Factors Affecting Infection Control Measures Performed by Dental Workers

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Abstract

**Background** We aimed to investigate factors associated with personal self-protection in infection control among dental care workers.

**Methods** A cross-sectional survey with self-report questionnaire was conducted between Jan and Dec, 2018. 275 dentists and 298 dental assistants were enrolled from randomly selected dental care settings.

**Results** Compliance with wearing hair caps, facial masks, and hand washing is not as high as oral masks and gloves (over 90%). For dentists, the level of clinical setting (aOR=3.1, P<0.001) and the correct use of disinfectants for impression materials (aOR=2.0, P<0.05) were associated with hair cap wearing. Gender (aOR=0.15, P<0.05) and correct use of indicator during sterilization (aOR=2.9, P<0.05) were associated with facial mask wearing. The correct use of indicator during sterilization (aOR=2.4, P<0.05) and disinfection for impression materials (aOR=2.2, P<0.05) were associated with hand washing. For dental assistants, longer work experience (aOR=1.05, P<0.05), working days (aOR=1.82, P<0.05), the correct use of disinfectants for impression materials (aOR=2.4, P<0.001), and the frequent use of gloves (aOR=8.0, P<0.05) were associated with facial mask wearing. The surface disinfection of working tables (aOR=2.8, P<0.001) and the frequent changing of gloves (aOR=5.96, P<0.05) were associated with hand washing.

**Conclusions** Gender, the length of work practice, and correct techniques for sterilization use were identified as major factors associated with compliance with self-protection in infection control among dental care workers.

Introduction

Infection control aims to prevent disease transmission and to promote a safe working environment. Reports of infectious disease transmission in dental clinics have been documented in previous studies. The regulation of infection control for all health care institutions and workers, including dental care professionals, is guided by government agencies and dental professional organizations to prevent working injury or exposure to blood and other potentially infectious materials. Infection control forms an important part of the practice for both patients and professional personnel in dental health care.

An investigation of US dental practitioners showed that only 26% of responding dentists had implemented three or four of the CDC recommendations. Thirty-four percent of practitioners had implemented none of the suggested recommendations in daily practice. The recommendations of infection control may not be successfully implemented in their clinical practice. A systematic review indicated that implementation strategies including audit and feedback, reminders, education, and multifaceted intervention have had some success in the dental setting, but more evidence regarding the effectiveness of each type of strategy is required. Additionally, the knowledge and attitude of practitioners might also play certain roles in the compliance with recommendations. However, in previous studies, knowledge and attitudes regarding these recommendations were not associated with adherence.
to infection control procedures among dental faculty members and students in dental colleges \(^4,5\). Many studies have elucidated the related factors leading to compliance with infection control procedures, but none of these studies have examined the gaps in infection control in terms of dental care workers’ perceptions, their attitude towards infection control procedures, or their number of years of practice. Risk factors are expected to be different in different types of dental clinics. Therefore, it is important to delineate the factors associated with the recommended guidelines according to different work characteristics, infection control procedures, and compliance rates.

The purpose of this study is to investigate perceptions and attitudes towards recommended infection guidelines and to reveal the factors associated with infection guidelines among dental care workers, including dentists and dental assistants.

**Materials And Methods**

**Study area and settings**

This is a cross-sectional study conducted in Taiwan between Jan 2018 and Dec 2018 at privately run dental clinics and associated hospitals. The participating clinics were under no strict selection criteria, and mostly all operate in a similar fashion. We believe our study sample to be sufficiently random and representative given that clinics were chosen from different, geographically distant areas of Taiwan: north, south, east, and west. This study complied with STROBE guidelines.

**Questionnaire**

The survey instrument used was a self-administered questionnaire. The anonymous questionnaire contained sixty-nine questions composing four major categories: personal characteristics; perception and attitude towards infection control procedures; exposure risk and training; and knowledge about and perception and attitude towards infectious disease. The expert validity and content validity of the questionnaire were verified prior to the investigation. This study was approved by Institutional Review Board of Taipei Medical University (TMU-JIRB: N201804006)

**Study Sample**

As dental clinic sizes vary by area, we used the probabilities proportional to size (PPS) method \(^6\) to randomly select subjects from different clinical settings in each area. A total of 60 hospitals and 340 dental clinics from four areas were therefore selected. We invited a dentist and a dental assistant from each setting to respond to the questionnaire. The finished questionnaire was returned by post. The questionnaire return rates for dentists and dental assistants were 68.75% and 74.5%, respectively.

