

Social determinants and oral health among cement industry workers

R. E. Haura Azzahra¹, Rosa Amalia², Derajad Sulisty Widhyharto³, Dibyo Pramono², Bambang Priyono²

¹Master of Dentistry Study Program, Faculty of Dentistry, Universitas Gadjah Mada, Yogyakarta, Indonesia

²Department of Preventive and Community Dentistry, Faculty of Dentistry, Universitas Gadjah Mada, Yogyakarta, Indonesia

³Department of Sociology, Faculty of Social and Political Sciences, Universitas Gadjah Mada, Yogyakarta, Indonesia

ABSTRACT

Background: Cement industry workers are exposed to significant oral health risks due to hazardous conditions, but the role of social determinants in this context is not well understood. **Purpose:** This study investigates the association between social determinants and oral health among factory and office workers in the cement industry. **Methods:** A cross-sectional study was conducted at PT. Semen Padang, West Sumatra, Indonesia. A stratified random sample of 83 workers was selected. Social determinants were assessed using World Health Organization (WHO) 2013 and Perceived Stress Scale (PSS-10) questionnaires, while oral health was evaluated using decayed, missing, and filled teeth index (DMF-T), community periodontal index (CPI), and inspection. Ten calibrated dentists conducted dental examinations. Multiple linear regression was used for data analysis. **Results:** Factory workers exhibited higher rates of dental caries (95.83%), periodontal disease (87.50%), abrasion (91.67%), and attrition (87.50%), compared to office workers. Social determinants significantly associated with dental caries in factory workers included age, sugar intake, tooth-brushing frequency, and last dental check-up ($r^2 = 0.573$), while only sugar intake was associated with caries in office workers ($r^2 = 0.290$). For periodontal disease determinants associated with age, psychosocial factors, and smoking ($r^2 = 0.558$) were significant in factory workers, whereas, in office workers, age, sugar intake, tooth-brushing frequency, last dental check-up, and smoking were significantly associated ($r^2 = 0.870$). Age was the only significant determinant of abrasion and attrition in both groups. **Conclusion:** Social determinants influence oral health among cement industry workers, especially factory workers, due to physiological and psychological changes caused by working conditions. However, office workers also face oral health challenges due to poor oral health behaviors.

Keywords: cement factory; factory workers; oral health; shift schedule; social determinant

Article history: Received 8 July 2024; Revised 13 October 2024; Accepted 23 October 2024; Online 1 September 2025

Correspondence: R. E. Haura Azzahra, Master of Dentistry Study Program, Faculty of Dentistry, Universitas Gadjah Mada. Jl. Denta 1, Sekip Utara, Yogyakarta, 55281, Indonesia. Email: rehauraazzahra@mail.ugm.ac.id

INTRODUCTION

Occupation is recognized as a key social determinant of health,¹ yet this aspect is often overlooked due to limitations in public health data systems.² Previous research has predominantly focused on social determinants without considering working conditions.^{3–5} Consequently, research findings are frequently inconsistent, as the outcomes for higher social position do not always exhibit a linear relationship with good health.^{6–9} Demographic and socioeconomic factors frequently obscure the crucial role of occupational exposures. Historical evidence from the early days of occupational health, where company data showed that workers in hazardous environments experienced higher

disease rates, highlights the consequences of occupational segregation.^{1,2} This has made it challenging for public health to define the social determinants that affect oral health, particularly among workers.²

The cement industry, known for its hazardous working conditions, poses significant risks to workers' oral health. Exposure to harmful particles, including heavy metals and abrasive dust,¹⁰ has been associated with dental caries,^{11,12} periodontal disease,^{10,11,13,14} and tooth wear.^{12,15} Factory workers are particularly vulnerable to dental health problems due to their work environments and irregular work schedules, especially shift work.¹¹ Shift work has been extensively linked to negative impacts on general health,^{16–19} yet its specific influence on oral health remains

understudied.^{7,11,20–23} Irregular schedules often disrupt physiological and psychological balance, leading to increased stress and poor oral health.^{11,23} The impacts of oral health problems among workers include the reduction of quality of life,²⁴ loss of productivity,²⁵ and economic burden for individuals and industry.²⁶

