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Does the Misuse of Oral Hygiene Facilitate the Spread of COVID-19 Among Cohabiting Individuals? A Cross-sectional Study

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Abstract

Background: Despite all the available guidelines for coronavirus disease 2019 (COVID-19), less emphasis has been placed on oral care to reduce the viral load in the mouth and saliva.

Objectives: This study aimed to investigate oral hygiene habits and infection control behaviors and their relationship with household transmission rates in patients with COVID-19.

Methods: In this analytical cross-sectional study, 179 patients with COVID-19 were investigated through continuous sampling in 2021 - 2022. The data collection tool was a 3-section questionnaire, including (1) social and clinical information about the individual infected with COVID-19, preliminary information about family members and transfer to another person in the family, (2) oral hygiene habits during quarantine, and (3) infection control behaviors. The collected data were analyzed using independent *t*-test, ANOVA, Spearman's correlation, and chi-square test in SPSS version 24.

Results: The rate of household disease transmission was 61.5%. There was no significant relationship between oral hygiene habits and the household transmission of COVID-19 ($P = 0.108$); however, the use of a shared toothbrush container and a toothpaste tube among family members was significantly related to the rate of household transmission ($P = 0.042$ and $P > 0.001$, respectively).

Conclusions: No relationship was found between oral hygiene habits and the intra-familial transmission of COVID-19; however, oral hygiene habits were influential in contracting a more severe type of disease and hospitalization rate. Using shared toothbrush containers and toothpaste tubes by the family members increased the probability of household transmission of COVID-19.

Keywords: Coronavirus, COVID-19, Oral Hygiene, Infection Control Behavior, Transmission

1. Background

Coronavirus disease 2019 (COVID-19) is an infectious disease caused by SARS-CoV-2. The virus is mainly spread through close contact between individuals and tiny droplets caused by coughing, sneezing, or talking (1, 2). The infectivity of SARS-CoV-2 depends on the ability of the virus to enter cells. There is clear evidence that the membrane protein of Angiotensin-converting Enzyme 2 (ACE2) is the primary receptor for this virus to enter cells (3). Mucous epithelial cells of different parts of the oral cavity, particularly in the tongue mucosa, highly express the ACE2 receptor. Since the oral cavity is one of the first interfaces between the outside and the body, this pathway is likely critical for virus colonization and COVID-19 infection onset. Apparently, during the initial ten days following infection, when the disease is typically asymptomatic but highly contagious, the virus builds up in the mucous membranes of the nose, mouth, pharynx, and subsequently in the lungs. It has also been shown that the salivary glands have more ACE2 receptors than the lungs, which could be a reservoir for SARS-CoV-2 in asymptomatic patients. Consequently, reducing the viral load in the saliva and mouth can temporarily reduce the carrier-excreted virus load. As a result, the risk of transmission will also decrease (4).

In contrast to SARS and MERS but similar to influenza, COVID-19 exhibits high viral shedding at an early stage of infection, when virus carriers display no or mild symptoms, which challenges the home quarantine for COVID-19 patients (5). The risk of infection from

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close contacts within the household is ten times higher than from contacts outside the household (6). In other words, the transmission rate at home, where social distancing is challenging, is the highest (7). Studies report a high transmission rate for this disease, particularly in households (8-11). Therefore, timely household studies can be highly informative for preventing COVID-19. Moreover, the developing protocols to support effective home quarantine can reduce household transmission and impact the overall epidemic.

Current measures to control the familial transmission of COVID-19 in most countries are limited to recommendations to minimize shared spaces and consume separate meals. Recent studies have revealed evidence of the potential impact of oral and dental health on the severity and rate of COVID-19 transmission (3, 12, 13). According to the studies, reducing the viral load in the mouth and saliva can reduce disease severity and transmission rate (4, 14).

Even though a better understanding of the influential factors in the transmission of this virus can help control measures, a few studies have been conducted on the relationship between oral health and household transmission and the severity of COVID-19. Moreover, the reported family transmission rates in different studies vary extremely (15-17). On the other hand, despite all the existing guidelines regarding COVID-19, so far, less emphasis has been placed on oral care to reduce the virus load in the mouth and saliva and thus reduce the risk of disease transmission (18).

