






Evaluation of the Droplets and Aerosols, Posing Potential Risks of COVID-19 Disease Infection Transmission in Dentistry: A Systematic Review and Meta-Analysis of Observational Studies

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ABSTRACT

Objective: To evaluate the droplets and aerosols, posing potential risks of infection transmission of COVID-19 disease in dentistry. **Material and Methods:** PubMed, Embase, ISI, Scopus, Medicine have been used to search for articles between September 2019 to December 2020. Data extracted from the studies were included, study, study design, sample size, Sample collection time, Hallway Air Samples (copies/L of air), Personal Air Samples (copies/L of air). Effect size with 95% confidence interval (CI), fixed effect model, Inverse-variance methods were calculated. The Meta-analysis was evaluated with Stata/MP v.16 statistical software (The fastest version of Stata). **Results:** According to the purpose of the study, 64 articles were found; studies that did not meet the inclusion criteria were excluded from the study; the full text of 11 studies was reviewed. Finally, two studies were selected. The effect size of airborne COVID-19 concentrations of the hallway and personal air samples was 64% copies/L of air (ES, 0.64 95% CI=-1.45-2.73) and 100% copies/L air (ES, 1.00 95% CI=-1.77-3.76), respectively. **Conclusion:** Evidence of aerosol transmission of COVID-19 in observational studies of patients with COVID-19 was 64% copies/L of air and 100% copies/L of air in the hallway and personal air samples, respectively.

Keywords: Disease Transmission, Infectious; Aerosols; COVID-19; SARS-CoV-2.

Introduction

In the current context of the world, since the advent of COVID-19 in Wuhan, China, in December 2019 [1], the disease has become a primary global health concern. On January 30, 2020, the WHO identified the outbreak of COVID-19 as the sixth health emergency after H1N1 (2009), polio (2014), Ebola in West Africa (2014), Zika Virus (2016), and Ebola (2019) [2]. Therefore, all health care workers, governments, and the general public must work together globally to prevent the spread of the virus [3]. According to the WHO, the global mortality rate over time was estimated at 5.7%, using a 14-day estimate [4]. Researchers first reported that the disease's cause was local seafood markets that sold live animals; subsequent research showed that pathogens are transmitted from animals to humans, and then research reported that the pathogen it is transmitted from human to human [5]. In the sixth edition of the COVID-19 treatment regimen (Trial Implementation) [6], it was reported that the possible routes of transmission of COVID-19 are direct contact and transmission through respiratory particles. In addition, aerosols may be transferred in a closed environment, and more people are at risk for aerosol transmission [7].

On the other hand, in dentistry, aerosols can pose potential risks to the dentist and reciprocally to the patient due to their occupational nature. To date, there have been no reports of COVID-19 spreading in the dental environment. However, it should be noted that the disease is spreading rapidly and transmission; dentists, dental assistants, and all staff in the oral care department should be vigilant and create a healthy and disinfectant environment for themselves and patients. As a result, it is necessary to know how the disease is transmitted, understand the aerosol transmission, the consequences in dentistry, appropriate and standard measures, and precautionary measures. Therefore, according to the subject's importance, the present study aimed to evaluate the droplets and aerosols, posing potential risks of infection transmission of COVID-19 disease in dentistry.

Material and Methods

Search Method

PubMed, Embase, ISI, Scopus, Medicine were used between September 2019 to December 2020 to search the articles. EndNote X9 was therefore used to manage electronic resources. PubMed Searching was performed using mesh terms:

("COVID-19"[Mesh] AND "SARS-CoV-2"[Mesh] AND "COVID-19 Testing"[Mesh]) AND "Aerosols"[Mesh] AND ("Aerosol Propellants"[Mesh] OR "Aerosol Propellants" [Pharmacological Action]) AND "Saliva"[Mesh] OR "Lipid Droplets"[Mesh] AND "Disease Transmission, Infectious"[Mesh] AND ("transmission" [Subheading] OR "Microscopy, Electron, Transmission"[Mesh]) AND ("Dentistry"[Mesh] OR "Evidence-Based Dentistry"[Mesh]) OR "Dental Health Services"[Mesh] OR "Infection Control, Dental"[Mesh].

Inclusion criteria included observational studies. Randomized controlled trial studies, controlled clinical trials, prospective and retrospective cohort studies, case-control studies, in vitro studies Reviews, case series, and case reports were excluded from the present article. This systematic review has been conducted based on the key consideration of the PRISMA Statement-Preferred Reporting Items for the Systematic Review and Meta-analysis [8] and PICO strategy (Table 1).

