

# Association between gastric reflux, obesity and erosive tooth wear among psychiatric patients

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## Abstract

The prevalence of erosive tooth wear and obesity are high in psychiatric patients and soft drink consumption is a common risk factor associated with both diseases. This study aimed to assess the association between soft drink consumption, gastric reflux, erosive tooth wear, and obesity among resident patients at the Psychiatric Hospital, Taif, Saudi Arabia.

This descriptive, cross-sectional study included 223 adult psychiatric inpatients (126 male, 97 female) with a mean age of 42.3 years ( $\pm$  2.2). Dental erosion detection was performed according to World Health Organization criteria. The medical evaluation included assessment of the body mass index (BMI). With appropriate sample weighting, relationships between erosive tooth wear, gastric reflux, and obesity were assessed using multivariable logistic regression.

Ninety eight patients (43.9%) presented with erosive tooth wear. The mean BMI for the entire study population was  $27.7 \pm 6.3$  kg/m<sup>2</sup>. Regression analysis showed a strong association between erosive tooth wear and chronic vomiting or bulimia (adjusted odds ratio = 2.11; 95% confidence interval [CI]=1.98–5.07,  $P < .001$ ), gastric reflux (adjusted odds ratio=2.13; 95% CI=1.34–6.23,  $P < .001$ ), consumption of soft drinks (adjusted odds ratio = 2.14; 95% CI = 1.03–6.08,  $P < .001$ ), and schizophrenia and delusional disorders (adjusted odds ratio = 2.07; 95% CI = 1.98–5.08,  $P < .001$ ).

This study demonstrates a significant association between erosive tooth wear prevalence and chronic vomiting or bulimia, consumption of soft drinks, and gastric reflux among resident patients at psychiatric hospital.

**Abbreviations:** BMI = body mass index, CI = confidence interval.

**Keywords:** erosive tooth wear, gastric reflux, obesity, psychiatric patients, soft drinks

## 1. Introduction

Erosive tooth wear or dental erosion is a chemical phenomenon which results in irreversible loss of dental hard tissues due to the effect of intrinsic or extrinsic acids without bacterial involvement.<sup>[1,2]</sup> It is a complex, multifactorial dental disease with prevalence varying from 28% to 86% depending on the population studied, the teeth involved, the age group, scoring

index used to assess the erosive tooth wear, and the presence of associated risk factors.<sup>[1,2–7]</sup> Consumption of acidic beverages and foods, as well as, gastric oesophageal reflux are considered the main risk factors for the development of erosive tooth wear.<sup>[1,2–7]</sup> Psychiatric illness is a condition associated with impaired levels of behavior, function, and perception.<sup>[8]</sup> Studies have shown that patients with psychiatric illness are prone to

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Ethical approval was obtained from the Ministry of Health, Directorate of Health Affairs, Research and Studies Department, Taif. All methods were carried out in accordance with relevant guidelines and regulations along with the approval from Ministry of Health, Directorate of Health Affairs, Research and Studies Department, Taif, with Ethical clearance number HAP-02-T-067.

Written informed consent was obtained from the guardians of selected participants prior to the start of the study.

The authors have no conflicts of interests to disclose.

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

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develop metabolic disorders like obesity because of unhealthy lifestyles, psychotropic medications, cigarette smoking, and healthcare inequalities.<sup>[9-11]</sup> More ever, self-negligence, medications for psychiatric illness, lack or limited access to oral health care, and fear of dental treatment influence the prevalence of oral diseases among patients with psychiatric illness.<sup>[12-15]</sup> The literature provides substantively conclusive evidence for association of dental caries and periodontal diseases among psychiatric patients<sup>[12-15]</sup> but, the erosive tooth wear among psychiatric patients has been largely overlooked. Among the limited available past research, high levels of acid reflex among psychiatric patients is attributed to increased prevalence of erosive tooth wear.<sup>[4-17]</sup> The diet is an common risk factor associated with erosive tooth wear and obesity. In spite of being multifactorial in nature, soft drink consumption is reported to be strongly associated with erosive tooth wear<sup>[18,19]</sup> and also obesity.<sup>[20,21]</sup> Considering that the prevalence of erosive tooth wear<sup>[4-17]</sup> and obesity<sup>[9-11]</sup> are high in psychiatric patients and that soft drink consumption is a common risk factor associated with both diseases,<sup>[18-21]</sup> this study aimed to assess the association between erosive tooth wear prevalence and obesity among psychiatric inpatients at mental health hospitals.