2. Objectives

Therefore, this study aimed to investigate oral hygiene habits and infection control behaviors and their relationship with the household transmission rate in patients with COVID-19.

3. Methods

3.1. Study Design, Setting, Population, and Sampling

In this analytical cross-sectional study conducted in 2022, 179 patients referred to a general hospital in Rasht, the referral center for patients with COVID-19, were included by the continuous sampling method from March 2022 to August 2020. The minimum sample size of 179 individuals was obtained using the formula for estimating the mean of the community and considering the standard deviation of 1.5 (changes in brushing score) of the Gonzalez-Olmo et al.'s study (19), α = 0.05, and d = 0.22. The inclusion criteria were age over 18 years, mastery of the Persian language, positive PCR test, informed consent, living with at least one other person, and no shared bathroom.

3.2. Measures and Data Collection

The questionnaire used in this research consisted of 3 sections. The first section included personal and social information of patients with COVID-19 (age, sex, education, marital status, number of family members, place of residence, use of shared bathroom and toilet, history of COVID-19), clinical information (symptoms at the time of disease onset, the time interval from onset of symptoms to hospitalization, underlying disease, quarantine duration), basic information of family members in contact with those infected with COVID-19 (age, gender, relationship with the person infected with COVID-19, duration of contact with COVID-19 patient, the symptoms at the time of disease onset), and the history of transmission to another person in the family (transmission to other persons who lived in the family and used a shared bathroom/toilet). The second section, designed based on a 5-point Likert scale (never = 1, rarely = 2, sometimes = 3, almost always = 4, always = 5), assessed participants' oral hygiene habits during quarantine using four questions (brushing twice or more a day, flossing once a day, mouthwash once a day, tongue brushing once a day). The last section evaluated individuals' infection control behaviors using seven questions (using a shared toothbrush holder, using a shared toothpaste tube, placing the toothbrush vertically, putting a perforated cover on the toothbrush, disinfecting the toothbrush, closing the toilet door before flushing, and changing the toothbrush after the test was positive) through yes/no answers.

In order to check the qualitative content validity, the questionnaire was provided to ten dentistry experts, and their opinions were applied. Afterward, the questionnaire was provided to 11 other dentists to check the quantitative content validity, based on which CVR = 0.91 and CVI=0.98 were obtained. According to Lawsche's table, the minimum acceptable value of CVR for 11 experts is 0.59 (20). Besides, according to Polit and Beck, the minimum acceptable value of CVI is 0.79 (21); therefore, the quantitative content validity of the questionnaire was confirmed. The questionnaire was provided to ten patients with COVID-19 to evaluate its reliability. Cronbach's alpha value for oral hygiene habits during quarantine was 0.73, and Koder Richardson's value was 0.75 for infection control behaviors. Considering the minimum acceptable value of 0.70, reliability was also confirmed.

3.3. Data Management and Analysis

The Pearson chi-square test was used to analyze qualitative data. For quantitative variables, independent *t*-tests and Analysis of Variance (ANOVA) with Tukey and James-Huell pairwise comparisons were used if the relevant assumptions were established; otherwise, Spearman's correlation test was employed. SPSS version 24 software was used for data analysis. Furthermore, a significance level of 0.05 was considered in all tests.

The ethical approval to conduct the study was obtained from the Institutional Review Board of Guilan University of Medical Sciences (IR.GUMS.REC.1400.631). This work is reported following the STROCSS criteria (22).

4. Results

In the present study, the mean age of the individuals infected with COVID-19 was 41.03 ± 17.16 years. Of all participants, 106 (59.2%) were female, and 116 (64.8%) were married. In addition, the average number of family members in the studied subjects was 3.42 ± 1.31, 78.2% of whom were urban dwellers, and 34.6% had a bachelor's degree. Fatigue (67%) was the most frequent symptom at the disease onset. The average duration of quarantine after the onset of symptoms was 8.65 ± 6.79, and 39 patients (21.8%) were hospitalized with a time interval of more than five days. Moreover, 28.5% of individuals had an underlying systemic disease.

