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Original Article

Distributions of dentists and physicians in Taiwan during the Japanese colonial period from 1923 to 1924

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KEYWORDS
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Background/purpose: In 1896, the first dentist opened his dental clinic in Taipei City and this also opened a new era of Taiwan's dentistry. This study tried to assess the dentist manpower in Taiwan during the Japanese colonial period from 1923 to 1924, and hence to explore the appearance of Taiwan's early dentistry.
Materials and methods: This study utilized the secondary data analysis to evaluate the numbers and distributions of dentists, physicians, and local practitioners in Taiwan from 1923 to 1924, to find the relationship among them, and further to explore the development of dentists in Taiwan at that period.
Results: The total numbers of dentists and physicians increased from 87 to 882 in 1923 to 97 and 927 in 1924, respectively. Moreover, the total number of local practitioners decreased

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from 583 in 1923 to 558 in 1924. Their Gini coefficients for dentists, physicians, and local practitioners were 0.18, 0.16 and 0.20 in 1923 and 0.27, 0.05 and 0.19 in 1924, respectively. From 1923 to 1924, dentists and physicians were mainly concentrated in the northern and southern regions of Taiwan, and dentists had more serious uneven distribution problem.
Conclusion: We conclude that the uneven distribution of dentist in Taiwan is an old problem. After a hundred years of development, the number of dentists increases at a higher rate than the number of physicians and there is no shortage of dentists to date in Taiwan. However, the problem of uneven distribution of dentists still exists and is even more serious now.

1. Introduction

Based on the needs for governance, Taiwan's medical and public health system must be established as soon as possible during the initial period of Japanese colonial rule in Taiwan. Therefore, the modern medical system was quickly introduced to Taiwan.[1] However, the accident of history contributed to the great leap forward in Taiwan's medical development from the end of the 19th century to the beginning of the 20th century. For example, health administration agencies, medical education and research institutions, medical institutions (hospitals and clinics), and epidemic prevention agencies were quickly established in Taiwan. In addition, modern medical personnel also began to appear in Taiwan at the time, such as physicians, dentists, nurses, midwives and pharmacists, etc.[2]

Nevertheless, before Japan ruled Taiwan, there were local practitioners who were engaged in patients' diagnosis, treatment, and drug administration, and most of them were practitioners for Chinese medicine. In order to manage these people, Taiwan Governor-general's Office issued the regulations about Taiwan local practitioners in Meiji 34 (1901), which stipulated that Taiwanese who were engaged in the medical profession in Taiwan before 1901 could apply for a doctor's license to the local governor and continue to be a doctor in practice. The deadline for the issuance of this doctor's license was December 31, 1901. This was the only one opportunity, and no more licenses were issued after that.[2]

According to the Taiwan Database for Empirical Legal Studies, in Taiwan, the number of physicians increased from 165 in Meiji 30 (1897) to 423 in Taisho 1 (1912), to 1019 in Showa 1 (1926), and further to 2441 in Showa 17 (1942). Besides, the number of dentists increased from 4 in Meiji 42 (1909) to 7 in Taisho 1 (1912), to 101 in Showa 1 (1926), and further to 567 in Showa 17 (1942). On the contrary, the number of local practitioners who obtained a doctor's license decreased year by year, from the highest number of 1903 in Meiji 35 (1902), to 1161 in Taisho 1 (1912), to 486 in Showa 1 (1926), and further to only 97 in Showa 17 (1942). We discovered from historical materials that among these local practitioners who obtained a doctor's license, there were also some people who were engaged in dental practice. In addition, the Taiwan Dental Association was established in Taisho 5 (1916). Generally, the Taisho era was a time when dentists developed well.[3]

Therefore, in this study, we tried to search the population and the numbers of dentists, physicians, and local practitioners in Taiwan from 1923 to 1924 according to the Taiwan Database for Empirical Legal Studies to analyze the relationship among the distributions of dentists, physicians, and local practitioners using the statistical methods and further to explore the development of dentists in Taiwan in that period.

2. Materials and methods

This study used the method of secondary data analysis to collect the information about the medical personnel and the population in Taiwan from 1923 to 1924. This information was open to access and could be collected from the related websites. We downloaded the Taiwan's health and demographic information of 1923 and 1924 stored in the Taiwan Database for Empirical Legal Studies, and extracted information about the medical personnel, including the numbers of dentists, physicians, and local practitioners in prefectures of Taiwan, and the total population in prefectures of Taiwan from 1923 to 1924.

Based on the number of each medical personnel in Taiwan from 1923 to 1924, we drew the Lorenz curve and calculated the Gini coefficient to understand the changes of the geographical distribution of each medical personnel from 1923 to 1924. When the number of each medical personnel per 100,000 people in each prefecture was completely even, the Lorenz curve was a diagonal line through the origin, called the equal distribution line. However, the more uneven was the geographical distribution of medical personnel, the more the Lorenz curve deviated from the equal distribution line. Besides, the actual value of the Gini coefficient was only between 0 and 1. The larger was the Gini coefficient (closer to 1), the more uneven was the distribution. On the contrary, the smaller was the Gini coefficient (closer to 0), the more even was the distribution.[4–7] Furthermore, we also defined the index for each medical personnel as the ratio of each medical personnel per 100,000 people in each prefecture to their corresponding values in the whole area of Taiwan, respectively. Then, the coefficient of correlation was used for comparisons between the dentist index and doctor index (including physician index, local practitioner index, and physician plus local practitioner index).[8] Moreover, the coefficient of correlation was used for comparisons

between the numbers of dentists and doctors (including physicians, local practitioners, and physicians plus local practitioners).

