# Knowledge of Dental Academics about the COVID-19 Pandemic: A Multi-Country Online Survey

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# Abstract

Background COVID-19 is a global pandemic affecting all aspects of life in all countries. We assessed COVID-19 knowledge and associated factors among dental academics in various countries. Method We invited dental academics to participate in a cross-sectional, multi-country, online survey from March to April 2020. The survey assessed knowledge of COVID-19 regarding the mode of transmission, symptoms, diagnosis, treatment, protection, and dental treatment precautions as well as participants' background variables. The analysis was based on multilevel linear models to assess the association between knowledge and factors at individual levels (personal and professional) and country-level (number of COVID-19 cases/ million population), accounting for random variation among countries. Results Two thousand forty-five academics from 26 countries participated in the survey (response rate= 14.3%, with 54.7% female and 67% younger than 46 years of age). The mean (SD) knowledge percent score was 73.2% (11.2), and the knowledge of symptoms score was significantly lower than the diagnostic methods score (53.1% and 85.4%). Knowledge was significantly higher among those living with partner/spouse than those living alone (regression coefficient (B)= 0.48); those with PhD than those with BDS (B= 0.48), those seeing 21 to 30 patients daily than those seeing no patients (B= 0.65) and those from countries with a higher number of COVID-19 cases/million population (B= 0.0007). Conclusions Dental academics had poorer knowledge of COVID-19 symptoms than diagnostic methods. Living arrangements, academic degrees, patient load, and magnitude of epidemic in the country were associated with COVD-19 knowledge among dental academics. COVID-19 training can be designed using these factors to target academics with the greatest need.


# Background

The 2019 novel coronavirus disease (COVID-19) is a viral respiratory infectious disease caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) (1) that is currently causing a pandemic. The total number of COVID-19 cases reported until May 22nd, 2020, was 5,279,643, with 338,666 deaths and 213 countries affected (2). Like most respiratory infections, SARS-CoV-2 is transmitted through respiratory droplets and contact transmission routes that naturally raise concerns of disease transmission from aerosol-generating procedures, such as many dental procedures (3). There have also been calls to assess the risk of transmission through saliva (4) and reports of asymptomatic and pre-symptomatic spread of infection (3).

Symptoms of COVID-19 infection vary from mild-to-severe fever, dry cough, shortness of breath, fatigue, and other atypical symptoms, such as muscle pain, confusion, headache, sore throat, diarrhea, and vomiting. Moderate-to-severe symptoms, such as severe acute respiratory distress, may progress to respiratory failure and death (5). A significant number of COVID-19 patients also present with loss of smell and taste (6), which may prompt them to consult a dentist for care.

COVID-19 is of interest to dentists because of the risk of infection in their practices. Transmission may occur through aerosols/droplets as well as saliva and blood. Dental practitioners can inhale aerosol/

droplets from infected asymptomatic patients or through direct contact with mucous membranes, oral fluids, and contaminated instruments and surfaces. Effective infection-control practices, such as good hand hygiene, disinfection of all surfaces in the clinic, use of personal protective equipment (including masks, gloves, gowns, and goggles or face shields), and specifically the use of N-95 masks for routine dental practice are recommended (3, 7).

Dentists and dental academics must be aware of their high risk of contracting and transmitting SARS-CoV-2. They also need to be conversant with details on transmission, symptoms, treatment, diagnosis, and dental treatment precautionary measures of the disease. Recent studies have assessed dentists' knowledge of COVID-19 in Jordan (8), Pakistan (9), and multiple countries (10). Dentists' fears (11) and the challenges to dental treatment during the epidemic also have been assessed (12). However, none of these studies was aimed at dental academia and academics globally. Dental academics have an extensive network of contacts, including dental students, supporting staff, patients, and the public at large. These dentists have had extensive training in infection prevention and control, and they enjoy the respect of society because of their academic and professional backgrounds. Thus, dental academics are ideally situated to guide those around them on safely dealing with the COVID-19 pandemic, to provide training to other dentists and dental students, and to serve as volunteer frontline staff when there is a shortage of health care personnel (13, 14).

The aim of the study was, therefore, to assess the knowledge of symptoms, modes of transmission, diagnosis, management, infection control, and dental-treatment precautions of COVID-19 disease among dental academics in countries around the world. We hypothesized that COVID-19 knowledge is higher among academics from countries that are most affected by the disease and among those with extensive contact with family, students, and patients.