This study aims to investigate the association between social determinants (such as age, gender, education, psychosocial factors, oral health behaviors, and working conditions) and oral health outcomes (caries, periodontal disease, abrasion, and attrition), among factory and office workers in the cement industry. Considering these social determinants in the workplace may help design more targeted oral health programs and improve workers' oral health and behaviors.²⁷

MATERIALS AND METHODS

This research is a cross-sectional study, employing an observational–analytical design, approved by the Research Ethics Commission of the Faculty of Dentistry–Prof. Soedomo Dental and Oral Hospital, Universitas Gadjah Mada (number 64/UN1/KEP/FGK-RSGM/EC/2024). This study was conducted in May 2024 at PT. Semen Padang, Padang City, West Sumatra, Indonesia. A stratified random sampling of 83 participants was determined by an analytical sample size calculation.²⁸ Participants were required to be voluntary, factory workers with at least five years of experience or office workers with no prior factory experience, and free of orthodontic appliances, systemic diseases, and routine drug use.

Data collection utilized a mouth mirror and a World Health Organization (WHO) periodontal probe. Social determinants were assessed using the WHO 2013 and Perceived Stress Scale (PSS-10) questionnaires, while oral health conditions were evaluated using the decayed, missing, and filled teeth index (DMF-T), community periodontal index (CPI), and number of abrasion and attrition affected teeth. Dental examinations were conducted by ten dentists who had undergone training and standardization to ensure consistent methodology and assessment of oral health. Dental examiners were trained and calibrated at the employee dental health care facility of PT. Semen Padang.

Data analysis involved descriptive statistics, bivariate analysis using Pearson Correlation and Independent T-tests, and multivariate analysis using multiple linear regression to examine the relationships between social determinants and oral health outcomes.

RESULTS

A total of 83 workers from the cement industry participated in this study. The sample comprised 48 factory workers (57.83%) and 35 office workers (42.17%), with an average

age of 40.50 years (SD = 7.00). See Table 1 for the subject characteristics.

Based on Table 1 data, respondents aged 35–44 years were in the majority (48.19%), and more workers were male (75.90%). The most prevalent level of formal education was 12 years (42.17%). Sugar intake categorized as moderate was most dominant (44.58%). Most respondents brushed their teeth more than twice a day (83.13%). The stress level most reported was categorized as mild (50.60%). Most respondents had their last dental check-up less than one year ago (60.24%). More respondents were non-smokers (65.06%) compared to smokers. More participants were shift workers (57.83%) compared to non-shift workers. The prevalence of dental diseases was highest among factory

Table 1. Subject characteristics

Indicator	n (%)
Age	
27–34 years	18 (21.69)
35–44 years	40 (48.19)
45–54 years	25 (30.12)
Gender	
Male	63 (75.90)
Female	20 (24.10)
Education	
12 years	35 (42.17)
15 years	22 (26.51)
≥ 16 years	26 (31.32)
Sugar intake	
Low	14 (16.87)
Moderate	37 (44.58)
High	32 (38.55)
Tooth brushing frequency	
< 2 a day	14 (16.87)
≥ 2 a day	69 (83.13)
Psychosocial	
Mild	42 (50.60)
Moderate	36 (43.37)
Severe	5 (6.02)
Last dental check-up	
≤1 year	50 (60.24)
>1 year	33 (39.76)
Smoking	
Smoker	29 (34.94)
Non-smoker	54 (65.06)
Work Schedule	
Shift	48 (57.83)
Non-shift	35 (42.17)
DMF-T	
Factory workers	46 (95.83)
Office workers	33 (94.29)
Periodontal Disease	
Factory workers	42 (87.50)
Office workers	24 (68.57)
Abrasion	
Factory workers	44 (91.67)
Office workers	29 (82.86)
Attrition	
Factory workers	42 (87.50)
Office workers	22 (62.86)

workers in all categories: caries (95.83%), periodontal disease (87.50%), abrasion (91.67%), and attrition (87.50%).

The social determinant most significantly linked to caries was sugar intake as presented in Table 2. Periodontal disease was significantly influenced by age, education level, stress level, and smoking habits. Attrition was significantly associated with age, and abrasion was significantly associated with age, education level, gender, and smoking.