The data collected by the above methods were stored in excel files and were put into analyses statistically. The results in this study can help us to understand the appearance of Taiwan's early dentistry and may become important references for the research on Taiwan's early dental history.

3. Results

We inquired the numbers of dentists, physicians, local practitioners, and population in each prefecture of Taiwan from 1923 to 1924 according to the Taiwan Database for Empirical Legal Studies. There were 7 prefectures in Taiwan during the Taisho era. Taipei and Hsinchu were the northern region of Taiwan. Taichung was the central region. Tainan and Kaohsiung were the southern region. Moreover, Taitung and Hualien were the eastern region. The results were described as follows.

3.1. The population in each prefecture and region of Taiwan from Taisho 12 (1923) to Taisho 13 (1924)

There were totally 3,891,921 people in Taiwan in 1923. Tainan Prefecture had the largest population (1,005,083, 25.82%), and Taitung Prefecture had the smallest population (41,459, 1.07%) (Table 1). Moreover, there were totally 3,956,706 people in Taiwan in 1924. Tainan Prefecture also had the largest population (1,019,813, 25.77%), and Taitung Prefecture also had the smallest population (41,922, 1.06%) (Table 1). From 1923 to 1924, the population increased by 64,785 people with a growth rate of 1.66%. Taichung Prefecture had the largest increase of 17,127 people with a growth rate of 2.04%, and Taitung Prefecture had the least increase of 463 people with a growth rate of 1.12%. In addition, the population was mainly concentrated in the northern and southern regions of Taiwan, which were 1,386,982 (35.64%) and 1,572,630 (40.41%) in 1923, as well as 1,407,647 (35.58%) and 1,597,784 (40.38%) in 1924, respectively (Table 2).

3.2. The numbers of dentists in each prefecture and region of Taiwan from Taisho 12 (1923) to Taisho 13 (1924)

The total number of dentists was 87 in 1923. Among all prefectures, Taipei Prefecture had the largest number of dentists (28, 32.18%), and Hualien Prefecture had the smallest number of dentists (1, 1.15%) (Table 1). Moreover, the official statistics distinguished dentists in public hospitals and in private dental clinics in 1924. Therefore, we found that the total number of dentists was 97 in 1924. Of these 97 dentists, there were 5 working in public hospitals and 92 working in private dental clinics. Among all prefectures, Taipei Prefecture had the largest number of dentists (35, 36.08%), and Taitung Prefecture and Hualien Prefecture each had the smallest number of dentists (1, 1.03%). However, the dentists were mainly concentrated in Taipei City (25, 25.77%) (Table 1). From 1923 to 1924, the dentists increased by 10 with an increase rate of 11.49%. Taipei Prefecture had the largest increase of 7 dentists with an increase rate of 25%. However, Taichung Prefecture had a decrease of 3 dentists with a decrease rate of 20%. In addition, the dentists were mainly concentrated in the northern and southern regions of Taiwan, which were 33 (37.93%) and 36 (41.38%) in 1923, as well as 39 (40.21%) and 44 (45.36%) in 1924, respectively (Table 2).

Furthermore, to consider the number of dentists in the population, the number of dentists per 100,000 people was 2.24 for the overall in 1923. Among all prefectures, the number of dentists per 100,000 people was the highest in Taitung Prefecture (4.82) due to its sparse population. However, the corresponding numbers were the second highest in Taipei Prefecture (3.52) and the lowest in Hsinchu Prefecture (0.85) (Table 1). Moreover, the number of dentists per 100,000 people was 2.45 for the overall in 1924. Among all prefectures, the number of dentists per 100,000 people was the highest in Taipei Prefecture (4.32). However, the corresponding numbers were the second highest in Kaohsiung Prefecture (3.46) and the lowest in Hsinchu Prefecture (0.67). Moreover, the Gini coefficients were 0.18 in 1923 and 0.27 in 1924. In addition, Taipei City was also the place with the best dentist manpower (13.08 dentists per 100,000 people) in 1924 (Table 1).

3.3. The numbers of physicians in each prefecture and region of Taiwan from Taisho 12 (1923) to Taisho 13 (1924)

The total number of physicians was 882 in 1923. Of these 882 physicians, there were 180 working in public institutions (including hospitals and clinics) and 702 working in private clinics. Among all prefectures, Taipei Prefecture had the largest number of physicians (252, 28.57%), and Taitung Prefecture had the smallest number of physicians (15, 1.70%). However, among private clinic physicians, Tainan Prefecture had the largest number of private clinic physicians (188, 26.78%) (Table 1).

Moreover, the total number of physicians was 927 in 1924. Of these 927 physicians, there were 326 working in public institutions (including hospitals and clinics) and 601 working in private clinics. Among all prefectures, Taipei Prefecture had the largest number of physicians (241, 26.00%), and Taitung Prefecture had the smallest number of physicians (15, 1.62%). However, among private clinic physicians, Tainan Prefecture had the largest number of private clinic physicians (167, 27.79%). Moreover, the physicians were mainly concentrated in Taipei City (144, 15.53%) (Table 1). From 1923 to 1924, the physicians increased by 45 with an increase rate of 5.10%. Kaohsiung Prefecture had the largest increase of 22 physicians with an increase rate of 19.47%. However, Taipei Prefecture had the largest decrease of 11 physicians with a decrease rate of 4.37%. In addition, the physicians were mainly concentrated in the northern and southern regions of Taiwan, which were 332 (37.64%) and 334 (37.87%) in 1923, as well as 331 (35.71%) and 362 (39.05%) in 1924, respectively (Table 2).

