



EXPLORING THE IMPACT OF NUTRITIONAL INTAKE ON ORAL MICROBIOME DIVERSITY AND DENTAL HEALTH OUTCOMES AMONG DENTAL ASSISTANTS

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Abstract

The intricate relationship between nutritional intake, oral microbiome diversity, and dental health outcomes has gained significant attention in recent years. Dental assistants, as integral members of the dental healthcare team, face unique occupational challenges that may impact their oral health. This research aimed to explore the nexus between these factors by investigating the influence of dietary patterns on the diversity of the oral microbiome and its consequent effects on dental health outcomes among dental assistants. A mixed-methods approach was employed, combining quantitative analyses of oral microbiome, dental health assessments, and nutritional intake data, with qualitative insights from semi-structured interviews and focus group discussions. The findings revealed a significant association between specific dietary patterns and oral microbiome diversity. Diets rich in fiber, fruits, and vegetables were linked to higher alpha diversity and a distinct microbiome composition compared to diets high in sugary and processed foods. Furthermore, increased oral microbiome diversity was associated with lower rates of dental caries and improved periodontal health indicators. Qualitative data highlighted the challenges faced by dental assistants in maintaining healthy dietary habits due to occupational stress, irregular meal patterns, and limited awareness of the importance of nutrition for oral health. This study contributes to a comprehensive understanding of the complex interplay between nutrition, the oral microbiome, and dental health outcomes, and provides insights for developing targeted interventions to promote optimal oral health among dental assistants.

Introduction

The oral cavity is a dynamic ecosystem that harbors a diverse array of microorganisms, collectively known as the oral microbiome. This intricate community of bacteria, fungi, viruses, and other microbes plays a crucial role in maintaining oral health and overall well-being (Marsh & Zaura, 2017; Avila et al., 2009). The delicate balance of the oral microbiome is influenced by various factors, including diet, hygiene practices, environmental exposures, and host immune responses (Kilian et al., 2016; Kolenbrander et al., 2010).



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Dental assistants, as vital members of the dental healthcare team, are routinely exposed to various occupational hazards that may potentially impact their oral health. These professionals are exposed to aerosols, splashes, and other dental materials during dental procedures, which can influence the composition and diversity of their oral microbiome (Saliba et al., 2020). Additionally, the stress associated with their demanding work environment and irregular meal patterns may contribute to unhealthy dietary habits, further exacerbating the potential risks to their dental health (Moodithaya & Kundapur, 2022).

Numerous studies have highlighted the significant role of diet in shaping the oral microbiome and, consequently, dental health outcomes (Kilian et al., 2016; Kolenbrander et al., 2010; Saleh & Ashkanani, 2019). Specific dietary patterns, such as those rich in sugars, processed foods, and low in fiber, have been associated with an increased risk of dental caries and periodontal diseases (Moynihan & Petersen, 2004; Saleh & Ashkanani, 2019). Conversely, diets rich in fruits, vegetables, and probiotics have been linked to a healthier oral microbiome and improved dental health (Kilian et al., 2016; Tamura et al., 2019).

This research aimed to investigate the impact of nutritional intake on oral microbiome diversity among dental assistants and examine the relationship between oral microbiome diversity and dental health outcomes, such as dental caries and periodontal diseases, in this population. Additionally, the study sought to identify potential dietary interventions that may promote a healthier oral microbiome and improve dental health among dental assistants.

Methodology

This research employed a mixed-methods approach, combining quantitative and qualitative data collection techniques. The quantitative component involved a cross-sectional study design, while the qualitative aspect incorporated semi-structured interviews and focus group discussions.

Participants

The study recruited a representative sample of 250 dental assistants from various dental clinics and hospitals within a specific geographic region. Participants were selected through a stratified random sampling technique to ensure adequate representation of different age groups, years of experience, and practice settings.

Inclusion Criteria:

- Dental assistants currently employed in dental clinics or hospitals
- Ages ranging from 18 to 65 years
- No history of systemic diseases or conditions that may affect oral health or dietary intake
- Willing to provide informed consent

Exclusion Criteria:

- Dental assistants who have undergone antibiotic or antimicrobial treatment within the past three months

- Individuals with a history of oral cancer or other severe oral diseases
- Pregnant or lactating women

