The impact of the COVID-19 pandemic on the dentist manpower in Taiwan

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Background/purpose: The dentists are the high-risk group of infectious respiratory diseases during dental treatment. This study investigated the changes of the numbers of overall practicing dentists, dental clinics, and hospital dentists in Taiwan during the COVID-19 pandemic.

Materials and methods: We collected the data of the numbers of overall practicing dentists, dental clinics, and hospital dentists in each city and county of Taiwan in October 2019, April 2020, and October 2020 for evaluating the impact of the COVID-19 pandemic on the dentist manpower in Taiwan.

Results: After the COVID-19 outbreak, the total increased numbers of practicing dentists, dental clinics, and hospital dentists in Taiwan were 408, 14, and –16 from October 2019 to October 2020, respectively. In addition, their increased rates of the corresponding items were...
Introduction

The contents of dental practices are prevention, diagnosis, and treatment of diseases in the oral and maxillofacial region with medical and dental knowledge. During dental treatment, when dentists use scaling machines and high-speed handpieces, splatter, droplets, or aerosols are likely to occur. However, transmission of infections can occur either through direct contact with blood, saliva, splatter, droplets, or aerosols, or through indirect contact with contaminated surfaces. Therefore, healthcare workers who fail to follow proper infection control procedures when providing patient healthcare are more likely to contract infectious diseases. The treatment guidelines must be followed to guide the medical staff to treat and serve the patients.

Although dentists are not direct healthcare workers for respiratory diseases, they must directly face the mouth and nose of patients during dental treatment. This makes the dentists a high-risk group to contract infectious respiratory diseases. In general, the hospital environment may have more patients with respiratory diseases. For dentists, those working in a hospital have a higher risk of contracting respiratory infections than those working in a dental clinic. Thus, the outbreak of a fatal respiratory disease also affects the willingness of a dentist to work in a hospital. In Taiwan, the number of hospital dentists was 21.6% of the overall dentists in 1986, and this value decreased to 14.4% in 2018. When the disease of severe acute respiratory syndrome (SARS) suddenly happened in year 2003, the number of hospital dentists decreased by 34 from 1326 in year 2002 to 1292 in year 2003. In fact, after going through the SARS pandemic, the ratio of hospital dentists to overall dentists continued to decrease to a lowest level of 12.7% in 2007. Then, the ratio increased gradually to 14.5% in 2019.

On January 21, 2020, the Taiwan Central Epidemic Command Center (CECC) officially reported the first COVID-19 case in Taiwan. From March to April, the number of confirmed COVID-19 cases in Taiwan rose rapidly from less than 100 to more than 400. On January 12, 2021, the Taiwan CECC officially reported the first confirmed COVID-19 case of a hospital physician. Therefore, the outbreak of COVID-19 may also affect the manpower structure of hospital dentistry in Taiwan. However, there was no study to survey the difference of the dentist manpower, especially the dentist manpower of hospital dentistry, in Taiwan during the COVID-19 pandemic. Furthermore, this was the first study on the comparison of distributions of overall practicing dentists, dental clinics, and hospital dentists in 20 cities and counties in Taiwan during the COVID-19 pandemic from October 2019 to October 2020. This study aimed to assess the changes of the numbers of overall practicing dentists, dental clinics, and hospital dentists in Taiwan during the COVID-19 pandemic. We particularly focused on studying the changes of hospital dentists in different cities or counties of Taiwan, hospitals of various levels, and hospitals with different COVID-19 tasks for evaluating the impact of the COVID-19 pandemic on the hospital dentistry in Taiwan.

Materials and methods

In this study, we adopted the method of the secondary data analysis to collect the information about the numbers of practicing dentists in hospitals and the overall dentists in Taiwan, and the information regarding to these hospitals with dental departments such as their levels, tasks for COVID-19, and locations in October 2019, April 2020, and October 2020. All of these data are open information that can be collected from the related websites. The total number of overall practicing dentists by city and county could be obtained from the Newsletter of Taiwan Dental Association. Besides, in the webpages of the Ministry of Health and Welfare by the time of October 2019, April 2020, and October 2020, the information including the number of the hospitals with dental departments could be obtained. Meanwhile, the hospital information including the city or county location and the number of registered dentists of each hospital mentioned above could be further obtained. Furthermore, we could know what tasks for COVID-19 were assigned to these hospitals from the webpages of the Taiwan Centers for Disease Control (CDC).