# Methods

This was a cross-sectional study that collected multi-country data using an online survey. The study was approved by the Research Ethics Committee of the Faculty of Dentistry, Alexandria University, Egypt (IRB 00010556)-(IORG 0008839)/6-11-2016), with further approvals from the University of Giessen in Germany, Bosnia and Herzegovina, (B&H), Indonesia, Iran, Jordan, Saudi Arabia, and Serbia. We included dental academics or educators working in dental academic institutions. Dental students (undergraduate and postgraduate) and dentists who do not work in dental educational institutions were excluded.

Table 1 lists the countries included in the study. The number of dental academics per country was estimated by using a ratio of 1:5 dental academics to dentists, based on information extracted from the World Health Organization's (WHO) Global Health Observatory database (15). The required number per country to achieve statistical power was calculated, assuming 95% confidence level, 5% margin of error, and 71% adherence to infection control practices among dental academics (16).

Table 1
Countries included in the study, the number of recruited dental academics, and response rate, March-April 2020.

| Countries | Number of recruited academics | Number of responses | Response rate |
|---|---|---|---|
| Bosnia and Herzegovina | 98 | 58 | 59.2 |
| Brazil | 1350 | 118 | 8.7 |
| Egypt | 310 | 126 | 40.6 |
| France | 630 | 44 | 7.0 |
| Germany | 1400 | 234 | 16.7 |
| India | 1662 | 240 | 14.4 |
| Indonesia | 200 | 178 | 89 |
| Iran | 700 | 274 | 39.1 |
| Italy | 527 | 62 | 11.8 |
| Japan | 205 | 6 | 2.9 |
| Jordan | 100 | 75 | 75.0 |
| Kenya | 60 | 4 | 6.7 |
| Korea | 220 | 36 | 16.4 |
| Libya | 103 | 32 | 31.1 |
| Myanmar | 100 | 28 | 28.0 |
| Nigeria | 86 | 45 | 52.3 |
| Palestine | 53 | 27 | 50.9 |
| Peru | 150 | 15 | 10.0 |
| Saudi Arabia | 90 | 55 | 61.1 |
| Serbia | 400 | 11 | 2.8 |
| Syria | 150 | 17 | 11.3 |
| Thailand | 470 | 27 | 5.7 |
| United Arab Emirates | 77 | 14 | 18.2 |
| United Kingdom | 150 | 63 | 42.0 |
| United States | 6820 | 175 | 2.6 |
| Yemen | 200 | 81 | 40.5 |

| Countries | Number of recruited academics | Number of responses | Response rate |
|---|---|---|---|
| Total = 26 | 14,281 | 2,045 | 14.3 |

We reached the convenience sample of participants with the use of two strategies. First, we asked collaborators to distribute the survey to dental academics in their respective countries. Second, we scanned the official institutional websites of dental schools in countries where we had no collaborators (USA and Brazil) to collect faculty email addresses and directly invited them to take part in the survey. We aimed to include academics from as many institutions per country as possible.

The online survey invitation included an introduction of the study team; the estimated time required to complete the survey; information about the right to withdraw from the survey; and details about confidential handling of the survey information. The survey was open from March 15th to April 27$^{th,}$ 2020.

The survey included two sections of close-ended questions. The first section assessed knowledge based on information from the WHO and the Centers for Disease Control and Prevention (CDC) official websites posted during March 2020 about COVID-19 (12, 16–18). We used questions with multiple selections of items about aspects of COVID-19 infection. Six items addressed the mode of transmission; 4 items addressed major warning symptoms; 5 items addressed treatment and management; 4 items addressed diagnosis; 5 items addressed protection, and 5 items addressed precautions during dental treatment. The score for each domain was the sum of the correct responses, with domain scores ranging from zero to a maximum of 6, 4, 5, 4, 5, and 5, respectively. The total knowledge score was the sum of all domains, ranging from zero to 29. The second section had 12 questions concerning the dentists' background: age; sex; living arrangements; country of practice; specialization; highest academic degree obtained; number of years in academia; number of courses taught/coordinated; average number of students per semester; average number of patients attended to in the clinic per day; training on the handling of public health emergencies; and administrative role. Appendix 1 includes details of the questionnaire.

In a pilot study, five dental academics tested the content and face validity of the questionnaire and the time taken to respond to the questionnaire (average, 4.36 minutes). The results of this pilot study were not included in the final analysis.

Using Survey Monkey®, an online survey platform, we prepared the links to the survey with settings to ensure that it would be anonymous, that participants could change their answers freely before they choose to submit, and that it was not time-limited. One submission per electronic device was allowed. We created the questionnaire in English and translated it when needed to the language of dental academia, such as in Brazil and Iran. The translation was done by native dentists with back translation to English to ensure accuracy. We sent out links to eligible participants through email or social media groups of academics only and offered no incentives or rewards. The first invitation to participate covered the period from March 15th to 27th 2020, and follow-up reminders covered the period from April 8th to 14th (19).