The data indicated that the mean age of the family members who had the most contact with the COVID-19 patient during quarantine was 41.13 ± 16.45 years; 104 (58.1%) were women, and 44.1% were husbands. Besides, 58.7% of the individuals had contact with the infected person for more than seven days. The family transmission rate was 61.5% (110 individuals).

The data also showed that only 22.9% of individuals always brushed their teeth twice daily, and 48% never brushed their tongues. Furthermore, 48% and 58.1% never used dental floss and mouthwash during the day, respectively (Table 1).

Based on the data, 97 (54.2%) individuals did not share their toothbrush container with other family members; however, 70.4% shared the toothpaste tube with other family members. Approximately 75.4% did not change their toothbrush after the positive PCR test (Table 2).

Oral hygiene habits had an inverse and significant relationship with age (r = 0.19, P = 0.001); the total score of oral hygiene habits decreased with age, and the mean score of urban dwellers' oral hygiene habits was significantly higher than that of rural dwellers (P = 0.002). However, the mean score of men's and women's oral hygiene habits (P = 0.084), married and single individuals (658) P = 0.0), and the number of households (r = 0.11, P = 0.132) had no significant difference. Moreover, regarding the relationship between oral hygiene habits and education level, pairwise comparisons between the levels showed that the mean score of illiterate individuals' oral hygiene habits was lower than that of individuals with bachelor's (P < 0.001) and master's degrees (P < 0.001).

The mean score of oral hygiene habits was significantly different only in the symptoms of vomiting or nausea (P = 0.001); therefore, the mean score of oral hygiene habits was lower in individuals with vomiting or nausea than in those lacking these symptoms. Moreover, the mean score of oral hygiene habits was lower in individuals with the underlying disease than those without it (P = 0.001). Also, the total score of oral hygiene habits increased significantly with an increase in the duration of quarantine (r = 0.32, P < 0.001); however, there was no significant relationship between the areas of oral hygiene habits and the coronavirus transmission to another person (P = 0.108).

The findings showed that infection control behaviors had no significant relationship with age (r = 0.04, P = 0.551), gender (P = 0.111), place of residence (P = 0.068), and number of households (r = 0.001, P = 0.990). However, the mean score of infection control behaviors was significantly higher in married individuals than in single ones (P = 0.024). Furthermore, there was a significant relationship between infection control behaviors and education level (P < 0.001); based on pairwise comparisons, the mean score of infection control behaviors in illiterate individuals had significant differences with those of high school (P = 0.027), diploma (P < 0.001), associate's (P = 0.024), bachelor's (P < 0.001), and master's degree holders (P < 0.001).

The mean score of infection control behaviors had no significant relationship with any symptoms at the disease onset. There was a significant difference between the infection control behaviors and the time interval between the symptom onset and hospitalization (P = 0.006); the mean score of infection control behaviors in the category of "not hospitalized" was higher than "0 to 1 day" (P = 0.042) and "more than five days" (P = 0.026). Besides, the mean score of infection control behaviors in patients with underlying disease was significantly lower than that of individuals without it (P = 0.006). There was also a direct and significant relationship between the duration of quarantine and infection control behaviors (r = 0.16, P = 0.031). In addition, using a toothbrush container and a common toothpaste tube increased the transmission percentage (P = 0.042 and P < 0.001, respectively).

Finally, data analysis showed a direct and significant

Table 1. Oral Hygiene Habits of Patients with COVID-19 During Quarantine [a]

Questions	Always	Almost Always	Sometimes	Rarely	Never
Did you brush your teeth twice a day or more during the quarantine period?	41 (22.9)	39 (21.8)	63 (35.2)	12 (6.7)	24 (13.4)
Did you floss your teeth at least once a day during the quarantine period?	22 (12.3)	15 (8.4)	37 (20.7)	19 (10.6)	86 (48)
Did you use mouthwash at least once a day during the quarantine period?	10 (5.6)	12 (6.7)	34 (19)	19 (10.6)	104 (58.1)
Did you brush your tongue at least once a day during the quarantine period?	25 (14)	17 (9.5)	37 (20.7)	14 (7.8)	86 (48)

[a] Values are expressed as No. (%).