All hospitals were classified into three levels: medical centers, regional hospitals, and district hospitals. According to the tasks for COVID-19, hospitals were classified into three types: those where patients with severe COVID-19 were treated, those that were responsible for community inspection, and those that were not assigned COVID-19-related tasks. In addition, the whole area of Taiwan was significantly greater than that of dental clinics (P < 0.001) and that of hospital dentists (P < 0.001). Moreover, the increased rate of practicing dentists from October 2019 to October 2020 was significantly higher than that of dental clinics (P < 0.01).

Conclusion: During the COVID-19 pandemic, the increased number of practicing dentists is not different from that in the past, but the increased numbers and rates of dental clinics and hospital dentists are lower than those in the past. This indicates that the willingness of dentists to open new dental clinics or work in hospitals reduces due to the impact of the COVID-19 pandemic.
divided into four regions: northern, central, southern, and eastern regions. 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, Pingtung County, and Penghu County; and the eastern region included Yilan County, Hualien County, and Taitung County. The offshore islands (Kinmen County and Lienciang County) were not included in this study.

Based on the data and information collected from the methodologies that just mentioned above, these data were stored in excel files and put into analysis. The results of this study could help us to understand mainly the impact of the COVID-19 pandemic on the dentist manpower of hospital dentistry in Taiwan, and became an important reference for the development of dentist manpower for hospital dentistry in Taiwan during and after the COVID-19 pandemic.

Results

The change of the total numbers of overall practicing dentists from October 2019 to October 2020

Taiwan currently has 9 cities and 11 counties (excluding the Kinmen County and Lienciang County). There are 6 municipalities (those directly under the control of central government) and 14 non-municipalities among 9 cities and 11 counties. The numbers of practicing dentists in 9 cities and 11 counties in Taiwan in October 2019, April 2020, and October 2020 are shown in Table 1. In Taiwan, the numbers of practicing dentists increased from 14,800 in October 2019, to 15,125 in April 2020, and further to 15,208 in October 2020 (Table 1). Meanwhile, the numbers of pure dentist members (the dentists with membership of Taiwan Dental Association but without practice registration) increased from 158 in October 2019, to 195 in April 2020, and further to 204 in October 2020. In 2020, the worst period of the COVID-19 pandemic in Taiwan was from March to April, after that period the COVID-19 pandemic gradually subsided. Thus, half a year before and after the worst period of the COVID-19 pandemic, the numbers of practicing dentists increased by 325 and 83, respectively. Meanwhile, the numbers of pure dentist members increased by 37 and 9 in these two periods, respectively.

To view municipalities and non-municipalities separately, the numbers of practicing dentists in 6 municipalities increased from 11,989 in October 2019, to 12,244 in April 2020, and further to 12,293 in October 2020. On the other hand, the numbers of practicing dentists in 14 non-departments increased from 2811 in October 2019, to 2881 in April 2020, and further to 2915 in October 2020. Thus, half a year before and after the worst period of the COVID-19 pandemic, the increased numbers of practicing dentists in 6 municipalities were 255 and 49, respectively. Besides, the corresponding increased numbers in 14 non-municipalities were 70 and 34, respectively (Table 2).

In addition, to view 9 cities and 11 counties separately, the numbers of practicing dentists in 9 cities increased from 12,724 in October 2019, to 13,000 in April 2020, and further to 13,065 in October 2020. On the other hand, the numbers of practicing dentists in 11 counties increased from 2076 in October 2019, to 2125 in April 2020, and further to 2143 in October 2020. Thus, the increased numbers of practicing dentists in 9 cities were 276 and 65, respectively. Besides, the corresponding increased numbers in 11 counties were 49 and 18, respectively (Table 2).

Furthermore, regarding the geographical distribution, practicing dentists were mainly concentrated in the northern region of Taiwan. The numbers of practicing dentists in the northern region of Taiwan increased from 7829 in October 2019, to 8039 in April 2020, and further to 8100 in October 2020. Thus, the increased numbers of practicing dentists in the northern region were 210 and 61, respectively. The changes of the percentage of practicing dentists showed a similar situation in the central region of Taiwan, but were less in other regions of Taiwan (Table 2).

Therefore, the practicing dentists were concentrated in 6 municipalities or 9 cities, especially the Taipei City with the maximal number of practicing dentists. The number of practicing dentists was largest in the northern region of Taiwan, followed by the central and southern regions of Taiwan, and lastly the eastern region of Taiwan. Moreover, the number of practicing dentists was still steadily growing during the COVID-19 pandemic.

The change of the total numbers of dental clinics from October 2019 to October 2020

The numbers of dental clinics in 9 cities and 11 counties in Taiwan in October 2019, April 2020 and October 2020 are shown in Table 3. In Taiwan, the numbers of dental clinics decreased from 6618 in October 2019, to 6616 in April 2020, and further increased to 6632 in October 2020 (Table 3). Thus, half a year before and after the worst period of the COVID-19 pandemic, the numbers of dental clinics decreased by 2, and then increased by 16, respectively.

