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 (± 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 ± 6.3 kg/m\textsuperscript{2}. Regression analysis showed a strong association between erosive tooth wear and chronic vomiting or bulimia (adjusted odds ratio = 2.11; 95% confidence interval [CI] = 1.96–5.07, \(P<.001\)), 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.\cite{1,2} 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.\cite{1,2,7} 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.\cite{1,2,7} Psychiatric illness is a condition associated with impaired levels of behavior, function, and perception.\cite{8} 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. 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. The literature provides substantively conclusive evidence for association of dental caries and periodontal diseases among psychiatric patients 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. The diet is a 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 and also obesity. Considering that the prevalence of erosive tooth wear and obesity are high in psychiatric patients and that soft drink consumption is a common risk factor associated with both diseases, 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, alpha 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 α = 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/m²) 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 |
|---|
| No. Days a week |

| 4. Dietary habits: |
|---|
| 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.
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. 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 ± 2.2 (range 19-years to 63-years old) years were included. The mean duration of hospital stay was 7.2 ± 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 ± 6.3 kg/m². 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 (olanzapine, haloperidol, benzotropine, invega) and anticonvulsant drugs (carbamazepine, valproic acid). Fifteen percent were on mood stabilizers (lithium, 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).
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.\textsuperscript{[18–21]} 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 2

| 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 U 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 U 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 |         |

\textsuperscript{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

4. Discussion
Erosive tooth wear and obesity are multifactorial diseases with diet as a common primary influencing factor.\textsuperscript{[18–21]} 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

| Teeth affected | Dental erosion categories |
|---------------|---------------------------|
|               | 1  | 2  | 3  | Total |
| 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, 44, 45, 46, 47) (n=1054) | 32 | 29  | 17 | 78 |

\textsuperscript{1} = enamel lesion, 2 = dentinal lesions, 3 = pulp involvement.
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.[24–27] Previous systematic review by Salas et al.[6] 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.[1,5–7]

### 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.[21] The high sugar content and low pH of the soft drinks contributes to obesity,[20,21] and erosive tooth wear,[18,19] 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.[18,19] Previous studies[28–30] 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.[6,31] 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.[1,4]

### 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.[32] among the Brazilian population, in which obesity was not associated with dental erosion.

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**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)† | \( P \) value |
|---------------------------------------|-------------------------------|-----------------------------|----------------------|-------------------|--------------|
| Age in yr                             |                               |                             |                      |                   |              |
| 19–30 (n = 136)†                      | 57/79                         | 41.9/58.1                   | 0.91 (0.01–1.78)     | 0.93 (0.02–1.86)  | .081         |
| 31–63 (n = 87)                        | 41/46                         | 47.1/52.9                   |                      |                   |              |
| Gender                                |                               |                             |                      |                   |              |
| Male (n = 126)†                       | 55/71                         | 43.7/56.3                   | 0.74 (0.01–1.16)     | 0.77 (0.04–1.22)  | .091         |
| Female (n = 97)                       | 43/54                         | 44.3/55.7                   |                      |                   |              |
| 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                   | 0.92 (0.08–1.63)     | 0.95 (0.09–1.67)  | .063         |
| Overweight and obese (n = 92)         | 43/49                         | 46.7/53.3                   |                      |                   |              |
| 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)  | .001         |
| 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.

* Adjusted for age, gender, psychiatric illness

† Adjusted for age, gender, type of disability, BMI, soft drink consumption, chronic vomiting, and gastric reflux.
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.[33,34] Increased gastric reflux among schizophrenia may be attributed to antipsychotic drugs that affect the esophageal motility, increased coughing and dysphagia.[33,33,36]

Along with these, previous studies showed increased gastric reflux among schizophrenia patients with smoking and alcohol consumption.[33,37] 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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Author contributions

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