We calculated the percentages of correct responses and plotted them as bar graphs. We assessed the internal consistency with Kuder-Richardson formula 20 (K-R 20), a modification of Cronbach's alpha (20). We compared the domain percentage scores using multivariate analysis of variance (MANOVA), controlling for country effect. We used the linear mixed-model procedure in SPSS version 23.0 to construct unadjusted multilevel linear regression models, where we entered the explanatory variables one at a time. The outcome variable was the total knowledge score. The explanatory variables were at the individual level (background information) and country-level (the number of COVID-19 cases per million population obtained from Worldometer website) (2). We developed an unconditional model, including no explanatory variables, to calculate the baseline variance due to random differences among countries. In the second step, we entered individual and country-level variables that were significantly associated with the outcome variable in the unadjusted models into a multilevel model as fixed effects and used country as a random effect. We calculated regression coefficients (B), 95% confidence intervals (CIs), residual variance, deviance (as -2 log-likelihood (LL)), $X^2$ test to assess improvement in the goodness of fit relative to the unconditional model and increase in pseudo $R^2$ (21).

# Results

There were 2,045 responses from 26 countries. The response rate ranged from 2.6% in the USA to 89% in Indonesia, with an overall response rate = 14.3% (Table 1). Table 2 shows that 1099 (54.7%) of participants were female; 706 (34.5%) were 25–35 years old; 1301 (63.6%) lived with partner/spouse; 1735 (84.8%) were specialists; 897 (43.9%) were PhD degree holders; 597 (29.2%) have been in academia for 5–10 years; 2.3 courses on average were coordinated/taught; 663 (32.4%) had 50–100 students per semester; 943 (46.1%) managed 1–10 patients per day; 1064 (52%) had no previous training in public health emergencies; and 1073 (52.2%) had administrative positions. The average number of COVID-19 cases per million population in the participating countries was 972.9, with a median of 375 COVID-19 cases per million.

Table 2
Individual and country-level factors of participating dental academics and their association with knowledge score.

| Factors | | N (%) | Knowledge score EM (SE) | B (95% CI) | P value |
|---|---|---|---|---|---|
| Individual-level factor | | | | | |
| Sex | Male | 911 (45.3) | 73.01 (0.37) | -0.47 (-1.45, 0.51) | 0.34 |
| | Female | 1099 (54.7) | 73.48 (0.34) | Reference | - |
| Age | 25–35 | 706 (34.5) | 72.85 (0.42) | -2.85 (-5.36, -0.34) | 0.03* |
| | > 35–45 | 664 (32.5) | 73.49 (0.43) | -2.21 (-4.72, 0.31) | 0.09 |
| | > 45–55 | 354 (17.3) | 72.87 (0.59) | -2.83 (-5.47, -0.19) | 0.04* |
| | > 55–65 | 236 (11.5) | 73.29 (0.73) | -2.41 (-5.17, 0.36) | 0.09 |
| | > 65 | 85 (4.2) | 75.70 (1.21) | Reference | - |
| Living arrangements | With parents | 335 (16.4) | 70.93 (0.61) | -1.99 (-3.84, -0.13) | 0.04* |
| | With partner/ spouse | 1301 (63.6) | 74.17 (0.31) | 1.25 (-0.30, 2.79) | 0.11 |
| | Shared accommodation | 76 (3.7) | 72.01 (1.27) | -0.91 (-3.78, 1.96) | 0.53 |
| | Other | 101 (4.9) | 70.50 (1.19) | -2.42 (-5.01, 0.17) | 0.07 |
| | Alone | 232 (11.3) | 72.92 (0.73) | Reference | - |
| Specialization | Specialist | 1735 (84.8) | 21.33 (0.08) | 0.58 (0.20) | 0.003* |
| | No-specialist | 310 (15.2) | 20.74 (0.18) | Reference | - |

Abbreviations: EM: estimated means based on unadjusted multilevel linear models with country as a random effect, SE: standard error, B: regression coefficient, CI: confidence interval.