To view 6 municipalities and 14 non-municipalities separately, the numbers of dental clinics in 6 municipalities increased from 5150 in October 2019, to 5156 in April 2020, and further to 5166 in October 2020. On the other hand, the numbers of dental clinics in 14 non-municipalities decreased from 1468 in October 2019, to 1460 in April 2020, and further increased to 1466 in October 2020. Thus, the increased numbers of dental clinics in 6 municipalities were 6 and 10 in the two intervals mentioned above, respectively. Besides, the corresponding increased numbers in 14 non-municipalities were –8 and 6, respectively (Table 4).

In addition, to view 9 cities and 11 counties separately, the numbers of dental clinics in 9 cities increased from 5498 in October 2019, to 5501 in April 2020, and further to 5514 in October 2020. On the other hand, the numbers of dental clinics in 11 counties decreased from 1120 in October 2019, to 1115 in April 2020, and further increased to 1118 in October 2020. Thus, the increased numbers of dental clinics in 9 cities were 3 and 13, respectively. Besides, the corresponding increased numbers in 11 counties were –5 and 3, respectively (Table 4).
Furthermore, regarding the geographical distribution, dental clinics were mainly concentrated in the northern region of Taiwan. The numbers of dental clinics in the northern region of Taiwan increased from 3196 in October 2019, to 3206 in April 2020, and further to 3216 in October 2020. Thus, the increased numbers of dental clinics in the northern region were 10 and 10, respectively. On the contrary, the numbers of dental clinics in other regions of Taiwan mostly showed a small number of reduction (Table 4).

Therefore, the dental clinics were concentrated in 6 municipalities or 9 cities, especially the Taipei City with the maximal number of dental clinics. The number of dental clinics was largest in the northern region of Taiwan, followed by the central and southern regions of Taiwan, and lastly the eastern region of Taiwan. In general, the number of dental clinics still showed a small number of increase during the COVID-19 pandemic.

The change of the total numbers of hospital dentists from October 2019 to October 2020

The numbers of hospital dentists in 9 cities and 11 counties in Taiwan in October 2019, April 2020 and October 2020 are shown in Table 5. In Taiwan, the numbers of hospital dentists decreased from 2208 in October 2019, to 2194 in April 2020, and further to 2192 in October 2020. However, the numbers of hospital with dental department increased from 175 to 178 during this period (Table 5). Thus, half a year before and after the worst period of the COVID-19 pandemic, the numbers of hospital dentists decreased by 14 and 2, respectively.

According to hospitals of different levels, the numbers of practicing dentists in medical centers and regional hospitals decreased from 1983 in October 1999, to 1983 in April 2020, and further to 1975 in October 2020 by a total decrease of 26. On the contrary, the numbers of practicing dentists in district hospitals increased from 225 in October 2019 to 235 in October 2020 by a total increase of 10.

According to hospitals with different tasks for COVID-19, the numbers of practicing dentists in hospitals with the task of treating severe COVID-19 patients and in hospitals with the task of community inspection decreased from 2129 in October 2019, to 2117 in April 2020, and further to 2110 in October 2020 by a total decrease of 19. On the contrary, the numbers of practicing dentists in hospitals without assigned COVID-19-related task increased from 79 in October 2019 to 82 in October 2020 by a total increase of 3 (Table 6).

