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Original Article

Current practice patterns and training project of orthodontic specialists in Taiwan in 2020

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Abstract *Background/purpose:* There were 661 board-certified orthodontic specialists in Taiwan in 2020. This study reported the current practice patterns and training project of orthodontic specialist in Taiwan.

Materials and methods: This study exploited the secondary data analysis and interview to survey the current practice patterns and training project of orthodontic specialists in Taiwan.

Results: Of the 661 orthodontic specialists, there were 84 registered in the medical centers, 44 in the regional hospitals, 7 in the district hospitals, and 526 in the dental clinics, respectively. There were 20 orthodontic specialist training institutions (15 medical centers, 3 regional

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hospitals, one district hospital, and one dental clinic) that had 218 dentists in orthodontic departments of training institutions and a training capacity of 51 dentists. Of the 20 orthodontic specialist training institutions in Taiwan in 2020, 12 were located in the northern, 4 in the central, and 4 in the southern regions of Taiwan. Moreover, we found none of the training institutions in the eastern and offshore island regions of Taiwan and the number of the orthodontic specialists did increase along with the population and the number of the practicing dentists.

Conclusion: There are three major orthodontic specialist occupation problems in Taiwan: a surplus of the orthodontic specialists in the near future, an uneven distribution of the orthodontic specialists, and a concentration of the orthodontic specialists in the metropolitan areas of the municipalities. Therefore, we suggest that the government and relevant professional groups should propose solutions for these problems as soon as possible.

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Introduction

The medical specialist system in Taiwan started from the implementation of the examination regulations for medical specialist by the Department of Health (after 2013, Department of Health was renamed as the Ministry of Health and Welfare) in 1988. However, the regulations dealt with only medical specialist system, and none of the dental specialist system was mentioned. It was not until the year of 1999, 2001 and 2009, the Department of Health announced the examination regulations regarding the specialists of oral and maxillofacial surgery, oral pathology, and orthodontics, respectively. Therefore, the commencement of the first dental specialist system was begun. In 2018, the Ministry of Health and Welfare announced the examination regulations for dental specialist system and the number of dental specialists increased to 10 classifications. Then, a complete dental specialist system was born in Taiwan. Besides, the examination regulations regarding to the specialists of pediatric dentistry was also passed in 2019.¹

The contents of dental practices are prevention, diagnosis, and treatment of diseases in the oral and maxillofacial region with medical and dental knowledge. The dentists also provide the consultation for oral health.¹ The orthodontics is highly professional, and the development of an experienced orthodontic specialist takes a long time. The practice type of an orthodontic specialist is quite different from that of a general dentist. Orthodontic treatment is a very special oral treatment that takes a long time and the treatment methods and procedures are different from general dentistry. The orthodontics refers to the use of various fixed or movable orthodontic devices and procedures to treat irregular teeth arrangement and unharmonious upper and lower jaw bones to achieve a beautiful, functional and healthy condition in the oral and maxillofacial region.²

Since the American scholar Edward H. Angle created the orthodontic angle system in 1888, orthodontic treatment has a history of more than 130 years. The treatment mode has also evolved from simple tooth movement to treatment and reconstruction of facial and jawbone deformities. The development of orthodontics has progressed from simple angle brackets to various types of orthodontic devices that

are transparent, fast, and light. Orthodontic treatment has become an important part of the development of stomatology today.³

Taiwan Association of Orthodontists (TAO) was founded in 1988, and one of its goals was to perform the examination for the specialist of orthodontics. Before the year of 2009, the orthodontic specialist certificates were issued by the TAO. Since 2009, the Department of Health recognized the orthodontics as one of the classifications in the dental specialist system and then the TAO was responsible for the issue of the orthodontic specialist certificates. The orthodontic specialist certificates issued by the TAO could be renewed by the Department of Health directly and the orthodontic specialist examination was firstly performed in 2009. At that time, 430 qualified orthodontic specialists obtained the certificates issued by the Department of Health.

By regulations, a dentist who wants to become an orthodontic specialist has to finish the two-year training as a general dentist and the two-year training as an orthodontic specialist first, and then he or she can apply for taking the orthodontic specialist examination. After passing the orthodontic specialist examination, he or she can acquire the orthodontic specialist certificate. In average, the number of the dentists who enter the officially recognized specialist training system for becoming orthodontic specialists was 20–25 per year. Till the year of 2020, 704 orthodontic specialist certificates were issued in Taiwan.