Table 1. PECO strategy.

PECO Strategy	Description
P	Population: Aerosol samples from patients with positive for COVID19
E	Exposure: Evaluate the aerosol samples
C	Comparison: Hallway and persona air samples
O	Outcome: Results of air samples

Data Extraction Methods

Data extracted from the studies were included, authors, study design, sample size, Sample collection time, Hallway Air Samples (copies/L of air), Personal Air Samples (copies/L of air). Quality was assessed according to previously published guidelines [9]. In the first part of this article, the meta-analysis results are reported as a systematic literature review. Effect size with 95% confidence interval (CI) and fixed-effect model and Inverse-variance methods were calculated. To deal with potential heterogeneity, random effects were used, and I² showed heterogeneity. I² values above 50% signified moderate-to-high heterogeneity. The meta-analysis was evaluated using the statistical software Stata/MP v.16 (The fastest version of Stata).

Results

According to the purpose of the study, in the initial search with keywords, 64 articles were found. In the first step of selecting studies, 60 studies were selected to review the abstracts. Then, studies that did not meet the inclusion criteria were excluded from the study. In the second step, the full text of 11 studies was reviewed. Finally, two studies were selected (Figure 1).

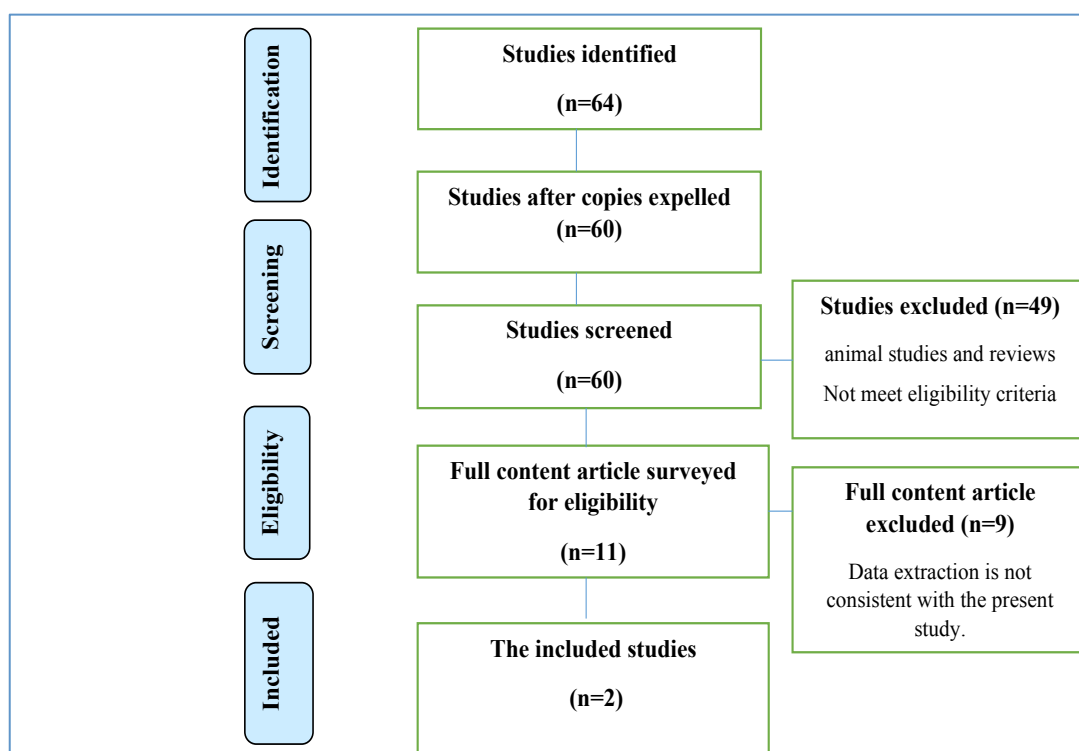


Figure 1. Study Attrition.

Two studies (observational studies) have been included in the present article. The number of aerosol samples total was 198 (Table 2). All studies included have a low risk of bias (Table 3).

Table 2. Details of selected studies according to inclusion criteria.

Authors	Study Design	Aerosol Samples	Sample Collection Time	Hallway Air Samples (copies/L of air)	Personal Air Samples (copies/L of air)
Santarpia et al., 2020 [10]	Observational	163	NR	66.7%	100.0%
Liu et al., 2020 [11]	Observational	35	February 17 and March 2, 2020	54.28	99.1%

Table 3. Risk of bias assessment.

