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Original Article

Evaluation of oral health among people with multimorbidity in the marginalized population of Karachi, Pakistan: A multicenter cross-sectional study

Hina Sharif, Pharm-D, MSPH [a,b,*], Muhammad Hammash, BDS, MSPH [b,c], Wajiha Anwer, BDS, MSPH [b,c], Nayma Hassan, BDS, RDS [d], Tooba Seemi, MSc. [a] and Sana S. Sheikh, MSc. MPH [a,e]

[a] *Research & Publication Department, SINA Health Education & Welfare Trust, Karachi, Pakistan*
[b] *Community Health Sciences Department, the Aga Khan University, Karachi, Pakistan*
[c] *Dow University of Health Sciences, Karachi, Pakistan*
[d] *Karachi Medical and Dental College, Karachi, Pakistan*
[e] *School of Public Health, University of Saskatchewan, Saskatoon, Canada*

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الملخص

أهداف البحث: ترتبط صحة الفم بالصحة الجسدية والعقلية. تعد أمراض الفم شائعة بين الفقراء والمحرومين اجتماعيا واقتصاديا في البلدان النامية والصناعية. تهدف هذه الدراسة إلى تقييم عبء أمراض صحة الفم بين الأشخاص من السكان المهمشين المصابين بأمراض مزمنة متعددة.

طريقة البحث: أجريت هذه الدراسة المقطعية في 16 موقعا في الأحياء الفقيرة في كراتشي، باكستان، لتقييم مشاكل أمراض صحة الفم بين الأشخاص الذين تتراوح أعمارهم بين 18 و70 عاما والذين يعانون من أمراض مصاحبة أو متعددة. غطى الاستبيان الحالة الاجتماعية العرقية والديموغرافية والمرضية للأشخاص الذين يعانون من حالة صحة الفم.

النتائج: تم أخذ 870 شخصا في الاعتبار لإجراء فحص صحة الفم، حيث قاموا بزيارة 16 موقعا محددا للأحياء الفقيرة في كراتشي، باكستان. كان التهاب اللثة منتشرا بشكل كبير، حيث بلغت نسبة 29% بين سكان الأحياء الفقيرة المصابين بأمراض متعددة مثل مرض السكري والتهاب الكبد وارتفاع ضغط الدم. يستخدم الداندا على نطاق واسع كمنظف للأسنان بنسبة 35%. في المقابل، أظهر 45.4% من الأشخاص ظروف نظافة الفم غير مرضية. أظهرت عرقية باثان أعلى معدل انتشار، أي 29.8% من مشاكل الأسنان المصحوبة بأمراض متعددة في 26.8% من سكان مدينة بالديا في كراتشي. من بين 870، ظهرت مشاكل الأسنان الأكثر ملاحظة بين الفئة العمرية بين 18 إلى 38 عاما (متوسط العمر ±42.9-28%) بين المشاركات الإناث 468 (53.8%).

الاستنتاجات: هناك حاجة ملحة لتعزيز برامج الصحة العامة على مستوى العالم، مع التركيز بشكل خاص على تنفيذ استراتيجيات فعالة للوقاية من أمراض الفم، وتعزيز صحة الفم، ومعالجة الأمراض المزمنة الأخرى ضمن إعدادات الرعاية الصحية الأساسية. يشكل تعزيز صحة الفم صعوبات كبيرة، خاصة في الدول الأقل نموا.

الكلمات المفتاحية: وبائيات أمراض الفم؛ فقدان الأسنان؛ الأمراض المتعددة؛ التهاب اللثة؛ نظافة الفم

Abstract

Background: Oral health is linked to physical and mental well-being. Oral disease is common among poor and socioeconomically disadvantaged people in developing and industrialized countries.

Objectives: This study assessed the oral health disease burden among people with multimorbidity in marginalized populations.

Methods: This cross-sectional study was conducted across 16 locations in the slums of Karachi, Pakistan, to assess oral health disease problems among adults aged 18 to 70 with comorbidity or multimorbidity. The questionnaire covered the socioethnic, demographic, and disease status of people with oral health status. Data analyses were performed using SAS version 9.4.

* Corresponding address: Research & Publication Department, SINA Health Education & Welfare Trust, Karachi, Pakistan.
E-mail: Hina.shf19@gmail.com (H. Sharif)

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Results: Of the 16 designated slum locations, 870 individuals were considered for oral health screening. Gingivitis was highly prevalent, 29% among slum dwellers with multimorbidity of diabetes, hepatitis, and hypertension. Dandasa was widely used as a tooth-cleansing agent in 35% of the study population. By contrast, 45.4% of people showed unsatisfactory oral hygiene conditions. Pathan ethnicity showed the highest prevalence (i.e., 29.8% of dental problems with disease multimorbidity in 26.8% of Baldia Town residents of Karachi). Of the 870 individuals, the highest frequency of dental problems was found in the age group of 18–38 years (28–42.9%) and among female participants (53.8%).

Conclusion: There is an urgent need for the global enhancement of public health programs, specifically focusing on implementing effective strategies to prevent oral illnesses, promote oral health, and address other chronic diseases in basic healthcare settings. Enhancing oral health poses significant difficulties, especially in less developed nations.

Keywords: Gingivitis; Multimorbidity; Oral disease epidemiology; Oral hygiene; Tooth loss

Introduction

The relationship between oral health and overall health is well acknowledged, with oral health considered a fundamental aspect of quality of life. For a long time, oral health assessment relied only on clinical evaluations, limiting the ability to fully understand the profound effects of dental diseases on patients' everyday functioning and their potential associations with other chronic illnesses.[1]

Caries and periodontal diseases continue to affect a significant portion of the global population, particularly impoverished individuals. For many years, the clinic determined oral health solely, which prevented an accurate assessment of the impact of oral maladies on patients' daily lives.[1] According to the World Health Organization (WHO), oral health is the condition of the mouth, dentition, and orofacial structures that enables individuals to execute vital functions such as feeding, breathing, and communicating. It is a significant indicator of overall health. Oral health helps incorporate psychosocial aspects such as well-being, quality of life, self-confidence, socialization, and discomfort-free employment.[2] Based on the findings of the WHO Global Oral Health Status Report (2022), it is estimated that about 3.5 billion persons globally are affected by oral diseases, with three-quarters living in middle-income countries. Primary tooth decay affects about 514 million children globally, whereas an estimated 2 billion adults are believed to have permanent dental decay.[2]

According to the WHO, multimorbidity refers to the presence of two or more chronic health disorders in a single person.[3] The National Institute for Health and Treatment Excellence defines multimorbidity as the coexistence of two or more chronic health disorders, according to their clinical recommendations for optimizing treatment for individuals with multiple chronic diseases. Comorbidity and multimorbidity are distinct concepts that provide various viewpoints when considering a person with many health conditions concurrently. They are not interchangeable and may coexist.[4] Comorbidity refers to the simultaneous presence of several health issues alongside a primary ailment that is the main area of concern. Multimorbidity refers to the simultaneous presence of many health disorders, none of which are regarded as the primary ailment receiving a particular treatment.[5] Numerous oral illnesses and ailments exhibit common modifiable risk factors with prominent noncommunicable diseases including diabetes,[3] cardiovascular diseases,[4] cancer,[5,6] chronic respiratory diseases,[6,7,8] and mental disorders.[8,9] The risk variables included in this study comprise cigarette use, alcohol intake, and unhealthy diets characterized by high levels of free sugars. It is noteworthy that these risk factors are now seeing an upward trend on a worldwide scale. A well-established correlation exists between dental health and overall well-being. According to available reports, there is a correlation between diabetes and the onset as well as advancement of periodontitis.[10] Furthermore, a causal relationship has been shown between excessive sugar intake and the development of diabetes,[11] obesity,[12] and cavities.[13]

Regrettably, several nations, including Pakistan, continue to face human, financial, and material resource inadequacies, hindering their ability to adequately address the demand for oral health care services and provide universal accessibility. Pakistan exhibits variation in prevalence rates and other features particular to different geographical locations. The oral health components of chronic disorders such as diabetes are often overlooked in conventional healthcare settings. The objective of this research was to assess the occurrence of oral health conditions accompanied by comorbidities in an urban slum located in Karachi, Pakistan.