**Statistical Analysis**
Data are summarized as the means (standard deviations, SDs) for continuous variables and counts (percentages) for categorical variables. Comparisons of personal characteristics and perceptions and attitudes towards infection control between dentists and dental assistants were performed by using the chi-squared test or t test as applicable. Multivariable backward stepwise logistic regression models were used to analyze factors associated with perceptions and attitudes towards infection control. All statistical analyses were performed with SAS 9.4.

Results

A total of 573 subjects (275 dentists and 298 dental assistants) participated in this study. Table 1 shows the personal characteristics of the two groups. A disproportionately higher percentage of dentists (81%) than dental assistants (3%) were male. More than half of the dentists were older than 50 years old, but the majority of assistants were younger than 50 years old. Therefore, the length of practice was significantly longer among the dentists. Among the dental assistants, only one-fourth had health-related backgrounds. There was no significant difference in the working days per week for the two groups. The majority of dentists (60%) treated 11–20 patients every day. Only a small group (4%) saw more than 30 patients per day. In both groups, approximately 20% of the samples were based out of hospitals.
Table 1
Personal characteristics of the included dentists and dental assistants

| Characteristics                      | Dentists | Dental assistants | P-Value |
|-------------------------------------|----------|-------------------|---------|
|                                     | N = 275  | N = 298           |         |
|                                     | N        | %                 | N        | %                 |
| Gender                              |          |                   |          |                   |
| Male                                | 222      | 80.73             | 8        | 2.68              |
| Female                              | 53       | 19.27             | 290      | 97.32             |
| Age (years)                         |          |                   |          |                   |
| <=30                                | 20       | 7.33              | 94       | 31.76             |
| 31 ~ 40                             | 48       | 17.58             | 118      | 39.86             |
| 41 ~ 50                             | 57       | 20.88             | 61       | 20.61             |
| 51 ~ 60                             | 91       | 33.33             | 15       | 5.07              |
| >=61                                | 57       | 20.88             | 8        | 2.70              |
| Length of practice (years)          |          |                   |          |                   |
| Mean, Sd.                           | 22.49    | 11.21             | 9.63     | 7.39              |
| Professional background             |          |                   |          |                   |
| Health related major                | 74       | 25.17             |          |                   |
| Other majors with professional training | 220      | 73.83             |          |                   |
| Working days per week               |          |                   | 0.054b   |                   |
| Mean, Sd.                           | 5.24     | 0.68              | 5.13     | 0.72              |
| Number of patients treated per day  |          |                   |          |                   |
| 0 ~ 10                              | 52       | 18.98             |          |                   |
| 11 ~ 20                             | 161      | 58.76             |          |                   |
| Sd.: standard deviation             |          |                   |          |                   |

Variables with missing values: Age (dentist 2; DA 2); Length of practice (dentist 3; DA 2); Professional background (DA 4); Working days per week (dentist 3; DA 1); Number of patients treated per day (dentist 1); Setting level (DA 1)

\(^a\) Chi-squared test

\(^b\) t-test
| Characteristics | Dentists | Dental assistants | P-Value |
|-----------------|----------|-------------------|---------|
|                 | N = 275  | N = 298           |         |
| 21 ~ 30         | 50       | 18.25             |         |
| > 30            | 11       | 4.01              |         |
| Setting level   |          |                   | 0.40<sup>a</sup> |
| Hospital        | 55       | 20.00             | 68      |
|                 |          | 22.90             |         |
| Local dental office | 220   | 80.00             | 229     |
|                 |          | 77.10             |         |
| Sd.: standard deviation |        |                   |         |

<sup>a</sup> Chi-squared test

<sup>b</sup> t-test

Variables with missing values: Age (dentist 2; DA 2); Length of practice (dentist 3; DA 2); Professional background (DA 4); Working days per week (dentist 3; DA 1); Number of patients treated per day (dentist 1); Setting level (DA 1)