**2. Material and methods**

**2.1. Study design, study population, and sample size**

This descriptive cross-sectional study included 223 adult psychiatric inpatients at a Mental Health Hospital, in Taif City, Saudi Arabia. Based on pilot study result (population proportion

of 0.65, alfa error of 5% and power of 80%), sample of 220 was decided keeping 10% of nonresponse bias. Ethical approval was obtained from the Ministry of Health, Directorate of Health Affairs, Research and Studies Department, Taif (ethical clearance number HAP-02-T-067). Written informed consent was obtained from the guardians of selected participants prior to the start of the study.

**2.2. Questionnaire**

All guardians of the selected participants received a pretested semi-structured questionnaire (Cronbach alpha  $\alpha=0.84$ ). The following information was collected: (a). Socio-demographic details (Age, Gender), (b). Oral hygiene practices (Method of tooth cleaning using tooth brush or miswak, frequency of teeth cleaning, material used for teeth cleaning), (c). Medication details (Type/group of medication, duration, number of times medicines taken), (d). Gastric reflux (yes/no, duration), (e). History of chronic vomiting (yes/no, duration), (f). Bulimia/Anorexia nervosa (Yes/no, duration), (g). Vitamin C consumption (yes/no), (h). Tobacco smoking details (yes/no, duration, frequency) and dietary habits (Fig. 1). Details of gastric reflux, Bulimia/Anorexia nervosa, medication details were taken from guardians and its presence was confirmed with hospital records.

**2.3. Measurement of BMI**

Body mass index (BMI; weight/height in kg/m<sup>2</sup>) was calculated. Single examiner weighed the participants using a platform scale in the presence of hospital authority. Participants were classified

1. Socio-demographic details: a. Age    b. Sex				
2. Psychological illness a. Type of Psychological illness b. Duration of illness e. Medication details: (yes/no, type/group of medication, duration of medication, number of times medication taken/day,				
3. Smoking: Yes/No, Duration, Frequency				
4. Dietary habits:	Never	≤ once a week	2-6 Days a week	≥ once a day
A. Consumption of sparkling water, colas, iced tea, lemonade, squash, fruit punch, diet soft drinks				
B. Consumption of citrus fruit or citrus fruit drink				
5. Oral Hygiene Practices a. Method of Teeth cleaning (Tooth brush/miswak/both)    b. Frequency of cleaning    c. Use of Fluoridated Tooth Paste				
6. Consumption of Vitamin C a. Yes/No    b. If yes, Time and frequency				
7. Gastric reflux or regurgitation details: (Yes/No, Frequency, Time of reflux, Since how many years)				
8. Presence of chronic vomiting: (Yes/No, Frequency, Duration)				
9. Bulimia/Anorexia (Yes/No, Frequency, Duration)				

