but also a keen artistic eye. The teeth have unique shapes and a wide range of color variations, which demand the careful observation and skill to fabricate a dental prothesis.[31] The clinical internships are essential for enhancing the students' practical experiences, and these are included in the different educational programs. However, the work conditions, salaries, and the environment for clinical dental technicians seem to affect the students' interest in pursuing the dental technology field. Additionally, the faculty availability poses another challenge, as it is difficult to find instructors with both clinical and teaching experiences, a challenge seen across the dentistry, dental technology, and oral hygiene fields.[32] These factors contribute to the declining registration rates, the student enrollment, and the graduation numbers in the dental technology schools. The low birth rate may also play a role in this downward trend. Meanwhile, the rapidly growing aging population has increased the demand for the dental prosthetics, indirectly creating a need for more dental technicians in the clinical roles.[33,34] Therefore, attracting more students to the field of dental technology to meet the clinical demand for the prosthesis fabrication remains a pressing concern.

This study evaluated only the educational status of dental technology students from 2017 to 2023, suggesting the need for further researches into the professional status of dental technicians to better understand the factors contributing to the decline in the student numbers and to propose the effective solutions. Based on the above analysis, the number of dental technology students is in decline, which raises the concerns for the dental healthcare regarding the potential shortage of the dental technology professionals. Preventing a scenario where the dental prostheses are unavailable in the clinical settings is essential. Additionally, offering the favorable working conditions and environments may be an effective strategy to attract more students to the dental technology field.

Declaration of competing interest

The authors have no conflicts of interest relevant to this article.

Acknowledgments

None.

