Distributions of dental freshmen enrolled by northern, central, and southern dental schools in each city or county and different regions of Taiwan in 2020

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Abstract Background/purpose: In Taiwan, the uneven distribution and the urban-rural gap of dentists are long-standing problems. Thus, the regional balance of domestic dental schools and their students are very important for the further distribution of practicing dentists. The main purpose of this study was to evaluate the distributions of dental freshmen enrolled by dental schools of general universities in each city or county and different regions of Taiwan in 2020. Materials and methods: This study mainly collected the number of dental freshmen enrolled by the northern, central, and southern dental schools and further evaluated their distributions in each city or county and different regions of Taiwan in 2020. Results: The distribution of dental freshmen in Taiwan in 2020 did have a regional imbalance. These dental freshmen were mainly concentrated in municipalities, cities with dental schools, and the northern region of Taiwan. The enrolled dental freshmen tended to choose a dental
Introduction

The uneven distribution and the urban-rural gap of medical resources in Taiwan are long-standing problems, and the same problems also exist in dental resources. The dentist manpower is the most important part of dental resources. However, the locations of dental schools and the distribution of dental students have an impact on the distribution of practicing dentists. There are 8 universities with dental schools or departments of dentistry in Taiwan, of which 7 are general universities and one is the military university. Furthermore, the time for the establishment of these 7 dental schools of general universities and their locations are as follows: the National Taiwan University was established in 1953, Taipei Medical University in 1960, and National Yang Ming Chiao Tung University in 1976 in Taipei City; the Chung Shan Medical University was established in 1960 and China Medical University in 1980 in Taichung City; the Kaohsiung Medical University was established in 1957 in Kaohsiung City; and the National Cheng Kung University was established in 2019 in Tainan City.

The Taiwan's government considered the regional balance of domestic dental schools, so the government decided to establish the 8th dental department of National Cheng Kung University in the southern region of Taiwan. However, the newly-established 8th dental department and the previously-established dental schools have a difference of nearly 40 years in their establishment time. The main reason considered by the government is that the establishment of the Department of Dentistry of National Cheng Kung University can balance the difference in dental resources between the northern and southern regions and reduce the gap in dental resources between urban and rural areas. The cities or counties where medical practitioners choose to open new clinics are quite geographically related, especially the locations of their enrolled universities and training hospitals. However, four Taiwan's dental schools are located in Taipei City, two in the former Taichung City, one in the former Kaohsiung City, and one in the former Tainan City. Moreover, the training hospitals for dental students are also mainly in areas of a high degree of urbanization. Therefore, the relationship between the dental freshmen enrolled by dental schools of different regions and those from different geographic regions of Taiwan is worth exploring.

In Taiwan, the recruitment of dental students has undergone for 66 years and the earliest dental students were recruited in the Department of Dentistry of National Taiwan University through the university entrance examination in 1955. However, there were no detailed analyses on the distributions of dental freshmen enrolled by the northern, central, and southern dental schools in each city or county and different regions of Taiwan in 2020. In addition, there were also no detailed analyses on the distributions of dental freshmen from each city or county and from different regions of Taiwan in the northern, central, and southern dental schools in Taiwan in 2020. In addition, this study also assessed whether there was a similar tendency between the distributions of dental freshmen and the distributions of practicing dentists in different cities or counties and different regions of Taiwan in 2020.

Materials and methods

This study used the secondary data analysis to collect the information about the numbers of practicing dentists and dental students enrolled by the seven dental schools or departments from 7 general universities in Taiwan in 2020. This information was open to access and could be collected from the related websites.

The information of overall practicing dentists in 22 cities and counties of Taiwan in May 2020 was available from the Newsletter of Taiwan Dental Association. Based on our previous study,1 we also obtained the information of enrolled dental freshmen in 2020 from the website of the Joint Board of College Recruitment Commission. In addition, this information included the dental schools and examination areas of enrolled dental freshmen. According to the locations of the examination rooms in different examination areas of Taiwan, we could find the locations of the cities or counties where enrolled dental freshmen came from.