Table 1 The numbers of population, dentists, physicians, and local practitioners in each prefecture of Taiwan from Taisho 12 (1923) to Taisho 13 (1924).

Prefecture	Population	Number of dentists*	Number of dentists per 100,000 people	Population served by each dentist	Physicians			Number of physicians per 100,000 people	Population served by each physician	Local practi-tioners	Number of local practi-tioners per 100,000 people	Population served by each local practitioner	Physicians plus local practi-tioners	Number of physicians plus local practitioners per 100,000 people	Population served by each physician plus local practitioner
					Public	Private	Total								
1923															
Taipei	796,269	28	3.52	28,438	98	154	252	31.65	3160	109	13.69	7305	361	45.34	2206
Hsinchu	590,713	5	0.85	118,143	7	73	80	13.54	7384	195	33.01	3029	275	46.55	2148
Taichung	838,026	15	1.79	55,868	16	164	180	21.48	4656	122	14.56	6869	302	36.04	2775
Tainan	1,005,083	22	2.19	45,689	33	188	221	21.99	4548	106	10.55	9482	327	32.53	3074
Kaohsiung	567,547	14	2.47	40,539	15	98	113	19.91	5023	51	8.99	11,128	164	28.90	3461
Taitung	41,459	2	4.82	20,730	7	8	15	36.18	2764	0	0	—	15	36.18	2764
Hualien	52,824	1	1.89	52,824	4	17	21	39.75	2515	0	0	—	21	39.75	2515
Overall	3,891,921	87	2.24	44,735	180	702	882	22.66	4413	583	14.98	6676	1465	37.64	2657
Gini coefficient	—	0.18	—	—	0.16			—	—	0.20	—	—	0.05	—	—
1924															
Taipei (Taipei City)	810,068 (191,135)	35 (4) (25)	4.32 (13.08)	23,145 (7645)	112 (68)	129 (76)	241 (144)	29.75 (75.34)	3361 (1327)	99 (24)	12.22 (12.56)	8183 (7964)	340 (168)	41.97 (87.90)	2383 (1138)
Hsinchu	597,579	4	0.67	149,395	45	45	90	15.06	6640	187	31.29	3196	277	46.35	2157
Taichung	855,153	12	1.40	71,263	45	151	196	22.92	4363	114	13.33	7501	310	36.25	2759
Tainan	1,019,813	24 (1)	2.35	42,492	60	167	227	22.26	4493	103	10.10	9901	330	32.36	3090
Kaohsiung	577,971	20	3.46	28,899	40	95	135	23.36	4281	55	9.52	10,509	190	32.87	3042
Taitung	41,922	1	2.39	41,922	13	2	15	35.78	2795	0	0	—	15	35.78	2795
Hualien	54,200	1	1.85	54,200	11	12	23	42.44	2357	0	0	—	23	42.44	2357
Overall	3,956,706	97 (5)	2.45	40,791	326	601	927	23.43	4268	558	14.10	7091	1485	37.53	2664
Gini coefficient	—	0.27	—	—	0.05			—	—	0.19	—	—	<0.01	—	—

* The official statistics distinguished dentists in private dental clinics and in hospitals in 1924. The total number of hospital dentists was 5 in 1924. Of these 5 dentists, there were 4 in Taipei Prefecture and one in Tainan Prefecture.

Table 2 The numbers of population, dentists, physicians, and local practitioners in each region of Taiwan from Taisho 12 (1923) to Taisho 13 (1924).

Regions of Taiwan	Population		Dentists		Physicians		Local practitioners		Physicians plus local practitioners	
	Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage
1923										
Northern	1,386,982	35.64%	33	37.93%	332	37.64%	304	52.14%	636	43.41%
Central	838,026	21.53%	15	17.24%	180	20.41%	122	20.93%	302	20.61%
Southern	1,572,630	40.41%	36	41.38%	334	37.87%	157	26.93%	491	33.52%
Eastern	94,283	2.42%	3	3.45%	36	4.08%	0	0	36	2.46%
Total	3,891,921	100%	87	100%	882	100%	583	100%	1465	100%
1924										
Northern	1,407,647	35.58%	39	40.21%	331	35.71%	286	51.25%	617	41.55%
Central	855,153	21.61%	12	12.37%	196	21.14%	114	20.43%	310	20.88%
Southern	1,597,784	40.38%	44	45.36%	362	39.05%	158	28.32%	520	35.02%
Eastern	96,122	2.43%	2	2.06%	38	4.10%	0	0	38	2.56%
Total	3,956,706	100%	97	100%	927	100%	558	100%	1485	100%

Furthermore, to consider the number of physicians in the population, the number of physicians per 100,000 people was 22.66 for the overall in 1923. Among all prefectures, the number of physicians per 100,000 people was the highest in Hualien Prefecture (39.75) and was the second highest in Taitung Prefecture (36.18) due to their sparse population. However, the corresponding numbers were the third highest in Taipei Prefecture (31.65) and the lowest in Hsinchu Prefecture (13.54) (Table 1).