Table 2. Infection Control Behaviors in Patients with COVID-19 [a]

Questions	Yes	No
Do you share a toothbrush container with other family members?	82 (45.8)	97 (54.2)
Do you share a tube of toothpaste with other family members?	126 (70.4)	53 (29.6)
Do you usually place your toothbrush vertically?	146 (81.6)	33(18.4)
Do you use a perforated cover for your toothbrush?	106 (59.2)	73 (40.8)
Do you disinfect your toothbrush?	17 (9.5)	162 (90.5)
When using the toilet, do you usually close the lid before flushing?	82 (45.8)	97 (54.2)
Did you change your toothbrush after the PCR test was positive?	44 (24.6)	135 (75.4)

[a] Values are expressed as No. (%).

relationship between infection control behaviors and oral hygiene habits ($r = 0.24$, $P = 0.001$); accordingly, the score of infection control behaviors increased with an increase in oral hygiene habits score.

5. Discussion

This study investigated the relationship between oral hygiene habits and the rate of household disease transmission in patients with COVID-19.

In our study, less than 30% of people always brushed their teeth twice daily, and about half did not use dental floss during the day. Unlike our study, in Costa et al.'s study, which was conducted to investigate the impact of the COVID-19 lockdown on oral health-related behaviors and practices of Portuguese and Spanish children, 46.4% of Spanish participants and 58.6% of Portuguese participants stated that their children brushed twice a day. However, the survey revealed that only 12.9% of Spanish and 14.3% of Portuguese children increased tooth brushing frequency during confinement compared to the previous period (23). Perhaps the main reason for this difference is that children's caregivers monitor their oral health habits and encourage them to brush their teeth.

The present study showed that oral hygiene decreased with age. In this regard, Raskiliene's study entitled "Oral hygiene and associated factors in Lithuanian adult population, 1994 - 2014" showed that patients' oral health reduced with age (24). The study by Olusile et al., conducted in 2014 to determine oral health status and oral hygiene practices among Nigerian adults, achieved similar results (25). It can be stated that the reduction of physical ability, various diseases, and limitations in performing tasks alone in the elderly lead to lower levels of oral hygiene.

Increasing the education level by improving oral health knowledge and changing individuals' attitudes regarding adherence to oral hygiene improved oral health in this group. In their studies, Raskiliene et al. reported a direct relationship between oral hygiene and education level (24-27). However, in the study by Rashidi-Maybodi et al., no significant relationship was shown between oral health and education level (28).

There was a significant relationship between oral hygiene habits and place of residence in patients with COVID-19. Perhaps easier access to the Internet and educational facilities in urban areas was the reason for improving patients' health behaviors in urban areas. In the studies by Rabiei et al. and Raskiliene et al., a significant relationship was observed between oral hygiene habits and place of residence (24, 29).

Married participants and those with a higher level of education obtained a higher score in infection control behaviors. It can be stated that since the instructions for COVID-19 prevention have repeatedly emphasized the unique role of each individual in complying with the

protocols and its impact on reducing contagion and breaking the chain of transmission, married individuals were aware of it, felt a responsibility toward their partner, and had greater adherence to infection control behaviors.

In this study, as the quarantine duration increased, the score of oral hygiene habits and infection control behaviors increased. In the literature review, no study was found evaluating the relationship between the duration of quarantine and oral hygiene habits or infection control behaviors. However, Al Zabadi et al.'s study on the factors affecting individuals' adherence to quarantine in 2020 (30) and Pollak et al.'s study in 2020 to identify the background factors influencing non-adherence to quarantine (31), individuals who emphasized health principles and had a higher education level were more adherent to quarantine and health protocols.