The dental schools of Taiwan could be divided into three groups according their locations: northern, central and southern dental schools. 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, Kaoshiung 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. In addition, the whole area of Taiwan could also be divided into two groups: municipalities and non-municipalities. Moreover, the whole area of Taiwan could also be divided into two groups: cities with dental schools as well as cities and counties without dental schools. For statistical analysis, Mann–Whitney U test was used for comparisons of data between two subgroups, and Kruskal–Wallis test was used for comparisons of data among three or more subgroups.

Results

Distributions of enrolled dental freshmen in northern, central and southern dental schools and in 22 cities and counties of Taiwan in 2020

The distributions of enrolled dental freshmen in northern, central and southern dental schools and in 22 cities and counties of Taiwan in 2020 are shown in Table 1. There were a total number of 386 enrolled dental freshmen accepted by the admission system of the Joint Board of College Recruitment Commission in 2020. Of these 386 enrolled dental freshmen, Taipei City was the city with the largest number of enrolled dental freshmen (108, 27.98%), and Nantou County, Hualien County, and Kinmen County were the counties with the smallest non-zero number of enrolled dental freshman (1, 0.26%) among all cities and counties in Taiwan (Table 1). It should be noted that there was none of enrolled dental freshman in Chiayi County and Taitung County. The mean number of enrolled dental freshmen in one city or county in Taiwan was 17.55 (386/22). Thus, there were 15 of the 22 cities and counties with 17 or fewer enrolled dental freshmen that were below the mean number of 17.55 enrolled dental freshmen nationwide (Table 1).

One hundred and fifty-four dental freshmen were enrolled by the northern dental schools. Taipei City was the city with the largest number of dental freshmen enrolled by the northern dental schools (57, 37.01%), and Hsinchu and Lienchiang Counties were the counties with the smallest non-zero number of dental freshmen enrolled by the northern dental schools (1, 0.65%) among 22 cities and counties in Taiwan (Table 1). It should be noted that there were 7 counties without any dental freshmen enrolled by the northern dental schools. The mean number of dental freshmen enrolled by the northern dental schools in one city or county of Taiwan was 7 (154/22). Thus, there were 15 of the 22 cities and counties with 6 or fewer enrolled dental freshmen that were below the mean number of 7.

Table 1 Distributions of enrolled dental freshmen in northern, central and southern dental schools and in 22 cities and counties of Taiwan as well as distributions of overall practicing dentists in 22 cities and counties of Taiwan in 2020.

|                    | Northern dental schools | Central dental schools | Southern dental schools | Total | Overall practicing dentists |
|--------------------|-------------------------|-----------------------|-------------------------|-------|----------------------------|
| Municipalities     |                         |                       |                         |       |                            |
| (n = 6)            |                         |                       |                         |       |                            |
| Taipei City        | 57                      | 34                    | 17                      | 108   | 3373                       |
| New Taipei City    | 10                      | 7                     | 8                       | 25    | 2673                       |
| Taoyuan City       | 7                       | 7                     | 4                       | 18    | 1218                       |
| Taichung City      | 21                      | 32                    | 15                      | 68    | 1979                       |
| Tainan City        | 11                      | 14                    | 14                      | 39    | 1136                       |
| Kaohsiung City     | 17                      | 8                     | 23                      | 48    | 1867                       |
| Non-municipalities |                         |                       |                         |       |                            |
| (n = 16)           |                         |                       |                         |       |                            |
| Keelung City       | 2                       | 1                     | 0                       | 3     | 186                        |
| Hsinchu City       | 6                       | 6                     | 3                       | 15    | 342                        |
| Chiayi City        | 9                       | 5                     | 6                       | 20    | 232                        |
| Hsinchu County     | 1                       | 0                     | 1                       | 2     | 251                        |
| Miaoli County      | 0                       | 1                     | 1                       | 2     | 183                        |
| Changhua County    | 5                       | 5                     | 7                       | 17    | 587                        |
| Nantou County      | 0                       | 1                     | 0                       | 1     | 167                        |
| Yunlin County      | 3                       | 0                     | 1                       | 4     | 185                        |
| Chiayi County      | 0                       | 0                     | 0                       | 0     | 110                        |
| Pingtung County    | 0                       | 3                     | 0                       | 3     | 208                        |
| Penghu County      | 2                       | 0                     | 1                       | 3     | 36                         |
| Yilan County       | 2                       | 1                     | 2                       | 5     | 184                        |
| Hualien County     | 0                       | 0                     | 1                       | 1     | 149                        |
| Taitung County     | 0                       | 0                     | 0                       | 0     | 66                         |
| Kinmen County      | 0                       | 1                     | 0                       | 1     | 19                         |
| Lienchiang County  | 1                       | 2                     | 0                       | 3     | 4                          |
| Nationwide (n = 22)| 154                     | 128                   | 104                     | 386   | 15,155                     |
| Mean               | 7                       | 5.82                  | 4.73                    | 17.55 | 688.86                     |
dental freshmen enrolled by the northern dental schools (Table 1).