Moreover, the number of physicians per 100,000 people was 23.43 for the overall in 1924. Among all prefectures, the number of physicians per 100,000 people was also the highest in Hualien Prefecture (42.44) and was the second highest in Taitung Prefecture (35.78) due to their sparse population. However, the corresponding numbers were the third highest in Taipei Prefecture (29.75) and the lowest in Hsinchu Prefecture (15.06). Moreover, the Gini coefficients were 0.16 in 1923 and 0.05 in 1924. In addition, Taipei City was also the place with the best physician manpower (75.34 physicians per 100,000 people) in 1924 (Table 1).

3.4. The numbers of local practitioners in each prefecture and region of Taiwan from Taisho 12 (1923) to Taisho 13 (1924)

The total number of local practitioners was 583 in 1923. Among all prefectures, Hsinchu Prefecture had the largest number of physicians (195, 33.45%), and Kaohsiung Prefecture had the smallest non-zero number of local practitioners (51, 8.75%). However, it should note that there was no local practitioner in Taitung Prefecture and Hualien Prefecture (Table 1).

Moreover, the total number of local practitioners was 558 in 1924. Among all prefectures, Hsinchu Prefecture also had the largest number of physicians (187, 33.51%), and Kaohsiung Prefecture also had the smallest non-zero number of local practitioners (55, 9.86%). However, it should note that there was no local practitioner in Taitung Prefecture and in Hualien Prefecture. Moreover, the local practitioners were not too concentrated in Taipei City (24, 4.30%) (Table 1). From 1923 to 1924, the local practitioners decreased by 25 with a decrease rate of 4.29%. Taipei Prefecture had the largest decrease of 10 local practitioners with a decrease rate of 9.17%. Conversely, Kaohsiung Prefecture had an increase of 4 local practitioners with an increase rate of 7.84%. In addition, the local practitioners were mainly concentrated in the northern region of Taiwan, which were 304 (52.14%) in 1923, and 286 (51.25%) in 1924, respectively (Table 2).

Furthermore, to consider the number of local practitioners in the population, the number of local practitioners per 100,000 people was 14.98 for the overall in 1923. Among all prefectures, the number of local practitioners per 100,000 people was the highest in Hsinchu Prefecture (33.01) (Table 1). Moreover, the number of local practitioners per 100,000 people was 14.10 for the overall in 1924. Among all prefectures, the number of local practitioners per 100,000 people was also the highest in Hsinchu Prefecture (31.29). Moreover, the Gini coefficients were 0.20 in 1923 and 0.19 in 1924 (Table 1).

3.5. The numbers of physicians plus local practitioners in each prefecture and region of Taiwan from Taisho 12 (1923) to Taisho 13 (1924)

The total number of physicians plus local practitioners increased from 1465 in 1923 to 1485 in 1924 with an increase number of 20 and an increase rate of 1.37%. Among all prefectures, Kaohsiung Prefecture had the largest increase of 26 physicians plus local practitioners with an increase rate of 15.85%. However, Taipei Prefecture had the largest decrease of 21 physicians plus local practitioners with a decrease rate of 5.82%. Among all prefectures, Taipei Prefecture had the largest number of physicians plus local practitioners, which were 361 (24.64%) in 1923 and 340 (22.90%) in 1924, followed by Tainan Prefecture with 327 (22.32%) in 1923 and 330 (22.22%) in 1924 (Table 1). In addition, the physicians and local practitioners were mainly concentrated in the northern and southern regions of Taiwan, which were 636 (43.41%) and 491 (33.52%) in 1923, as well as 617 (41.55%) and 520 (35.02%) in 1924, respectively (Table 2).

Furthermore, to consider the number of physicians plus local practitioners in the population, the number of physicians plus local practitioners per 100,000 people decreased slightly from 37.64 for the overall in 1923 to 37.53 for the overall in 1924. Among all prefectures, Hsinchu Prefecture had the largest number of physicians plus local practitioners per 100,000 people, which were 46.55 in 1923 and 46.35 in 1924, followed by Taipei Prefecture with 45.34 in 1923 and Hualien Prefecture with 42.44 in 1924. Moreover, the Gini coefficients were 0.05 in 1923 and <0.01 in 1924. In addition, Taipei City was also the place with the best physician and local practitioner manpower (87.90 physicians and local practitioners per 100,000 people) in 1924 (Table 1).

3.6. The coefficient of correlation between dentists and doctors (physicians and local practitioners) in Taisho 12 (1923) and Taisho 13 (1924)

The values for each medical personnel per 100,000 people were calculated with an index of 100. The coefficients of correlation between the dentist index and doctor index were positive for physicians ($R^2 = 0.3826$ with a slope of 0.8494, $P = 0.14$), and negative for local practitioners ($R^2 = 0.0291$ with a slope of -0.5783, $P = 0.72$) and for physicians plus local practitioners ($R^2 = 0.3969$ with a slope of -0.4913, $P = 0.13$) in 1923. Meanwhile, coefficients of correlation between the dentist index and doctor index were also positive for physicians ($R^2 = 0.0675$ with a slope of 0.3292, $P = 0.57$), and also negative for local practitioners ($R^2 = 0.102$ with a slope of -1.1282, $P = 0.49$) and for physicians plus local practitioners ($R^2 = 0.153$ with a slope of -0.2634, $P = 0.39$) in 1924 (Fig. 1).