*: Statistically significant at $P < 0.05$.

| Factors | | N (%) | Knowledge score<br>EM (SE) | B (95% CI) | P value |
|---|---|---|---|---|---|
| Highest academic degree | PhD | 897 (43.9) | 73.95 (0.37) | 1.88 (0.62, 3.15) | 0.004* |
| | MSc | 703 (34.4) | 73.06 (0.42) | 1.00 (-0.33, 2.32) | 0.14 |
| | BDS | 445 (21.8) | 72.07 (0.53) | Reference | - |
| Number of years in academia | < 5 | 530 (25.9) | 73.25 (0.48) | -0.16 (-1.62, 1.30) | 0.83 |
| | 5–10 | 597 (29.2) | 72.93 (0.46) | -0.48 (-1.91, 0.94) | 0.51 |
| | 11–20 | 527 (25.8) | 73.43 (0.49) | 0.02 (-1.44, 1.48) | 0.98 |
| | 21+ | 391 (19.1) | 73.41 (0.56) | Reference | - |
| Number of courses coordinated: mean (SD) | | 2.3 (1.7) | - | -0.21 (-0.48, 0.07) | 0.15 |
| Number of students per semester | None | 131 (6.4) | 70.20 (0.97) | Reference | - |
| | 1–49 | 506 (24.7) | 73.96 (0.49) | 1.09 (0.47, 1.71)* | 0.001* |
| | 50–100 | 663 (32.4) | 73.17 (0.43) | 0.86 (0.25, 1.47)* | 0.005* |
| | 101–200 | 370 (18.1) | 73.30 (0.58) | 0.90 (0.25, 1.54)* | 0.006* |
| | 201+ | 375 (18.3) | 73.36 (0.57) | 0.92 (0.27, 1.56)* | 0.005* |
| Number of patients seen daily | None | 224 (11.0) | 72.17 (0.74) | Reference | - |
| | 1–10 | 943 (46.1) | 72.51 (0.36) | 0.10 (-0.37, 0.57) | 0.68 |
| | 11–20 | 525 (25.7) | 74.78 (0.48) | 0.76 (0.25, 1.26)* | 0.003* |

Abbreviations: EM: estimated means based on unadjusted multilevel linear models with country as a random effect, SE: standard error, B: regression coefficient, CI: confidence interval.

*: Statistically significant at P < 0.05.

| Factors | | N (%) | Knowledge score<br>EM (SE) | B (95% CI) | P value |
|---|---|---|---|---|---|
| | 21–30 | 156 (7.6) | 72.61 (0.89) | 0.13 (-0.53, 0.79) | 0.70 |
| | 31+ | 197 (9.6) | 74.29 (0.79) | 0.61 (-0.003, 1.23) | 0.05 |
| Training for public health emergencies | No | 1064 (52) | 73.43 (0.34) | 0.41 (-0.56, 1.38) | 0.40 |
| | Yes | 981 (48) | 73.02 (0.36) | Reference | - |
| Administrative position | No | 972 (47.5) | 73.34 (0.36) | 0.20 (-0.77, 1.17) | 0.68 |
| | Yes | 1073 (52.5) | 73.14 (0.34) | Reference | - |
| Country-level factor | | | | | |
| Number of cases COVID-19 per million population: mean (SD) | | 972.9 (1123.1) | - | 0.002 (0.002, 0.003) | < 0.0001* |

Abbreviations: EM: estimated means based on unadjusted multilevel linear models with country as a random effect, SE: standard error, B: regression coefficient, CI: confidence interval.

*: Statistically significant at P < 0.05.

Figure 1 illustrates the levels of dentists' COVID-19 knowledge. About 92% knew that COVID-19 could be transmitted through breathing infected droplets and direct contact with aerosols. Almost all participants (98.3%) identified difficulty in breathing as a warning symptom, while only 28.2% identified confusion as a warning symptom. About 91% knew that there is no COVID-19 vaccine, and 63.9% knew there is no COVID-19 antiviral therapy currently. Almost all participants (98.4%) ruled out urine culture as a method to diagnose COVID-19. Hand hygiene was identified by 97.2% of respondents as protective against infection, and 60.7% identified avoiding touching the face as a protective measure. Most participants (91.7%) identified the use of N95/FFP2 masks during aerosol-generating procedures, and 59.4% identified the use of extra-oral rather than intraoral radiographs as protective measures when treating COVID-19-suspected patients.

Figure 1: Percentage of correct responses for items of transmission (blue), symptoms (red), treatment (green), diagnosis (orange), protection (grey) and dental precautions (purple).

Figure 2 illustrates the mean percentage scores in the six knowledge domains. The percent scores of knowing disease symptoms and treatment modalities were significantly different from each other and

significantly lower than all other scores. The percent scores of transmission, protection, and dental treatment precautions were not significantly different from each other.

Figure 2: Percent scores of transmission, warning symptoms, treatment, diagnosis, protection, and dental treatment precautions. Different letters (a, b, c, and d) below the x-axis next to the domain label denote statistically significant differences. All scores were adjusted for the country.