Orthodontics was accredited by the government later than oral and maxillofacial surgery as well as oral pathology. However, orthodontics is a popular specialty for dentists to choose. Therefore, the cumulative number of certificates for the specialists of orthodontics soon exceeded that of oral and maxillofacial surgery, and oral pathology. Up to 2020, the cumulative number of certificates issued for the specialists of orthodontics, oral and maxillofacial surgery, and oral pathology were 704, 431 and 80, respectively. It can be seen that there may be the supply and demand problems of orthodontic specialists in Taiwan.

Because of the lack of the studies in the human resources of orthodontic specialists in Taiwan, the main purpose of this study was to survey the current practice patterns of orthodontic specialists and to find the supply and demand problems of orthodontic specialists in Taiwan.

Through this survey, we tried to find the supply and demand problems of orthodontic specialists in Taiwan. In addition, the geographical distribution of orthodontic specialists in Taiwan was also assessed and reported.

Materials and methods

In this study, we adopted the methods of the secondary data analysis and the interview survey to collect the information about the practice patterns of 800 dentist members of the TAO in 2020. There were several ways to collect information for the secondary data analysis, and all of them were open information that could be obtained from the governmental websites. These data were described as follows.

Current practice patterns and working institutions of orthodontic specialists

From the homepage of the TAO, there were 800 dentist members (including 661 board-certified orthodontic specialists) in Taiwan up to the year of 2020. The information of gender and their currently working locations and institutions could be obtained. Besides, their institution levels, which were further divided into medical center, regional hospital, district hospital, and dental clinic by the time of December 2020, could be acquired from searching the open information webpages in the website of the Ministry of Health and Welfare. In addition, with the help of the institution and staff searching system of the Ministry of Health and Welfare, the information of all dentist members (including the board-certified orthodontic specialists) and their practice registration classifications could be obtained. Some of them were registered as the orthodontics, the general dentistry, or the other dental specialties.

Furthermore, for the analysis of the geographical distribution of orthodontic specialists, the whole area of Taiwan was divided into five regions: northern, central, southern, and eastern regions, and offshore islands. The northern region included Taipei City, New Taipei City, Keelung City, Taoyuan City, Hsinchu City, and Hsinchu County. The central region included Miaoli County, Taichung City, Changhua County, Nantou County, and Yunlin County. The southern region included Chiayi City, Chiayi County, Tainan City, Kaohsiung City, and Pingtung County. The eastern region included Yilan County, Hualien County, and Taitung County. Moreover, the offshore islands included Penghu County, Kinmen County, and Lienchiang County.

Orthodontic specialists working in hospitals from 2009 to 2020

We also used *"The current status of medical institutions and statistics on hospital medical services"* published by the Ministry of Health and Welfare to inquire the number of orthodontic specialists working in the hospitals in Taiwan.⁴ Since the investigation of the number of orthodontic specialists started from the year of 2009, the period of interest in this study was from 2009 to 2020. However, this number in 2020 was calculated based on our data in the previous section. Besides, the numbers of the practicing dentists,

newly issued orthodontic specialists, and newly issued dentists every year could also be acquired from searching the open information webpages in the website of the Ministry of Health and Welfare. Based on what we got by this searching approach, the number of orthodontic specialists working in the hospitals per practicing dentists was calculated for the proceeding data.

Current status of orthodontic specialist training institutions and training capacity

From the homepage of the Ministry of Health and Welfare, we found that the orthodontic specialist training institutions that were appointed by the Ministry of Health and Welfare were 19 hospitals and one dental clinic. Moreover, the orthodontic specialist training capacity was 51 dentists for the year of 2020. Meanwhile, through the open information webpages of the Ministry of Health and Welfare, we also knew the locations and institution levels of these 20 training institutions. In addition, through exploiting the institution and staff searching system of the Ministry of Health and Welfare, the numbers of the orthodontic specialists who were registered in the above-mentioned institutions were recorded.

Current status of dental specialties in hospitals of different levels

On the open information webpages of the Ministry of Health and Welfare, the numbers of hospitals of each institution level and those hospitals with dental departments, so-called hospital dentistry, could be obtained. Moreover, the developing status of the departments of dental specialties including the orthodontics, oral and maxillofacial surgery, and oral pathology, in the hospitals of each level could also be understood. Then, we could compare the current status of these 3 dental specialties in hospital dentistry.