Furthermore, the coefficients of correlation between the numbers of dentists and doctors were all positive for physicians ($R^2 = 0.9495$ with a slope of 0.1064, $P < 0.001$), for local practitioners ($R^2 = 0.1432$ with a slope of 0.0551, $P = 0.40$), and for physicians plus local practitioners ($R^2 = 0.6768$ with a slope of 0.0588, $P < 0.05$) in 1923. Meanwhile, the coefficients of correlation between the numbers of dentists and doctors were also all positive for physicians ($R^2 = 0.7892$ with a slope of 0.1239, $P < 0.01$), for local practitioners ($R^2 = 0.0736$ with a slope of 0.0528, $P = 0.56$), and for physicians plus local practitioners ($R^2 = 0.5152$ with a slope of 0.0664, $P = 0.07$) in 1924 (Fig. 2).

4. Discussion

The development of oral medicine has also been accompanied by the improvement of Taiwan's economy and education quality. Not only the number of dentists has gradually increased, but also the quality of oral medicine has improved.[9] The first modern dentist who came from Japan opened his dental clinic on the main street inside the city wall of Taipei in Meiji 29 (1896).[10] In 2019, there were 15,128 dentists and 35.13 million dental outpatient visits paid by national health insurance in Taiwan.[11] In addition, the Taiwan's government also implemented a comprehensive dental specialist system with 10 dental specialties in 2017.[12]

One of the directions of Taiwan's economic development during the era of Japanese rule was the direction of modernization. Moreover, modernization has enabled Taiwan's economy to grow and also improved the people's living standards.[13] Since Taiwan has made significant improvements in economics and public health during the Taisho era (from 1912 to 1926), this study tried to search for statistical data on the number and distribution of medical staff in the late Taisho era, and tried to use statistical analysis to study the profile of dentists at that time, and their relevance to physicians or local practitioners.

From Taisho 1 (1912) to Showa 1 (1926), the number of dentists increased by 94 (from 7 to 101), the number of physicians increased by 596 (from 423 to 1019), and the number of local practitioners decreased by 675 (from 1161 to 486) in Taiwan. Thus, the increased rates were 13.86 times for dentists and 1.41 times for physicians during the Taisho era. In addition, the ratio of physician to dentist decreased from 60.43 (423/7) to 10.09 (1019/101) during the Taisho era. This shows the rapid growth of dentists during the Taisho era. In fact, the Taiwan Physician Order and the Taiwan Dentist Order were announced at the same time in Taisho 5 (1916), confirming that both physicians and dentists were practitioners with the legal status.[1] Besides, Taiwan Dental Association and Taipei City Dental Association were established in Taisho 5 (1916) and Taisho 13 (1924), respectively, highlighting the important role of dentists in Taiwan's medical development.[3]

According to our findings, in Taiwan, the total number of dentists and physicians increased from 87 to 882 in 1923 to 97 and 927 in 1924, respectively. Meanwhile, the total population increased from 3,891,921 in 1923 to 3,956,706 people in 1924. Thus, there was an increase of 10 dentists by 11.49%, of 45 physicians by 5.10%, and of 64,785 people by 1.66%. Moreover, the number of overall dentists per 100,000 people increased from 2.24 in 1923 to 2.45 in 1924, demonstrating an increase of 0.21 dentist per 100,000 people. The corresponding number for physicians increased from 22.66 in 1923 to 23.43 in 1924, demonstrating an