Table 3 shows that the social determinants significantly associated with caries for factory workers were age, sugar intake, tooth-brushing frequency, and last dental check-up. In contrast, for office workers, only sugar intake shows a significant association. The social determinants significantly associated with periodontal disease for factory workers were age, psychosocial factors, and smoking. Conversely, for office workers, age, sugar intake, tooth-brushing frequency, last dental check-up, and smoking were significantly associated. The social determinants significantly associated with abrasion for factory workers were age and education, while for office workers, only age was significantly related. Age and smoking were significantly associated with attrition in factory workers, while for office workers, only age was significantly associated.

DISCUSSION

The study involved factory workers on shift schedules and office workers with regular daytime schedules in the cement industry. Sugar intake was associated with incidence of caries among cement industry workers. This finding is in line with Vitosyte et al.⁵ who found that adults with high sugar intake scores had a high prevalence of caries. A meta-analysis concluded that sugar intake is a major cause of caries²⁹ and several systematic reviews consistently showed that sugar intake is a primary cause of caries in children and adults.^{30–34} This could be attributed to easy access to sugary foods in the workplace, especially in office environments. Office workers have access to kitchens with a variety of foods available, including those high in sugar. The provision of various foods is a company's contribution to supporting worker productivity. The study results also showed that age, education, tooth-brushing frequency, psychosocial factors, gender, last dental check-up, smoking, and working hours were not significantly associated with caries. Individuals in all categories experienced caries. These findings indicate a potential association between social determinants and caries, even though statistical significance was not achieved. Nonetheless, the present study revealed sugar intake as the primary determinant of caries.

Table 2. Association between social determinants and oral health

Variable	DMF-T		PPD		Abrasion		Attrition	
	r	p-value	r	p-value	r	p-value	r	p-value
Age	0.115	0.301	0.329	0.002*	0.436	0.000*	0.535	0.000*
Education	-0.001	0.989	-0.340	0.002*	-0.018	0.874	-0.217	0.049*
Sugar intake	0.488	0.000*	0.125	0.261	-0.072	0.518	-0.080	0.470
Brushing frequency	-0.151	0.174	-0.124	0.264	0.044	0.691	0.005	0.962
Psychosocial	-0.038	0.733	0.271	0.013*	0.011	0.920	0.210	0.056
	t	p-value	t	p-value	t	p-value	t	p-value
Gender	-1.092	0.278	1.968	0.053	1.027	0.307	2.938	0.004*
Last dental check-up	-1.335	0.186	-0.830	0.409	0.146	0.884	0.773	0.442
Smoking	1.227	0.223	6.925	0.000*	0.751	0.455	2.764	0.007*
Work schedule	-1.254	0.214	3.453	0.001*	1.652	0.102	4.482	0.000*

Statistical analysis using the Pearson correlation test and independent t-test; PPD=Periodontal Pocket Depth (≥ 4 mm); r = correlation coefficient; t = t-value ($t_{\text{student}} = 1.664$); p = significance value; *significance at the level of < 0.05 .

Table 3. Association between social determinants and oral health among factory and office workers in the cement industry

Indicator	Age	Education	Sugar intake	Brushing frequency	Psycho-social	Last dental check-up	Smoking	r^2
	p-value	p-value	p-value	p-value	p-value	p-value	p-value	
DMF-T								
Factory	0.024*	0.898	0.000*	0.005*	0.834	0.035*	0.317	0.573
Office	0.518	0.294	0.029	0.481	0.446	0.185	0.274	0.290
PPD								
Factory	0.006*	0.580	0.160	0.611	0.007*	0.507	0.000*	0.558
Office	0.000*	0.083	0.024*	0.014*	0.369	0.012*	0.000*	0.870
Abrasion								
Factory	0.012*	0.026*	0.595	0.830	0.092	0.589	0.128	0.278
Office	0.005*	0.756	0.339	0.348	0.089	0.963	0.802	0.429
Attrition								
Factory	0.000*	0.217	0.669	0.996	0.179	0.644	0.011*	0.564
Office	0.045*	0.544	0.064	0.220	0.177	0.096	0.918	0.433

Statistical analysis using the multiple linear regression test; PPD = Periodontal Pocket Depth (≥ 4 mm); p = significance value; r^2 = coefficient of determination; *significance at the level of < 0.05 .