A total of 128 dental freshmen were enrolled by the central dental schools. Taipei City was also the city with the largest number of dental freshmen enrolled by the central dental schools (34, 26.56%). There were 5 cities or counties with the smallest non-zero number of dental freshmen enrolled by the central dental schools (1, 0.78%) among 22 cities and counties in Taiwan. It should be noted that there were 6 cities or counties without any dental freshmen enrolled by the central dental schools. The mean number of dental freshmen enrolled by the central dental schools in one city or county of Taiwan was 4.73 (104/22). Thus, there were 15 of the 22 cities and counties with 5 or fewer enrolled dental freshmen that were below the mean number of 5.82 dental freshmen enrolled by the central dental schools (Table 1).

A total of 104 dental freshmen were enrolled by the southern dental schools. Kaohsiung City was the city with the largest number of dental freshmen enrolled by the southern dental schools (23, 22.12%). There were 5 counties with the smallest non-zero number of dental freshmen enrolled by the southern dental schools (1, 0.96%) among 22 cities and counties of Taiwan. It should be noted that there were 7 cities and counties without any dental freshmen enrolled by the southern dental schools. The mean number of dental freshmen enrolled by the southern dental schools in one city or county of Taiwan was 4.73 (104/22). Thus, there were 15 of the 22 cities and counties with 4 or fewer enrolled dental freshmen that were below the mean number of 4.73 dental freshmen enrolled by the southern dental schools (Table 1).

**Distribution of overall practicing dentists in 22 cities and counties of Taiwan in 2020**

The number of overall practicing dentists in 22 cities and counties of Taiwan in 2020 are shown in Table 1. There were a total number of 15,155 practicing dentists in May 2020. Of the 15,155 practicing dentists, Taipei City was the city with the largest number of practicing dentists (3373, 22.26%), and Taitung County and offshore islands (Penghu County, Kinmen County and Lienchiang County) were the counties with fewer than 100 practicing dentists among 22 cities and counties of Taiwan (Table 1). It should be noted that Taitung County was the county with the smallest number of practicing dentists (66, 0.44%) among all cities and counties on the main island of Taiwan, while Lienchiang County was the county with the smallest number of practicing dentists (4, 0.03%) among 3 offshore islands of Taiwan (Table 1). The mean number of practicing dentists in one city or county of Taiwan was 688.86 (15,155/22). Thus, there were 16 (all belong to non-municipalities) of the 22 cities and counties with 587 or fewer practicing dentists that were below the mean number of 688.86 practicing dentists nationwide (Table 1).

**Comparisons of enrolled dental freshmen from different regions of Taiwan in 2020**

Comparisons of enrolled dental freshmen from different regions of Taiwan in 2020 are shown in Table 2. The enrollment number or rate of dental freshmen from municipalities (306 or 79.27%) was significantly higher than that from non-municipalities (80 or 20.73%, \( P < 0.001 \)). Moreover, 123, 102, and 81 dental freshmen from municipalities and 31, 26, and 23 dental freshmen from non-municipalities were enrolled by the northern, central and southern dental schools, respectively. Thus, the dental freshmen enrollment rates in the northern dental schools (31.87%), the central dental schools (26.42%), and the southern dental schools (20.98%) for the 306 dental freshmen from municipalities were all significantly higher than the corresponding dental freshmen enrollment rates (8.03%, 6.74%, and 5.96%, respectively) for the 80 dental freshmen from non-municipalities of Taiwan (Table 2).