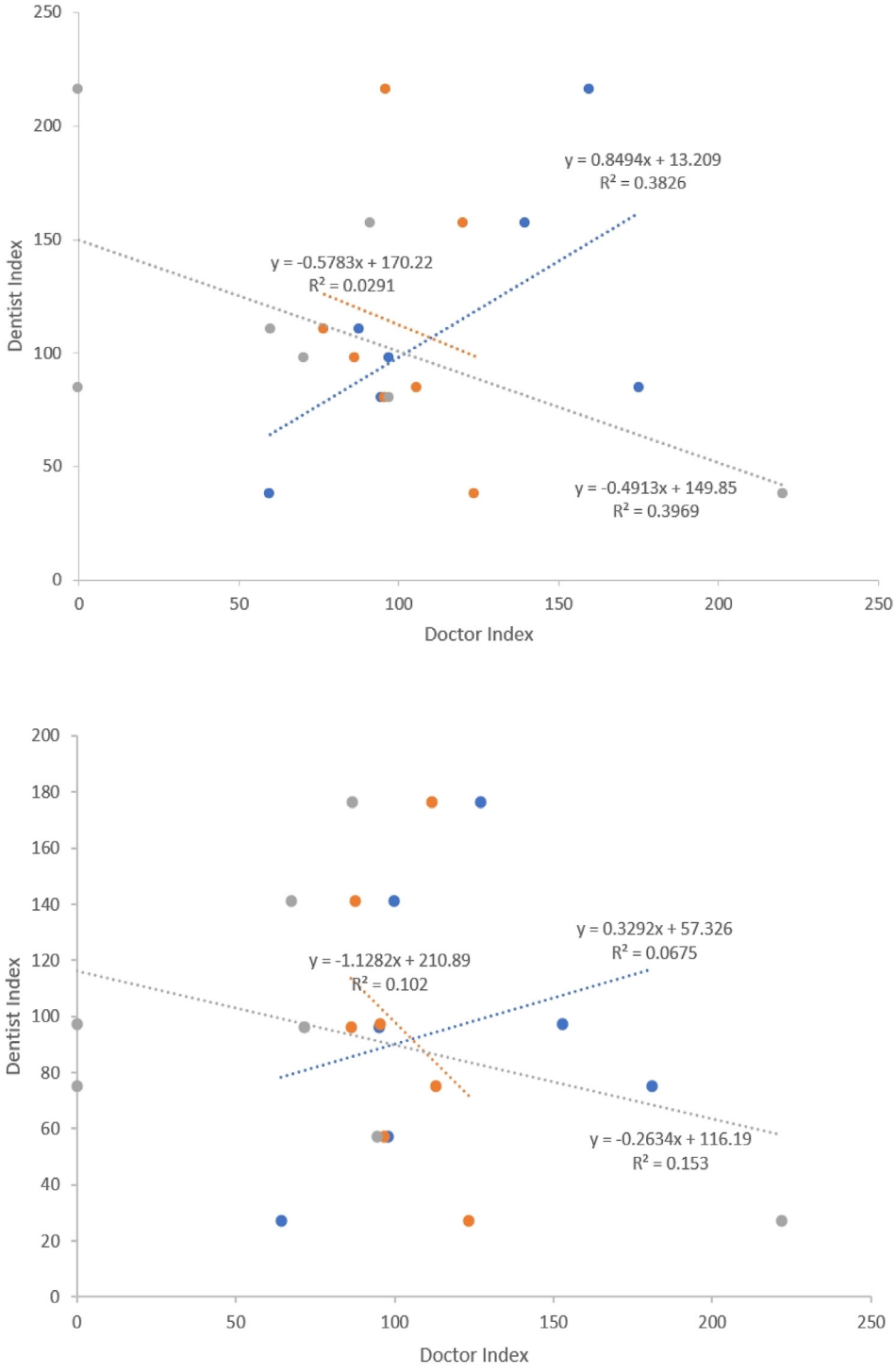

Figure 1 Correlation of dentist index and doctor index (physicians, local practitioners, and physicians plus local practitioners) in Taiwan in 1923 and 1924.
Upper (1923):
●: The regression between dentist index and physician index (n = 7): y = 0.8494x + 13.209, R^2 = 0.3826 (*P* = 0.14).
●: The regression between dentist index and local practitioner index (n = 7): y = −0.5783x + 170.22, R^2 = 0.0291 (*P* = 0.72).
●: The regression between dentist index and physician plus local practitioner index (n = 7): y = −0.4913x + 149.85, R^2 = 0.3969 (*P* = 0.13).
Lower (1924):
●: The regression between dentist index and physician index (n = 7): y = 0.3292x + 57.326, R^2 = 0.0675 (*P* = 0.57).
●: The regression between dentist index and local practitioner index (n = 7): y = −1.1282x + 210.89, R^2 = 0.102 (*P* = 0.49).
●: The regression between dentist index and physician plus local practitioner index (n = 7): y = −0.2634x + 116.19, R^2 = 0.153 (*P* = 0.39).