We also interviewed the former chief of secretariat and current director of the TAO, Dr. Tsai, Shih-Jaw. With his helps, we confirmed the data for the number of the TAO's dentist members, the number of orthodontic specialist training institutions, and the number of hospitals with orthodontic departments in service. These data were collected via the secondary data analysis to further check and explore whether these board-certified orthodontic specialists actually were in practice. Based on the data and information collected from the methodologies that just mentioned above, these data were stored in excel files and then put into analysis. We hoped that the results of this study could help us to understand the current practice patterns of orthodontic specialists in Taiwan. Moreover, these data could become an important reference for the development of orthodontic specialist training program.

Results

Current practice patterns of orthodontic specialists

In this study, there was a list of 800 dentist members of the TAO, of which 763 were registered to practice (Table 1). We searched each registered member for his or her practice

pattern registered in the websites of the TAO and the Ministry of Health and Welfare, and also interviewed the former chief of secretariat of the TAO to confirm the current practice patterns of these 763 registered members.

The practice patterns of the 763 registered members (399 males and 364 females) in 2020 are described in Table 1. Of the 763 registered members, there were 661 board-certified orthodontic specialists. Among them, there were 12 orthodontic specialists also qualified as specialists in pediatric dentistry and 2 orthodontic specialists also qualified as specialists in oral and maxillofacial surgery. There were 135 practitioners registered to work in hospitals and 526 practitioners registered to work in dental clinics, respectively (Table 1). The remaining 102 registered members without orthodontic specialist qualifications were mainly general dentists. Among them, there were 3 practitioners qualified as specialists in pediatric dentistry and 3 practitioners qualified as specialists in oral and maxillofacial surgery. In addition, there were 16 practitioners registered to work in hospitals and 86 practitioners registered to work in dental clinics, respectively (Table 1).

Based on the above data, for the 661 orthodontic specialists in Taiwan, the percentage of practitioners registered in the hospitals was 20.42% (135/661), and that in the dental clinics was 79.58% (526/661). In addition, for the remaining 102 registered members without orthodontic specialist qualifications, the percentage of practitioners registered in the hospitals was 15.69% (16/102), and that registered in the dental clinics was 84.31% (86/102).

Geographical distribution of orthodontic specialists

The geographical distribution of orthodontic specialists and their registered specialties in Taiwan in 2020 are

shown in Table 2. In summary, of these 661 orthodontic specialists, there were 84 registered in the medical centers, 44 in the regional hospitals, 7 in the district hospitals, and 526 in the dental clinics. In addition, there were 68 and 319 registered in the northern hospitals and dental clinics, 28 and 85 in the central hospitals and dental clinics, 36 and 114 in the southern hospitals and dental clinics, as well as 3 and 8 in the eastern hospitals and dental clinics, respectively. It should be noted that there was no orthodontic specialist registered in Penghu County and offshore islands (Table 2).

Due to the regulations of practice registration for practitioners in Taiwan, dentists who are qualified as dental specialists can choose general dentistry or one of their specialties for registration. Therefore, we also found that there were 99 orthodontic specialists mainly registered in orthodontics, another 33 in general dentistry, 2 in pediatric dentistry, and one in oral and maxillofacial surgery among 135 orthodontic specialists in the hospitals (Table 2). On the other hand, there were 504 orthodontic specialists mainly registered in general dentistry, another 21 in orthodontics, and one in oral and maxillofacial surgery among 526 orthodontic specialists in the dental clinics (Table 2).

The number of orthodontic specialists in the hospitals from 2009 to 2020

According to "The current status of medical institutions and statistics on hospital medical services" published by the Ministry of Health and Welfare and our data in this study,⁴ the numbers of orthodontic specialists in the hospitals and practicing dentists in service in Taiwan from 2009 to 2020 can be obtained and shown in Table 3. From 2009 to 2020, both the orthodontic specialists and practicing dentists in Taiwan increased year by year gradually. The hospital orthodontic specialists increased from 17 to 135, suggesting an increase of approximately 10.73 orthodontic specialists per year. Moreover, the practicing dentists increased from 11,351 to 15,486, suggesting an increase of approximately 375.91 dentists per year (Table 3). However, the hospital orthodontic specialists fluctuated up and down. Those were 17 in year 2009, and they reached to 135 in year 2020. During the period from 2009 to 2020, the hospital orthodontic specialists declined abruptly from 2015 to 2016 and from 2017 to 2018 (Table 3).