We further compared the personal protection barrier techniques implemented in the two groups (Table 2). We found that the compliance with wearing gloves was high in both groups (95% of dentists and 92% of dental assistants, p = 0.08). Gloves were changed after treating each patient by the majority of dentists (97%) and assistants (95%). However, allergies to protective gloves were more frequent among dental assistants (40%) than among dentists (27%) (p = 0.001). The strategies employed to address the reaction, including consuming allergy medication or changing the type of gloves, were similar for the two groups. It is interesting to see that the hand washing behavior before putting on gloves was similar between dentists (75%) and assistants (76%) (p = 0.65), but assistants were more likely to wash their hands (92%) than dentists (84%) (p = 0.005) after removing gloves.
Table 2
Barrier techniques for infection control among dentists and dental assistants

| Variables                                      | Dentist | Dental assistants | \(P\)-Value\(^a\) |
|------------------------------------------------|---------|-------------------|-------------------|
| | N = 275 | N = 298 |                    |
| N % | N %               |                     |
| Gloves                                      | 0.08    |
| Yes (yes and optional)                       | 262 95.27 | 273 91.61 |                     |
| No                                          | 13 4.73 | 25 8.39 |                     |
| Frequency of changing gloves                 | 0.29    |
| Every patient                               | 263 96.69 | 280 94.92 |                     |
| More than one patient                        | 9 3.31 | 15 5.08 |                     |
| Glove allergy                                | 0.001   |
| Yes                                          | 74 26.81 | 118 39.6 |                     |
| No                                           | 201 73.19 | 180 60.4 |                     |
| Has allergies and takes medical treatment    | 0.78    |
| No                                           | 47 65.28 | 74 63.25 |                     |
| Yes                                          | 25 34.72 | 43 36.75 |                     |
| Has allergies and changes to different gloves| 0.77    |
| No                                           | 22 31.88 | 34 29.82 |                     |
| Yes                                          | 47 68.12 | 80 70.18 |                     |
| Changes type of gloves                       | 0.27    |
| Did not change                               | 22 31.88 | 34 29.82 |                     |
| Latex with powder                            | 8 11.59 | 24 21.05 |                     |
| Latex without powder                         | 30 43.48 | 48 42.11 |                     |
| Non-latex                                    | 9 13.04 | 8 7.02 |                     |
| Washes hands before putting on gloves       | 0.65    |

\(^a\) Chi-squared test

Variables with missing values: Frequency of changing gloves (dentist 3; DA 3); Has allergies and takes medical treatment (dentist 2; DA 1); Has allergies and changes to different gloves (dentist 5; DA 4); Work attire (dentist 0; DA 9); Washes hand after removing gloves (dentist 1; DA 0)
| Variables                              | Dentist | Dental assistants | P-Value<sup>a</sup> |
|----------------------------------------|---------|-------------------|---------------------|
|                                        | N = 275 | N = 298           |                     |
| Washes hands after removing gloves     |         |                   | 0.005               |
| Yes                                    | 205     | 227               | 74.55 76.17         |
| No                                     | 70      | 71                | 24.45 23.83         |
| Oral masks                             |         |                   | 0.07                |
| Yes                                    | 231     | 274               | 84.31 91.95         |
| No                                     | 43      | 24                | 15.69 8.05          |
| Hair caps                              |         |                   | 0.011               |
| Yes                                    | 57      | 37                | 20.73 12.42         |
| Optional                               | 109     | 114               | 39.64 38.26         |
| No                                     | 109     | 147               | 39.64 49.33         |
| Facial mask                            |         |                   | <0.0001             |
| Yes                                    | 99      | 37                | 36.00 12.42         |
| Optional                               | 134     | 121               | 48.73 40.60         |
| No                                     | 42      | 140               | 15.27 46.98         |
| Work attire                            |         |                   | 0.027               |
| Casual clothes                         | 10      | 12                | 3.64 4.15           |
| Work clothes                           | 184     | 220               | 66.91 76.12         |
| Scrubs                                 | 81      | 57                | 29.45 19.72         |

<sup>a</sup> Chi-squared test

Variables with missing values: Frequency of changing gloves (dentist 3; DA 3); Has allergies and takes medical treatment (dentist 2; DA 1); Has allergies and changes to different gloves (dentist 5; DA 4); Work attire (dentist 0; DA 9); Washes hand after removing gloves (dentist 1; DA 0)

As far as other personal protection means, we found that compliance with wearing oral masks was very high in Taiwan for both groups (99% in dentists and 97% in dental assistants). However, the behavior of wearing hair caps, goggles, and other protective attire was different between dentists and dental assistants. A higher proportion of dentists (60.3%) wore hair caps (p = 0.011) and facial masks (goggles)
Dental assistants were more likely (76%) than dentists (67%) to wear uniform gowns but less likely to wear protective gowns (29% for dentists and 20% for assistants) (p < 0.0001). Dental assistants were more likely (76%) than dentists (67%) to wear uniform gowns but less likely to wear protective gowns (29% for dentists and 20% for assistants) (p = 0.027).