The score of health habits was higher in patients who were not hospitalized. It can be mentioned that individuals with poor oral hygiene were more likely to be hospitalized and develop a more severe form of COVID-19. The oral cavity is a potential reservoir for respiratory pathogens, predisposing patients to secondary bacterial infection (18). In Mishra et al.'s study, the HRCT intensity score correlated with the increase in periodontal parameters. The results showed that the probability of contracting severe COVID-19 was 2.81 times higher in patients with periodontitis (32). In 2020, Mitronin et al. showed a correlation between the severity of COVID-19 and oral and dental diseases. Chronic infection in the oral cavity and poor oral hygiene can be risk factors for viral infections, especially COVID-19 (33). In 2021, Costa et al.'s study showed a positive relationship between oral and dental diseases, especially periodontitis, and the severe consequences of COVID-19, which was in line with our results (34). In 2021, Marouf et al. investigated 568 patients suffering from severe complications of COVID-19, the results of which showed that periodontitis was associated with more severe complications of COVID-19, including hospitalization in the intensive care unit, the need for assisted ventilation, increased blood biomarkers, and death (35).

The data showed that the underlying systemic disease was higher in individuals with a lower score of oral hygiene habits and infection control behaviors. The oral cavity is the intersection of medicine and dentistry and a window to the patient's general health. According to Scannapieco and Cantos's study, poor oral and dental health is associated with the onset and progression of diabetes mellitus and heart and neurological diseases (36). VanWormer et al.'s study in 2010 likewise reported a relationship between oral health and metabolic diseases such as diabetes and heart diseases (37). Chang et al.'s study showed a direct relationship between oral and periodontal health and chronic kidney disease (CKD) (38). The results of our study showed that as the score of oral hygiene habits increased, the score of infection control behaviors increased accordingly. Individuals who are aware of oral diseases and prevent various diseases, such as periodontal diseases and dental caries, through brushing teeth, mouthwash, and other methods pay more attention to infection control behaviors, such as protecting toothbrushes from contamination and separating devices such as toothbrushes and toothpaste, which may increase the possibility of various diseases transmission.

The household transmission rate of COVID-19 was related to using a shared toothbrush container and a toothpaste tube. Toothbrushes and other oral and dental cleaning devices are placed where they are often at risk of contamination with microorganisms between uses. Toothbrushes can be infected with viruses, bacteria, and fungi and transmit them. In patients with infectious diseases such as tuberculosis, hepatitis, or AIDS, microbes can be easily transmitted this way (39). Gonzalez-Olmo et al. found a direct relationship between using a shared toothbrush holder and a toothpaste tube and the household transmission of COVID-19, which was in line with our study. This study showed a significant relationship between the transmission rate and tongue brushing, disinfecting the toothbrush, closing the toilet door before flushing, and changing the toothbrush after a positive PCR test (19). However, Schmalz et al., in an in vitro study, showed that the viral load of coronavirus and influenza virus is reduced by air-drying, especially following water rinsing. They concluded that toothbrushes per se play an insignificant role in the self-transmission of coronavirus and influenza virus (40).

5.1. Conclusions

There was no relationship between oral hygiene habits (brushing, flossing, mouthwash, and tongue brushing) and the transmission of coronavirus disease in family members; however, oral hygiene habits were influential in contracting a more severe type of the disease and the hospitalization rate. The use of shared toothbrush containers and toothpaste tubes by family members increased the chance of household transmission of COVID-19. Therefore, it is necessary to pay attention to oral hygiene to reduce the severity and symptoms of the disease and fully comply with infection control protocols such as separating toothbrushes and toothpaste tubes to reduce the household transmission of the disease.

5.2. Limitations

A possible limitation arises from self-report measures, which may be affected by responses based on social desirability. Another limitation was that only measures affecting the dental environment were considered; consequently, the results could be partially biased.

Footnotes

Authors' Contribution: N.B: Study concept and design, administrative, technical, and material support, study supervision, and critical revision of the manuscript for important intellectual content; N.M: Study concept and design, analysis and interpretation of data, drafting of the manuscript, critical revision of the manuscript for important intellectual content, statistical analysis, administrative, technical, and material support, and study supervision; M.M: Study concept and design, acquisition of data, analysis, and interpretation of data, and drafting of the manuscript; M.KH: Study concept and design, drafting of the manuscript, and critical revision of the manuscript for important intellectual content.

Conflict of Interests: The authors declare no conflict of interest.

Data Reproducibility: The dataset presented in the study is available on request from the corresponding author during submission or after publication.

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