We also found that the enrollment number or rate of dental freshmen from cities with dental schools (263 or 68.13%) was significantly higher than that from cities and counties without any dental schools (123 or 31.87%, \( P < 0.001 \)) (Table 2). In addition, the dental freshmen enrollment numbers or rates in the northern dental schools (27.46%), the central dental schools (22.80%), and the southern dental schools (17.88%) for the 263 dental freshmen from cities with dental schools were all significantly higher than the corresponding dental freshmen enrollment rates (12.44%, 10.36%, and 9.07%, respectively) for the 123 dental freshmen from cities and counties without dental schools in Taiwan (Table 2).

Furthermore, the enrollment number or rate of dental freshmen from the northern region of Taiwan (171, 44.30%) was higher than that of dental freshmen from each of other 4 regions of Taiwan. In addition, the dental freshmen enrollment numbers or rates in the northern dental schools (83 or 21.50%) or in the central dental schools (55 or 14.25%) for the 171 dental freshmen from the northern region of Taiwan were both relatively higher than that of dental freshmen from each of other 4 regions of Taiwan, respectively. However, the dental freshmen who came from the southern region of Taiwan and were admitted by the southern dental schools had the higher enrollment number or rate (43 or 11.14%) than that of dental freshmen who came from each of other 4 regions of Taiwan and were admitted by the southern dental schools, respectively. Therefore, it implies that a large number and proportion of enrolled dental freshmen are from the northern region (171 and 44.30%, respectively), municipalities (306 and 79.27%, respectively; especially the Taipei City, 108 and 27.98%, respectively) or cities with dental schools (263 and 68.13%, respectively).

**Comparisons of the practicing dentists in different regions of Taiwan in 2020**

The number or frequency of practicing dentists in municipalities (12,246 or 80.81%) was significantly higher than that in non-municipalities (2909 or 19.19%, \( P < 0.001 \)) (Table 2). Moreover, the number or frequency of practicing dentists in cities with dental schools (8355 or 55.13%) was significantly higher than that in cities and counties without dental schools (6800 or 44.87%, \( P < 0.01 \)) (Table 2). In addition, the number or frequency of practicing dentists in the northern region of Taiwan (8043 or 53.07%) was also significantly higher than that in other regions of Taiwan (9540 or 63.27%, respectively). Moreover, the number or frequency of practicing dentists in non-municipalities (2132 or 13.15%) was significantly lower than that in municipalities (12,246 or 80.81%); the number or frequency of practicing dentists in central municipalities (3808 or 24.53%) was significantly lower than that in northern municipalities (8043 or 53.07%) and central municipalities (5904 or 38.34%) but higher than that in southern municipalities (2909 or 19.19%).
higher than that in each of other 4 regions of Taiwan ($P < 0.05$) (Table 2). Therefore, it indicates that enrolled dental freshmen tend to choose a dental school that is in the same location as they grow up. The practicing dentists are more concentrated in the northern region (especially the northern municipalities) of Taiwan than the enrolled dental freshmen.

Comparisons of dental freshmen enrolled by northern, central and southern dental schools in 2020

We also compared the dental freshmen enrolled by northern, central and southern dental schools in 2020 (Table 2). For 154 dental freshmen enrolled by the northern dental schools, 79.87% (123/154) came from the municipalities and 20.13% (31/154) came from the non-municipalities. Regarding the 128 dental freshmen enrolled by the central dental schools, 79.69% (102/128) came from the municipalities and 20.31% (26/128) came from the non-municipalities. Moreover, for the 104 dental freshmen enrolled by the southern dental schools, 77.88% (81/104) came from the municipalities and 22.12% (23/104) came from the non-municipalities of Taiwan (Table 2).

Furthermore, for 154 dental freshmen enrolled by the northern dental schools, 68.83% (106/154) came from the cities with dental schools and 31.17% (48/154) came from the cities and counties without dental schools. Regarding the 128 dental freshmen enrolled by the central dental schools, 68.75% (88/128) came from the cities with dental schools and 31.25% (40/128) came from the cities and counties without dental schools. Moreover, for the 104 dental freshmen enrolled by the southern dental schools, 66.35% (69/104) came from the cities with dental schools and 33.65% (35/104) came from the cities and counties without dental schools in Taiwan (Table 2).