The behavior of disinfection and sterilization for infection control was similar in dentists and dental assistants (Table 3). Compliance with the use of autoclaves for sterilizing general dental instruments, extraction instruments, and hand pieces was excellent in Taiwan for both dentists and dental assistants. Dental assistants (78%) were more likely than dentists (73%) to autoclave dental burs (p = 0.014). Approximately 80% (453/574) of the participants used chemical indicators during sterilization. The most frequent disinfectant was glutaraldehyde. Seventy-five percent of dentists and 81% of dental assistants conducted surface disinfection of working tables. For impression materials, approximately 70% used water for disinfection.
Table 3  
Disinfection and sterilization for infection control among dentists and dental assistants

| Variables                          | Dentist | Dental Assistants | \( P \text{-Value}^{a} \) |
|-----------------------------------|---------|-------------------|--------------------------|
|                                   | N = 275 | N = 298           |                          |
| Variables with missing values:    |         |                   |                          |
| General dental instrument disinfection |         |                   |                          |
| Autoclave                         | 246 93.89 | 267 92.39          | 0.056                    |
| Chemicals                         | 3 1.15   | 12 4.17            |                          |
| Other                             | 13 4.96  | 9 3.13             |                          |
| Extraction instrument disinfection |         |                   |                          |
| Autoclave                         | 263 97.41 | 280 95.56          | 0.24                     |
| Other                             | 7 2.59   | 13 4.44            |                          |
| Handpiece disinfection            |         |                   |                          |
| Autoclave                         | 231 86.19 | 255 87.63          | 0.52                     |
| Chemicals                         | 11 4.10  | 7 2.41             |                          |
| Other                             | 26 9.70  | 29 9.97            |                          |
| Bur disinfection                  |         |                   |                          |
| Autoclave                         | 199 73.43 | 229 77.89          | 0.014                    |
| Chemicals                         | 50 18.45 | 58 19.73           |                          |
| Other                             | 22 8.12  | 7 2.38             |                          |
| Chemical indicator use during sterilization |         |                   | 0.37                     |
| Yes                               | 213 77.45 | 240 80.54          |                          |
| No                                | 62 22.55 | 58 19.46           |                          |
| Disinfectant                      |         |                   | 0.20                     |
| Glutaraldehyde                    | 156 65.27 | 135 59.73          |                          |

\(^a\) Chi-squared test

Variables with missing values: General dental instrument disinfection (dentist 13; DA 10); Extraction instrument disinfection (dentist 5; DA 5); Handpiece disinfection (dentist 7; DA 7); Bur disinfection (dentist 4; DA 4); Disinfectants (dentist 36; DA 72); Surface disinfection of working tables (dentist 0; DA 1); Disinfection of impression materials (dentist 1; DA 0)
Factors associated with personal protection behavior, such as wearing hair caps and facial masks and hand washing, were identified using multivariable logistic regression. The full model is presented in Table 4. The reduced model is presented in Table 5. For wearing hair caps, we found that setting level was a significant factor for both dentists (aOR = 3.10, 95% CI: 1.38–6.96) and dental assistants (aOR = 2.33, 95% CI: 1.10–4.96). Using disinfectants for impression materials was also positively associated with hair cap wearing (aOR = 2.03 for dentists (95% CI: 1.04–3.95) and 3.55 for dental assistants (95% CI: 1.79–7.02)). Surface disinfection of working tables was also a significant factor for hair cap wearing for assistants (aOR = 3.00, 95% CI: 1.35–6.65) but not for dentists.

| Variables                                      | Dentist | Dental Assistants | \( P \)-Value<sup>a</sup> |
|------------------------------------------------|---------|-------------------|--------------------------|
| N = 275                                        |         |                   |                          |
| Phenol & NaOCl                                 | 38      | 15.90             | 34                       | 15.04                        |
| Alcohol                                        | 12      | 5.02              | 9                        | 3.98                         |
| Others                                         | 33      | 13.81             | 48                       | 21.24                        |
| Surface disinfection of working tables         |         |                   |                          |
| Yes                                            | 207     | 75.27             | 241                      | 81.14                        |
| No                                             | 68      | 24.73             | 56                       | 18.86                        |
| Disinfection of impression materials           |         |                   |                          |
| Disinfectant                                   | 84      | 30.66             | 81                       | 27.18                        |
| Water                                          | 190     | 69.34             | 217                      | 72.82                        |