References

1. Inglehart MR, Albino J, Feine JS, Okunseri C. Sociodemographic changes and oral health inequities: dental workforce considerations. *JDR Clin Trans Res* 2022;7:5—15.
2. Cheng FC, Wang LH, Ozawa N, Wang CY, Chang JY, Chiang CP. Dental manpower and treated dental diseases in department of dentistry, Taipei Hospital (the predecessor of National Taiwan University Hospital) in 1923. *J Dent Sci* 2022;17:170—5.
3. Ray M, Lane CK, Rogo EJ. The experiences of dental hygienists providing restorative patient care. *Int J Dent Hyg* 2023;21:669—81.
4. Wang LH, Cheng FC, Liu WC, Tsai PF, Chiang CP. Overview of education system for oral hygienists in Taiwan. *J Dent Sci* 2022;17:1704—13.
5. Wang LH, Cheng FC, Lee MC, Liu SY, Chiang CP. Overview of dental assistants in Taiwan from 2009 to 2021. *J Dent Sci* 2022;17:1640—7.
6. Dobrzański LA, Dobrzański LB. Dentistry 4.0 concept in the design and manufacturing of prosthetic dental restorations. *Processes* 2020;8:525.
7. Mrugalska B, Dovramadjiev T, Pavlova D, et al. Open source systems and 3D computer design applicable in the dental medical engineering industry 4.0—sustainable concept. *Procedia Manuf* 2021;54:296—301.
8. Cheng FC, Lin WC, Chiang CP. Current challenges of dental laboratory in Taiwan: the perspectives from a senior certified dental technician in a dental laboratory attached to a teaching hospital. *J Dent Sci* 2025;20:678—82.
9. Robinson DS. *Modern dental assisting-e-book: modern dental assisting-e-book. Cannada*. Elsevier Health Sciences, 2023.
10. Ray M, Kanderis Lane C, Rogo EJ. Experiences of dental hygienists providing restorative care. *J Dent Hyg* 2023;97:128—42.
11. American dental association. *Dental team careers*. Available from, https://www.ada.org/resources/careers/dental-team-careers. [Accessed 8 November 2024].
12. Tseng CW, Yong CY, Fang CY, Lee SY, Wang YC, Lin WC. Comparative analysis of bonding strength between enamel and overlay of varying thicknesses following an aging test. *J Dent Sci* 2023;18:1850—8.
13. Liu CM, Lin WC, Lee SY. Evaluation of the efficiency, trueness, and clinical application of novel artificial intelligence design for dental crown prostheses. *Dent Mater* 2024;40:19—27.
14. Fan KC, Lin YL, Tsao HW, et al. In vivo evaluation of the effects of sintering temperature on the optical properties of dental glass-ceramics. *Nanomaterials* 2022;12:2187.
15. Skorulska A, Piszko P, Rybak Z, Szymonowicz M, Dobrzyński M. Review on polymer, ceramic and composite materials for CAD/CAM indirect restorations in dentistry—application, mechanical characteristics and comparison. *Materials* 2021;14:1592.
16. Pillai S, Upadhyay A, Khayambashi P, et al. Dental 3D-printing: transferring art from the laboratories to the clinics. *Polymers* 2021;13:157.
17. Han YT, Lin WC, Fan FY, Chen CL, Lin CC, Cheng HC. Comparison of dental surface image registration and fiducial marker registration: an in vivo accuracy study of static computer-assisted implant surgery. *J Clin Med* 2021;10:4183.
18. Chuang CC, Cheng FC, Chen MH, Lin WC, Chiang CP. Comparisons of precision and trueness of digital dental casts produced by desktop scanners and intraoral scanners. *J Dent Sci* 2025;20:137—46.
19. Sahrir CD, Ruslin M, Lee SY, Lin WC. Effect of various post-curing light intensities, times, and energy levels on the color of 3D-printed resin crowns. *J Dent Sci* 2024;19:357—63.
20. Teng TY, Wu JH, Lee CY. Acceptance and experience of digital dental technology, burnout, job satisfaction, and turnover intention for Taiwanese dental technicians. *BMC Oral Health* 2022;22:342.
21. Uoshima K, Akiba N, Nagasawa M. Technical skill training and assessment in dental education. *Jpn Dent Sci Rev* 2021;57:160—3.
22. Cheng FC, Wang YL, Wang LH, Yu-Fong Chang J, Liu SY, Chiang CP. Overview of dental education system and gender distribution of undergraduate dental students in Taiwan. *J Dent Sci* 2023;18:420—7.
23. Taiwan Ministry of Education. *2023 Academic year university and college directory by the ministry of education*. Available from: https://udb.moe.edu.tw/ulist/Map. [Accessed 8 November 2024].
24. Tian Y, Chen C, Xu X, et al. A review of 3D printing in dentistry: technologies, affecting factors, and applications. *Scanning* 2021;2021:9950131.
25. Watanabe H, Fellows C, An H. Digital technologies for restorative dentistry. *Dental Clinics* 2022;66:567—90.
26. Mangano FG, Admakin O, Lerner H, Mangano C. Artificial intelligence and augmented reality for guided implant surgery planning: a proof of concept. *J Dent* 2023;133:104485.
27. Huang C, Wang J, Wang S, Zhang Y. A review of deep learning in dentistry. *Neurocomputing* 2023;554:126629.
28. Cheng FC, He YZ, Wang LH, et al. Comparison of past and current dental school curricula for dental students of National Taiwan University. *J Dent Sci* 2022;17:1169—79.
29. Cheng FC, Wang LH, Ozawa N, et al. Dental technology of Taiwan during the Japanese colonial period. *J Dent Sci* 2022;17:882—90.
30. Tsai MC, Peng SC, Kuo WB. Singlehood and childlessness: an age-period-cohort analysis of changing attitudes toward family in Taiwan (2005-2020). *J Fam Stud* 2023;29:853—74.
31. Newton JT, Subramanian SS, Westland S, Gupta AK, Luo W, Joiner A. The impact of tooth colour on the perceptions of age and social judgements. *J Dent* 2021;112:103771.
32. Sabato E, Doubleday AF, Lee CT, Correa LP, Huja S, Crain G. Recommendations for remaining agile in the face of a dental faculty workforce shortage. *J Dent Educ* 2023;87:295—302.
33. Lipsky MS, Singh T, Zakeri G, Hung M. Oral health and older adults: a narrative review. *Dent J* 2024;12:30.
34. Slack-Smith L, Arena G, See L. Rapid oral health deterioration in older people - a narrative review from a socio-economic perspective. *J Clin Med* 2023;12:2396.