Age, education, and psychosocial factors were associated with increased periodontal disease among cement industry workers. These findings align with previous studies demonstrating that socioeconomic factors, such as lower education, socioeconomic status, and smoking, are linked to a higher prevalence of periodontal disease.³⁵ Moreover, psychosocial factors and elevated salivary cortisol levels have been associated with periodontal disease.³⁶ Older age, lower education, and higher stress levels may contribute to periodontal disease through weakened immune systems, reduced access to dental care, and unhealthy lifestyle choices, respectively. Additionally, shift work was associated with increased periodontal disease, consistent with previous research.^{7,11,20–23} The irregular sleep patterns and increased stress associated with shift work may compromise the immune system, making individuals more susceptible to periodontal disease. Furthermore, smoking was strongly linked to periodontal disease, with smokers exhibiting deeper periodontal pockets and greater attachment loss.³⁷ The harmful effects of tobacco on periodontal tissues, including reduced blood flow, impaired wound healing, and immunosuppression, contribute to the development and progression of periodontal disease. While statistical analysis revealed no significant associations between sugar intake, brushing frequency, gender, and last dental check-up, periodontal pockets were observed in all groups regardless of these variables. This study suggests a relationship between social determinants and periodontal disease, with age, education, psychosocial factors, smoking, and work schedule emerging as the most influential factors.

Abrasion in cement industry workers was associated with age and education. Sharma et al.¹² found that tooth wear was related to age, education, and poor oral hygiene habits among cement industry workers. This is likely influenced by exposure to cement dust and brushing techniques among workers. The most common cause of tooth wear in cement industry workers, found in the cervical area, was attributed to incorrect brushing techniques, excessive brushing pressure, duration, frequency, brush bristle design, and abrasive toothpaste.³⁸ Cement dust, containing abrasive particles such as silica, can adhere to teeth and when combined with saliva forms a hard paste that gradually erodes tooth enamel, especially when compounded by vigorous or improper brushing. Using a hard-bristled toothbrush, brushing vigorously, or brushing in a horizontal direction can exacerbate the abrasive effects of cement dust, accelerating enamel abrasion and potentially leading to increased tooth sensitivity and gingival recession. Despite the lack of statistically significant associations with other factors, abrasion was prevalent across all levels of education, sugar intake, brushing frequency, psychosocial factors, gender, last dental check-up, smoking, and work schedule.

Attrition was significantly associated with age in cement industry workers, aligning with previous studies.^{39–41} Aging is associated with increased occlusal forces and bruxism,

a condition characterized by involuntary grinding or clenching of the teeth, both of which contribute to attrition. Moreover, older individuals often experience higher stress levels, further exacerbating bruxism.⁴² Males exhibited higher levels of tooth wear compared to females, possibly due to dietary factors and stronger chewing forces.⁴¹ While no direct studies have compared the dental structure or saliva composition between genders, bruxism, which is more prevalent in males, is a likely contributing factor. Shift workers also demonstrated higher levels of tooth wear, potentially linked to increased stress and bruxism. Although direct evidence is lacking, the association between shift work, psychosocial stress, and bruxism is well-established.⁴² Similarly, smokers exhibited higher levels of tooth wear, likely due to increased stress and bruxism. While no direct studies have examined the relationship between smoking and tooth wear, the association between stress and bruxism is well-documented.^{42,43} Although other factors were not statistically significant, tooth wear was observed in all groups regardless of these variables. However, this study found that age, education, gender, smoking, and work schedule were the most influential factors contributing to tooth attrition.