<sup>a</sup> Chi-squared test

Variables with missing values: General dental instrument disinfection (dentist 13; DA 10); Extraction instrument disinfection (dentist 5; DA 5); Handpiece disinfection (dentist 7; DA 7); Bur disinfection (dentist 4; DA 4); Disinfectants (dentist 36; DA 72); Surface disinfection of working tables (dentist 0; DA 1); Disinfection of impression materials (dentist 1; DA 0)
Table 4
Factors associated with hair cap, facial mask wearing and hand washing by multivariable (full model)

| Variables                      | Hair Cap | Facial Mask | Hand washings |
|--------------------------------|----------|-------------|---------------|
|                                | Dentist  | Dental Assistant | Dentist  | Dental Assistant | Dentist  | Dental Assistant |
|                                | OR     | (95%CI) | OR     | (95%CI) | OR     | (95%CI) |
| Gender                         |         |         |         |         |         |         |
| Female                         | 1.00    |         |         |         |         |         |
| Male                           | 0.22*   | (0.05–0.99) |         |         |         |         |
| Length of practice             |         |         |         |         |         |         |
| years                          | 1.05**  | (1.01–1.09) | 1.06*  | (1.01–1.10) |         |         |
| Setting level                  |         |         |         |         |         |         |
| Local dental office            | 1.00    | 1.00    | 1.00    |         |         |         |
| Hospital                       | 2.86**  | (1.37–5.97) | 2.53** | (1.28–4.99) | 2.03*  | (1.07–3.84) |
| Frequency of changing gloves   |         |         |         |         |         |         |
| More than one patient          | 1.00    |         | 1.00    |         |         |         |
| Every patient                  | 6.71*   | (1.35–33.28) | 5.61** | (1.59–19.81) |         |         |
| Bur disinfection               |         |         |         |         |         |         |
| Chemical                       | 1.00    |         |         |         |         |         |

*P< 0.05

**P< 0.01

Backward selection with P< 0.05
| Variables                                    | Hair Cap | Facial Mask | Hand washings |
|----------------------------------------------|----------|-------------|---------------|
|                                              | Dentist  | Dental Assistant | Dentist | Dental Assistant | Dentist | Dental Assistant |
| Autoclave                                    | 2.28*    |             |              |
|                                              | (1.12– 4.67) |             |              |
| Chemical indicator use during sterilization  |          |             |              |
| No                                           | 1.00     | 1.00        | 1.00          |
| Yes                                          | 3.38**   | 1.95*       |              |
|                                              | (1.53– 7.46) | (1.04– 3.62) |              |
| Surface disinfection of working tables       |          |             |              |
| No                                           | 1.00     | 1.00        | 1.00          |
| Yes                                          | 2.48*    |             | 2.98**       |
|                                              | (1.23– 5.00) |             | (1.52– 5.85) |
| Disinfection of impression materials         |          |             |              |
| Water                                        | 1.00     | 1.00        | 1.00          |
| Disinfectant                                 | 2.16*    | 3.64**      | 3.47*         |
|                                              | (1.19– 3.93) | (1.90– 6.95) | (1.15– 10.46) |
|                                              |          |             | 2.17*         |
|                                              |          |             | (1.18– 4.00) |
|                                              |          |             | 2.05*         |
|                                              |          |             | (1.09– 3.87) |
|                                              |          |             | 2.43*         |
|                                              |          |             | (1.10– 5.34) |
| *P<0.05                                      |          |             |              |
| **P<0.01                                     |          |             |              |
| Backward selection with *P<0.05              |          |             |              |
Table 5
Factors associated with hair cap, facial mask wearing and hand washing by multivariable (reduced model)