Study aim

The aim of the study was to assess the correlation of oral health status of individual with multimorbidity residing in marginalized population of Karachi, Pakistan. The secondary aim was to determine the prevalence and barriers of accessing the oral health status.

Materials and Methods

Study design

The study design used in this research was descriptive and cross-sectional in nature.

Research site

Our study was conducted in five densely populated slum neighborhoods, specifically focusing on 16 economically disadvantaged communities in Karachi, Pakistan. The research was conducted in Karachi, Pakistan, a metropolis

renowned for its extensive urban development and status as the nation's biggest city. Karachi, a vibrant urban center, has a heterogeneous demographic composition and is the residence of a substantial segment of the nation's population. The research mainly focused on economically marginalized urban settlements in Karachi. The slum settlements exhibit notable features such as a dense population, restricted availability of essential services, and inadequate living conditions. These individuals often experience marginalization and encounter a multitude of socioeconomic obstacles. The slum communities that were chosen for this study encompassed various regions within Karachi, such as Shireen Jinnah, Baldia Town, Machar Colony, Yousuf Sahab Goth, Mewashah, Tameer-e-millat, Machar Gujro, Mehran Town, Bilal Colony, Jumma Goth, Sherpao Colony, Moach Goth, Khairabad, Jamali goth, Nazimabad slum, and Majeed colony Landhi. The primary objective of this comprehensive assortment was to include the multifaceted socioeconomic and cultural circumstances prevalent among slum communities in Karachi.

SINA Health Education & Welfare Trust

It is important to acknowledge that the research was conducted inside the premises of a primary healthcare institution, SINA Health Education & Welfare Trust (SINA) is a privately funded non-profit organization serving slum communities of different ethnic backgrounds since 1998 through a network of 38 clinic sites, including three mobile vans in slum areas.[14] Together, these clinics serve approximately 1 million people annually with different chronic health conditions. They provide quality primary healthcare to disadvantaged people, especially women, children, and adolescents. SINA clinics are spread throughout Karachi City, Pakistan. Therefore, we regarded it as a representative study setting. This measure guaranteed that participants could get medical advice from duly qualified healthcare professionals. Following the provision of medical treatments and medications, patients were evaluated for oral screening by dentists qualified by the Pakistan Medical and Dental Council.

Study population

Karachi, a densely populated metropolis in Pakistan, is home to a wide range of people, including marginalized populations that face various socioeconomic difficulties. Marginalized groups often encounter obstacles in obtaining healthcare, resulting in a greater incidence of chronic illnesses such as diabetes, hypertension, anemia, hepatitis, and gastrointestinal issues attributable to factors such as poverty, insufficient healthcare infrastructure, and limited knowledge.

The goal of this study was to investigate the demographics of a marginalized group in Karachi who are enrolled in basic healthcare clinics of SINA and have multimorbidity or comorbidity chronic health conditions. The research sample consisted of 870 adult individuals dwelling in urban slum regions in 16 distinct sites in Karachi, Pakistan. The research participants were selected using a multistage cluster sampling technique. The research especially focused on those between 18 and 70 since they are most directly affected by oral health concerns and multimorbidity as per the registration obtained from SINA clinics.

Inclusion criteria

The inclusion criteria were: (a) adults between 18 and 70 years old; (b) inhabiting certain urban slum regions of Karachi, Pakistan; (c) the desire to engage in the research and provide informed consent; (d) proficiency in comprehending and articulating responses to interview inquiries in the designated language(s); and (e) the act of visiting or seeking healthcare services in a primary healthcare facility operated by SINA, which offers highly subsidized healthcare services in the designated study regions.

Exclusion criteria

The exclusion criteria were: (a) individuals within the age bracket of below 18 years or over 70 years; (b) living in regions of Karachi that are not officially categorized as urban slums; (c) the act of declining or being unable to provide informed permission for participation; (d) lack of proficiency in the chosen language(s) hindering their ability to appropriately respond to the interview inquiries; and (e) failing to access or use healthcare services at the selected primary healthcare facility that offers heavily subsidized healthcare services in the specified study regions.

Oral health examination

The oral exams were conducted in accordance with the guidelines set by the WHO by a qualified dentist. The clinical tests were performed using a dental mirror of size 5 and a probe of WHO-type with a tip diameter of 0.5 mm, all completed in naturally illuminated settings under controlled artificial lighting as needed.[15] The research eliminated the third molars, and the lost teeth were identified as those with missing root tips.

Periodontitis

To assess the presence of severe periodontitis, insertion level and pocket depth measurements were conducted in contralateral quadrants, focusing on the quadrants containing the most significant number of teeth. The dental professional born measurements at the mesiobuccal and mid-oral sites. Severe periodontal disease was diagnosed if the patient exhibited at least one place with an insertion loss of $\geq$5 mm.

Gingival recession

Gingival recession is measured clinically as the distance from the cementoenamel junction (CEJ) to the depth of the free gingival margin using the millimeter markings on the periodontal probe. It reflects the exposure of the root cementum. First, the dentist measures the pocket depth (PD) or recession by placing the probe at the site of clinical attachment loss (CAL) and feeling for the CEJ indent (CEJ to gingival margin [GM]).[16] The calculation of the CAL is as follows:

$$PD + CEJ \text{ to } GM = CAL$$

Gingivitis

Clinically, the gingival tissues are characterized by swelling, redness, tenderness, a shiny surface, and bleeding upon gentle probing. Gingivitis seldom generates spontaneous bleeding and is commonly painless; therefore, many patients do not recognize the disease and fail to seek attention.[17] A case exhibiting localized gingival inflammation was characterized by the presence of bleeding on probing (BOP) in 10−30% of the affected areas. The BOP percentage ranged from 10% to 30% for cases without widespread gingival inflammation, whereas those with extensive gingival inflammation had a BOP percentage over 30%. Cases with minor inflammation of the gums were characterized as having fewer than 10% of bleeding sites (BOP% $<$ 10%).[18]

Xerostomia

The diagnosis of xerostomia was established by examining the patient's medical history and current medication, which includes both prescribed and over-the-counter drugs. Additional clinical manifestations include halitosis, xerostomia, parched and coarse tongue, oral ulcers, chapped lips, escalated plaque formation, dental caries, and periodontal disease.[19]

Oral submucous fibrosis

By assessing the clinical manifestations described by the patients, such as discomfort, ulceration, and burning sensation, a diagnosis was made. Additionally, a review of depigmentation, whitening of the mucosa, loss of tongue papillae, and restricted mouth opening was done.[20,21]

Attrition

The clinical crown height is determined by measuring the distance from the highest point of the tooth's cusp or incisal edge to the bottom of the gingival sulcus. Attrition will decrease this metric.[22]