**Figure 1.** Questionnaire.

**Table 1**  
**Body mass index categories according to the variables studied.**

Variable	Underweight		Normal weight		Overweight		Obese	
	n (%)	P value	n (%)	P value	n (%)	P value	n (%)	P value
Age in yr								
19–30 (n=136)	5 (3.7)	.2*	83 (61.03)	.08*	29 (21.3)	.21*	19 (13.9)	.03*
31–63 (n=87)	3 (3.4)		40 (45.9)		18 (20.7)		26 (29.9)	
Gender								
Male (n=126)	2 (1.6)	.21*	71 (56.3)	.17*	28 (22.2)	.32*	25 (19.8)	.23*
Female (n=97)	6 (6.2)		52 (53.6)		19 (19.6)		20 (20.6)	
Consume soft drinks								
Yes (n=97)	2 (2.06)	.06*	40 (41.2)	.06*	27 (27.8)	.03*	28 (28.9)	.03*
No (n=126)	6 (4.76)		83 (65.9)		20 (15.9)		17 (13.5)	
Type of psychiatric illness								
MR (n=49)	2 (4.08)	.09**	24 (48.9)	.07**	12 (24.6)	.08**	11 (22.6)	.06**
SD (n=61)	2 (3.3)		40 (65.6)		12 (19.6)		7 (11.5)	
MD (n=43)	1 (2.3)		23 (53.5)		9 (20.9)		10 (23.3)	
AD (n=37)	1 (2.7)		17 (45.9)		9 (24.3)		10 (27.03)	
OT (n=33)	2 (6.06)		19 (57.6)		5 (15.2)		7 (21.2)	

AD = anxiety disorders, MD = mood disorders, MR = mental retardation, OT = others (patients with multiple psychiatric problems, syndromes), SD = schizophrenia and delusional disorders.

\* Chi-Squared test P value.

\*\* Kruskal–Wallis H test

into 4 categories: obese –  $>30\text{ kg/m}^2$ , overweight – 25 to  $30\text{ kg/m}^2$ , normal weight –  $18.5$  to  $25\text{ kg/m}^2$ , and underweight –  $<18.5\text{ kg/m}^2$ .<sup>[22]</sup>

#### 2.4. Dental examination

Dental examinations of the study participants were performed by a single practitioner under natural light using community periodontal index probes and plane mouth mirrors. The instruments were sterilized by autoclaving. No radiography was performed and no transillumination was used. Dental erosion was diagnosed according to World Health Organization guidelines.<sup>[23]</sup> All teeth were examined for the presence of dental erosion. The highest score of erosion was recorded for each tooth: 0 – no signs of erosion, 1 – enamel lesion, 2 – dentinal lesions, and 3 – pulp involvement. All tooth surfaces were examined for the presence of dental erosion. The severity of dental erosion was recorded according to the surface with the highest erosion score. The number of teeth involved was also recorded. Teeth with gross decay, crown placement, extensive restoration, and developmental defects were excluded from examination. The examiner was calibrated to achieve significant intra-examiner correlation concerning the diagnostic criteria of erosion (kappa value of 0.95,  $P < .05$ ).

#### 2.5. Statistical analysis

Frequency distribution tables were obtained for all independent and outcome variables. The difference in proportion was tested using chi-square and Kruskal–Wallis H analysis of variance tests followed by intergroup comparison using Mann–Whitney *U* test. The differences in mean were tested using independent sample *t*-test and one-way analysis of variance followed by intergroup comparison using Tukey's post hoc test. Multivariable logistic regression was used to determine the relationships between erosive tooth wear (yes/no), obesity, dietary factors, gastric reflux, chronic vomiting or bulimia, and disability type. The analysis was performed using the Statistical Package for Social Science version 24 (IBM SPSS Statistics, IBM Corp., Armonk,

NY). All statistical tests were two-sided, and the significance level was set at  $P < .05$ .

### 3. Results

Two hundred twenty three (126 male, 97 female) psychiatric inpatients with a mean age of  $42.3 \pm 2.2$  (range 19-years to 63-years old) years were included. The mean duration of hospital stay was  $7.2 \pm 4.7$ -years. Twenty seven percent of patients were presented with schizophrenia, 21.9% with mental retardation, 19.7% with bipolar mood disorder, and 14.8% with multiple psychiatric problems. The mean BMI was  $27.7 \pm 6.3\text{ kg/m}^2$ . Approximately 55.2% of inpatients were normal weight, 21.1% were overweight, and 20.2% were obese. Of the 223 psychiatric inpatients, 98 (43.9%) presented with erosive tooth wear. Sixty one percent of participants were on antidepressants (mirtazapine, amitriptyline, agomelatine). Twenty three percent were on antipsychotics (aripiprazole, trifluoperazine, haloperidol, benztropine, invega) and anticonvulsant drugs (carbamazepine, valproic acid). Fifteen percent were on mood stabilizers (sodium valproate) and anxiolytics (clonazepam, diazepam). Twenty seven inpatients (12.1%) had smoking habits.