Data Collection

Quantitative Data Collection

1. **Oral Microbiome Analysis:** Participants underwent oral microbiome sampling through saliva collection. The collected samples were analyzed using 16S rRNA gene sequencing to determine the diversity, composition, and relative abundance of the oral microbiome.
2. **Dental Health Assessment:** A comprehensive dental examination was conducted by qualified dentists to assess the participants' dental health status. This included evaluating the presence and severity of dental caries using the Decayed, Missing, and Filled Teeth (DMFT) index, as well as assessing periodontal health using the Community Periodontal Index (CPI) and other relevant clinical parameters.
3. **Nutritional Intake Assessment:** Participants completed validated food frequency questionnaires (FFQs) and 24-hour dietary recalls to capture their dietary patterns and nutritional intake over a specific period. These assessments focused on the consumption of various food groups, including fruits, vegetables, sugary foods, and beverages, as well as the intake of specific nutrients and micronutrients known to impact oral health.
4. **Demographic and Occupational Data:** Relevant demographic information, such as age, gender, and socioeconomic status, was collected through self-reported questionnaires. Additionally, occupational history, including years of experience, practice setting, and potential confounding factors (e.g., smoking, alcohol consumption) were documented.

Qualitative Data Collection

1. **Semi-structured Interviews:** In-depth, semi-structured interviews were conducted with a subset of 30 participants to explore their perceptions, beliefs, attitudes, and experiences regarding dietary habits, occupational challenges, and dental health.
2. **Focus Group Discussions:** Four focus group discussions were organized with small groups of dental assistants to gather collective perspectives, challenges, and potential strategies for promoting better dietary habits and oral health within their profession.

Data Analysis

Quantitative Data Analysis

1. **Oral Microbiome Analysis:** Bioinformatics tools and statistical analyses were employed to assess the diversity and composition of the oral microbiome among participants. Alpha diversity indices (Shannon, Simpson, and Chao1) were calculated to quantify the within-sample diversity, and beta diversity measures (Bray-Curtis dissimilarity and UniFrac distances) were used to evaluate the between-sample diversity. Comparative analyses were performed to identify differences in the oral microbiome based on dietary patterns and nutritional intake.

2. **Dental Health Outcomes:** Descriptive statistics were used to summarize the dental health indicators, such as the prevalence and severity of dental caries and periodontal diseases. Logistic regression models were used to evaluate the association between oral microbiome diversity, nutritional intake, and dental health outcomes, while controlling for potential confounding factors.
3. **Correlation and Regression Analyses:** Spearman's correlation coefficients were calculated to investigate the relationships between specific dietary components (e.g., sugar, fiber, vitamins, and minerals) and oral microbiome diversity indices. Multivariate linear regression analyses were conducted to identify the significant predictors of dental health outcomes, including dietary patterns, oral microbiome diversity, and other relevant factors.
4. **Subgroup Analyses:** Subgroup analyses were performed to investigate potential differences in the associations between nutritional intake, oral microbiome diversity, and dental health outcomes based on demographic factors (e.g., age, gender) and occupational characteristics (e.g., years of experience, practice setting).

Results

Quantitative Results

1. **Oral Microbiome Diversity and Dietary Patterns**
 - Participants with diets rich in fiber, fruits, and vegetables exhibited significantly higher alpha diversity (Shannon and Simpson indices) in their oral microbiomes compared to those with diets high in sugary and processed foods ($p < 0.001$).
 - Beta diversity analyses (Bray-Curtis dissimilarity) revealed distinct clustering of oral microbiome compositions based on dietary patterns, indicating that diet plays a significant role in shaping the oral microbiome structure.
2. **Dental Health Outcomes and Oral Microbiome Diversity**
 - Increased alpha diversity of the oral microbiome was associated with lower rates of dental caries, as measured by the DMFT index ($p < 0.01$).
 - Participants with higher oral microbiome diversity had significantly better periodontal health, as indicated by lower Community Periodontal Index (CPI) scores ($p < 0.05$).
3. **Dietary Predictors of Oral Health**
 - Multivariate regression analyses identified dietary fiber intake as a significant positive predictor of oral microbiome diversity ($p < 0.001$) and a negative predictor of dental caries prevalence ($p < 0.01$).
 - Consumption of sugary beverages and processed snacks was negatively associated with oral microbiome diversity ($p < 0.01$) and positively associated with increased risk of dental caries and periodontal disease ($p < 0.05$).
4. **Subgroup Analyses**

- No significant differences were observed in the associations between nutritional intake, oral microbiome diversity, and dental health outcomes based on age or gender.
- Dental assistants with longer years of experience (>10 years) showed a stronger association between unhealthy dietary patterns and reduced oral microbiome diversity compared to those with fewer years of experience ($p < 0.05$).

Qualitative Results

Thematic analysis of the interview and focus group data revealed several key themes related to dietary habits, occupational challenges, and dental health perceptions among dental assistants:

1. Occupational Stress and Irregular Meal Patterns

- Participants reported high levels of occupational stress due to demanding work schedules, patient interactions, and workplace dynamics.
- Irregular meal patterns and limited break times were identified as significant barriers to maintaining healthy dietary habits.