Trismus

Trismus is characterized by a normal mouth opening of above 30 mm, moderate trismus with a mouth opening between 20 and 30 mm, and severe trismus with a mouth opening of less than 10 mm.[23] These results indicate that the act of placing three fingers in the mouth during a dental checkup is a practical measure for evaluating the typical maximum mouth openness.[24]

Normal dentition

The typical permanent dentition in adults consists of four incisors, two canines, four premolars, and six molars in each jaw, totaling 32 teeth.[25]

Patient flow at SINA and comorbidity and multimorbidity measure

Upon visiting any health facility linked with SINA, patients are required to undergo a series of procedures. The electronic management record system captures all new and follow-up patient data at reception after their sociodemographic characteristics have been confirmed. Subsequently, the patient is sent to the vital sign station to assess their vital signs, height, and weight. They are then given a token number, indicating their position in the queue to speak with either a physician or a specialist. Physicians determine the absence of a disease by evaluating either the clinical symptoms or the results of laboratory tests. Upon receiving confirmation from the laboratory test, the patient's file will be issued for further consultations. These patients will come to the SINA clinic for a follow-up appointment. The co-existence of chronic disease will term as the either co-morbidity or multimorbidity. Multimorbidity (two or more chronic diseases) was measured by a simple count of self-reported chronic diseases from a list of 16 diseases.

Figure 1 shows the Oral/Dental Health Assessment in Participants with multimorbidity at the SINA clinic during the screening and record keeping for the study.

Sampling procedure

The sample methodology used in this research utilized a multistage cluster sampling technique to choose individuals from urban slum regions in Karachi, Pakistan. To provide a scientifically rigorous and methodologically sound sampling technique from the selection of slum areas, stratum formation and selection of slum locations through random sampling technique were conducted to achieve the desired sample size with consideration of the target confidence level, margin of error, and projected prevalence or impact size. In all, we collected data from 870 potentially eligible individuals using the following procedures.

Data collection procedure

The data collection procedure for this study involved oral health screening and conducting structured interviews with the selected participants using a comprehensive questionnaire. The following steps were followed to ensure a systematic and standardized approach to data collection.

Questionnaire development

To collect multidimensional oral health data, a well-developed questionnaire was created. A thorough review of relevant academic publications, significant discussion with dental experts, and careful consideration of study aims guided the questionnaire. The study included demographic factors, socioeconomic status, ethnicity, educational attainment, oral hygiene practices such as tooth brushing and flossing, oral hygiene products such as toothpaste and mouthwash, disease status upon visiting primary healthcare clinics, oral hygiene knowledge, oral screening history, and factors influencing the decision to use or not use oral health products. Figure 2 shows the questionnaire used in this study.

Training of interviewers

To guarantee uniform and standardized data collection, Study on Internet Addiction (SINA) interviewers underwent extensive training. Participants were trained on the study aims, ethics, interviewing, and questionnaire usage. Privacy, secrecy, connection with participants, and tackling tough topics were also stressed throughout the course.

Pilot testing

A preliminary study assessed the questionnaire's effectiveness, clarity, comprehensibility, and suitability for the target audience before data collection began. Twenty people were chosen to represent the study's target demographic for

the pilot study. Following the pilot study participant comments, the questionnaire was modified and finalized.

Informed consent

Informed consent was acquired from each participant before the interview and oral health test. Participants were informed of the study's aims, voluntary nature, and data confidentiality. The research participants were told their participation was voluntary and that they may quit at any time without penalty.

Data collection

The interviews were done in a private, comfortable location to protect confidentiality. Interviewers used a standardized questionnaire and appropriately recorded responses. The interviewers were neutral and supportive, making participants feel comfortable sharing their thoughts and experiences.

Quality control

The data gathering procedure was monitored regularly to ensure data integrity and consistency. The lead investigator guided the interviewees, answered questions, and regularly checked the data for completeness and accuracy.

Data Management: The collected data were kept private and protected. The data entry method used appropriate software for accuracy and reliability. The researchers cleaned and validated the data to find and fix errors.

Sample size

We were interested in determining how common oral health issues are overall. One study indicated an incidence of dental caries of 60−70%. In these circumstances, a cautious estimate of 0.7 (70%) may be used to establish the maximum necessary sample size. We used the OpenEpi software to calculate the sample sizes. Using a 95% confidence level and margin of error of 5%, the formula to calculate the sample size was as follows:

$$\text{sample size } n = [DEFF*Np(1-p)]/[(d2/Z21-\alpha/2*(N-1) + p*(1-p)].$$

Considering $p = 0.7$, $q = 1 - p = 0.3$, $Z = 1.96$ (corresponding to a 99% confidence level), and $E = 0.05$ (margin of error), we could substitute these values into the formula.

The calculated sample size was approximately 558. With a non-response rate of 50%, the sample size was increased to 837.

Statistical analyses

The data were entered using Microsoft Excel and exported to SAS version 9.4 for analyses. All collected data were validated for accuracy and consistency. We summarized the data through descriptive statistics using counts and proportions. The dependent variable was dental health issues (i.e., presence vs. absence of dental health issues). Due to the nature of objective and non-parametric data, we performed the chi-square test to assess the association of outcome variables with comorbidities, demographic, and dental health-related predictors (e.g., sex, age, gum bleeding, bleeding on probing, tooth loss, teeth cleaning frequency).

Results

Descriptive analysis

Table 1 represents the descriptive analysis and prevalence of study participants regarding the presence and absence of

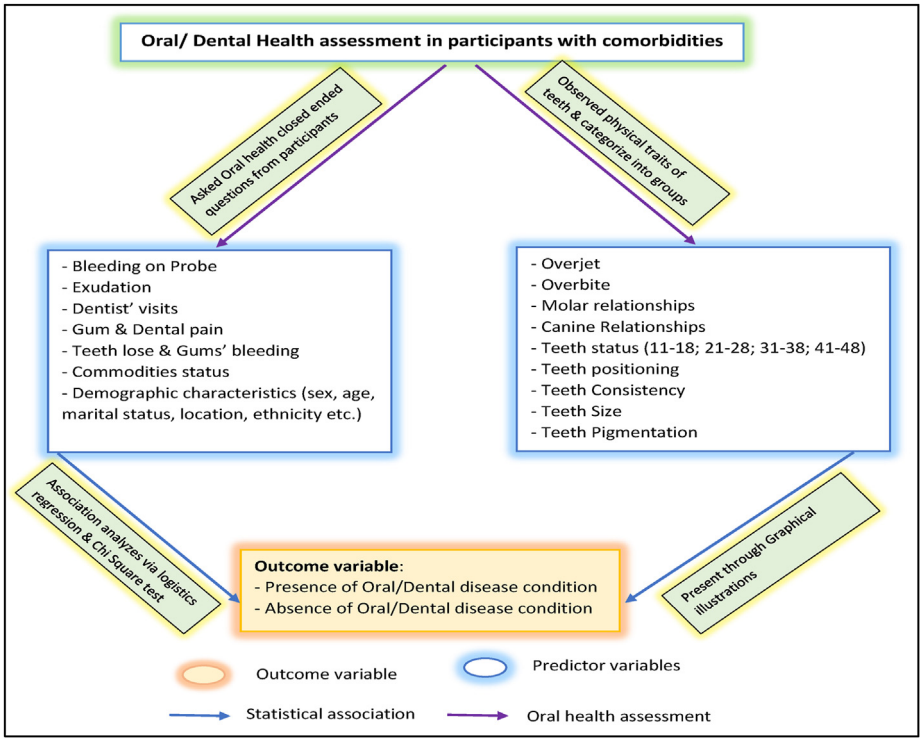

Figure 1: Oral/dental health assessment among participants with multimorbidities.

oral/dental disease conditions; most of our population was females (79%), and 54% had oral health issues. The most representative age group was between 18 and 38 years of age (64%), of whom 43% had oral health issues. Most study participants were married (85%). Among them, 60% had oral health issues. The represented participants were from Baldia town (36%) and belonged to the Pathan ethnic group (44%). Among them, 27% of Baldia dwellers were of Pathan ethnicity, and 30% had an oral health issue. Regarding the frequency of tooth brushing, 45.4% of individual did not prefer to brush their teeth and out of this, 31.4% (273) had oral health problems. Approximately 75.7% (659) of the study participants had never visited a dentist and managed their problems through home remedies or quacks. Approximately (35%, 305) people living at slums prefer Dandasa as a tooth cleaning agent, of whom 22% suffered from oral health problems. At the same time, 23% of the participants preferred plain water for gargling as their cleansing agent. Additionally, 74% of the participants experienced pain in the gums, 64% experienced gum bleeding, and 41% lost their teeth without injury.