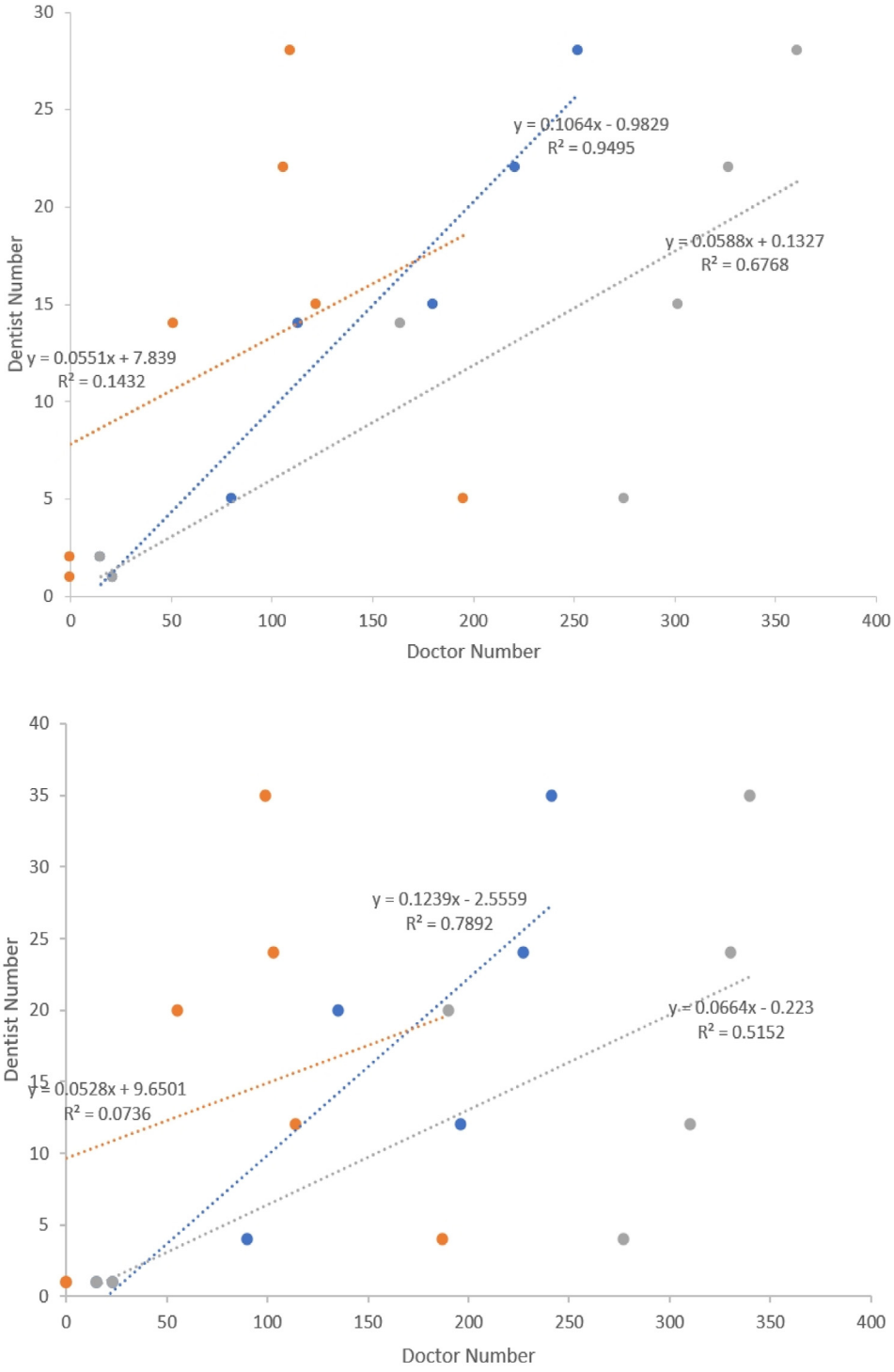

Figure 2 Correlation of the numbers of dentists and doctors (physicians, local practitioners, and physicians plus local practitioners) in Taiwan in 1923 and 1924.

Upper (1923):

●: The regression between the numbers of dentists and physicians (n = 7): $y = 0.1064x - 0.9829$, $R^2 = 0.9495$ ($P < 0.001$).

●: The regression between the numbers of dentists and local practitioners (n = 7): $y = 0.0551x + 7.839$, $R^2 = 0.1432$ ($P = 0.40$)

●: The regression between the numbers of dentists and physicians plus local practitioners (n = 7): $y = 0.0588x + 0.1327$, $R^2 = 0.6768$ ($P < 0.05$).

Lower (1924):

●: The regression between the numbers of dentists and physicians (n = 7): $y = 0.1239x - 2.5559$, $R^2 = 0.7892$ ($P < 0.01$).

●: The regression between the numbers of dentists and local practitioners (n = 7): $y = 0.0528x + 9.6501$, $R^2 = 0.0736$ ($P = 0.56$)

●: The regression between the numbers of dentists and physicians plus local practitioners (n = 7): $y = 0.0664x - 0.223$, $R^2 = 0.5152$ ($P = 0.07$).

increase of 0.77 physician per 100,000 people. In other words, the number of people served by each dentist decreased from 44,735 in 1923 to 40,791 in 1924. The number of people served by each physician decreased from 4413 in 1923–4268 in 1924. In fact, as the population increases, the market demand for dental services also increases. Therefore, these findings indicate that Japanese dentists successively come to Taiwan to practice and Taiwanese students who go to Japan or Korea for studying in dental schools also successively return to Taiwan to practice after they graduate from the dental schools in Japan or Korea, which finally causes an increase in the number of dentists in Taiwan at that time.[4] This is not only because the number of dentists in Taiwan was relatively small in the early days, but also there was a higher rate of growth in the number of dentists. Moreover, it also showed that for Japanese dentists, practicing in Taiwan could also be an option of their lifelong career, and for Taiwanese people, studying dentistry abroad and returning to Taiwan to practice was also a good option of their lifelong career in that era.

However, in Taipei Prefecture, these increase rates of dentists and population were 25% (7/28) and 1.73% (13,799/796,269), respectively. The number of dentists per 100,000 people increased from 3.52 in 1923 to 4.32 in 1924, demonstrating an increase of 0.8 dentist per 100,000 people. Moreover, there were 35 dentists, 241 physicians and 810,068 people in Taipei Prefecture in 1924, which accounted for 36.08% (35/97) of all dentists, 26.00% (241/927) of all physicians, and 20.47% (810,068/3,956,706) of the total population. Besides, there were 25 dentists, 144 physicians, and 191,135 people in Taipei City in 1924, which accounted for 25.77% (25/97) of all dentists, 15.53% (144/927) of all physicians, and 4.83% (191,135/3,956,706) of the total population. These findings indicate that the dentists and physicians at that time are mainly concentrated in the northern region of Taiwan such as Taipei Prefecture and the metropolitan areas such as Taipei City. In addition, there were also many dentists and physicians concentrated in Tainan Prefecture.