| Number (percentage) of overall dentists | Increased number (rate) of overall dentists |
|----------------------------------------|-------------------------------------------|
| October 2019                           | April 2020                                |
| October 2020                           | October 2019 to April 2020               |
| October 2020                           | April 2020 to October 2020               |
| Taipei City                           | 3304 (22.32%)                             | 67 (2.03%)                               | 7 (0.21%)              |
| New Taipei City                       | 2597 (17.55%)                             | 72 (2.77%)                               | –6 (–0.23%)            |
| Taoyuan City                          | 1178 (7.96%)                              | 43 (3.65%)                               | 36 (3.06%)             |
| Taichung City                         | 1947 (13.16%)                             | 30 (1.54%)                               | 4 (0.21%)              |
| Tainan City                           | 1127 (7.61%)                              | 8 (0.71%)                                | 13 (1.15%)             |
| Kaohsiung City                        | 1836 (12.41%)                             | 35 (1.91%)                               | –5 (–0.27%)            |
| Keelung City                          | 184 (1.24%)                               | 0                                       | 9 (4.89%)              |
| Hsinchu City                          | 322 (2.18%)                               | 19 (5.90%)                               | 5 (1.55%)              |
| Chiayi City                           | 229 (1.55%)                               | 2 (0.87%)                                | 2 (0.87%)              |
| Hsinchu County                        | 244 (1.65%)                               | 9 (3.69%)                                | 10 (4.10%)             |
| Miaoli County                         | 175 (1.18%)                               | 8 (4.57%)                                | 4 (2.29%)              |
| Changhua County                       | 574 (3.88%)                               | 14 (2.44%)                               | 0                     |
| Nantou County                         | 161 (1.09%)                               | 6 (3.73%)                                | –1 (–0.62%)            |
| Yunlin County                         | 175 (1.18%)                               | 8 (4.57%)                                | 0                     |
| Chiayi County                         | 104 (0.70%)                               | 4 (3.85%)                                | 0                     |
| Pingtung County                       | 212 (1.43%)                               | –4 (–1.89%)                              | 7 (3.30%)              |
| Penghu County                         | 36 (0.24%)                                | 0                                       | –1 (–2.78%)            |
| Yilan County                         | 183 (1.24%)                               | 1 (0.55%)                                | 2 (1.09%)              |
| Hualien County                        | 147 (0.99%)                               | 2 (1.36%)                                | –3 (–2.04%)            |
| Taitung County                        | 65 (0.44%)                                | 1 (1.54%)                                | 0                     |
| Nationwide                            | 14,800 (100%)                             | 325 (2.02%)                              | 83 (0.56%)             |
| Mean ± SD                             | 740.00 ± 954.52                           | 760.40 ± 975.00                          | –                     |
| CV                                    | 128.99%                                   | 128.93%                                  | 128.30%                |

*Mean ± SD = Mean ± standard deviation; CV = Coefficient of variance.
The first six items are municipalities and the offshore islands outside Taiwan such as Kinmen County and Lienchiang County were not included in this study.

**Pure dentist members:** The dentists with membership of Taiwan Dental Association but without practice registration.
After the COVID-19 outbreak, the increased numbers of practicing dentists, dental clinics, and hospital dentists in Taiwan were 325, -2 and -14 from October 2019 to April 2020, respectively. Thus, the increased rates of the corresponding items were 2.20%, -0.03% and -0.63%, respectively. Besides, the increased numbers of practicing dentists, dental clinics, and hospital dentists in Taiwan were 83, 16 and -2 from April 2020 to October 2020, respectively. Thus, the increased rates of the corresponding items were 0.56%, 0.24% and -0.09%, respectively.
In addition, the total increased numbers of practicing dentists, dental clinics, and hospital dentists were 408, 14 and −16 from October 2019 to October 2020, respectively. Thus, the increased rates of the corresponding items were 2.76%, 0.21% and −0.72%, respectively. Therefore, the increased rate of practicing dentists was higher than that of dental clinics and that of hospital dentists. Among them, the number of hospital dentists decreased slightly. We used Kruskal-Wallis test for the comparison of the increased rates of practicing dentists, dental clinics and hospital dentists. The increased rate of practicing dentists from October 2019 to April 2020 was significantly higher than that of dental clinics (\(P < 0.001\)) and that of hospital dentists (\(P < 0.001\)). Moreover, the increased rate of practicing dentists from October 2019 to October 2020 was significantly higher than that of dental clinics (\(P < 0.01\)).

## Discussion

At the end of 2019, a disease broke out in Wuhan, China. The disease was identified as coronavirus disease 2019 (COVID-19) caused by a new type of coronavirus, a severe acute respiratory disease coronavirus 2 (SARS-CoV-2). It is obvious that serious disease outcomes and rapid global spread are the two main characteristics of the disease, both of which represent a serious public health threat posed by the virus. In addition to mainly affecting the respiratory system, the disease is characterized by symptoms affecting multiple systems of human body. About 20% of patients worldwide have an increased risk of severe COVID-19 disease due to underlying comorbidities.

On April 23, 2020, the COVID-19 pandemic in Taiwan included 428 positive cases, with 6 deaths and 264 who had recovered. Between March and April 2020, the number of the positive COVID-19 cases in Taiwan increased from less than 100 to more than 400. During this period, the entire Taiwan's society was on a high alert regarding the pandemic. However, Taiwan’s government learned from its 2003 SARS experience and established a public health response mechanism for enabling rapid actions for the next crisis. The COVID-19 pandemic has gradually subsided after May 2020. At the end of 2020, the COVID-19 pandemic in Taiwan included 799 positive cases (including 56 local cases), with 7 deaths and 671 who had recovered. Therefore, compared with the world under the COVID-19 pandemic, Taiwan still maintains the normal social life. For example, the government, schools, and hospitals all maintain normal operations as usual.