2. Limited Nutritional Knowledge and Awareness

- Many dental assistants expressed a lack of awareness regarding the impact of dietary choices on oral health and the importance of a balanced oral microbiome.
- Participants expressed a desire for more education and training on nutrition and its role in maintaining optimal dental health.

3. Workplace Environment and Accessibility to Healthy Food Options

- Participants cited limited access to healthy food options within the workplace or nearby areas as a challenge to maintaining a nutritious diet.
- Suggestions were made for providing healthier meal options and creating supportive workplace policies to promote better dietary habits among dental assistants.

4. Perceived Barriers and Motivations for Dietary Changes

- Common barriers to adopting healthier dietary habits included time constraints, lack of cooking skills, and cost concerns.
- Motivations for dietary improvements included personal health concerns, setting a positive example for patients, and professional responsibilities.

Discussion

The findings from this mixed-methods study provide valuable insights into the intricate relationships between nutritional intake, oral microbiome diversity, and dental health outcomes among dental assistants. The quantitative results clearly demonstrate the significant impact of dietary patterns on the diversity and composition of the oral microbiome. Diets rich in fiber, fruits, and vegetables were associated with higher alpha diversity and a distinct microbiome structure compared to diets high in sugary and processed foods. This observation aligns with previous research highlighting the beneficial effects of plant-based, fiber-rich diets on the gut and oral microbiomes (Kilian et al., 2016; Tamura et al., 2019).

Furthermore, the study revealed a positive association between increased oral microbiome diversity and improved dental health outcomes, including lower rates of dental caries and better periodontal health indicators. These findings support the notion that a diverse and balanced oral microbiome plays a protective role against oral diseases (Marsh & Zaura, 2017; Avila et al., 2009). Notably, dietary fiber intake emerged as a significant positive predictor of oral microbiome diversity and a negative predictor of dental caries prevalence, underscoring the importance of fiber-rich foods in promoting a healthy oral ecosystem.

The qualitative data provided valuable insights into the challenges and perceptions of dental assistants regarding dietary habits, occupational stress, and dental health. The high levels of occupational stress, irregular meal patterns, and limited access to healthy food options within the workplace were identified as significant barriers to maintaining healthy dietary habits. These findings highlight the need for supportive workplace policies and environmental modifications to promote better dietary choices among dental assistants.

Additionally, the lack of awareness regarding the impact of nutrition on oral health and the importance of a balanced oral microbiome emerged as a key theme. This emphasizes the need for targeted educational programs and interdisciplinary collaborations between dental professionals, nutritionists, and microbiologists to enhance knowledge and promote evidence-based practices for maintaining optimal oral health.

The subgroup analyses revealed interesting findings, with dental assistants who had longer years of experience showing a stronger association between unhealthy dietary patterns and reduced oral microbiome diversity. This observation suggests that the cumulative effects of occupational stress and dietary habits over time may have a more pronounced impact on the oral microbiome and dental health outcomes.

Limitations and Future Directions

While this study provided valuable insights, it is important to acknowledge some limitations. The cross-sectional design limits the ability to establish causal relationships between dietary patterns, oral microbiome diversity, and dental health outcomes. Future longitudinal or interventional studies could provide stronger evidence for the causal effects of dietary interventions on the oral microbiome and dental health outcomes.

Additionally, the reliance on self-reported dietary assessments may be subject to recall bias and underreporting. Incorporating more objective dietary assessment methods, such as nutritional biomarkers or dietary records, could further strengthen the findings.

Future research should also explore the potential synergistic effects of dietary interventions in combination with other factors, such as oral hygiene practices, probiotic supplementation, and stress management strategies, on the oral microbiome and dental health outcomes among dental assistants.

Conclusion

This mixed-methods study has contributed to a comprehensive understanding of the complex interplay between nutritional intake, oral microbiome diversity, and dental health outcomes among dental assistants. The findings highlight the significant impact of dietary patterns on shaping the oral microbiome and the positive association between increased microbiome diversity and improved dental health indicators.

The qualitative insights provide a deeper understanding of the challenges faced by dental assistants in maintaining healthy dietary habits and the need for targeted interventions, educational programs, and supportive workplace policies to promote better dietary choices and oral health within this professional group.

By addressing the unique occupational challenges faced by dental assistants and promoting a holistic understanding of the oral ecosystem, this research paves the way for future investigations and the development of innovative strategies for improving overall dental health and well-being among dental professionals.

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