| Variables          | Hair Cap | Facial Mask | Hand washing |
|--------------------|----------|-------------|--------------|
|                    | Dentist  | Dental Assistant | Dentist  | Dental Assistant | Dentist  | Dental Assistant |
| Gender             |          |              |              |                  |          |                 |
| Female             | 1.00     | –            | 1.00        | –                | 1.00     | –                |
| Male               | 0.93     | 0.15*        | 0.65        | –                |          |                 |
|                    | (0.42–2.03) | (0.02–0.98) | (0.30–1.41) |                  |          |                 |
| Age                |          |              |              |                  |          |                 |
| Dentist            |          |              |              |                  |          |                 |
| ≤ 40               | 1.00     | 1.00         | 1.00        | 1.00             | 1.00     | 1.00             |
| ≤ 30               |          |              |              |                  |          |                 |
| 41~50              | 1.14     | 0.84         | 0.42        | 0.94             | 1.49     | 0.83             |
|                    | (0.36–3.62) | (0.42–1.66) | (0.06–3.00) | (0.49–1.80)     | (0.45–4.92) | (0.39–1.74)     |
| 51~60              | 0.36     | 1.31         | 0.17        | 1.19             | 0.90     | 1.21             |
|                    | (0.08–1.57) | (0.55–3.17) | (0.01–1.92) | (0.50–2.83)     | (0.19–4.21) | (0.42–3.46)     |
| ≥ 61               | 0.73     |              | 0.27        |                  | 2.61     |                  |
|                    | (0.10–5.09) |              | (0.01–6.43) |                  |          |                  |
| Length of practice |          |              |              |                  |          |                 |
| years              | 1.01     | 1.01         | 1.06        | 1.05*            | 1.00     | 1.05             |
|                    | (0.95–1.08) | (0.97–1.06) | (0.96–1.17) | (1.00–1.10)     | (0.93–1.06) | (0.99–1.11)     |

†P<0.10

*P<0.05

**P<0.01
| Variables                        | Hair Cap Dentist | Hair Cap Dental Assistant | Facial Mask Dentist | Facial Mask Dental Assistant | Hand washing Dentist | Hand washing Dental Assistant |
|---------------------------------|------------------|----------------------------|---------------------|-------------------------------|----------------------|-------------------------------|
| Working days per week           |                  |                            |                     |                               |                      |                               |
| > 5 days                        | 1.00             | 1.00                       | 1.00                | 1.00                          | 1.00                 | 1.00                          |
| ≤ 5 days                        | 1.59             | 1.77†                      | 1.00                | 1.82*                         | 1.39                 | 1.17                          |
|                                 | (0.87–2.91)      | (0.95–3.27)                | (0.41–2.45)         | (1.01–3.30)                   | (0.77–2.52)          | (0.59–2.32)                   |
| Setting level                   |                  |                            |                     |                               |                      |                               |
| Local dental office             | 1.00             | 1.00                       | 1.00                | 1.00                          | 1.00                 | 1.00                          |
| Hospital                        | 3.10**           | 2.33*                      | 2.96                | 1.58                          | 1.29                 | 1.23                          |
|                                 | (1.38–6.96)      | (1.10–4.96)                | (0.61–14.35)        | (0.78–3.20)                   | (0.59–2.85)          | (0.52–2.86)                   |
| Number of patients treated per day |                  |                            |                     |                               |                      |                               |
| 0 ~ 10                          | 1.00             | −                          | 1.00                | −                             | 1.00                 | −                             |
| 11 ~ 20                         | 1.36             | −                          | 1.56                | −                             | 1.74                 | −                             |
|                                 | (0.63–2.94)      |                            | (0.53–4.53)         |                               | (0.83–3.65)          |                               |
| > 20                            | 1.63             | −                          | 1.56                | −                             | 1.40                 | −                             |
|                                 | (0.66–4.05)      |                            | (0.42–5.78)         |                               | (0.59–3.33)          |                               |
| Professional background         |                  |                            |                     |                               |                      |                               |
| Other majors                    | −                | 1.00                       | −                   | 1.00                          | −                    | 1.00                          |
| Health related major            | −                | 1.42                       | −                   | 1.52                          | −                    | 1.15                          |
|                                 |                  | (0.71–2.83)                |                     | (0.79–2.95)                   |                      | (0.52–2.55)                   |