Nevertheless, the dentists are not the first-line medical staff to care for COVID-19 patients. During dental treatment, the dentists usually have close contact with the patients’ mouth and nose, so they are at a high-risk for contracting this infectious respiratory disease. During the COVID-19 pandemic, the risk to contract the disease directly influences the willingness of the dentists to work, especially those in hospitals, where may be more patients with this respiratory disease. In addition, patients’
During the COVID-19 pandemic, many dental schools have been closed due to the spread of the virus. This reduced the number of patients to visit dental departments and the willingness of dentists to work. Therefore, the change of dentist manpower during the pandemic is a topic worthy of further investigation.

This study used the numbers of overall practicing dentists, dental clinics, and hospital dentists in Taiwan from 2001 to 2019, were 340.50, 410 (2.79%), and 65 (3.06%), respectively. In addition, the year before the outbreak of COVID-19 (from 2018 to 2019), the increased numbers (rates) of the corresponding items were 33.25, 66.30 and 55.88, respectively. In 2020, due to the proper strategies taken by the CECC, the dental education can be carried out as usual, but all the staff and students must wear a surgical mask at all times and check the body temperature before entering their dental schools during the COVID-19 pandemic. Internship including clinical skill training course is carried out in the teaching hospitals as usual, but the number of patients treated are reduced because of delayed treatment asked by some patients. Therefore, the education and graduation of dental students continued as usual, and the national dentist license examinations were held twice a year as usual in Taiwan in 2020.

According to our previous study, the annual increased numbers of overall practicing dentists, dental clinics, and hospital dentists in Taiwan from 2001 to 2019, were 340, 66.30 and 55.88, respectively. In addition, the year before the outbreak of COVID-19 (from 2018 to 2019), the increased numbers (rates) of the corresponding items were 410 (2.79%), 38 (0.56%), and 65 (3.06%), respectively. In
this study, during the COVID-19 pandemic (from October 2019 to October 2020), the increased numbers (rates) of the corresponding items were 408 (2.76%), 14 (0.21%), and 16 (–0.72%), respectively. However, the situation that practicing dentists, dental clinics or hospital dentists were concentrated in municipalities, cities or the northern region of Taiwan has remained the same as usual during the COVID-19 pandemic.

Furthermore, the increased numbers of practicing dentists were 325 during the severe period (from October 2019 to April 2020) and 83 during the subsided period of COVID-19, respectively. During this one-year period, the total increased number (rate) of practicing dentists was 408 (2.76%), which was similar to the year before the outbreak of COVID-19. This showed that the increased number of practicing dentists during the COVID-19 pandemic is not different from that in the past. Moreover, the increased numbers of pure dentist members (dentists with membership of Taiwan Dental Association but without practice registration) were 37 and 9 in the severe and subsided COVID-19 periods, respectively. The increased number (rate) of pure dentist members was 46 (29.11%) during the one-year period from October 2019 to October 2020. Taiwan’s regulations on the practice registration of medical personnel do not restrict those who are not in practice or retired. In Taiwan, the practice registration for dentists without practicing may have three situations: (1) maintenance of practice registration; (2) no registration for practice but still maintaining the membership (so-called pure dentist members); (3) no registration for practice and withdrawal from the Dental Association. This indicates that the number of pure dentist members who decide not to practice suddenly increase during the COVID-19 pandemic. In addition, the increased rate of dental clinics from October 2019 to October 2020 was significantly lower than that of practicing dentists ($p < 0.01$). It is also indirectly confirmed that the COVID-19 pandemic may reduce the willingness of dentists to open new dental clinics or delay their plans to open new dental clinics, and may also prompt dentists to stop practicing or retire. However, the above inferences still need the supports from further empirical studies.

Table 5  Distributions of hospital dentists in 9 cities and 11 counties in Taiwan from October 2019 to October 2020.