Table 1 shows the BMI categories according to the variables studied. A significant difference was seen between the consumption of soft drinks and the prevalence of overweight and obesity (Chi-Squared test,  $P = .03$ ). A higher prevalence (29.9%) of participants who were obese were 31 to 63 years of age (Chi-Squared test,  $P = .03$ ).

Table 2 presents erosive tooth wear prevalence according to the variables studied. Patients who consumed soft drinks more than once per day (47.05%), and 2 to 6 days per week (53.7%), presented with higher prevalence of erosive tooth wear compared to patients who never consumed soft drinks (40.5%;  $P = .04$ ). Patients with chronic vomiting or bulimia (70.6%) and gastric reflux (61.8%) presented with a higher frequency of erosive tooth wear compared to patients without these conditions ( $P = .0001$ ).

Six hundred forty seven teeth were affected by erosion. Upper anterior teeth were most frequently affected (Table 3).

**Table 2****Erosive tooth wear prevalence according to variables studied.**

Variables	Present (n)	%	P value
Age in yr			
19–30 (n=136)	57	41.9	.06*
31–63 (n=87)	41	47.1	
Gender			
Male (n=126)	55	43.7	.12*
Female (n=97)	43	44.3	
BMI			
Underweight (n=8)	2	25	.06***
Normal weight (n=123)	53	43.09	
Overweight (n=47)	21	44.7	
Obese (n=45)	22	48.9	
Consumption of soft drinks			
a. ≤ once per wk (n=39)	17	43.6	.04** (Mann–Whitney <i>U</i> test b > d, c > d)
b. 2–6 days per week (n=41)	22	53.7	
c. ≥ once per day (n=17)	8	47.05	
d. Never (n=126)	51	40.5	
Type of psychiatric illness			
MR (n=49)	19	38.8	.04** (Mann–Whitney <i>U</i> SD > MR, AD)
SD (n=61)	32	52.4	
MD (n=43)	18	41.9	
AD (n=37)	15	40.5	
OT (n=33)	14	42.4	
Citrus fruit consumption			
Yes (n=126)	58	46.03	.09*
No (n=97)	40	41.2	
Chronic vomiting or bulimia			
Yes (n=17)	12	70.6	.001*
No (n=206)	86	41.7	
Consumption of vitamin C			
Yes (n=52)	25	48.07	.08*
No (n=171)	73	42.7	
Gastric reflux			
Yes (n=68)	42	61.8	.001*
No (n=155)	56	36.1	
Smoking			
Yes (n=27)	7	25.9	.07*
No (n=196)	91	46.4	

AD = anxiety disorders, BMI = body mass index, MD = mood disorders, MR = mental retardation, OT = others (patients with multiple disabilities, syndromes), SD = Schizophrenia and delusional disorders.

\* Chi-Squared test *P* value

\*\* Kruskal–Wallis *H* test

Regression analysis showed a strong association between erosive tooth wear and chronic vomiting or bulimia (adjusted odds ratio=2.11; 95% confidence interval [CI]=1.98–5.07,  $P < .001$ ), gastric reflux (adjusted odds ratio=2.13; 95% CI=1.34–6.23,  $P < .001$ ), consumption of soft drinks (adjusted odds ratio = 2.14; 95% CI=1.03–6.08,  $P < .001$ ), and schizophrenia and delusional disorders (adjusted odds ratio = 2.07; 95% CI=1.98–5.08,  $P < .001$ ) (Table 4).