†P < 0.10

*P < 0.05

**P < 0.01
| Variables                        | Hair Cap | Facial Mask | Hand washing |
|---------------------------------|----------|-------------|--------------|
|                                 | Dentist  | Dental Assistant | Dentist | Dental Assistant | Dentist | Dental Assistant |
| General dental instrument disinfection |         |              |             |                |          |                |
| Chemicals                       | 1.00     | 1.00         | 1.00        | 1.00           | −        | 1.00            |
| Autoclave                       | 0.61 (0.02–17.31) | 5.45 (0.60–49.10) | 2.71 (0.07–101.24) | 0.67 (0.16–2.80) | −        | 2.85 (0.55–17.74) |
| Extraction instrument disinfection |         |              |             |                |          |                |
| Not autoclave                   | 1.00     | 1.00         | −           | 1.00           | 1.00     | 1.00            |
| Autoclave                       | 0.33 (0.02–5.53) | 1.12 (0.22–5.55) | −           | 2.08 (0.47–9.19) | 4.87     | 0.54            |
| Handpiece disinfection          |         |              |             |                |          |                |
| Chemicals                       | 1.00     | 1.00         | 1.00        | 1.00           | 1.00     | 1.00            |
| Autoclave                       | 1.10 (0.24–5.01) | 0.35 (0.05–2.39) | 0.91 (0.11–7.28) | 1.79 (0.17–18.72) | 0.55     | 0.91            |
| Bur disinfection                |         |              |             |                |          |                |
| Chemicals                       | 1.00     | 1.00         | 1.00        | 1.00           | 1.00     | 1.00            |
| Autoclave                       | 0.58 (0.26–1.32) | 2.09† (0.87–5.03) | 1.89 (0.66–5.42) | 1.33 (0.59–3.00) | 0.47† | 0.52 (0.19–1.40) |
| Chemical indicator use during sterilization |       |              |             |                |          |                |
| No                              | 1.00     | 1.00         | 1.00        | 1.00           | 1.00     | 1.00            |

†P < 0.10

*P < 0.05

**P < 0.01
| Variables                                      | Hair Cap                  | Facial Mask               | Hand washing             |
|------------------------------------------------|---------------------------|---------------------------|--------------------------|
|                                                | Dentist | Dental Assistant | Dentist | Dental Assistant | Dentist | Dental Assistant |
| Yes                                            | 1.01    | 1.24            | 2.94*   | 0.97             | 2.36*   | 1.96†            |
|                                                | (0.46–2.07) | (0.59–2.63)   | (1.19–7.24) | (0.47–1.98)   | (1.17–4.75) | (0.93–4.16)     |
| Surface disinfection of working tables          | No      | 1.00            | 1.00    | 1.00             | 1.00    | 1.00             |
|                                                | Yes     | 1.94†           | 3.00**  | 1.34             | 2.05†   | 1.96**           |
|                                                |         | (0.99–3.84)    | (1.35–6.65) | (0.53–3.39)   | (0.99–4.25) | (0.67–2.56)     |
| Disinfection of impression materials            | Water   | 1.00            | 1.00    | 1.00             | 1.00    | 1.00             |
|                                                | Disinfectant | 2.03*         | 3.55**  | 3.03†            | 2.40**  | 2.24*            |
|                                                |         | (1.04–3.95)    | (1.79–7.02) | (0.91–10.14)  | (1.25–4.61) | (1.11–4.53)     |
|                                                | Gloves  | No              | 1.00    | 1.00             | 1.00    | 1.00             |
|                                                |         | Yes             | 3.45    | 0.56             | 1.66    | 0.94             |
|                                                |         | (0.62–19.27)   | (0.16–1.92) | (0.28–9.67)  | (0.28–3.17) | (0.09–1.84)     |
| Frequency of changing gloves                    | More than one patient     | 1.00            | 1.00    | 1.00             | –       | 1.00             |
|                                                | Every patient | 0.77           | 1.57    | 3.06             | 8.04*   | 5.96*            |
|                                                |         | (0.11–5.39)    | (0.38–6.54) | (0.37–25.27) | (1.39–46.47) | (1.39–25.51)    |
| Oral masks                                     | †P<0.10 |
|                                                | *P<0.05  |
|                                                | **P<0.01 |

“*” *P* < 0.05

“**” *P* < 0.01

“†” *P* < 0.10
Factors related to facial masks were different between dentists and assistants. Gender (male; aOR = 0.15 (95% CI: 0.02–0.98)) and chemical indicator use during sterilization (aOR = 2.94, 95% CI: 1.19–7.24) were significant factors for dentists. For assistants, a longer working experience (aOR = 1.05 (95% CI: 1.00–1.10) per year longer), fewer working days per week (aOR = 1.82, 95% CI: 1.01–3.30), the use of disinfectants for impression materials (aOR = 2.40, 95% CI: 1.25–3.30), and the frequent use of gloves (aOR = 8.04, 95% CI: 1.39–46.47) were positively associated with wearing facial masks. The use of chemical indicators during sterilization (aOR = 2.36, 95% CI: 1.17–4.75) and disinfectants for impression materials (aOR = 2.24, 95% CI: 1.11–4.53) were associated with hand washing for dentists, whereas surface disinfection of working tables (aOR = 2.76, 95% CI: 1.29–5.90) and frequent changing of gloves (aOR = 5.96, 95% CI: 1.39–25.51) were associated with hand washing for assistants.