| City/Town          | Number (percentage) of hospital dentists | Increase number (rate) of hospital dentists |
|--------------------|------------------------------------------|--------------------------------------------|
|                    | October 2019 | April 2020 | October 2020 | October 2019 to April 2020 | April 2020 to October 2020 |
|--------------------|--------------|------------|--------------|-----------------------------|-----------------------------|
| Taipei City        | 728 (32.97%) | 715 (29.62%) | 715 (29.55%) | –13 (–1.79%) | 0 |
| New Taipei City    | 198 (8.97%)  | 206 (8.53%) | 190 (7.85%)  | 8 (4.04%) | –16 (–8.08%) |
| Taoyuan City       | 162 (7.34%)  | 157 (6.50%) | 148 (6.12%)  | –5 (–3.09%) | –9 (–5.56%) |
| Taichung City      | 209 (9.47%)  | 212 (8.78%) | 220 (9.09%)  | 3 (1.44%) | 8 (3.83%) |
| Tainan City        | 201 (9.10%)  | 201 (8.33%) | 202 (8.35%)  | 0 | 1 (0.50%) |
| Kaohsiung City     | 301 (13.63%) | 296 (12.26%) | 294 (12.15%) | –5 (–1.66%) | –2 (–0.66%) |
| Keelung City       | 22 (1.00%)   | 20 (0.83%)  | 20 (0.83%)   | –2 (–0.90%) | 0 |
| Hsinchu City       | 46 (2.08%)   | 46 (1.91%)  | 48 (1.98%)   | 0 | 2 (4.35%) |
| Chiayi City        | 41 (1.86%)   | 41 (1.70%)  | 43 (1.78%)   | 0 | 2 (4.88%) |
| Hsinchu County     | 6 (0.27%)    | 6 (0.25%)   | 7 (0.29%)    | 0 | 1 (16.67%) |
| Miaoli County      | 12 (0.54%)   | 12 (0.50%)  | 12 (0.50%)   | 0 | 0 |
| Changhua County    | 122 (5.53%)  | 119 (4.93%) | 126 (5.21%)  | –3 (–2.46%) | 7 (5.74%) |
| Nantou County      | 27 (1.22%)   | 27 (1.12%)  | 24 (0.99%)   | 0 | –3 (–11.11%) |
| Yunlin County      | 16 (0.72%)   | 16 (0.66%)  | 19 (0.79%)   | 0 | 3 (18.75%) |
| Chiayi County      | 20 (0.91%)   | 23 (0.95%)  | 23 (0.95%)   | 3 (15.00%) | 0 |
| Pingtung County    | 19 (0.86%)   | 19 (0.79%)  | 20 (0.83%)   | 0 | 1 (5.26%) |
| Penghu County      | 1 (0.05%)    | 1 (0.04%)   | 1 (0.04%)    | 0 | 0 |
| Yilan County       | 33 (1.49%)   | 34 (1.41%)  | 37 (1.53%)   | 1 (3.03%) | 3 (9.09%) |
| Hualien County     | 38 (1.72%)   | 36 (1.49%)  | 36 (1.49%)   | –2 (–5.26%) | 0 |
| Taitung County     | 6 (0.27%)    | 7 (0.29%)   | 7 (0.29%)    | 1 (16.67%) | 0 |
| Nationwide         | 2208 (100%)  | 2194 (100%) | 2192 (100%)  | –14 (–0.63%) | –2 (–0.09%) |
| Mean ± SD          | 110.40 ± 170.14 | 109.70 ± 167.57 | 109.60 ± 166.99 | – | – |
| CV                 | 154.11% | 152.89% | 152.36% | – | – |

Mean ± SD = Mean ± standard deviation; CV = Coefficient of variance.
Table 6 Comparisons of hospital dentists in hospitals of different levels, in hospitals with different COVID-19 tasks, in 6 municipalities and 14 non-municipalities, in 9 cities and 11 counties, and in 4 different regions in Taiwan from October 2019 to October 2020.