Furthermore, the ratio of hospital orthodontic specialists to dentists in service grew from 0.15% to 0.89%. To consider the growth of practicing dentists and compare with the past, the degree of the people in Taiwan shared more hospital orthodontic specialists was better than that for practicing dentists (Table 3). In addition to 430 newly issued orthodontic specialists in the first year 2009 and zero in year 2011, the number of newly issued orthodontic specialists per year ranged from 23 to 36, and the number of newly issued dentists per year ranged from 383 to 495, suggesting that the ratio of newly issued orthodontic specialists to newly issued dentists during this period was approximately 5.61% (274/4887) (Table 3).

Table 1 Practice patterns for 800 dentist members of Taiwan Association of Orthodontists (TAO) in 2020.

Registration patterns	Male	Female	Total
Total members	421	379	800
Members with registration	399	364	763
Members without registration	22	15	37
Registered members with orthodontic specialist qualifications	343	318	661
Orthodontic specialist only	336	311	647
Also pediatric dentistry specialist	7	5	12
Also oral and maxillofacial surgeon	0	2	2
Working in hospitals	74	61	135
Working in dental clinics	269	257	526
Registered members without orthodontic specialist qualifications	56	46	102
General dentistry only	52	44	96
Pediatric dentistry specialist	2	1	3
Oral and maxillofacial surgeon	2	1	3
Working in hospitals	9	7	16
Working in dental clinics	47	39	86

Table 2 Geographical distribution of 661 orthodontic specialists and their registered specialties in Taiwan in 2020.

Institution levels	Hospitals				Dental clinics	Total
	Medical centers	Regional hospitals	District hospitals	Total		
Geographical distribution						
Northern	45	18	5	68	319	387
Central	19	9	0	28	85	113
Southern	19	16	1	36	114	150
Eastern	1	1	1	3	8	11
Total	84	44	7	135	526	661
Registered specialties						
General dentistry	5	21	7	33	504	537
Orthodontics	77	22	0	99	21	120
Pediatric dentistry	2	0	0	2	0	2
Oral and maxillofacial surgery	0	1	0	1	1	2
Total	84	44	7	135	526	661

Table 3 The number of orthodontic specialists working in the hospitals, and the number of dentists in Taiwan from 2009 to 2020.

Year	Number of orthodontic specialists in hospitals	Number of practicing dentists	Number of orthodontic specialists in hospitals/number of practicing dentists (%)	Number of newly issued orthodontic specialists	Cumulative number of issued orthodontic specialists	Number of newly issued dentists
2009	17	11,351	0.15	430 (17) ^a	430	396
2010	31	11,656	0.27	25	455	383
2011	52	11,992	0.43	0	455	403
2012	74	12,391	0.60	33	488	430
2013	77	12,794	0.60	28	516	434
2014	81	13,178	0.61	23	539	448
2015	97	13,502	0.72	24	563	477
2016	91	13,912	0.65	24	587	495
2017	110	14,379	0.77	36	623	461
2018	105	14,717	0.71	25	648	471
2019	116	15,127	0.77	26	674	471
2020	135	15,486	0.89	30	704	414

^a Of these 430 newly issued orthodontic specialists, 413 renewed their licenses issued by Taiwan Association of Orthodontists (TAO) and another 17 passed the orthodontic specialist examination.

Current status of orthodontic specialist training institutions and training capacity

The geographical distribution, institution levels, and training capacity of 20 orthodontic specialist training institutions in Taiwan in 2020 are shown in Table 4. In summary, these 20 orthodontic specialist training institutions (15 medical centers, 3 regional hospitals, one district hospital, and one dental clinic) had a total of 218 dentists registered in their orthodontic departments and an orthodontic specialist training capacity of 51 dentists. Of the 20 orthodontic specialist training institutions in Taiwan in 2020, 12 were located in the northern region, 4 in the central region, and 4 in the southern region of Taiwan. It should be noted that there was no orthodontic specialist training institution in the eastern and offshore island regions of Taiwan (Table 4).