The results of multivariable logistic regression with backward selection are shown in Table 5. The use of disinfectants for impression materials was consistently positively associated with the three personal protection behaviors for both dentists and assistants. The others remain similar as in the full model. However, the frequency of changing gloves became insignificant.

**Discussion**

The present survey aimed to elucidate not only the perceptions and attitudes of infection control but also the factors associated with infection control among dentists and dental assistants. Most dental care workers were aware of the standard infection control guidelines. Overall compliance with infection control parameters, including wearing gloves, changing gloves for each patient, and wearing oral masks, was 90% or above. The compliance with these parameters was not different between dentists and dental assistants. The compliance with infection control practices has improved since our previous survey. The level of compliance was comparable to the DHCWs in some other countries. The compliance with hand washing after removing gloves was slightly lower (84%) among dentists than among dental assistants (96.6%) (P < 0.05), whereas compliance with wearing hair caps and facial masks was higher.
among dentists than among dental assistants. The performance of dental assistants was not satisfactory with respect to some infection control areas.

The results of the study demonstrated the use of accurate methods for sterilizing the instruments. More than 90% of respondents used autoclave disinfection for general dental instruments and extraction instruments, and more than 70% of respondents used autoclaving as the major disinfection method for headpieces and burs and followed the standard guidelines for the use of chemical indicators during sterilization. Our results were consistent with those of other studies. Gurevich et al reported that 68% of respondents believed they were sterilizing their instruments but did not use appropriate chemicals or exposure times, and 49% of respondents did not use biological indicators.

The behavioral factors associated with wearing hair caps and facial masks, and hand washing were not fully identical between dentists and dental assistants. First, the common factor for these self-protection behaviors was the use of the correct method of disinfection for impression materials. For wearing hair caps, common factors between dentists and dental assistants were the work setting and the methods employed for impression material disinfection. Staff working in hospitals were more likely to wear hair caps. The possible reason could be due to the higher standard for infection control in hospitals. Two additional parameters, bur disinfection and working table disinfection, were associated with the behavior of wearing hair caps among dental assistants. Male dentists were less likely to wear facial masks, whereas dentists that followed standard procedures in the use of chemical indicators during sterilization were more likely to wear facial masks. Similar factors were also observed for hand washing among dentists. Dental assistants with longer lengths of practice or who frequently changed their gloves were more likely to perform hand washing. The differences in the factors associated with these self-protection behaviors suggest that different educational or audit programs should be made available for different targeted staff members. For example, audit programs for wearing masks should focus on educating male dentists. Compliance with infection control among both dental and dental assistants remains inadequate, and more training along with monitoring is required to improve compliance.

The attitude towards and knowledge concerning the prevention of infection and compliance with self-protection remain insufficient in many countries worldwide. As concluded in these studies, providing correct information for infection control procedures requires the development and implementation of a curriculum for dental schools and of continuing dental education for practicing dentists. Continuing infection control education for dental assistants is also very important. In addition, we must continue to improve current infection prevention and control strategies to prevent the unexpected outbreak of fatal infectious diseases such as COVID-19.

Our study had some limitations. The study did not assess the association between the overall levels of knowledge and compliance with the infection control procedure. Further studies are needed to find further associations between knowledge items and adherence to infection control.

**Conclusion**
Gender, length of working practice, and correct techniques in the use of sterilization are major factors associated with the compliance with self-protection in infection control among Taiwanese dentists and dental assistants.

**Abbreviations**

CDC: Centers for Disease Control and Prevention; US: United State; STROBE: Strengthening the Reporting of Observational Studies in Epidemiology (collaboration); PPS: probabilities proportional to size; SDs: standard deviations; DHCWs: Dental Health Care Workers. SAS: Statistical Analysis System: OR: odd ratio; aOR: adjusted odd ratio. COVID-19: coronavirus discovered in late 2019

**Declarations**

**Ethics approval and consent to participate**

This study was approved by Institutional Review Board of Taipei Medical University (TMU-JIRB: N201804006). The consent was obtained from the participants who voluntary to participate and the data were kept confidential.

**Consent for publication**

Not applicable

**Availability of data and materials**

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

**Competing interests**

All authors declare that there are no any competing interests to disclose.

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**Authors' contributions**
HCC and YCY were major contributor in writing the manuscript, AMFY and SLSC analyzed and interpreted data in this study. All authors read and approved the final manuscript.

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