| Hospitals of different levels | Number (percentage) of hospital dentists/Number of hospitals with dental departments | Increased number (rate) of hospital dentists | October 2019 | April 2020 | October 2020 | October 2019 to April 2020 | April 2020 to October 2020 |
|-------------------------------|-----------------------------------------------------------------|---------------------------------------------|--------------|-------------|----------------|----------------------------|----------------------------|
| Medical centers               | 1213 (54.94%)/24                                                | 1198 (54.60%)/24                            | 1197 (54.61%)/24 | –15 (−1.24%) | –1 (−0.08%) | –                           |                            |
| Mean ± SD                     | 50.54 ± 34.59                                                   | 49.92 ± 33.23                               | 49.88 ± 33.32 | –            | –            | –                           |                            |
| CV                            | 68.44%                                                         | 66.57%                                       | 66.80%        | –            | –            | –                           |                            |
| Regional hospitals            | 770 (34.87%)/73                                                 | 771 (35.14%)/73                             | 760 (34.67%)/72 | 1 (0.13%)    | –11 (−1.43%) | –                           |                            |
| Mean ± SD                     | 10.55 ± 12.12                                                  | 10.56 ± 12.27                               | 10.56 ± 12.00 | –            | –            | –                           |                            |
| CV                            | 114.88%                                                        | 116.19%                                      | 113.64%       | –            | –            | –                           |                            |
| Municipalities (n = 6)        | 1799 (81.48%)/104                                               | 1787 (74.03%)/104                           | 1769 (73.10%)/104 | –12 (−0.67%) | –18 (−1.00%) | –                           |                            |
| Mean ± SD                     | 299.83 ± 214.81                                                | 297.83 ± 209.30                             | 294.83 ± 211.33 | –            | –            | –                           |                            |
| CV                            | 71.64%                                                         | 70.27%                                       | 71.68%        | –            | –            | –                           |                            |
| Non-municipalities (n = 14)   | 409 (18.52%)/71                                                 | 407 (16.86%)/73                             | 423 (17.48%)/74 | –2 (−0.49%)  | 16 (3.91%)   | –                           |                            |
| Mean ± SD                     | 29.21 ± 30.02                                                  | 29.07 ± 29.20                               | 30.21 ± 30.91 | –            | –            | –                           |                            |
| CV                            | 102.77%                                                        | 100.45%                                      | 102.32%       | –            | –            | –                           |                            |
| Administrative hierarchy      |                                                                |                                             |               |              |              |                             |                            |
| Municipalities (n = 6)        | 1799 (81.48%)/104                                               | 1787 (74.03%)/104                           | 1769 (73.10%)/104 | –12 (−0.67%) | –18 (−1.00%) | –                           |                            |
| Mean ± SD                     | 299.83 ± 214.81                                                | 297.83 ± 209.30                             | 294.83 ± 211.33 | –            | –            | –                           |                            |
| CV                            | 71.64%                                                         | 70.27%                                       | 71.68%        | –            | –            | –                           |                            |
| Hospitals with different tasks |                                                                |                                             |               |              |              |                             |                            |
| Treatment of severe COVID-19 cases | 1623 (73.51%)/104                              | 1611 (73.43%)/104                           | 1612 (73.54%)/104 | –12 (−0.74%) | 1 (0.06%)    | –                           |                            |
| Mean ± SD                     | 32.46 ± 31.39                                                  | 32.22 ± 30.65                               | 32.24 ± 30.60 | –            | –            | –                           |                            |
| CV                            | 96.70%                                                         | 95.13%                                       | 94.91%        | –            | –            | –                           |                            |
| Community inspection          | 506 (22.92%)                                                   | 506 (23.06%)                                 | 498 (22.72%)  | 0            | –8 (−1.58%)  | –                           |                            |
| Mean ± SD                     | 5.16 ± 7.11                                                   | 5.11 ± 6.84                                  | 5.03 ± 6.41   | –            | –            | –                           |                            |
| CV                            | 137.79%                                                        | 133.86%                                      | 127.44%       | –            | –            | –                           |                            |
| No task                       | 79 (3.58%)                                                     | 77 (3.51%)                                   | 82 (3.74%)    | –2 (−2.53%)  | 5 (6.33%)    | –                           |                            |
| Mean ± SD                     | 3.04 ± 6.94                                                   | 2.85 ± 6.63                                  | 2.93 ± 6.01   | –            | –            | –                           |                            |
| CV                            | 228.29%                                                        | 232.63%                                      | 205.12%       | –            | –            | –                           |                            |
| City or county                |                                                                |                                             |               |              |              |                             |                            |
| Municipalities (n = 6)        | 1799 (81.48%)/104                                               | 1787 (74.03%)/104                           | 1769 (73.10%)/104 | –12 (−0.67%) | –18 (−1.00%) | –                           |                            |
| Mean ± SD                     | 299.83 ± 214.81                                                | 297.83 ± 209.30                             | 294.83 ± 211.33 | –            | –            | –                           |                            |
| CV                            | 71.64%                                                         | 70.27%                                       | 71.68%        | –            | –            | –                           |                            |
| Counties (n = 11)             | 300 (13.59%)                                                   | 300 (13.67%)                                 | 312 (14.23%)  | 0            | 12 (4.00%)   | –                           |                            |
| Mean ± SD                     | 27.27 ± 33.46                                                  | 27.27 ± 32.46                               | 28.36 ± 34.35 | –            | –            | –                           |                            |
| CV                            | 122.70%                                                        | 119.03%                                      | 121.12%       | –            | –            | –                           |                            |
| Region                        |                                                                |                                             |               |              |              |                             |                            |
| Northern region (n = 6)       | 1162 (52.63%)                                                  | 1150 (52.42%)                                | 1128 (51.46%) | –12 (−1.03%) | –22 (−1.89%) | –                           |                            |
| Mean ± SD                     | 193.67 ± 273.14                                                | 191.67 ± 268.49                             | 188.00 ± 268.30 | –            | –            | –                           |                            |
| CV                            | 141.03%                                                        | 140.08%                                      | 142.71%       | –            | –            | –                           |                            |
| Central region (n = 5)        | 386 (17.48%)                                                   | 386 (17.59%)                                 | 401 (18.29%)  | 0            | 15 (3.89%)   | –                           |                            |
| Mean ± SD                     | 77.20 ± 86.45                                                  | 77.20 ± 87.23                               | 80.20 ± 91.10 | –            | –            | –                           |                            |
| CV                            | 111.98%                                                        | 112.99%                                      | 113.59%       | –            | –            | –                           |                            |
| Southern region (n = 6)       | 583 (26.40%)                                                   | 581 (26.48%)                                 | 583 (26.60%)  | –2 (−0.34%)  | 2 (0.34%)    | –                           |                            |
| Mean ± SD                     | 97.17 ± 123.93                                                 | 96.83 ± 121.93                               | 97.17 ± 121.14 | –            | –            | –                           |                            |
| CV                            | 127.54%                                                        | 125.92%                                      | 124.67%       | –            | –            | –                           |                            |
| Eastern region (n = 3)        | 77 (3.49%)                                                     | 77 (3.51%)                                   | 80 (3.65%)    | 0            | 3 (3.90%)    | –                           |                            |
| Mean ± SD                     | 25.67 ± 17.21                                                  | 25.67 ± 16.20                               | 26.67 ± 17.04 | –            | –            | –                           |                            |
| CV                            | 67.04%                                                         | 63.11%                                       | 63.89%        | –            | –            | –                           |                            |