#### 4. Discussion

Erosive tooth wear and obesity are multifactorial diseases with diet as a common primary influencing factor.<sup>[18–21]</sup> This is the first study to assess the association between erosive tooth wear and obesity among psychiatric inpatients. A total of 223 adult psychiatric inpatients were examined for the relationship between erosive tooth wear and obesity, controlling for covariates like socio-demographic, dietary, psychiatric illness,

**Table 3****Dental erosion severity according to teeth affected.**

Teeth affected	Dental erosion categories			Total
	1	2	3	
Upper anterior, permanent (11, 21, 12, 22, 13, 23) (n=1095)	79	162	69	310
Lower anterior, permanent (31, 32, 41, 42, 33, 43) (n=997)	42	76	39	157
Upper posterior, permanent (14, 15, 16, 17, 24, 25, 26, 27) (n=907)	32	47	23	102
Lower posterior, permanent (34, 35, 36, 37, 44, 45, 46, 47) (n=1054)	32	29	17	78

1 – enamel lesion, 2 – dentinal lesions, 3 – pulp involvement.

**Table 4****Association between age, gender, type of disability, BMI, soft drink consumption, chronic vomiting, and gastric reflux and the dependent variable (erosion).**

Variable	Erosive tooth wear (n) yes/no	Erosive tooth wear (% yes)	Un-adjusted ORs (CI)	Adjusted ORs (CI) <sup>†</sup>	P value
Age in yr					
19–30 (n = 136)*	57/79	41.9/58.1			.081
31–63 (n = 87)	41/46	47.1/52.9	0.91 (0.01–1.78)	0.93 (0.02–1.86)	
Gender					
Male (n = 126)*	55/71	43.7/56.3			.091
Female (n = 97)	43/54	44.3/55.7	0.74 (0.01–1.16)	0.77 (0.04–1.22)	
Type of psychiatric illness					
MR (n = 49)*	19/30	38.8/61.2			
SD (n = 61)	32/29	52.4/47.6	2.03 (1.91–5.04)	2.07 (1.98–5.08)	.001
MD (n = 43)	18/25	41.9/58.1	0.43 (0.01–0.7)	0.49 (0.01–0.8)	.073
AD (n = 37)	15/22	40.5/59.5	0.75 (0.01–1.09)	0.83 (0.01–1.12)	.074
OT (n = 33)	14/19	42.4/57.6	0.53 (0.01–1.01)	0.57 (0.01–1.03)	.081
BMI					
Underweight and normal weight (n = 131)*	55/76	41.9/58.1			.063
Overweight and obese (n = 92)	43/49	46.7/53.3	0.92 (0.08–1.63)	0.95 (0.09–1.67)	
Consumption of soft drinks					
≤ once per week and never (n = 165)*	68/97	41.2/58.8			.001
2–6 times per week and ≥ once/day (n = 58)	30/28	51.7/48.3	2.12 (1.02–6.05)	2.14 (1.03–6.08)	
Chronic vomiting and bulimia					
Yes (n = 17)	12/5	70.6/29.4	2.09 (1.97–5.04)	2.11 (1.98–5.07)	.001
No (n = 206)*	86/120	41.7/58.3			
Gastric reflux					
Yes (n = 68)	42/26	61.8/38.2	2.08 (1.32–6.12)	2.13 (1.34–6.23)	.001
No (n = 155)*	56/99	36.1/63.9			

AD = anxiety disorders, BMI = body mass index, CI = confidence interval, MD = mood disorders, MR = mental retardation, ORs = odds ratios, OT = others (patients with multiple disabilities, syndromes), SD = schizophrenia and delusional disorders.

\* Reference.

<sup>†</sup> Adjusted for age, gender, psychiatric illness

and behavioral factors. Of the 223 inpatients, 98 (43.9%) presented with erosive tooth wear. Previous point prevalence studies conducted among general population in Saudi Arabia showed a prevalence 8% to 26% among children and adolescents and 28% among adults using the similar indices to record the dental erosion.<sup>[24–27]</sup> Previous systematic review by Salas et al<sup>[6]</sup> showed a prevalence of 30.4% (95% CI: 23.8–37.0) among 8–19-year-old. The wide variation in prevalence may be attributed to variation in sample size, geographical factors, teeth involved, method of assessment, age group, and risk factors associated with the erosion.<sup>[1,5–7]</sup>