Authors	Study Participation	Study Attrition	Prognostic Factor Measurement	Outcome Measurement	Confounding Measurement and Account	Analysis Appropriate	Risk Assessment
Santarpia et al., 2020 [10]	+	?	+	+	-	+	Low
Liu et al., 2020 [11]	+	?	?	+	-	+	Low

Low (+); Unclear (?); High (-).

Evidence of Airborne Transmission of COVID-19

The effect size of airborne COVID-19 concentrations of hallway air samples was 64% copies/L of air (ES, 0.64 95% CI= -1.45-2.73), heterogeneity found $I^2=0\%$ (Figure 2). The effect size of airborne COVID-19 concentrations of personal air samples was 100% copies/L of air (ES, 1.00 95% CI= -1.77-3.76) and heterogeneity found $I^2=0\%$ (Figure 3).

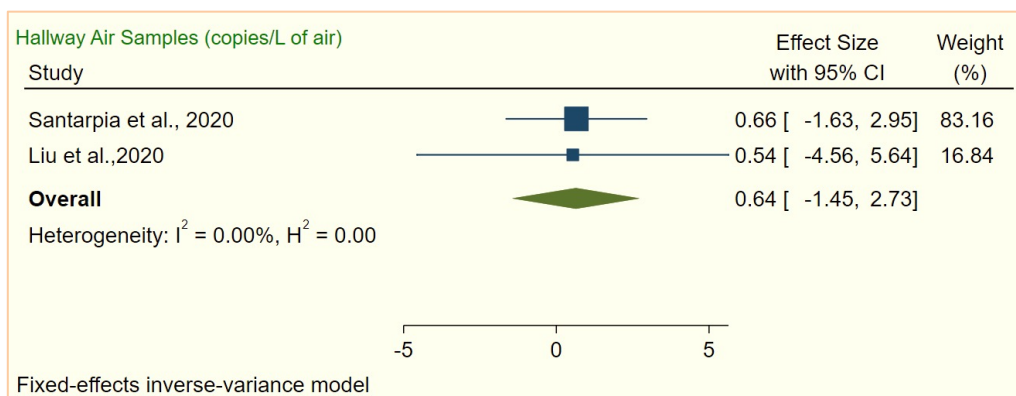


Figure 2. Effect size of airborne COVID-19 concentrations of hallway air samples.

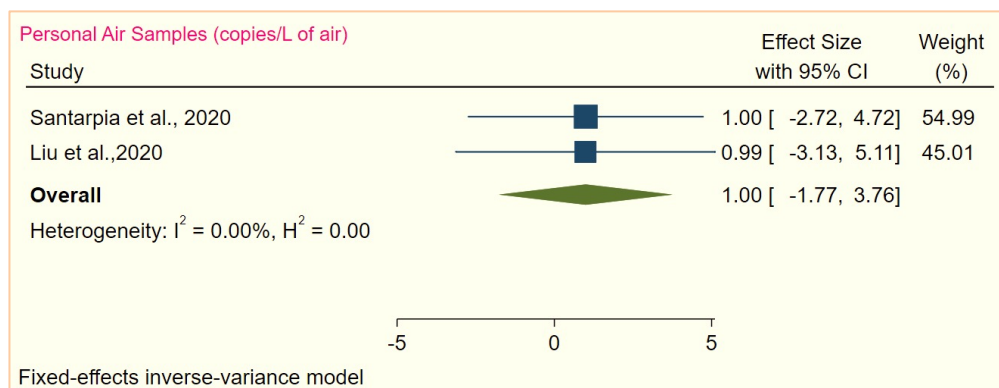


Figure 3. Effect size of airborne COVID-19 concentrations of personal air samples.

Discussion

The present systematic review and Meta-analysis found insufficient evidence of aerosol transmission of COVID-19; the hallway and personal air samples' outcome was 64% copies/L of air and 100% copies/L of air, Respectively. According to the WHO (2014), aerosol droplets are produced when coughing, laughing, talking, or sneezing. Aerosol droplets are droplets smaller than five μm diameter and larger droplets larger than five μm diameter. Small droplets settle faster than larger droplets and stay in the air longer, while large droplets fall to the ground quickly and can be transferred to another person in less time. Baghizadeh Fini [12], examine the routes of respiratory virus transmission among humans; the result showed respiratory viruses are transmitted via contact, droplets, or aerosols. Also, Otter et al. [13] evaluate the evidence that contaminated surfaces contribute to the transmission of hospital pathogens; the result showed contaminated surfaces contribute to transmission. According to reports, the COVID-19 can also be transmitted through contact with infected surfaces.