Oral/dental disease status (presence vs. absence)

Table 1 shows the association of oral/dental disease status (presence vs. absence) with sex, age, and location. We found that sex was significantly associated with oral/dental disease status (test statistics > critical value; $p < 0.05$), indicating there were mean differences in the presence and absence of oral and dental disease statuses between males and females. Furthermore, the location of participants was significantly associated with oral/dental disease status (test statistics > critical value; $p < 0.05$), indicating there were mean differences in the presence and absence of oral and dental disease status among different locations of the study population. Staining of the teeth, frequency of tooth brushing, and frequency of gum bleeding were significantly associated with oral/dental disease status (test statistics >

Oral Health Status with multimorbidity of patients among the marginalized population of Karachi, Pakistan. A multicentered cross-sectional study
Questionaire

Sex:
- Female
- Male

Age:
- 18-38
- 39-58
- 59-78

Marital Status:
- Divorced
- Married
- Unmarried
- Widow

Ethnicity:
- Afghani
- Balochi
- Pathan
- Punjabi
- Sindhi
- Urdu Speaking
- Other minorities

Clinical locations:
- Baldia town
- Gadap town
- Korangi district
- Landhi town
- Orangi town

Exudation:
- Yes
- No

Bleeding on probe:
- Yes
- No

Staining on teeth:
- Mild
- Moderate
- Severe

Frequency of teeth brushing:
- Once
- Twice
- Thrice
- Sometimes
- Never

Teeth clean through:
- Tooth paste
- Manjan
- Salt
- Miswak
- Dandasa
- Gargle with plain water

Have you ever visited Dentist?
- Yes
- No

Have you ever experienced dental pain?
- Yes
- No

Have you ever experienced gums pain?
- Yes
- No

How often gums bleed?
- Frequently
- Sometimes
- Rarely
- Never

Have any of your teeth ever become loose on their own, without any injury
- Yes
- No

Disease Status:
- Anemia
- Arthritis
- Diabetes
- Diabetes, Hepatitis
- Diabetes, Hypertension
- Diabetes, Hypertension, Hepatitis
- Hypertension
- Upset Stomach
- Unhygienic oral issue
- Thyroid
- No disease

Duration of disease:
- 1-5 years
- 6-10 years
- 11-15 years
- 16-20 years
- No disease

Have you ever experienced bleeding in gums?
- Yes
- No

Figure 2: Questionnaire.

Figure 2: (*continued*).

critical value; $p < 0.05$), indicating there were mean differences in the presence and absence of oral and dental disease statuses among the levels of these predictors. Additionally, in a multimorbidity status among study subjects, anemia, diabetes, hepatitis, and stomach pain were significantly associated with oral and dental disease (test statistics $\chi^2 >$ critical value; $p < 0.05$). Furthermore, 'diabetes with hepatitis' and 'diabetes with hypertension and hepatitis' conditions together were also significantly associated with oral and dental disease, indicating there was a mean difference in the presence and absence of oral/dental health disease among the study population with those chronic conditions. The remaining study predictors (age, exudation, bleeding on the probe, dentist visits, dental and gums pain, lost teeth without injury, and bleeding) were insignificantly associated with oral and dental health issues. Moreover,

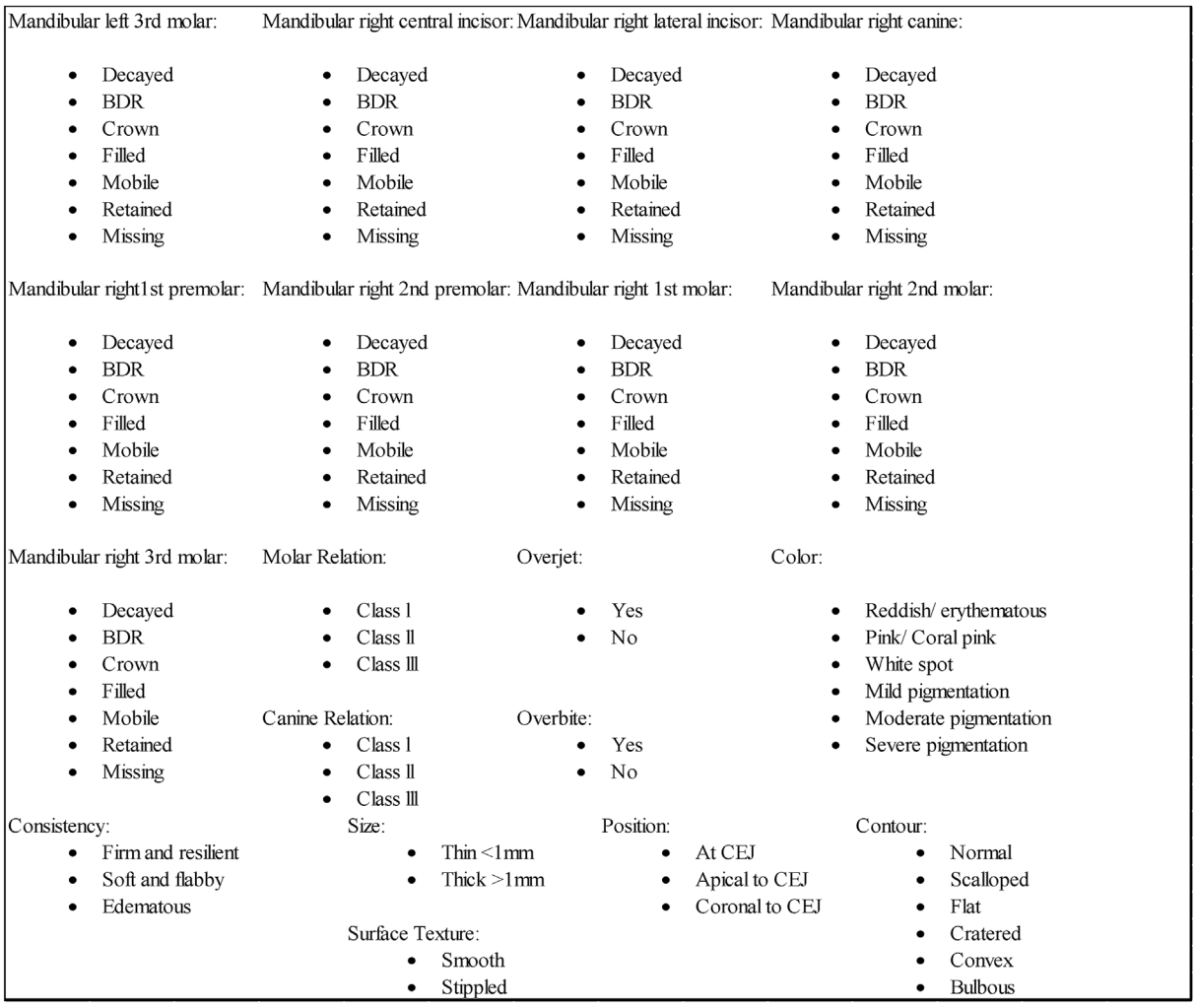

Figure 2: (*continued*).