In 2019, there were 15,103 dentists, 49,437 physicians, and 23,449,847 people in Taiwan (excluding Kinmen County and Lienchiang County). In addition, there were 3325 dentists, 10,711 physicians, and 2,645,041 people in Taipei City in 2019, which accounted for 22.02% of all dentists, 21.67% of all physicians, and 11.28% of the total population. Therefore, we could know that the dentists, physicians, and population in Taiwan have grown by 174 times, 56 times, and 6 times, respectively, from 1923 to 2019. The numbers of dentists and physicians per 100,000 people were 64.41 and 210.82, respectively, in Taiwan in 2019. However, these corresponding numbers were 125.71 and 404.95, respectively, in Taipei City in 2019. In addition, the ratio of physician to dentist decreased from 10.14 (882/87) in 1923 to 9.56 (927/97) in 1924. This ratio decreased to 3.27 (49,437/15,103) in Taiwan (excluding Kinmen County and Lienchiang County) in 2019. These findings also indicate that after a century of development, the number of dentists and physicians in Taiwan has grown tremendously, and the growth rate of dentists is much higher than that of physicians. Similar to the previous situation, both dentists and physicians were still mainly concentrated in northern metropolitan areas such as Taipei City. This also indicates that the urban-rural gap and the unbalanced distribution of dentists have been problems for a long time in Taiwan. It is necessary to establish some policies to improve these long-term problems.[14–17]

We also use the Gini coefficient to analyze the differences in the distribution of each medical personnel in Taiwan in 1923 and in 1924. The Gini coefficients were 0.18 for dentists, 0.16 for physicians, 0.20 for local practitioners, and 0.05 for physicians plus local practitioners in 1923, respectively. Meanwhile, the Gini coefficients were 0.27, 0.05, 0.19, and <0.01 in 1924, respectively. These results indicate that the degree of uneven distribution of dentists is more obvious than that of physicians. However, the uneven distribution of dentists in Taiwan is indeed a long-term and old problem. In modern times, the Gini coefficient was 0.33 for dentists in Taiwan in 2018.[7] These data also showed that from 1923 to 1924, the uneven distribution of dentists became more serious, while that of physicians improved. We found that most of the number of dentists or physicians in each prefecture showed an increase, but the number of physicians in private clinics in Taipei Prefecture decreased a lot from 1923 to 1924. This difference has greatly improved the uneven distribution of physicians. However, it requires further in-depth studies to evaluate whether there were some public health policy interventions at that period. In addition, the degree of uneven distribution of local practitioners did not change. This might be due to the reason that local practitioners were issued only once in Meiji 34 (1901), and then the government allowed them to decrease without any further interventions, and their practice locations were also restricted. However, the degree of uneven distribution of physicians plus local practitioners was very limited, even close to a balanced distribution in 1924, and this could be revealed by the small value of Gini coefficient which was less than 0.01. The local practitioner system was designed to supplement the shortage of physicians in the early stage of Japanese colonial rule, but we didn't know whether the government at that time also considered to use the local practitioners to balance the distribution of practitioners (physicians plus local practitioners).

Furthermore, we used regression analysis to explore the index and number of each medical personnel and found that the number of dentists was positively correlated with the number of physicians, and it was significant. Considering demographic factors, dentist index and physician index were also positively correlated, although not significant. This result also indicates that the numbers of dentists and physicians are relatively larger in the areas where resources are good, such as Taipei and Tainan Prefectures, and the numbers of dentists and physicians decrease in the areas where resources are lacking, such as Taitung and Hualien Prefectures. However, dentist index and local practitioner index were negatively correlated, which might be due to the interventions by public health policies or influenced by demographic factors.

In fact, the local practitioners' practice locations were restricted, and there was no local practitioner in Taitung and Hualien Prefectures. In addition, the distributions of dentists and physicians in each prefecture were relatively close in proportion, indicating that their distributions may

also be mainly affected by market factors. However, the distribution of local practitioners in each prefecture was not the same in proportion as those of dentists and physicians, and this finding suggests that its distribution may be affected by government policy factors. Moreover, because the population was too small in Taitung and Hualien Prefectures, the number of each medical personnel per 100,000 people was enlarged in Taitung and Hualien Prefectures.

We conclude that from 1923 to 1924, dentists and physicians are mainly concentrated in the northern and southern regions as well as the metropolitan areas, such as Taipei Prefecture/City and Tainan Prefecture/City. After one hundred years of development, the number of dentists in Taiwan has increased from less than 100 to more than 15,000, and the number of physicians in Taiwan has increased from less than 1000 to more than 49,000. In addition, the ratio of physicians to dentists has dropped from 13.67 in 1923 to 3.27 in 2019, indicating that dentists increase at a higher rate than physicians, but dentists and physicians are still mainly concentrated in the metropolitan areas, such as the present Taipei City. However, according to the Gini coefficient, the problem of uneven distribution of dentists was indeed much more serious than those of physicians and local practitioners at that time.

Although there were local practitioners who were also engaged in dental practice and many illegal dentists were engaged in dental practice without a license at that time,[2,3] we had none of information about the exact data of these dental practitioners and illegal dentists. Even in Taipei City, the city with the most enough dentist manpower at the time, the number of dentists per 100,000 people was only 13.08. It was far below the current standard of at least 50 to meet the demand,[9] indicating that there are the problems of a shortage and an uneven distribution of regular dentists at that time. Today, there is no shortage of dentists in Taiwan, but the problem of uneven distribution still exists and is even more serious. Therefore, in the future development of dentists in Taiwan, in addition to the promotion of oral medicine specialties, we must also pay attention to the problems caused by the oversupply and uneven distribution of dentists.

Declaration of competing interest

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

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