K-R 20 for all items was 0.58. The mean (SD) percent knowledge score was 73.2% (11.2). Table 2 shows that in the unadjusted multilevel models the percent knowledge score was significantly associated with age, living arrangements, specialization, highest academic degree obtained, number of students per semester, number of patients seen per day, and number of COVID-19 cases per million population ($P < 0.05$). Younger participants (25–35 and > 45–55) had significantly lower scores than did participants who were > 65 years old ($P = 0.03$ and 0.04). Those living with their parents had significantly lower scores than did those living alone ($P = 0.04$). Specialists had significantly higher scores than did non-specialists ($P = 0.003$). PhD degree holders had significantly higher scores than did academics with only Bachelor of Dental Science (BDS) degrees ($P = 0.004$). Those who taught students had significantly higher scores than did those who did not teach students ($P < 0.05$). Those who saw 11–20 patients daily had higher knowledge than did those who saw no patients ($P = 0.003$). Participants from countries with a higher number of COVID-19 affected people per million population had significantly higher scores than did those with a lower number of affected people ($P < 0.0001$).

Table 3 shows that the full model including individual- and country-level factors showed significant improvement in fit over the unconditional model (P of $X^2 < 0.0001$), with an increase in pseudo $R^2$ of 35.5%. The full model had lower deviance (10,488.18) than did the unconditional model (15,670.16) and less residual variance (9.78 versus 15.17). In the full model, those living with partner/spouse had significantly higher knowledge percent score than did those living alone (B = 0.48, 95% CI = 0.03, 0.92). PhD degree holders had significantly higher scores than did academics with only BDS (B = 0.48, 95% CI = 0.07, 0.89). Participants tending to 21–30 patients per day had significantly higher scores than did those seeing no patients (B = 0.65, 95% CI = 0.15, 1.16). Participants from countries with a higher number of COVID-19 cases per million population had significantly higher scores than those from countries with a lower number of COVID-19 cases (B = 0.0007, 95% CI = 0.0005, 0.0008).

Table 3
Multilevel models for individual and country-level factors affecting dental academics knowledge of COVID-19.

| Factors | | Unconditional model[a] | Full model[b] B (95% CI) |
|---|---|---|---|
| Individual factors | | | |
| Age | 25–35 versus > 65 | - | 0.28 (-0.47, 1.02) |
| | > 35–45 versus > 65 | | 0.15 (-0.60, 0.90) |
| | > 45–55 versus > 65 | | -0.21 (-0.98, 0.56) |
| | > 55–65 versus > 65 | | -0.39 (-1.18, 0.41) |
| Living arrange | With parents versus alone | | 0.02 (-0.52, 0.57) |
| | With partner/ spouse versus alone | | 0.48 (0.03, 0.92)* |
| | Shared accommodation versus alone | | 0.12 (-0.69, 0.94) |
| | Other verses alone | | -0.25 (-0.99, 0.49) |
| Specialty | Specialist versus non-specialist | | 0.34 (-0.06, 0.75) |
| Highest degree obtained | PhD versus BDS | | 0.48 (0.07, 0.89)* |
| | MSc versus BDS | | 0.29 (-0.12, 0.70) |
| Number of students per semester | 1–49 versus none | | 0.52 (-0.14, 1.18) |
| | 50–100 versus none | | 0.38 (-0.27, 1.04) |
| | 101–200 versus none | | 0.16 (-0.46, 0.78) |
| | 201 + versus none | | 0.50 (-0.13, 1.12) |
| Number of patients seen daily | 1–10 versus none | | 0.55 (-0.06, 1.17) |
| | 11–20 versus none | | -0.04 (-0.69, 0.61) |
| | 21–30 versus none | | 0.65 (0.15, 1.16)* |
| | 31 + versus none | | 0.22 (-0.25, 0.68) |

a: Unconditional model: no explanatory factors included- country included as a random effect.

b: Full model: individual and country factors included with mutual adjustment- country included as a random effect.

Abbreviations: B: adjusted regression estimates, CI: confidence interval.

| Factors | Unconditional model[a] | Full model[b] B (95% CI) |
|---|---|---|
| Country factor | | |
| COVID-19 cases per million | | 0.0007 (0.0005, 0.0008)* |
| Residual | 15.17 | 9.78 |
| Deviance | 15,670.16 | 10,488.18 |
| P of $X^2$ of improved fit | - | < 0.0001* |
| Increase in $R^2$ | - | 35.5% |
| a: Unconditional model: no explanatory factors included- country included as a random effect. | | |
| b: Full model: individual and country factors included with mutual adjustment- country included as a random effect. | | |
| Abbreviations: B: adjusted regression estimates, CI: confidence interval. | | |

# Discussion

The study found that awareness of the mode of transmission, methods of diagnosis, and preventive dental practices of COVID-19 was better than the knowledge of the symptoms of COVID-19 and its treatment. Factors associated with better knowledge included having more contacts (living with spouse/partner and higher patient load), having a PhD degree, and the magnitude of the country's COVID-19 pandemic. Thus, the study hypothesis was partly substantiated.