#### 4.1. Soft drink consumption and prevalence of erosive tooth wear

Soft drinks usually refer to carbonated, non-alcoholic, flavored beverages that are mostly sweetened conventionally or in some beverages with low/non-caloric sugar substitutes.<sup>[21]</sup> The high sugar content and low pH of the soft drinks contributes to obesity<sup>[20,21]</sup> and erosive tooth wear<sup>[18,19]</sup> respectively upon frequent consumption. In the current study, consumption of soft drinks 2 to 6 days per week was reported by 18.4% and more than once daily by 7.6% of inpatients. The inpatients with increased soft drink consumption showed 2.14 times greater odds of erosive tooth wear (95% CI = 1.03–6.08,  $P < .001$ ). The pH and buffering capacity of soft drink determines its erosive potential which in turn contributes to erosive tooth wear.<sup>[18,19]</sup> Previous studies<sup>[28–30]</sup> showed consumption of Vitamin C associated with dental erosion due to drop in salivary pH below

2. However, present study did not show any association between consumption of Vitamin C and dental erosion prevalence. This might be due to small sample size in the present study, so statistical power might not have been sufficient to detect the differences.

#### 4.2. Chronic vomiting/bulimia, gastric reflux, and dental erosion

In the present study, 68 inpatients (30.5%) presented with gastric reflux (47 [69.1%] with regurgitation) confirmed through medical records. Regression analysis showed that these patients were 2.13 times more likely to have erosive tooth wear than those without gastric reflux. This result is in line with previous studies which showed a high prevalence of dental erosion among individuals with gastric reflux.<sup>[6,31]</sup> The regression analysis also showed a strong association (adjusted odds ratio = 2.11; 95% CI = 1.98–5.07,  $P < .001$ ) between chronic vomiting/bulimia and erosive tooth wear prevalence. This may be due to exposure of the teeth to vomitus, leading to erosion.<sup>[3,4]</sup>

#### 4.3. Obesity and dental erosion

In the present study, both bivariate and regression analyses showed no significant difference in erosive tooth wear prevalence among obese and non-obese inpatients. This is in line with the study conducted by Salas et al<sup>[32]</sup> among the Brazilian population, in which obesity was not associated with dental erosion.

#### 4.4. Erosion prevalence and type of psychiatric illness

In the present study, subjects with schizophrenia and delusional disorders were 2.07 times more likely to have erosive tooth wear compared to those with other psychiatric illnesses. This may be due to the high prevalence of gastric reflux among these patients, which might have indirectly contributed to high erosive tooth wear prevalence.<sup>[33,34]</sup> Increased gastric reflux among schizophrenia may be attributed to antipsychotic drugs that affect the esophageal motility, increased coughing and dysphagia.<sup>[33,35,36]</sup> Along with these, previous studies showed increased gastric reflux among schizophrenia patients with smoking and alcohol consumption.<sup>[33,37]</sup> However, in the present study 27 (12.1%) psychiatric inmates had smoking habits and it was not associated with erosive tooth wear. None of the psychiatric inmates reported consumption of alcohol; hence no association could be drawn with the prevalence of erosive tooth wear.

#### 4.5. Study limitations

Since this was a cross-sectional study, it was difficult to establish causal relationships and the observed associations could be due to other unexplored factors. A recall bias regarding dietary information cannot be ruled out. The influence of psychiatric medications on quantity and quality of saliva secretion, which might have influenced prevalence of dental erosion, was not considered under present study scope due to lack of consent. The future research considering the influence of quality and quantity of saliva on prevalence of erosive tooth wear would strengthen the study finding.

### 5. Conclusion

To conclude, the present study showed a 44% prevalence of erosive tooth wear among psychiatric inpatients. Regression analysis showed a strong association between erosive tooth wear and consumption of soft drinks, bulimia and chronic vomiting, gastric reflux, and schizophrenia and delusional disorders. No association was observed between obesity and erosive tooth wear prevalence. Future research is needed on this topic, particularly longitudinal studies to confirm the findings of this study. This research should incorporate validated dietary assessments with estimation of pH, calcium, and fluoride concentration of carbonated beverages, knowledge on saliva secretion/saliva quality specifically in relation to medication, as well as assessment of oral hygiene compliance and other factors that may act as confounders or effect modifiers. Study of erosive tooth wear at an individual level must account for these variables.