In addition, for 154 dental freshmen enrolled by the northern dental schools, a large proportion of them (53.90%, 83/154) came from the northern region, followed by the southern region (24.03%, 37/154) and central region of Taiwan (18.83%, 29/154). Regarding the 128 dental freshmen enrolled by the central dental schools, a large proportion of them (42.97%, 55/128) came from the northern region, followed by the central region (30.47%, 39/128) and southern region of Taiwan (23.44%, 30/128).
Moreover, for the 104 dental freshmen enrolled by the southern dental schools, a large proportion of them (41.35%, 43/104) came from the southern region, followed by the northern region (31.73%, 33/104) and central region of Taiwan (23.08%, 24/104) (Table 2).

Discussion

In Taiwan, various resources, such as educational and medical resources, are unevenly distributed. In addition to the problem of the urban-rural gap, the balance among different regions is another problem. In the whole Taiwan area, there is a serious problem of the resource gap between the main island and the offshore islands. In the main island of Taiwan, the educational and medical resources of the eastern region are obviously lagging behind that of the western region. Moreover, in the western region, the educational and medical resources are mostly concentrated in the northern region. This situation makes various resources more concentrated in the northern part or cities of Taiwan, especially the Taipei City. Therefore, the Taiwan’s government has long been committed to balancing regional development of educational, medical and dental resources.

In Taiwan, dental resources also have problems with the urban-rural gap and the regional imbalance. There are currently the problems of a surplus of dentists, uneven distribution of dentists, and concentration of dentists in the metropolitan areas. Therefore, the Taiwan’s government has implemented a total number control of students enrolled by domestic dental schools for many years. Thus, under the premise that the total number of enrolled dental students does not increase, the government agrees to establish the 8th dental school in the southern region of Taiwan, and this dental school began to enroll dental freshmen since 2019. The dentists are the most important dental resources. However, the dental schools have two pivotal roles in dental resources and educational resources. Therefore, the difference in dental resources in different regions is reflected to the differences in the distribution of dentists and dental schools. The past studies have also pointed out that the choice of practice locations for physicians or dentists is affected by the locations where they grow up, the locations of their medical or dental schools, and the locations of their training hospitals. This is because they tend to choose the same locations mentioned above as their practice locations.

The impact of dental schools on the geographical distribution of dentists is not only the locations of dental schools that influence their graduates’ choice of practice locations, but also the regions of dental schools that may recruit students from different regions, which in turn affects the geographical distribution of dentists in the future. Therefore, the difference in the regional composition of dental students on the choice of dental schools in different regions is worth studying.

Our study found that the enrolled dental freshmen’ locations where they grew up had an impact on the selection of the northern, central, and southern dental schools. Moreover, enrolled dental freshmen were uniformly concentrated in municipalities or cities with dental schools. In addition, the enrollment rates of dental freshmen enrolled by the northern dental schools (31.87%), the central dental schools (26.42%), and the southern dental schools (20.98%) for the 306 enrolled dental freshmen from the municipalities were all significantly higher than the corresponding enrollment rates (8.03%, 6.74%, and 5.96%, respectively) for the 80 enrolled dental freshmen from non-municipalities of Taiwan. Besides, the enrollment rates of dental freshmen enrolled by the northern dental schools (27.46%), the central dental schools (22.80%), and the southern dental schools (17.88%) for the 263 enrolled dental freshmen from cities with dental schools were all significantly higher than the corresponding enrollment rates (12.44%, 10.36%, and 9.07%, respectively) for the 123 enrolled dental freshmen from cities and counties without dental schools in Taiwan (Table 2). The worrying situation is that the vast majority of dental freshmen from metropolitan areas almost continue to practice in metropolitan areas (such as the locations where they grow up) after they become dentists, while a very small number of dental freshmen from remote areas or offshore islands are also likely to continue to practice in metropolitan areas (such as the locations near their dental schools) after they become dentists. Therefore, the problems of the urban-rural gap and the uneven distribution of dentists most likely become worse. However, such inferences still need to be supported by further empirical studies.