Regarding the orthodontic specialist training capacity, of these 20 orthodontic specialist training institutions, 15 medical centers had the training capacity of 40 dentists, 3 regional hospitals had the training capacity of 6 dentists, and another one district hospital and one dental clinic each had the training capacity of 2 and 3 dentists, respectively (Table 4). Of the training capacity of 51 dentists for orthodontic specialist training in Taiwan in 2020, 31 were trained in the northern region, 8 in the central region, and 12 in the southern region of Taiwan. It should be noted that there was no orthodontic specialist training institution in the eastern region of Taiwan (Table 4).

We also found that there were 9 training institutions with the training capacity of 25 dentists in Taipei City, one training institution with the training capacity of one dentist in New Taipei City, 2 training institutions with the training

Table 4 Geographical distribution, institution levels, and the training capacity of 20 orthodontic specialist training institutions in Taiwan in 2020.

Geographical distribution in Taiwan	Institution levels				Total number of institutions (Training capacity, %)	Number of dentists registered in orthodontic departments of training institutions ^a
	Medical centers (Training capacity, %)	Regional hospitals (Training capacity, %)	District hospital (Training capacity, %)	Dental clinic (Training capacity, %)		
Northern	8 (22, 43.1%)	2 (4, 7.8%)	1 (2, 3.9%)	1 (3, 5.9%)	12 (31, 60.8%)	127 (58.3%)
Central	3 (6, 11.8%)	1 (2, 3.9%)	0	0	4 (8, 15.7%)	33 (15.1%)
Southern	4 (12, 23.5%)	0	0	0	4 (12, 23.5%)	58 (26.6%)
Total	15 (40, 78.4%)	3 (6, 11.8%)	1 (2, 3.9%)	1 (3, 5.9%)	20 (51, 100%)	218 (100%)

^a The total number of dentists registered in orthodontic departments, including general dentists and specialists.

capacity of 5 dentists in Taoyuan City, 3 training institutions with the training capacity of 6 dentists in Taichung City, 2 training institutions with the training capacity of 5 dentists in Tainan City, and 2 training institutions with the training capacity of 7 dentists in Kaohsiung City, as well as one training institution with the training capacity of 2 dentists in Changhua County, suggesting that there was 49.01% (25/51) training capacity concentrated in Taipei City, and 96.08% (49/51) training capacity concentrated in municipalities.

Current status of dental specialties in hospitals of different levels

In Taiwan, there were 467 hospitals (excluding 4 children's hospitals) of all levels in 2020, including 21 medical centers, 87 regional hospitals, and 359 district hospitals (Table 5). Of the 180 hospitals with dental departments, 21 were medical centers, 76 regional hospitals, and 83 district hospitals. In these 180 hospitals, we further surveyed whether they had the departments of the orthodontics, the oral and maxillofacial surgery, and/or the oral pathology. We found that 37 hospitals had the orthodontic departments, including 21 medical centers, 15 regional hospitals, and one district hospital. In addition, there were 62 hospitals that had the oral and maxillofacial surgery departments and 19 hospitals that had the oral pathology departments (Table 5). The above findings demonstrate that the development of the orthodontics in hospital dentistry is later than the oral and maxillofacial surgery or the oral pathology, but its development is relatively faster and better.

Discussion

The orthodontics is a clinical compulsory course in the school of dentistry, which is also a popular choice for the career development of new-entry dentists. The orthodontic treatment is a very special oral treatment, which takes a long time for each patient, and the treatment method and procedure are different from the general dental treatment. The orthodontics is the use of various fixed or movable orthodontic devices and surgical procedures to treat irregular teeth arrangement and unharmonious jaw bones to achieve a beautiful, functional, and healthy facial and dental systems. In Taiwan, as early as the 1950s, orthodontic technology has been introduced in a few teaching hospitals. In fact, Taipei Hospital (the predecessor of National Taiwan University Hospital) had provided orthodontic treatment a hundred years ago. In the past 30 years, Taiwan's dental technology has developed vigorously, and the people's awareness of oral health care has increased. The orthodontic treatment has become fashionable in Taiwan.^{2,3}

In 2009, the Taiwan's Department of Health recognized the orthodontics as a dental specialty. The orthodontic specialists have developed a strict training and examination system, which results in a significant improvement in Taiwan's orthodontic specialty.³ Although the implementation of national health insurance in 1995 does not cover the cost of the orthodontic treatment, the average income and life quality of an orthodontic specialist are relatively better than those of a general dentist or other dental specialist. The orthodontics has continued to develop well in Taiwan. For example, oral and maxillofacial surgery, oral pathology, and orthodontics were recognized by the government as dental

Table 5 Overview of numbers of hospitals with dental departments in all levels of hospitals in 2020^a.