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### References

- [1] Skalsky Jarkander M, Grindefjord M, Carlstedt K. Dental erosion, prevalence and risk factors among a group of adolescents in Stockholm County. *Eur Arch Paediatr Dent* 2018;19:23–31.
- [2] Lussi A, Carvalho TS. Erosive tooth wear: a multifactorial condition of growing concern and increasing knowledge. *Monogr Oral Sci* 2014;25:1–15.
- [3] Otsu M, Hamura A, Ishikawa Y, Karibe H, Ichijyo T, Yoshinaga Y. Factors affecting the dental erosion severity of patients with eating disorders. *Biopsychosoc Med* 2014;8:25.
- [4] Hermont AP, Oliveira PA, Martins CC, Paiva SM, Pordeus IA, Auad SM. Tooth erosion and eating disorders: a systematic review and meta-analysis. *PLoS One* 2014;9:e111123.
- [5] Jaeggi T, Lussi A. Prevalence, incidence and distribution of erosion. *Monogr Oral Sci* 2014;25:55–73.
- [6] Salas MM, Nascimento GG, Huysmans MC, Demarco FF. Estimated prevalence of erosive tooth wear in permanent teeth of children and adolescents: an epidemiological systematic review and meta-regression analysis. *J Dent* 2015;43:42–50.
- [7] Picos A, Lasserre JF, Chisnoiu AM, et al. Factors associated with dental erosions in gastroesophageal reflux disease: a cross-sectional study in patients with heartburn. *Med Pharm Rep* 2020;93:23–9.
- [8] World Health Organization. The ICD-10 classification of mental and behavioral disorders: diagnostic criteria for research. 10th ed., Geneva; 1993:5–27.
- [9] Annamalai A, Kosir U, Tek C. Prevalence of obesity and diabetes in patients with schizophrenia. *World J Diabetes* 2017;8:390–6.
- [10] Chwastiak LA, Rosenheck FA, Kazis LE. Association of psychiatric illness and obesity, physical inactivity and smoking among a national sample of veterans. *Psychosomatics* 2011;52:230–6.
- [11] Daré LO, Bruand PE, Gérard D, et al. Co-morbidities of mental disorders and chronic physical diseases in developing and emerging countries: a meta-analysis. *BMC Public Health* 2019;19:304.
- [12] Ashour AA, Basha S, Enan ET, Basalem A, Al Qahatani A. Association between obesity/overweight and dental caries in psychiatric patients. *Ann Saudi Med* 2019;39:178–84.