A major strength of the study is the large sample size and diversity of respondents' countries, which allowed us to demonstrate between-country differences related to the size of the pandemic. The rapidly evolving nature of the pandemic means that information assessed in this study may have already become outdated by the time we conducted the analysis. The validity of our conclusions is, therefore, time relevant. However, this analysis is the first of its kind and provides useful insights. The findings are valuable for designing and planning continuing education programs for dental academics on COVID-19 and for identifying areas where emphasis on correct updated information is needed.

Most existing studies that have assessed the knowledge of dental personnel focused on dentists (8–11, 22, 23), with little information about dental academics. A recent multi-country study (10) reported lower dentists' knowledge of COVID-19 (67.5%) than that among dental academics in the current study. The academics' higher knowledge also applies to various COVID-19 aspects, which was higher than that previously reported among dentists regarding MERS-CoV or COVID-19. The difference in knowledge between academics in the present study and dentists in previous studies includes knowledge of symptoms, which was higher than among dentists in Saudi Arabia where ≤ 58% correctly identified

MERS-CoV manifestations (23) and knowledge of treatment including that there is no vaccine, which was higher than among dentists in Saudi Arabia regarding MERS-CoV (22) and dentists from various countries regarding COVID-19 (68%) (10). The knowledge level regarding diagnosis was higher also among academics in the present study than dentists in Saudi Arabia for MERS-CoV (23) and in other countries for COVID-19 (10). If not higher, knowledge of common symptoms among academics in the present study was similar to that among dentists in Saudi Arabia (22) and other countries (8, 10). Higher knowledge in the present study may be attributed to the global nature of the COVID-19 pandemic compared to the one-region MERS-CoV outbreak in previous studies. The higher knowledge may also be the result of increased opportunities to receive updated information through webinars, social media, and other education channels. An example of this increased information is the extensive media coverage of the race among countries and big pharmaceutical companies to develop a COVID-19 vaccine (24).

The rapid pace at which the COVID-19 outbreak and information about it changes emphasizes the importance of credible information sources (25). International agencies with global reach, such as the WHO, are offering open online courses on COVID-19 in multiple languages to ensure that health professionals such as dental academics keep up to date with new information (26). Information availability is especially important in regions where the shortage of health care professionals calls for training dentists/ dental academics as first responders in public health emergencies (27).

In the present study, better knowledge of COVID-19 was associated with greater risk of dental academics' exposure to SARS-CoV-2, including a higher patient load and a bigger social network. Such a higher perceived risk may lead academics to seek COVID-19 information. Similarly, the association of greater knowledge with a higher number of COVID-19 cases per million population may be attributed to greater exposure to media information about the disease as it assumes greater relevance per country (28, 29). The relationship between risk perception and knowledge should be explored in future studies.

The higher knowledge score revealed in the present study among PhD holders compared to academics with BDS degrees accords with a previous study that assessed COVID-19 knowledge among dentists (10). The higher knowledge level among PhD holders might be explained by their broader general knowledge base and more comprehensive insight into disease processes and management (30).

This study has some limitations. Because of its cross-sectional design, dentists' knowledge was recorded at only one point in time. With more exposure to news of the pandemic, their knowledge may change. Thus, our results may underestimate knowledge by time. In addition, convenience sampling may reduce statistical representativeness. However, this strategy is the only feasible method to sample academics in the absence of a framework listing dental schools and academics worldwide. The low response rate from some countries is another limitation and may partly be explained by the psychologic impact of the lockdown enforced in most countries, the busy schedule of academics with online teaching duties (31), as well as the saturation occurring due to their exposure to multiple surveys about COVID-19 from different research teams. We addressed this low response rate by sending reminders, using personalized emails, and communicating with academics directly through in-country collaborators. Previous studies

also reported low response in surveys of health professionals and for online surveys in general (32). Despite these limitations, the inclusion of a diverse group of dental academics from countries with different income levels, geographic locations, and educational systems increases the generalizability of the findings.

## Conclusion

Dental academics from several countries around the world had similar or better COVID-19 knowledge than dentists in previous studies. The academics were, however, less aware of COVID-19 symptoms and treatment modalities than they were of diagnostic and precaution methods. Better COVID-19 knowledge was associated with advanced academic degrees, more extensive social network, and greater magnitude of disease spread at country level.