Table 1: Descriptive statistics and chi-square association with respect to dental disease/problems.

	Total n (%)	Oral/Dental disease/problems		Chi−Square Test; $CV^{\alpha} < \chi^2$			
		Present [n (%)]	Absent [n (%)]	χ^2	CV	df	p-value
Sex							
Female	687 (79)	468 (53.8)	219 (25.2)	6	3.84	1	‡
Male	183 (21)	142 (16.3)	41 (4.7)				
Age (years)							
18−38	553 (63.6)	373 (42.9)	180 (20.7)				
39−58	255 (29.3)	189 (21.7)	66 (7.6)	5	5.99	2	ns
59−78	62 (7.1)	48 (5.5)	14 (1.6)				
Marital status							
Divorced	4 (0.5)	1 (0.1)	3 (0.3)				
Married	742 (85.3)	520 (59.8)	222 (25.5)	2	7.81	3	ns
Unmarried	117 (13.4)	85 (9.8)	32 (3.7)				
Widow	7 (0.8)	4 (0.5)	3 (0.3)				
Ethnicity							
Afghani	20 (2.30)	7 (0.8)	13 (1.5)				
Balochi	63 (7.2)	46 (5.3)	17 (2)				
Pathan	382 (43.9)	259 (29.8)	123 (14.1)				
Punjabi	90 (10.3)	67 (7.7)	23 (2.6)	56	12.59	6	‡
Sindhi	111 (12.8)	83 (9.5)	28 (3.2)				
Urdu Speaking	114 (13.1)	75 (8.6)	75 (8.6)				
Other minorities	90 (10.3)	73 (8.4)	17 (2)				

(*continued on next page*)

Table 1 (*continued*)

	Total n (%)	Oral/Dental disease/problems		Chi−Square Test; $CV^{\alpha} < \chi^2$			
		Present [n (%)]	Absent [n (%)]	χ^2	CV	df	p-value
Clinical locations							
Baldia town	314 (36.1)	233 (26.8)	81 (9.3)				
Gadap town	162 (18.6)	64 (7.4)	98 (11.3)				
Korangi district	186 (21.4)	162 (18.6)	24 (2.8)	118	9.49	4	‡
Landhi town	111 (12.8)	94 (10.8)	17 (2)				
Orangi town	97 (11.1)	57 (6.6)	40 (4.6)				
Exudation							
Yes	68 (7.8)	45 (5.2)	23 (2.6)	1	3.84	1	ns
No	802 (92.2)	565 (64.9)	237 (27.2)				
Bleeding on probe							
Yes	265 (30.5)	193 (22.2)	72 (8.3)	1	3.84	1	ns
No	605 (69.5)	417 (47.9)	188 (21.6)				
Staining on teeth							
Mild	515 (59.2)	291 (33.4)	224 (25.7)				
Moderate	208 (23.9)	172 (19.8)	36 (4.1)	124	5.99	2	‡
Severe	147 (16.9)	147 (16.9)	0 (0)				
Frequency of tooth brushing							
Once	206 (23.7)	147 (16.9)	59 (6.8)				
Twice	30 (3.4)	19 (2.2)	11 (1.3)				
Thrice	109 (12.5)	92 (10.6)	17 (2.0)	17	9.48	4	‡
Sometimes	395 (45.4)	273 (31.4)	122 (14.0)				
Never	130 (14.9)	79 (9.1)	51 (5.9)				
Have you ever visited the dentist?							
Yes	211 (24.3)	154 (17.7)	57 (6.6)	1	3.48	1	ns
No	659 (75.7)	456 (52.4)	203 (23.3)				
Have you ever experienced dental pain?							
Yes	660 (75.9)	456 (52.4)	204 (23.4)	1	3.48	1	ns
No	210 (24.1)	154 (17.7)	56 (6.4)				
Have you ever experienced gum pain?							
Yes	646 (74.3)	454 (52.2)	192 (22.1)	1	3.48	1	ns
No	224 (25.7)	156 (17.9)	68 (7.8)				
Have any of your teeth ever become loose on their own, without any injury?							
Yes	355 (40.8)	250 (28.7)	105 (12.1)	1	3.48	1	ns
No	515 (59.2)	360 (41.4)	155 (17.8)				
Have you ever experienced gum bleeding?							
Yes	559 (64.3)	382 (43.9)	177 (20.3)	2	3.48	1	ns
No	311 (35.7)	228 (26.2)	83 (9.5)				
How often do your gums bleed?							
Frequently	204 (23.4)	121 (13.9)	83 (9.5)				
Sometimes	347 (39.9)	256 (29.4)	91 (10.5)	15	7.81	3	‡
Rarely	311 (35.7)	228 (26.2)	83 (9.5)				
Never	8 (0.9)	5 (0.6)	3 (0.3)				
Multimorbidities							
Anemia	22 (2.5)	7 (0.8)	15 (1.7)	11	3.48	1	‡
Arthritis	58 (6.7)	36 (4.1)	22 (2.5)	1	3.48	1	ns
Diabetes	94 (10.8)	76 (8.7)	18 (2.1)	6	3.48	1	‡
Diabetes, hepatitis	64 (7.4)	59 (6.8)	5 (0.6)	16	3.48	1	‡
Diabetes, hypertension	61 (7.0)	36 (4.1)	25 (2.9)	2	3.48	1	ns
Diabetes, hypertension, hepatitis	109 (12.5)	103 (11.8)	6 (0.7)	31	3.48	1	‡
Hypertension	119 (13.7)	78 (9.0)	41 (4.7)	1	3.48	1	ns
Pain in stomach	32 (3.7)	9 (1.0)	23 (2.6)	19	3.48	1	‡
Thyroid	55 (6.3)	34 (3.9)	21 (2.4)	0	3.48	1	ns
No disease/chronic condition	256 (29.4)	172 (19.8)	84 (9.7)	Ref	–	–	–

‡: P-value <0.05; $\chi 2$: test statistics value; df: Degree of freedom; CV: Critical value; ns: non-significant.

Table 2: Co-occurrence of multiple oral health problems with multimorbidity.