	Medical centers	Regional hospitals	District hospitals	Total
Total number of hospitals	21	87	359	467
Hospitals with dental departments	21	76	83	180
Hospitals with orthodontic departments	21	15	1	37
Hospitals with oral and maxillofacial surgery departments	21	35	6	62
Hospitals with oral pathology departments	14	4	1	19

^a Excluding children's hospitals, currently there are 4 children's hospitals in Taiwan, all of which are medical centers, of which 3 have dental departments.

specialists in the year of 1999, 2001 and 2009. Up to 2020, the cumulative numbers of certificates issued for the specialists of oral and maxillofacial surgery, oral pathology, and orthodontics were 431, 80 and 704, respectively. In addition, the specialist training capacity for the above three specialists were 46, 10, and 51 dentists, respectively, in 2020. In Taiwan, the orthodontics has already become the largest dental specialist group recognized by the government.

This study firstly aimed to understand the current practice patterns of orthodontic specialists. We collected the information about 800 dentist members of the TAO. Among them, there were 763 members with registration, suggesting that the majority of the dentist members are still in practice. However, there were 37 members without registration and they did not engage in dental services. The possible reasons were that they were in advanced studies for a master or a PhD degree, engaged in teaching and researching, and retired or died. We also discovered that of the 763 registered members, there were 661 board-certified orthodontic specialists. The remaining 102 registered members were general dentists only or other dental specialists. These findings indicate that only 13.37% (102/763) of the registered members do not have the orthodontic specialist qualifications. Since the TAO members must be dentists who have completed the specialist training, these members without orthodontic specialist qualifications may not have passed the specialist qualifications, or they may have obtained orthodontic specialist qualifications but have not renewed their certificates. However, among the 763 registered members, 20 dentists also had other specialties, including 15 orthodontic specialists who also had certificates of pediatric dentistry specialists. It may be due to the overlap of the two specialties in the field of orthodontics for children and adolescents. It is also possible that some dentists try to possess two specialties in their careers.

A large number of dental clinics in Taiwan and a high proportion of total dentists working in these dental clinics are two characteristic features of Taiwan's dental status. However, the ratio of dental clinic dentists to the total practicing dentists increased from 78.36% (2930/3739) in 1986 to the highest point 87.26% (9372/10,740) in 2007, and then decreased to 85.55% (12,941/15,127) in 2019. In fact, this ratio exceeded 85% (85.11%, 7013/8240) in 1999 and lasted for 20 years.^{5–8} On the other hand, the ratio of hospital dentists to the total practicing dentists increased from 12.74% in 2007 to 14.45% in 2019. It might be related to the implementation of the postgraduate year training program for dentists (PGYD) in 2010 and a complete dental specialist system born in 2018. The implementation of these new systems may attract more dentists to receive either PGYD or specialist training or both in the hospitals.⁸ In our study, of these 763 registered members, there was 19.79% (151/763) of them working in the hospitals. In addition, of 661 board-certified orthodontic specialists, there was 20.42% (135/661) of them working in the hospitals. To compare with overall practicing dentists, there is still a higher proportion of orthodontic specialists working in the hospitals.

Furthermore, the urban-rural gap and the unbalanced distribution of practicing dentists have been problems for a

long time.^{6,7,9–11} According to the statistics from Taiwan Dental Association, there were 15,486 practicing dentists in Taiwan in 2020. In summary, of the total practicing dentists, there were 12,497 (80.70%) who worked in municipalities, 8252 (53.29%) in the northern region of Taiwan, and 3450 (22.28%) in the Taipei City.¹² However, according to our findings, there were 661 board-certified orthodontic specialists in Taiwan in 2020. Of the total orthodontic specialists, there were 575 (86.99%) who worked in municipalities, 387 (58.55%) in the northern region of Taiwan, and 239 (36.16%) in Taipei City. Besides, of the total orthodontic specialist training capacity of 51 dentists, there were 49 (96.08%) who were trained in municipalities, 31 (60.78%) in the northern region of Taiwan, and 25 (49.02%) in Taipei City. Therefore, the urban-rural gap and the unbalanced distribution of orthodontic specialists are more serious than those of practicing dentists. For example, there was no board-certified orthodontic specialist in Penghu County and offshore islands. Similarly, these problems are more extreme and serious in the allocation of the orthodontic specialist training capacity, which may be a hidden worry about the imbalance in the distribution of manpower for orthodontic specialists in the future.