The incidence of dental caries in factory workers who work in shift schedules was significantly associated with age, sugar intake, brushing frequency, and last dental check-up. These findings align with previous studies,¹¹ indicating a higher risk of caries among shift workers compared to those with regular schedules. A systematic review suggests that shift workers are more likely to experience disrupted eating patterns, consuming more unhealthy foods and sugary drinks.³⁸ These dietary differences can lead to elevated blood sugar levels and reduced salivary flow, increasing susceptibility to caries.⁴⁴ In contrast, dental caries incidence among office workers was primarily associated with sugar intake, consistent with findings from Janapareddy et al.²⁴ The higher prevalence of caries among office workers is attributed to increased opportunities for sugar intake during working hours and easier access to sugary foods.²⁴ Despite the lack of statistically significant associations with other factors, this study revealed that dental caries among factory workers were primarily influenced by age, sugar intake, brushing frequency, and last dental check-up, whereas office workers' caries experience was primarily associated with sugar intake.

Periodontal disease among factory workers who work shift schedules was related to age, psychosocial, and smoking. Shift workers exhibited higher levels of oral inflammation and periodontal health concerns. Periodontal disease increased with age.^{11,22} Stress and anxiety, which can lead to poor oral hygiene, increased smoking, and poor nutrition, can elevate cortisol levels and disrupt the balance between pro- and anti-inflammatory responses. In office workers, periodontal disease was significantly associated with age, sugar intake, brushing frequency, last dental check-up, and smoking status, aligning with Kharbanda et al.⁴⁵ However, this finding contradicts Zaitso et al.⁷ and

Ishizuka et al.²⁰ who reported lower periodontal disease among daytime office workers. This discrepancy may be attributed to differences in oral health behaviors. Although other factors were not statistically significant, the results suggest that periodontal disease in factory workers is more influenced by systemic conditions such as age, psychosocial factors, and smoking, while in office workers it is more influenced by oral health behaviors.

Abrasion in factory workers was associated with age and education, while in office workers, it was primarily related to age. These findings align with Ali et al.⁴⁶ who reported that tooth wear is influenced by age, gender (especially in males), and brushing technique. Prevalence of tooth wear increases with age, and education level is often correlated with lifespan.⁴⁶ Inappropriate brushing techniques among workers may be attributed to a lack of practical dental health knowledge. This could be particularly relevant to cement industry workers, who may have limited awareness of proper brushing techniques. Although other factors were not statistically significant, both factory and office workers experienced abrasion, and age was the most influential factor, possibly due to prolonged exposure to abrasive particles.

Attrition in factory workers was associated with age and smoking status, while in office workers, it was primarily influenced by age. This aligns with Sharma et al.¹² who reported an increase in attrition among cement industry workers with advancing age. The abnormal loss of tooth structure due to attrition is a consequence of occupational exposure. Prolonged exposure to cement dust exacerbates tooth wear.¹² It is plausible that cement industry workers may experience stress-induced bruxism, which can contribute to attrition.^{47–49} Although other factors were not statistically significant, both factory and office workers exhibited tooth wear, with age being the most prominent factor. However, smoking status significantly influenced tooth wear only among factory workers, suggesting a potential synergistic effect of occupational exposure and lifestyle factors.¹⁵

This study demonstrates that social determinants significantly influence the oral health of cement industry workers, particularly factory workers, due to physiological and psychological changes caused by hazardous working conditions and work schedules. However, office workers also face oral health challenges, primarily due to poor oral health behaviors, especially high sugar consumption. The study found a strong correlation between sugar intake and dental caries among cement industry workers, and it highlighted the influence of age, education, psychosocial factors, and shift work on periodontal disease. The conditions of abrasion and attrition are significantly influenced by age, which is related to the duration that teeth are exposed to abrasive materials. Untreated abrasion and attrition can heighten the risk of caries and progression to pulpitis. Pulpitis observed in cement industry workers often manifests in the form of abrasion and attrition. These findings indicate that the causes of caries may also

stem from tooth wear. However, this aspect is frequently overlooked by dental clinicians, and there is a lack of adequate research references related to this finding.

This study has several limitations. For instance, this research did not investigate the relationship between length of employment and oral health condition. The duration of employment in the cement industry may influence the development and severity of oral diseases, especially among long-term exposed workers. The study did not explore oral hygiene practices such as frequency and technique, which could provide additional insights into oral health outcomes. The gender distribution in this study was imbalanced, with a majority of male participants, which could potentially influence the results due to gender differences in oral health. The use of alternative stress assessment tools might yield different results. Further clinical research is needed to investigate cement-dust-induced tooth wear and develop effective preventive measures. By understanding social determinants and working conditions, we can identify the causes of oral health problems more precisely, prioritize at-risk groups, and address oral health issues equitably in the workplace.