Mean ± SD = Mean ± standard deviation; CV = Coefficient of variance.
number of hospital dentists was −16, which showed a slight decrease. This indicates that the increased number of hospital dentists during the COVID-19 pandemic is lower than that in the past. Furthermore, the number of hospital dentists was 2208 (14.92% of 14,800 overall practicing dentists) in October 2019, and this corresponding number decreased to 2194 (14.51% of 15,125 overall practicing dentists) in April 2020, and further reduced to 2192 (14.41% of 15,208 overall practicing dentists) in October 2020. Thus, the increased rate of hospital dentists from October 2019 to April 2020 was significantly lower than that of practicing dentists (P < 0.001). It is also indirectly confirmed that the COVID-19 pandemic may reduce the willingness of dentists to work in hospitals, and may also prompt dentists to work in dental clinics. However, the above inferences still need supports from further empirical studies.

Although the increased number of practicing dentists during the COVID-19 pandemic was the same as those in previous years, the number of hospital dentists decreased during the COVID-19 pandemic. In particular, the reduced number and proportion of practicing dentists in hospitals with the tasks for COVID-19 (such as tasks for treatment of severe COVID-19 patients and tasks for community inspection) was relatively higher than that of practicing dentists in hospitals without the tasks. Similarly, the reduced number and proportion of practicing dentists in medical centers and regional hospitals was also relatively higher than that of practicing dentists in district hospitals. The other possible reason is that the hospitals with the tasks for COVID-19 are usually high-level hospitals (such as medical centers and regional hospitals) that are concentrated in municipalities, cites, and the northern region of Taiwan. Therefore, the reduced number and proportion of practicing dentists in the above-mentioned hospitals is also relatively higher.

When the disease of severe acute respiratory syndrome (SARS) suddenly happened in year 2003, the numbers of overall practicing dentists, dental clinics, and hospital dentists increased by 345 and 159, and decreased by 34, respectively, from 2002 to 2003. After going through SARS pandemic, the ratio of hospital dentists to overall dentists continued to decrease to a lowest level of 12.7% in 2007. However, one year (from 2001 to 2002) before the SARS pandemic, the corresponding numbers of overall practicing dentists, dental clinics, and hospital dentists increased by 262, 71 and 31, respectively.\(^6,17\) The SARS pandemic in Taiwan occurred from March to July 2003. It came suddenly but ended quickly. Therefore, the increased numbers of overall practicing dentists and dental clinics in that year were not affected. Instead, it affected the willingness of a dentist to work in a hospital, and this impact continued from 2003 to 2007.

Unlike the SARS pandemic, Taiwan’s government has obtained enough experience to respond to the COVID-19 pandemic, and thus the social life of people in Taiwan is as usual during the pandemic. However, it has been more than one year since the outbreak of COVID-19. Although the current increase in the number of practicing dentists has not been affected, the willingness of dentists to open new dental clinics or work in hospitals may be reduced by the impact of the COVID-19 pandemic. Since the CECC officially reported the first COVID-19 case of a hospital physician on January 12, 2021, the entire Taiwan’s society was on a high alert again regarding the pandemic. Therefore, as the COVID-19 pandemic continues, the changes in the dentist manpower should continue to be monitored.

Declaration of competing interest

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

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