Farah et al. [14] evaluate the effect of cooling water temperature on pulp chamber temperature changes and showed that too much heat is generated when using a high-speed handpiece, which should use a water coolant. Water coolants can create aerosols, and when combined with saliva in the oral cavity, bio-aerosols are formed. Bio-aerosols originate from various sources and can pose a hazard to healthcare workers and patients due to their potential pathogenic nature. Zemouri et al. [15], in a review, reported that 38 types of microorganisms found in the dental clinic air and both patients and health workers, all aerosols could be hazardous. Several studies show that the transmission of COVID-19 occurs mostly through oral droplets [16-19]. As mentioned in the introduction, the disease's incubation period is 14 days, and early detection without testing is impossible. The virus can also be transmitted during the incubation period. Given the unique nature of dentistry and the use of devices that produce significant amounts of droplets and aerosols, the importance of aerosol transfer and its consequences in dentistry should be considered, and a potential guide to dentists' guidance reported. In addition to standard precautions, special precautions should be taken at the time of the outbreak. Yu et al. [20] investigate the resumption of endodontic practices. The result showed there is a concern among endodontic clinicians of contracting/spreading COVID-19. The fear is negatively associated with years of practice, and most clinicians believe they and their patients can be protected from COVID-19 by rubber dam isolation. The present study had some limitations, the sample size was small, and sample collection time was not reported in one study, and only two studies were found. However, it is not possible to determine whether the studies were erroneous or poorly reported.

Further studies are needed in this regard. A high sample size is recommended for future studies. Also, the lack of studies in this field means that the results of this study do not provide sufficient evidence. In addition to general precautions, the following measures are recommended:

- 1) Use of rubber dam in endodontic practice is important for several reasons. In COVID-19, the rubber dam creates an operational environment without infection and isolates the tooth from oral and salivary contamination, and reduces or eliminates the presence of salivary components in the aerosol.
- 2) Unnecessary hand contact with endodontic instruments, devices, and equipment should be minimized.
- 3) After the end of the dental treatment and the patient leaving and before the arrival of another patient, the whole room should be disinfected by dental healthcare personnel. This allows droplets to fall sufficiently from the air after a dental procedure.
- 4) Use N95 masks or facemask and full-face shield to prevent the transfer of aerosols.
- 5) Use eye protection during dental practice and should be discarded after use.






- 6) Disposable gloves are required and should be discarded after each use. The use of gloves minimizes the risk of aerosol transmission from the patients to dental healthcare personnel and conversely.
- 7) Use rotary instruments for a root canal to reduce droplet production, splatter, and aerosols by dental drills and saliva.
- 8) Use rubber dam isolation to reduce the transmission of saliva to dental healthcare personnel hands.
- 9) To reduce the burden of pediatric visits, proper brushing techniques, fluoride toothpaste, flossing, and all methods of caring for cocaine should be taught to children and their parents wholly and correctly.
- 10) Hand instruments and ultrasonic scalers are used mostly to prevent periodontal disease and remove deposits on the tooth surface. On the other hand, an ultrasonic scaler is one of the largest producers of spatter droplets and aerosols used in dentistry. Therefore, it is recommended to use hand instruments in the covid-19 epidemic to reduce transmission risk through droplets and aerosols.

Finally, droplets containing COVID-19 can be dispersed on the surrounding surfaces and remain during the aerosol production process. Studies have shown that COVID-19 can remain on surfaces for up to 9 days. Therefore, the result on all surfaces should be cleaned with surface disinfectants within one minute after each patient visit.

Conclusion

Evidence of aerosol transmission of COVID-19 in observational studies of patients with COVID-19 was 64% copies/L of air and 100% copies/L of air in the hallway and personal air samples, respectively. Dentists are more at risk for COVID-19, so new challenges and responsibilities need to be defined for them. They need to know the risk of aerosol transmission and the consequences of not following the protocols to their detriment. In addition to standard precautions, special precautions should be taken to prevent transmission of the disease from asymptomatic carriers. All protocols can be used as a guide to control the prevalence of COVID-19 and used in the prevention of other respiratory diseases.

Authors' Contributions

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All authors declare that they contributed to critical review of intellectual content and approval of the final version to be published.

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Conflict of Interest

The authors declare no conflicts of interest.

Data Availability

The data used to support the findings of this study can be made available upon request to the corresponding author.

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