ACKNOWLEDGEMENTS

The author would like to thank PT. Semen Padang who contributed to this research and the reviewers for their assistance in preparing this journal article.

REFERENCES

1. Armenti K, Sweeney M, Lingwall C, Yang L. Work: a social determinant of health worth capturing. *Int J Environ Res Public Health*. 2023; 20(2): 1199.
2. Silver SR, Sweeney MH, Sanderson WT, Pana-Cryan R, Steege AL, Quay B, Carreón T, Flynn MA. Assessing the role of social determinants of health in health disparities: The need for data on work. *Am J Ind Med*. 2024; 67(2): 129–42.
3. Tellez M, Zini A, Estupiñan-Day S. Social determinants and oral health: an update. *Curr Oral Heal Reports*. 2014; 1(3): 148–52.
4. Rodriguez JL, Thakkar-Samtani M, Heaton LJ, Tranby EP, Tiwari T. Caries risk and social determinants of health: A big data report. *J Am Dent Assoc*. 2023; 154(2): 113–21.
5. Vitosyte M, Puriene A, Stankeviciene I, Rimkevicius A, Trumpaite-Vanagiene R, Aleksejuniene J, Stangvaltaite-Mouhat L. Oral health among adult residents in Vilnius, Lithuania. *Int J Environ Res Public Health*. 2022; 19(1): 582.
6. Novrinda H, Han D-H, Jung-Choi K, Ryu J-I. Neo-Marxian social class inequalities in oral health among the South Korean population. *Community Dent Oral Epidemiol*. 2019; 47(2): 162–70.
7. Zaitzu T, Kanazawa T, Shizuma Y, Oshiro A, Takehara S, Ueno M, Kawaguchi Y. Relationships between occupational and behavioral parameters and oral health status. *Ind Health*. 2017; 55(4): 381–90.
8. Irie K, Tsuneishi M, Saijo M, Suzuki C, Yamamoto T. Occupational difference in oral health status and behaviors in Japanese workers: a literature review. *Int J Environ Res Public Health*. 2022; 19(13): 8081.
9. Irie K, Yamazaki T, Yoshii S, Takeyama H, Shimazaki Y. Is there an occupational status gradient in the development of periodontal disease in Japanese workers? A 5-year prospective cohort study. *J Epidemiol*. 2017; 27(2): 69–74.