On the other hand, we also found the interlaced relationship between dental schools in different regions and dental freshmen from different regions of Taiwan. In terms of the regions of dental schools, for the northern dental schools, their dental freshmen were mostly (more than half) from the northern region of Taiwan, followed by the southern region of Taiwan, the central region of Taiwan, and the eastern and offshore island regions of Taiwan. For the central dental schools, their dental freshmen were mainly from the northern region of Taiwan, followed by the central region of Taiwan, the southern region of Taiwan, and the eastern and offshore island regions of Taiwan. However, for the southern dental schools, their dental freshmen were mostly from the southern region of Taiwan, followed by the northern region of Taiwan, the central region of Taiwan, and the eastern and offshore island regions of Taiwan. Furthermore, in terms of the regions where dental freshmen came from, for the dental freshmen from the northern region of Taiwan, they were mainly enrolled by the northern dental schools, followed by the central dental schools, and the southern dental schools. For the dental freshmen from the central region of Taiwan, they were mainly enrolled by the central dental schools, followed by the northern dental schools, and the southern dental schools. However, for the dental freshmen from the southern region of Taiwan, they were mainly enrolled by the southern dental schools, followed by the northern dental schools, and the central dental schools. Overall, the northern dental schools enrolled the majority of dental freshmen, and the enrolled dental freshmen mostly came from the northern region of Taiwan.

For regional distributions of practicing dentists in May 2020, there were 80.81% (12,246/15,155) of the total practicing dentists in municipalities, 55.13% (8355/15,155) of the total practicing dentists in cities with dental schools, and 53.07% (8043/15,155) of the total practicing dentists in
the northern region of Taiwan. For regional distributions of
dental freshmen, there were 79.27% (306/386) of the total
dental freshmen in municipalities, 68.13% (263/386) of the
total dental freshmen in cities with dental schools, and
44.30% (171/386) of the total dental freshmen in the
northern region of Taiwan in 2020 in this study. These
findings indicate that dental schools may attract more local
dental students. However, when dental students graduate
from dental schools and become dentists, they may be
more concentrated in municipalities and the northern re-
region of Taiwan due to the market factors and their own
personal factors. If the locations where dental students
grow up and the locations of their dental schools and
training hospitals are metropolitan areas, they may tend to
practice in metropolitan areas close to one of the same
locations mentioned above. Even dental students from
remote areas are likely to be affected by their dental
schools and training hospitals, and tend to stay in metropo-
lar areas to practice after graduation. Dental students
or dentists who have studied or trained in the northern
dental schools or hospitals are more likely to continue
practicing in the northern region of Taiwan. Therefore, in
discussing the impact of dental schools on the distribution
and the supply of dentists, in addition to the geographical
location of the dental schools, it should also include the
number and regional composition of their dental students,
the difference between the number of enrolled dental
freshmen through the university admission examination and
the number of graduates from domestic dental schools, and
the difference between the number of dental graduates
who participate in the dentist national examination and the
number of graduates from domestic dental schools, as well
as the number of new issued dentists.

Furthermore, we further found the numbers of enrolled
dental freshmen through the university admission exami-
nation in 2014 from the websites of the Joint Board of
College Recruitment Commission, the domestic dental
graduates from the Ministry of Education, the total dental
graduates who participated in the dentist national exami-
nation from the Ministry of Examination, and new issued
dentists in 2020 from the Ministry of Health and Welfare.
For the enrolled dental freshmen through the university
admission examination in 2014, there were 165 enrolled
dental freshmen in the northern dental schools, 139 in the
central dental schools, and 89 in the southern dental
schools, respectively, with a total of 393. After 6 years, for
domestic dental graduates in 2020, there were 186, 130,
and 91 domestic dental graduates in the northern, central,
and southern dental schools, respectively, with a total of
407. We unexpectedly discovered the difference between
the number of dental freshmen enrolled through university
admission examination in 2014 and the number of dental
graduates in 2020. The number of dental students did not
decrease but increase from enrolment to graduation,
indicating that there are other special admission channels
and department transfers for dental students that finally
cause an increase in dental students. However, this situa-
tion may cause the total number control of domestic dental
students to become out of control, and the supply of den-
tists finally exceeds the number of expected dentists in the
original plan. Moreover, the increased rates of dental stu-
dents from enrollment in 2014 to graduation in 2020, there
were 12.73% (21/165) dental students in the northern
dental schools, −6.47% (−9139) dental students in the
central dental schools, and 2.25% (2/89) dental students in
the southern dental schools, respectively, with a total in-
significant increase of 3.56% (14/393) overall dental students. The rate
of increase or decrease varied greatly in different regions
of Taiwan, with the highest increase in the northern dental
schools. For example, among them, a certain dental school
in the northern region had a very high increase rate of
16.48% (15/91), which would further cause an imbalance in the
distribution of dentists.