Multiple Oral Health Problems	Comorbidity
Diabetes as a Comorbidity (n = 130)	
1. Gingival recession, gingivitis, attrition, periodontitis, trismus, xerostomia	1%
2. Gingival recession, periodontitis	9.89%
3. Gingivitis, gingival recession	13.20%
4. Attrition	5%
5. Gingivitis	19%
6. Normal dentation	51.91%
Diabetes and hypertension as multimorbidity (n = 99)	
1. Gingival recession, periodontitis	1.58%
2. Gingival recession, periodontitis, gingivitis	3.17%
3. Gingival recession, gingivitis	4.76%
4. Gingival recession, gingivitis, attrition	7.93%
5. Normal dentition	26.98%
Diabetes and hepatitis as multimorbidity (n = 69)	
1. Gingival recession	10.45%
2. Gingivitis	33.90%
3. Gingival recession, gingivitis	4.41%
4. Gingival recession, gingivitis, periodontitis	6.34%
5. Normal dentition	44.90%
Diabetes, hepatitis and hypertension multimorbidity (n = 117)	
1. Gingival recession, oral submucous fibrosis, gingivitis	1.85%
2. Gingival recession, periodontitis	6.70%
3. Periodontitis	5.56%
4. Gingival recession	10.57%
5. Gingivitis	29.9%
6. Normal dentition	45.42%
Hypertension comorbidity (n = 142)	
1. Gingivitis, gingival recession	0.77%
2. Attrition, gingivitis, gingival recession, periodontitis, torus platinus	1.55%
3. Gingivitis attrition	2.32%
4. Gingival recession	3.87%
5. Gingivitis	27%
6. Normal dentition	41%
Stomach issues comorbidity (n = 31)	
1. Gingival recession, gingivitis, periodontitis	3.22%
2. Gingivitis	6.45%
3. Normal dentition	70.96%
Anemia comorbidity (n = 22)	
1. Gingivitis, attrition, periodontitis, oral submucous fibrosis, trismus, xerostomia	4.54%
2. Gingivitis	13.63%
3. Normal dentition	63.63%

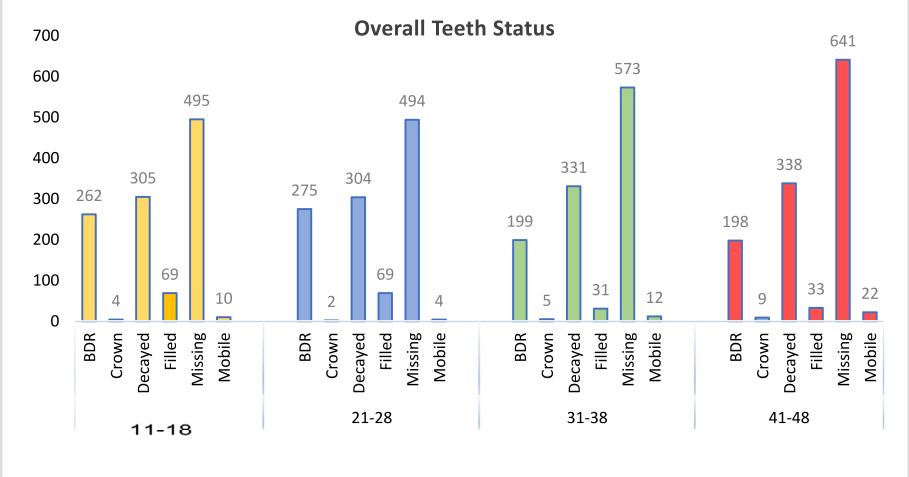

Figure 3: Overall tooth status of the study participants.

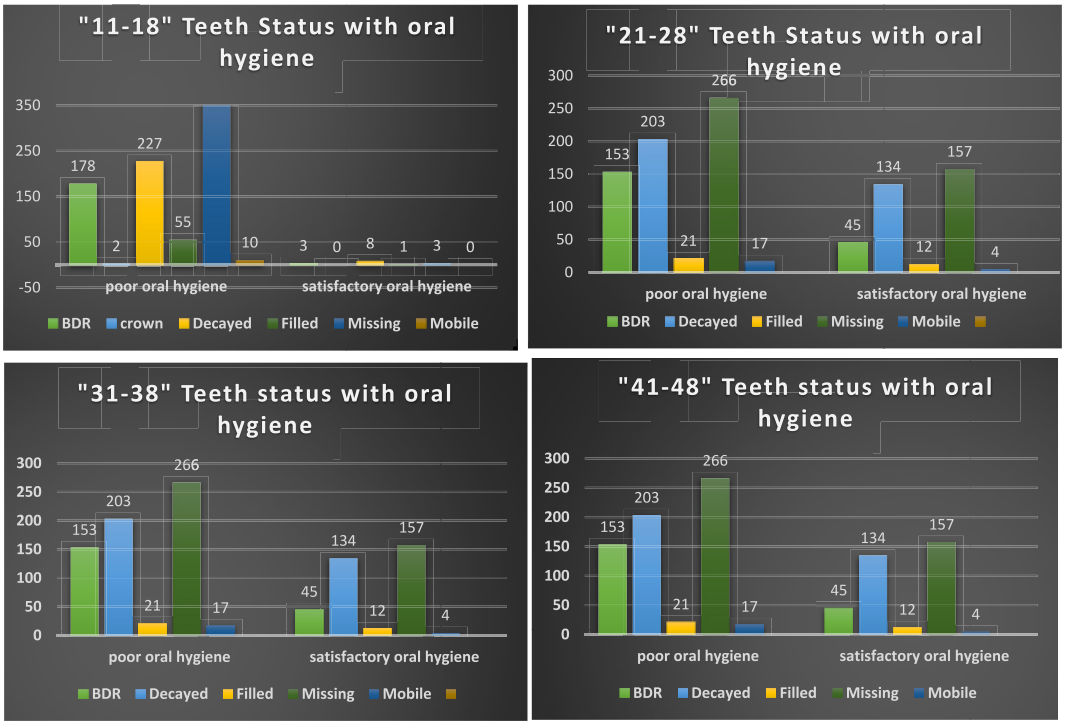

Figure 4: Detailed view of tooth status of the study participants with respect to oral health.

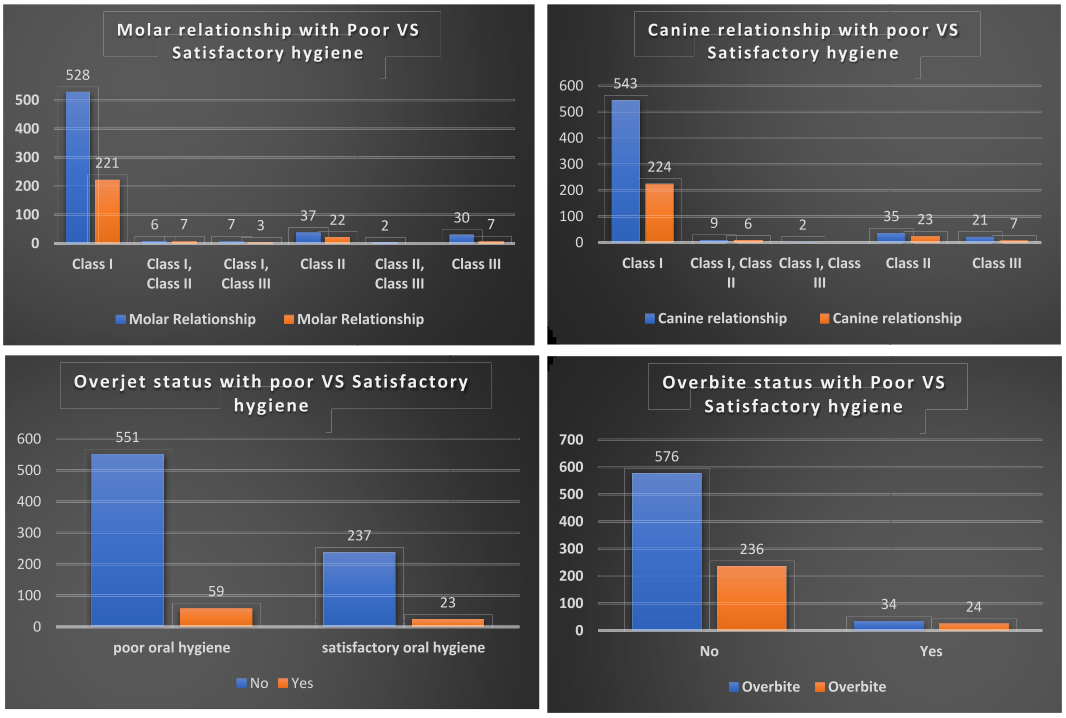

Figure 5: Different tooth conditions among the study participants with respect to oral health issues.

hypertension, thyroid condition, and arthritis were also insignificantly associated with oral and dental health issues, which means there was no mean difference in the presence and absent of oral and dental health issues among the study population with these conditions.