In our study, the practice registration of orthodontic specialists in the hospitals was mainly registered in orthodontics (73.33%, 99/135), while the practice registration of those in dental clinics is mainly registered in general dentistry (95.82%, 504/526). However, due to the regulations of practice registration for practitioners in Taiwan, what kind of dental specialty is registered does not affect the scope and content of a dentist's practice. Therefore, the registration of specialties does not substantially affect the practice content of a dentist in Taiwan.

In our previous studies related to the human resource in dentistry, the findings indicated that all the human and training resources of dental specialists were concentrated in the medical centers and in the northern region of Taiwan.^{9,13–16} This study also showed the similar results that there were 12 (60%) of the 20 orthodontic specialist training institutions located in the northern region of Taiwan, especially 9 (45%) in Taipei City. Of these training institutions, 15 (75%) were qualified as medical centers. This could be due to the fact that a medical center can provide better training environment and abundant supporting systems for the orthodontics.

We also found that there was a more proportionate growth of orthodontic specialists along with the increase of the practicing dentists in Taiwan. The number of practicing dentists per 100,000 people in Taiwan grew year by year, demonstrating that the quantity of the practicing dentists for Taiwanese people are elevated and become better.¹ Furthermore, the number of hospital orthodontic specialists per practicing dentists also grew year by year. This ratio grew from 0.15% in 2009 to 0.89% in 2020, demonstrating that the growth rate of the hospital orthodontic specialists is higher and better than that of the practicing dentists. From 2009 to 2020, the growth rates of the newly issued orthodontic specialists and the practicing dentists were 63.72% (274/430) and 36.43% (4135/15,351), respectively, also indicating that the number of the orthodontic

specialists for Taiwanese people is elevated and becomes better. In average, the number of newly issued orthodontic specialists per newly issued dentists was approximately 5.61% (274/4887).

The proportion of dental specialists practicing in private clinics in USA accounted for approximately 14.4% of the total number of dentists. Among these dental specialists, the proportion of orthodontic specialists was the largest. In addition, each orthodontic specialist in USA had to serve 33,640 people in average in 2006.¹⁰ Using the same proportion for calculation, the required number of orthodontic specialists for the population of Taiwan in 2020 was 700. Taiwan currently has 661 board-certified orthodontic specialists in service in 2020. Although the demand of 700 specialists based on the American standard has not yet been met, due to the negative growth of Taiwan's population for the first time in 2020 and approximately 25 newly issued orthodontic specialists per year, it is estimated that the number of orthodontic specialists in Taiwan will exceed the demand of 700 orthodontic specialists in 2022.

Due to the better income and life quality of an orthodontic specialist, there are still many new-entry dentists choosing to engage in the field of orthodontics in the future. Therefore, the number of orthodontic specialists in the future may be too over and even increases rapidly in a short time. In addition, the dentists without orthodontic specialist qualifications in Taiwan can also perform the orthodontic treatment. Therefore, it can be inferred that the number of dentists actually engaged in the orthodontic treatment should have already far exceeded the demand.

The development of the orthodontics in Taiwan has lasted for 30 years since the foundation of the TAO, and the orthodontic specialist is also one of the earliest officially recognized classifications of dental specialist. In addition, the orthodontics is currently the largest dental specialist group recognized by the Taiwan government. Nevertheless, according to the findings of this study, we conclude that there are three major orthodontic specialist occupation problems in Taiwan. First, in a short time, there may be an oversupply of the orthodontic specialists after 2022. Second, the current distribution of the orthodontic specialists is extremely unbalanced, even more unbalanced than that of practicing dentists. Third, the orthodontic specialists are very concentrated in the metropolitan areas of the municipalities with a serious urban-rural gap, which is also more serious than that of practicing dentists. Therefore, we suggest that the government and relevant professional groups should propose solutions for the above problems as soon as possible.

Declaration of competing interest

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

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