For overall dental graduates who participated in the
dentist national examination in 2020, there were 33 in the
northern region, 17 in the central region, and 8 in the
southern region, respectively, with a total of 58 dental
graduates in the first dentist national examination, of
which 38 passed the examination. Moreover, there were
213, 143, and 103 dental graduates in the northern, central,
and southern regions of Taiwan, respectively, with a total
of 459 dental graduates in the second dentist national ex-
amination, of which 376 passed the examination. There-
fore, there were 414 new issued dentists in 2020. Assuming
that those who failed the first examination would take the
second examination, we estimated that there were a total
of 497 dental graduates who participated in the dentist
national examination in 2020. In the same year, the number
of dental graduates who participate in the dentist national
examination is much higher than the number of domestic
dental graduates, indicating that there are not only some
graduates who retake the examination but also many
graduates from foreign dental schools (so-called foreign
dental graduates) that have caused a large increase in the
overall dental graduates in Taiwan. However, foreign
dental graduates have surpassed the mechanism of the
total number control of domestic dental students, and
further cause the oversupply of dentists in Taiwan. More-
over, we also found the difference in the number of dental
graduates who participated in the dentist national exami-
nation in different regions of Taiwan. The number of dental
graduates who participated in the dentist national exami-
nation in the northern region of Taiwan was indeed much
higher. It can be speculated that the students who can go to
foreign dental schools for studying dentistry are mostly
from families with high socioeconomic status, and thus,
these families may also be mostly from the northern
metropolitan areas. This also causes the supply of dentists
to exceed the original expectation and the uneven distri-
bution of dentists in Taiwan in the future, because they
may be large in number and their future practice locations
may be more concentrated in the northern metropolitan
areas. Nevertheless, the above inference needs to be sup-
ported by the long-term observations and empirical studies.

Every year, many new-entry dentists graduate from Ja-
pain’s 29 dental universities and schools (dental colleges) in
19 of the 47 prefectures, and this has a particularly sig-
ificant impact on the number of dentists in prefectures
with dental colleges. Unlike Japan, in addition to
dental graduates from Taiwan’s 7 domestic dental schools
in 4 of the 22 cities and counties (the newly-established 8th
dental school still has no graduate students currently),
every year, many foreign dental graduates come back to
Taiwan to take the dentist national examination for the
future practice in Taiwan, and this also has a particularly significant impact on the oversupply and the uneven distribution of dentists.\textsuperscript{2,5,10} However, every year the new issued dentists who are concentrated in the metropolitan areas may cause the uneven distribution of dentists to become more and more serious. Thus, to obtain effective oral health care services, it is necessary to maintain a balance between the supply of new-entry dentists with balanced distribution and the population through resolution of regional differences and urban concentrations.\textsuperscript{11–14}

We conclude that the dental freshmen are mainly concentrated in municipalities, cities with dental schools, and the northern region of Taiwan. Moreover, the dental freshmen enrolled by the northern or central dental schools mostly come from the northern region of Taiwan and those enrolled by the southern dental schools majorly come from the southern region of Taiwan. These phenomena may be potential factors that cause an imbalance in the distribution of practicing dentists in the future. Therefore, in addition to efforts aimed in resolving regional differences in oral health care services, the policy for the balanced distribution of domestic dental schools to rectify the uneven regional distribution of dental students is required. Moreover, the policies for the total number control of domestic dental students to prohibit excessive and additional dental students (such as foreign dental students) and to normalize the number of new-entry dentists are required. Moreover, we also recommend that the policy for the postgraduate year training program for dentists (PGYD) to request oral health care services in remote areas is required.\textsuperscript{5,10–17}

Declaration of Competing Interest

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

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