Relationship of the multimorbidity versus oral health status

Table 2 shows the single or multiple oral health disease conditions found in our study participants who visited the clinics with comorbidity or multimorbidity. As per the study participants, gingivitis is highly prevalent. Gingivitis

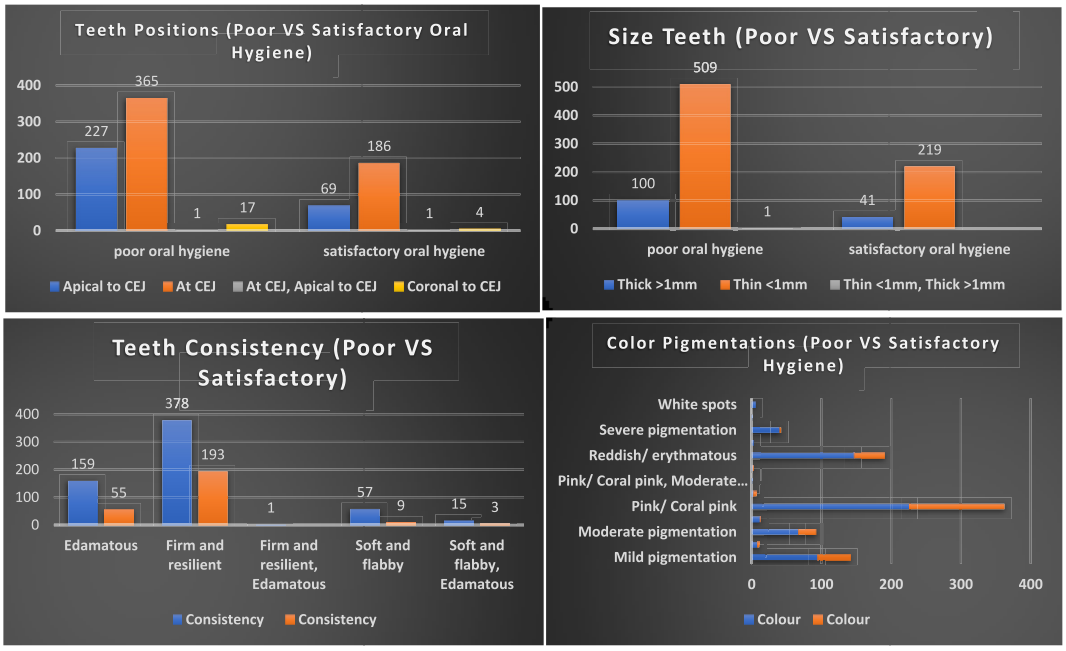

Figure 6: Physical aspects of tooth conditions among the study participants with respect to oral health issues.

either presents as a single cause of dental problems or multiple dental problems in people with comorbidity or multimorbidity. Gingivitis was prevalent in 19% of individuals with diabetes morbidity, 33% of individuals with multimorbidity of diabetes and hepatitis, and 29.9% of individuals with multimorbidity of diabetes, hepatitis, and hypertension. Gingivitis was present in 27%, 6.45%, and 13.63% of people with hypertension, stomach-related issues, and anemia comorbidity, respectively. Gingival recession stands in the second position in our studied population. Approximately 10.57% of gingival recession is present among people in slums having multimorbidity of diabetes, hypertension, and hepatitis. As in other disease conditions, gingival recession is present either with periodontitis, attrition, or gingivitis. In our screened population, 4.54% of people with anemia showed gingivitis, attrition, periodontitis, OSF, trismus, and xerostomia. By contrast, 1.85% of the population showed gingival recession, OSF, and gingivitis as multidental problems among people having multimorbidity of hepatitis, hypertension, and diabetes. Details of the multidental problems are presented in Table 2.

Tooth status of the participants

Figure 3 illustrates the overall tooth status (groups: 11–18 = Maxillary right (central incisor, lateral incisor, canine, 1st premolar, 2nd premolar, 1st molar, 2nd molar, 3rd molar), 21–28 = Maxillary left (central incisor, lateral incisor, canine, 1st premolar, 2nd premolar, 1st molar, 2nd molar, 3rd molar) 31–38 = mandibular left (central incisor, lateral incisor, canine, 1st premolar, 2nd premolar, 1st molar, 2nd molar, 3rd molar) 41–48 = mandibular right (central incisor, lateral incisor, right canine,1st premolar, 2nd premolar, 1st molar, 2nd molar, 3rd molar)) among the study participants; most participants had missing teeth. Figure 4 illustrates a detailed view of tooth status concerning hygiene level. Figure 5 illustrates the participants' oral health issues regarding overjet, overbite, molar relationship, and canine relationship; most of the molar and canine relationships were 'class 1' in both groups (presence and absence of oral issues). Moreover, no overjet and overbite were found among the participants with oral health issues. Figure 6 illustrates the physical traits of teeth among the study participants. In both groups (presence and absence of oral issues), the most represented position of teeth was 'at CEJ'; the represented size of the teeth in both the groups was '<1 mm thin'; the tooth consistency in most of the participants in the oral disease group was 'firm and resilient'; the stain color mostly found among participants with an oral disease condition was 'pink/coral pink' and 'reddish/erythematous.'

Discussion

The findings of this research will contribute to the advancement of more efficacious interventions aimed at managing the co-occurrence of chronic illnesses. Furthermore, the findings of this study will provide a foundational framework for future researchers seeking to undertake extensive investigations in the impoverished urban settlements of Pakistan. Individuals investigating the correlation between a range of pathological conditions will find this research advantageous. This study showed that worse oral health conditions were related to comorbidity when considering sociodemographic, health, and health behavior variables. The study indicates that the relationship between oral health and mortality is primarily a result of the relationship between oral health and these other variables.[26] The findings of this research provide evidence of a positive correlation between the coexistence of several oral health issues and the existence of multimorbidity or comorbidity. As per the surveys and screened population, those who have multimorbidity showed prevalence of periodontal disease such as diabetes,

cardiovascular disease, unfavorable pregnancy outcomes, and ischemic vascular disease.

Gingivitis

In our study, gingivitis was more prevalent among people in slums. Approximately 19% of people with diabetes as a comorbidity showed gingivitis as a source of oral problems. However, those patients who visited the clinic with multimorbidity of diabetes, hypertension, and hepatitis showing an increased prevalence of gingivitis.