- [13] Kisely S, Baghaie H, Lalloo R, Siskind D, Johnson NW. A systematic review and meta-analysis of the association between poor oral health and severe mental illness. *Psychosom Med* 2015;77:83–92.
- [14] Kisely S, Sawyer E, Siskind D, Lalloo R. The oral health of people with anxiety and depressive disorders - a systematic review and meta-analysis. *J Affect Disord* 2016;200:119–32.
- [15] Corridore D, Guerra F, La Marra C, Di Thiene D, Ottolenghi L. Oral health status and oral health-related quality of life in Italian deinstitutionalized psychiatric patients. *Clin Ter* 2017;168:e77–83.
- [16] Uhlen MM, Tveit AB, Stenhagen KR, Mulic A. Self-induced vomiting and dental erosion - a clinical study. *BMC Oral Health* 2014;14:92.
- [17] Piccoli L, Besharat LK, Cassetta M, Migliau G, Di Carlo S, Pompa G. Tooth wear among patients suffering from mental disorders. *Ann Stomatol (Roma)* 2014;5:52–60.
- [18] Jensdottir T, Arnadottir IB, Thorsdottir I, et al. Relationship between dental erosion, soft drink consumption, and gastroesophageal reflux among Icelanders. *Clin Oral Investig* 2004;8:91–6.
- [19] Basha S, Enan ET, Noor Mohamed R, Ashour AA, Salem Alzharani F, Al-Mutairi NE. Association between soft drink consumption, gastric reflux, dental erosion, and obesity among special care children. *Spec Care Dentist* 2020;40:97–105.
- [20] Harrington S. The role of sugar-sweetened beverage consumption in adolescent obesity: a review of the literature. *J Sch Nurs* 2008;24:3–12.
- [21] Basu S, McKee M, Galea G, Struckler D. Relationship of soft drink consumption to global overweight, obesity, and diabetes: a cross-national analysis of 75 countries. *Am J Public Health* 2013;103:2071–7.
- [22] World Health Organization. Obesity and overweight fact sheet number 311. 2015. Available from <http://www.who.int/mediacentre/factsheets/fs311/en/>. Accessed December 30, 2017
- [23] World Health Organization. Oral health surveys: basic methods. 5th ed., Geneva, Switzerland; 2013.
- [24] Al-Majed I, Maguire A, Murray JJ. Risk factors for dental erosion in 5–6 year old and 12–14 year old boys in Saudi Arabia. *Community Dent Oral Epidemiol* 2002;30:38–46.
- [25] Jastaniyah N, Al-Majed I, Alqahtani A. The relationship between overweight/obesity and dental erosion among a group of Saudi children and adolescents. *Indian J Dent Res* 2019;30:200–6.
- [26] Syed Mohammed Y, Rafi Ahmed T, Zakirulla M, et al. Dental erosion among 12-15-year-old school boys in southern Saudi Arabia. *Arch Orofacial Sci* 2013;8:14–9.
- [27] Johansson AK, Johansson A, Birkhed D, Omar R, Baghdadi S, Carlsson GE. Dental erosion, soft-drink intake, and oral health in young Saudi men, and the development of a system for assessing erosive anterior tooth wear. *Acta Odontol Scand* 1996;54:369–78.
- [28] Wegehaupt FJ, Lunghi N, Hogger VM, Attin T. Erosive potential of vitamin and vitamin+ mineral effervescent tablets. *Swiss Dental J* 2016;126:457–65.
- [29] Giunta JL. Dental erosion resulting from chewable vitamin C tablets. *J Am Dent Assoc* 1983;107:253–6.
- [30] Hellwig E, Lussi A. Oral hygiene products, medications and drugs - hidden aetiological factors for dental erosion. *Monogr Oral Sci* 2014;25:155–62.
- [31] Lechien JR, Chiesa-Estomba CM, Henriquez CC, et al. Laryngopharyngeal reflux, gastroesophageal reflux and dental disorders: a systematic review. *PLoS One* 2020;15:e0237581.
- [32] Salas MM, Vargas-Ferreira F, Nascimento G, Huysmanns MC, Demarco FF. Tooth erosion association with obesity: findings from a Brazilian survey in schoolchildren. *Pesquisa Brasileira em Odontopediatria e Clínica Integrada* 2018;18:1–13.
- [33] Kasap E, Ayer A, Bozoglan G, Ozen C, Eslek I, Yüceyar H. Schizophrenia and gastroesophageal reflux symptoms. *Indian J Psychiatry* 2015;57:73–7.
- [34] Avidan B, Sonnenberg A, Giblovich H, Sontag SJ. Reflux symptoms are associated with psychiatric disease. *Aliment Pharmacol Ther* 2001;15:1907–12.
- [35] Joseph J, Cadenhead K. M57. Gastrointestinal disease impact on antipsychotic induced weight gain in Schizophrenia: analysis of randomized controlled trials. *Schizophrenia Bulletin* 2017;43:S231.
- [36] Javelot H, Michel B, Kumar D, Audibert B. Clozapine-induced esophagitis at therapeutic dose: a case report. *Braz J Psychiatry* 2016;38:176–7.
- [37] Fujiwara Y, Kubo M, Kohata Y, et al. Cigarette smoking and its association with overlapping gastroesophageal reflux disease, functional dyspepsia, or irritable bowel syndrome. *Intern Med* 2011;50:2443–7.