10. Abdelhamid A. Effect of exposure to portland cement dust on the periodontal status and on the outcome of non-surgical periodontal therapy. *Int J Health Sci (Qassim)*. 2016; 10(3): 339–52.
11. Ghasemi H, Darmohammadi R, Namdari M, Ghorbani Z. Oral health outcomes and shift working among male workers: A cross-sectional survey. Chaubal T, editor. *PLoS One*. 2022; 17(10): e0275924.
12. Sharma A, Thomas S, Dagli R, Solanki J, Arora G, Singh A. Oral health status of cement factory workers, Sirohi, Rajasthan, India. *J Heal Res Rev*. 2014; 1(1): 15.
13. Elagib MFA, Ghandour IA, Abdel Rahman ME, Baldo SMH, Idris AM. Influence of cement dust exposure on periodontal health of occupational workers. *Toxin Rev*. 2021; 40(4): 1496–504.
14. Abdullah MI, Ali SM, Jassim JA. Periodontal status of smoker and nonsmoker between the workers at El Kubaisa factory of cement. *Iraqi Dent J*. 2017; 39(2): 82.
15. Abdulla MI, Al-Waheb AM. Occupational dental wear among El-Kubasis cement factory workers : an observational study. *J Baghdad Coll Dent*. 2014; 26(2): 135–7.
16. Kecklund G, Axelsson J. Health consequences of shift work and insufficient sleep. *BMJ*. 2016; 355: i5210.
17. Proper KI, van de Langenberg D, Rodenburg W, Vermeulen RCH, van der Beek AJ, van Steeg H, van Kerkhof LWM. The relationship between shift work and metabolic risk factors: a systematic review of longitudinal studies. *Am J Prev Med*. 2016; 50(5): e147–57.
18. Torquati L, Mielke GI, Brown WJ, Burton NW, Kolbe-Alexander TL. Shift work and poor mental health: a meta-analysis of longitudinal studies. *Am J Public Health*. 2019; 109(11): e13–20.
19. Dall’Ora C, Ball J, Recio-Saucedo A, Griffiths P. Characteristics of shift work and their impact on employee performance and wellbeing: A literature review. *Int J Nurs Stud*. 2016; 57: 12–27.
20. Ishizuka Y, Yoshino K, Takayanagi A, Sugihara N, Maki Y, Kamijyo H. Comparison of the oral health problems and behavior of male daytime-only and night-shift office workers: An Internet survey. *J Occup Health*. 2016; 58(2): 155–62.
21. Park JS, Jeong Y, Jung J, Ryu J-J, Lim H-K, Jung S-K, Song I-S. Shift work sleep disorder is closely associated with an increased risk for periodontal disease. *J Clin Periodontol*. 2021; 48(8): 1066–75.
22. Jung S-K, Lim H-K, Jeong Y, Lee SJ, Park JS, Song I-S. Influence of shift work on periodontitis according to the occupation group. *Sci Rep*. 2023; 13(1): 17921.
23. Roestamadjji RI, Nastiti NI, Surboyo MDC, Irmawati A. The risk of night shift workers to the glucose blood levels, saliva, and dental caries. *Eur J Dent*. 2019; 13(03): 323–9.
24. Janapareddy K, Parlapalli V, Pydi S, Pottem N, Chatti P, Pallekonda AP. Oral health status and oral health-related quality of life (OHRQoL) among steel factory workers of Visakhapatnam-A cross-sectional study. *J Fam Med Prim Care*. 2020; 9(10): 5309.
25. Aldosari M, Mendes S da R, Aldosari A, Aldosari A, de Abreu MHNG. Factors associated with oral pain and oral health-related productivity loss in the USA, National Health and Nutrition Examination Surveys (NHANES), 2015–2018. Qian J, editor. *PLoS One*. 2021; 16(10): e0258268.
26. Peres MA, Macpherson LMD, Weyant RJ, Daly B, Venturelli R, Mathur MR, Listl S, Celeste RK, Guarnizo-Herreño CC, Kearns C, Benizian H, Allison P, Watt RG. Oral diseases: A global public health challenge. *Lancet*. 2019; 394(10194): 249–60.
27. Blacker A, Dion S, Grossmeier J, Hecht R, Markle E, Meyer L, Monley S, Sherman B, VanderHorst N, Wolfe E. Social determinants of health—an employer priority. *Am J Heal Promot*. 2020; 34(2): 207–15.
28. Hulley SB, Cummings SR, Browner WS, Grady DG, Newman TB. *Designing clinical research*. 4th ed. Philadelphia: Lippincott Williams & Wilkins; 2013. p. 79.
29. Olczak-Kowalczyk D, Turska A, Gozdowski D, Kaczmarek U. Dental caries level and sugar consumption in 12-year-old children from Poland. *Adv Clin Exp Med*. 2016; 25(3): 545–50.