Periodontitis

Reports from researchers from the UK showed that 10–15% of individuals with diabetes had extreme gingivitis called periodontitis.[27] Periodontal illnesses include two main conditions: gingivitis, characterized by inflammation limited to the gingiva and potentially reversible with proper dental hygiene; and periodontitis, characterized by inflammation that spreads and leads to tissue damage and resorption of the alveolar bone. Tissue degradation in periodontitis leads to the deterioration of collagen fibers inside the periodontal ligament, resulting in the development of a periodontal pocket between the gingiva and tooth. "Pocketing" cannot be readily seen by an essential visual examination, necessitating a periodontal probe for accurate evaluation.[27] The initial phase of periodontal disease is gingivitis, in which the primary objective of treatment in the early stage is to mitigate or eradicate inflammation of the gingival tissues. The desired outcome is attained with the comprehensive elimination of all elements that contribute to inflammation of the gingiva including plaque, calculus, the rectification of faulty restorations, and carious lesions, among others.[28] In our studied population, gingivitis prevalence was high, and there may be multiple reasons due to the multimorbidity of chronic diseases and poor oral hygiene.[29]

Gingival Recession

In our study population, gingival recession was the second most common condition in hypertensive patients (3.87%) and approximately (10.57%) were prevalent among people with multimorbidity of diabetes, hypertension, and hepatitis. It was also more common in women than men; however, studies[30–33] have claimed that is more common in males than females. By contrast, one study from Finland reported that gingival recession is equally prevalent across both sexes.[34] It has also been linked with age in many studies.[35] However, in our study population, gingival recession was most prevalent in adults 18–38 years of age, which is also supported by a Brazilian study.[36] By contrast, a higher incidence of recession was seen in people with excellent oral hygiene than in those with poor oral hygiene.[37,38] Gingival recession often manifests in conjunction with tooth abrasion and is related to regular and vigorous brushing with a hard toothbrush.[39,40] In our study population, the use of Dandasa (walnut tree bark), use of a hard toothbrush, or excessive use of Miswaak (chewing stick/tooth-cleaning stick) caused gum inflammation.

Periodontitis

Periodontitis and diabetes are frequent chronic noncommunicable illnesses that pose substantial public health issues in global populations. The interconnections between diabetes and periodontitis are more intricate than previously understood. Compelling evidence indicates a reciprocal interaction between the two conditions, wherein one exerts detrimental effects on the other.[41] In our collected data, people with multimorbidity had multiple dental issues along with periodontitis. Diabetes, along with hypertension and hepatitis, were present in people with periodontitis in our screened population. A study from Italy in 2020 reported that hypertension plays an important role in the development of periodontal disease in the adult population, especially in males.[42]

OSF

OSF is a chronic, insidious, and progressive condition that primarily affects the oral mucosa, encompassing the whole oral cavity and occasionally extending to the pharynx. The condition is precancerous, exhibiting symptoms such as blanching and a burning sensation of the oral mucosa, discoloration of the teeth and gingiva, and limited mouth opening. OSF is considered multifactorial, displaying a notable prevalence among individuals who chew areca nut (AN). OSF has a malignant transformation rate of 7%–30%, leading to the development of oral squamous cell carcinoma.[43] In our screened population, individuals with anemia reported an OSF incidence of 4.54% and other oral health problems such as periodontitis, gingivitis, trismus, and xerostomia. The incidence of OSF is correlated with nutritional issues, such as shortages in protein and vitamins and the presence of anemia. A strong correlation also exists between the reduction in iron, selenium, and zinc serum levels and the increased susceptibility to OSF.[44,45] A decrease in serum iron levels can alter the structure of epithelial cells and enhance the permeability of mucosal membranes, impeding their ability to serve as practical barriers. The presence of selenium in the body is associated with anti-fibrotic properties. A decrease in selenium levels can lead to a reduction in activity of the peroxidase system in the oral mucosa, hence inhibiting the elimination of some detrimental compounds. The oral mucosa is susceptible to degradation and fibrosis when subjected to persistent external stimulation. Another leading cause of OSF is the addition of betel nut chewing. According to reports, the likelihood of developing OSF among individuals who chew AN or betel nut is 109–287 times more significant compared to those who do not engage in chewing. Furthermore, this risk increases in correlation with the frequency and length of daily betel nut chewing.[46] OSF has also been observed in people with multimorbidity of diabetes, hypertension, and hepatitis.

Trismus and Xerostomia

Trismus and Xerostomia are the two oral health conditions present in individuals with diabetes and anemia. The frequency of these conditions is comparatively lower than the above-mentioned oral conditions. Approximately 1% of diabetic

patients and 4.5% of slum dwellers have these conditions. Trismus describes any restriction to mouth opening due to certain infections, trauma, dental treatment, oral tumors, and drugs.[47] There are limited studies on the association of trismus with comorbidity. However, head and neck cancer, infection, or untreated dental caries are associated with Trismus.[48–51] In comparison, anemia may be due to the poor nutritional status among people with xerostomia due to temporary or chronic hyposalivation. This condition is due to nutritional deficiencies, and various diseases are sometimes accompanied by a reduced salivary flow rate or due to Sjögren's syndrome (an autoimmune disease condition).[52] In our study population, xerostomia was more prevalent among women than men. Similarly, a study in Sweden[53] found that the prevalence of perceived xerostomia was 21.3% for men and 27.3% for women. This sex difference was determined to be statistically significant. In addition, individuals taking any medication had a higher prevalence of xerostomia (32.5% for males and 28.4% for females) than those not taking any medications (18.8% for males and 14.2% for females). In addition, the authors discovered that the prevalence of xerostomia increased with age, duration of medication use, and number of medications. Ultimately, it has been shown that persons afflicted with a neurological or mental disease, or those who used detachable dentures, exhibit a much higher likelihood of developing xerostomia than those without such disorders or dentures.[54]

This research represents the first evidence of distinct clusters of oral clinical disorders among individuals living in slum areas and the coexistence of several chronic conditions among patients seeking treatment at basic healthcare facilities with comorbidity or multimorbidity. Using a novel methodology in oral epidemiology, we showed the complex patterns of many co-occurring health disorders in primary healthcare settings. The results indicate that oral illnesses continue to pose a significant public health concern among individuals living in slum areas due to their widespread occurrence and detrimental effects on overall well-being and quality of life of affected individuals.[55] Furthermore, there is a correlation between oral health disparities and other oral clinical diseases. Healthcare organizations, particularly those operating at the primary healthcare level, should prioritize delivering oral health care and formulating health policies. These efforts should reduce socioeconomic disparities and enhance oral health outcomes while adopting a multimorbidity approach to address chronic illnesses.[56]

Conclusion

The results of this study demonstrate a clear link between the presence of many oral health problems and a higher likelihood of developing multimorbidity or comorbidity. Periodontal disease is prevalent among people with multimorbidity, including diabetes, hypertension, anemia, and many related health problems. The coexistence of many chronic conditions and oral illnesses is a significant difficulty in the adult population living in slums, as it negatively impacts their quality of life and is linked to substantial healthcare expenses. Initiating health preventive initiatives throughout the early stages of patients' lives is crucial for ensuring the enhanced quality of life in maturity. It is necessary for the dentistry profession to address this issue and contemplate the implementation of initial screening at the primary healthcare level.

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Conflict of interest

The authors assert that the research was conducted without any commercial or financial affiliations, a factor that may be seen as a conflict of interest.

Ethical approval

The research adhered to ethical protocols to safeguard the participants' rights and welfare. The confidentiality and privacy of the participants were rigorously upheld, ensuring the strict maintenance of information. The proposal was submitted to the ethical review board of the SINA organization, and received clearance under reference number ERB0000014/03-23 before commencement of the research.

Consent for publication

The outcomes of this investigation are ready for dissemination in a scholarly journal.

Authors' contributions

HS was involved in the study concept, study design, and final manuscript. SSS was involved in the biostatistics analyses, graphical illustrations, and result interpretations. MH, NH, WA, and FA were involved in patient screening. TS was involved in collecting and curating the data. MH NH were involved in the literature search. All authors reviewed and approved the final version of the study. All authors have critically reviewed and approved the final draft and are responsible for the content and similarity index of the manuscript.

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Availability of data and materials

Upon request, the datasets used and analyzed in the present work will be provided by the corresponding author.

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