## Abbreviations

WHO
World Health Organization
COVID-19
The 2019 Novel Coronavirus
SARS-CoV 2
Severe Acute Respiratory Syndrome Coronavirus 2
CDC
Centers For Disease Control And Prevention
MANOVA
Multivariate Analysis Of Variance

## Declarations

# Ethics approval and consent to participate

The study was approved by the Research Ethics Committee of the Faculty of Dentistry, Alexandria University, Egypt (IRB 00010556)-(IORG 0008839)/6-11-2016), with further approvals from the University of Giessen in Germany, Bosnia and Herzegovina, (B&H), Indonesia, Iran, Jordan, Saudi Arabia, and Serbia. Participants in the survey provided implicit consent by answering the questions and submitting the survey.

# Consent for publication

Not applicable.

# Availability of data and materials

Data available on request due to privacy/ethical restrictions.

# Competing interests

MOF is a Sectional Editor with the BMC Oral Health. MET is an Associate Editor with the BMC Oral Health. All other authors declare that they have no competing interests.

# Funding

There was no funding to support this research.

# Authors' contributions

NA, NMA and MET conceptualized the study and drafted the first version of the manuscript. MET designed and performed the analysis plan. All authors participated in data collection, read and approved of the final version of the manuscript.

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# Figures

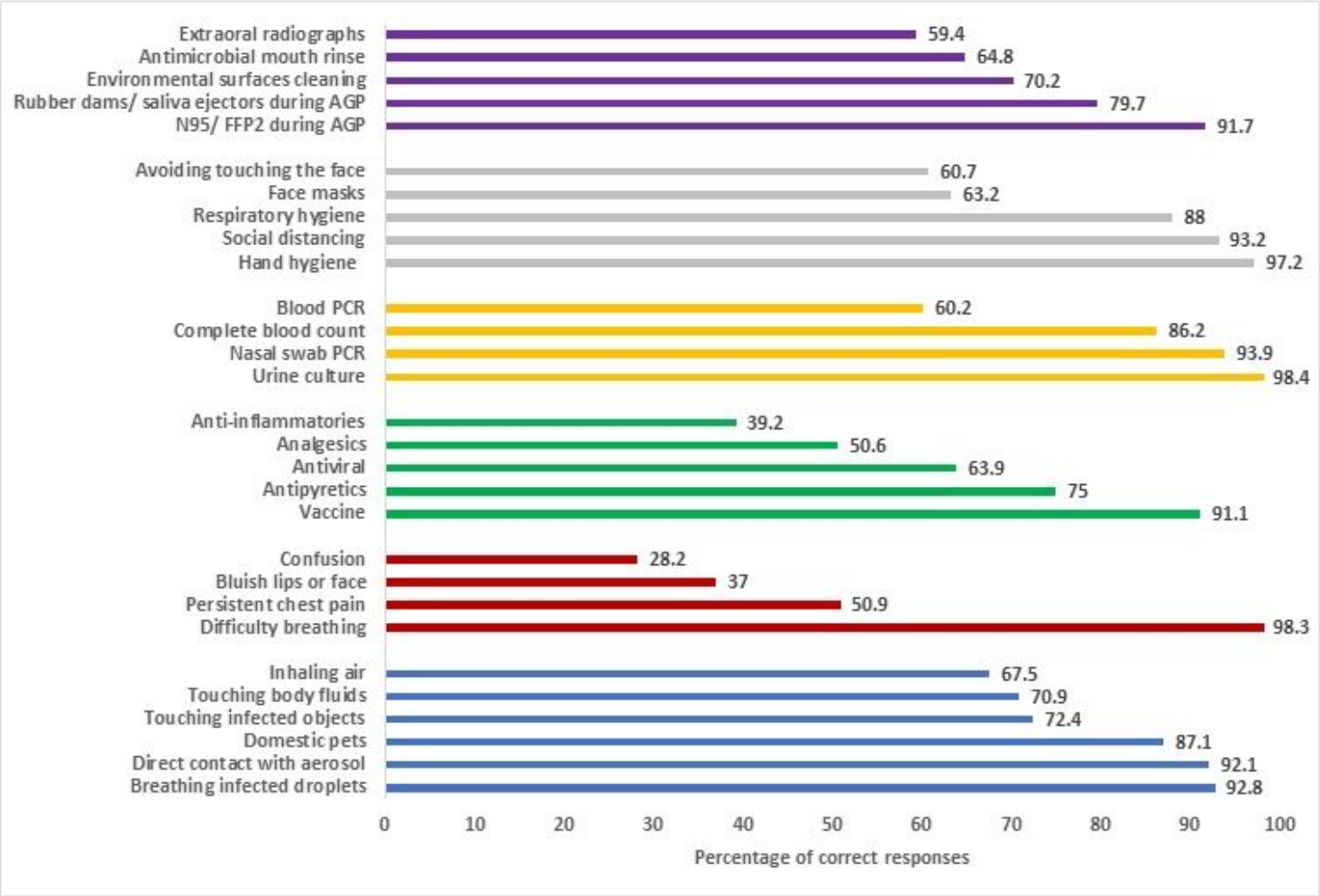


**Figure 1**

Percentage of correct responses for items of transmission (black), symptoms (white), treatment (black and white stripes), diagnosis (black and grey diagonal), protection (dark grey), and dental precautions (light grey).

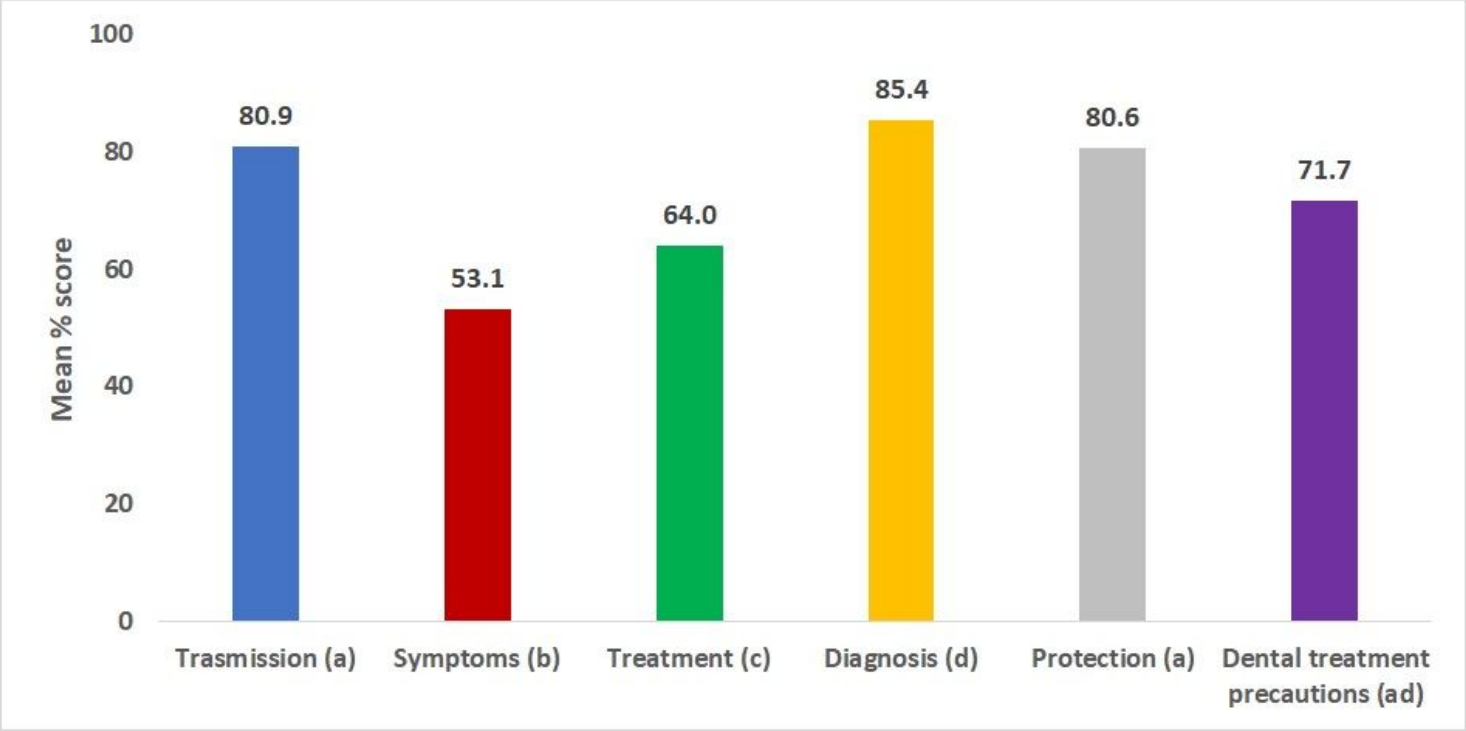


**Figure 2**

Percent scores of transmission, warning symptoms, treatment, diagnosis, protection, and dental treatment precautions. Different letters (a, b, c, and d) below the x-axis next to the domain label denote statistically significant differences. We adjusted all scores for country effect.

# Supplementary Files

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- supplement1.docx
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