30. Moynihan PJ, Kelly SAM. Effect on caries of restricting sugars intake: systematic review to inform WHO guidelines. *J Dent Res*. 2014; 93(1): 8–18.
31. Hancock S, Zinn C, Schofield G. The consumption of processed sugar- and starch-containing foods, and dental caries: a systematic review. *Eur J Oral Sci*. 2020; 128(6): 467–75.
32. Feldens CA, Pinheiro LL, Cury JA, Mendonça F, Groisman M, Costa RAH, Pereira HC, Vieira AR. Added sugar and oral health: a position paper of the brazilian academy of dentistry. *Front Oral Heal*. 2022; 3: 869112.
33. Mahboubi Z, Pakdaman A, Yazdani R, Azadbakht L, Montazeri A. Dietary free sugar and dental caries in children: A systematic review on longitudinal studies. *Heal Promot Perspect*. 2021; 11(3): 271–80.
34. Moores CJ, Kelly SAM, Moynihan PJ. Systematic review of the effect on caries of sugars intake: ten-year update. *J Dent Res*. 2022; 101(9): 1034–45.
35. Almerich-Silla J, Alminana-Pastor P, Boronat-Catala M, Bellot-Arcis C, Montiel-Company J. Socioeconomic factors and severity of periodontal disease in adults (35–44 years). A cross sectional study. *J Clin Exp Dent*. 2017; 9(8): 0–0.
36. Dubar M, Clerc-Urmès I, Baumann C, Clément C, Alauzet C, Bisson C. Relations of psychosocial factors and cortisol with periodontal and bacterial parameters: a prospective clinical study in 30 patients with periodontitis before and after non-surgical treatment. *Int J Environ Res Public Health*. 2020; 17(20): 7651.
37. Ahmed N, Arshad S, Basheer SN, Karobari MI, Marya A, Marya CM, Taneja P, Messina P, Yean CY, Scardina GA. Smoking a dangerous addiction: a systematic review on an underrated risk factor for oral diseases. *Int J Environ Res Public Health*. 2021; 18(21): 11003.
38. Warreth A, Abuhijleh E, Almaghribi MA, Mahwal G, Ashawish A. Tooth surface loss: A review of literature. *Saudi Dent J*. 2020; 32(2): 53–60.
39. Kanaan M, Brabant A, Eckert GJ, Hara AT, Carvalho JC. Non-biological and biological risk indicators for tooth wear outcomes in adults. *Caries Res*. 2022; 56(4): 407–18.
40. Prakash AR, Reddy AVS, RajiniKanth M, Sreenath G, Hussain SMK, Harsha DPS. Attrition – A criteria in estimating the age. *J Forensic Dent Sci*. 2021; 13(April): 24–9.
41. Thippanna RK, Ramu VC. Prevalence of dental attrition and its severity in relation to age and gender: a clinical study. *CODS J Dent*. 2017; 9(1): 16–21.
42. Chemelo VDS, Né YG de S, Frazão DR, Souza-Rodrigues RD de, Fagundes NCF, Magno MB, Silva CMT da, Maia LC, Lima RR. Is there association between stress and bruxism? A systematic review and meta-analysis. *Front Neurol*. 2020; 11: 590779.
43. Polmann H, Réus JC, Massignan C, Serra-Negra JM, Dick BD, Flores-Mir C, Lavigne GJ, De Luca Canto G. Association between sleep bruxism and stress symptoms in adults: A systematic review and meta-analysis. *J Oral Rehabil*. 2021; 48(5): 621–31.
44. Souza RV, Sarmento RA, de Almeida JC, Canuto R. The effect of shift work on eating habits: a systematic review. *Scand J Work Environ Health*. 2019; 45(1): 7–21.
45. Kharbanda OP, Priya H, Mishra D, Gupta S, Ivaturi A, Ravi P, Bhatia A, Prasad A, Ali A, Haldane D. Oral health status and treatment needs of government employees in New Delhi. *Workplace Health Saf*. 2019; 67(12): 573–8.
46. Ali AST, Varghese SS, Shenoy RP. Association between cervical abrasion, oral hygiene practices and buccolingual dimension of tooth surfaces: a cross-sectional study. *J Pharm Bioallied Sci*. 2022; 14(Suppl 1): S403–9.
47. Okura K, Shigemoto S, Suzuki Y, Noguchi N, Omoto K, Abe S, Matsuka Y. Mandibular movement during sleep bruxism associated with current tooth attrition. *J Prosthodont Res*. 2017; 61(1): 87–95.
48. Vieira AR, Scariot R, Gerber JT, Arid J, Küchler EC, Sebastiani AM, Palinkas M, Díaz-Serrano K V., Torres CP, Regalo SCH, Nelson-Filho P, Bussanelli DG, Deeley K, Modesto A. Bruxism throughout the lifespan and variants in MMP2, MMP9 and COMT. *J Pers Med*. 2020; 10(2): 44.
49. Rees JS, Somi S. A guide to the clinical management of attrition. *Br Dent J*. 2018; 224(5): 319–23.