The Impact Of Dental Restoration Problems

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ABSTRACT
Dental restoration failure is a high-prevalence and multifactorial etiology with a considerable clinical and economic burden in all countries, but context-specific epidemiological data on the Kingdom of Saudi Arabia were rare, which restricted the construction of specific preventive measures. The objectives of this study were to establish the prevalence, identify the major risk factors, and assess the influence of dental restoration issues on oral health-related quality of life (OHRQoL) of a Saudi patient group. The facet of clinical evaluation was a cross-sectional analytic study of the three large public dental facilities in Riyadh, which consisted of 450 patients and clinical analysis of 1,127 restorations. Standardized examinations and validated questionnaires (OHIP-14) were used to collect data, and multivariate logistic regression was used to analyze them. The general rate of restoration issues was 20.1% and the most frequent problem of failure was secondary caries (43.2%). The patient-reported bruxism (AOR=2.21, 95% CI: 1.6130.44, p<0.001), poor oral hygiene (AOR=2.05, 95% CI: 1.412.99, p<0.001) and excessive intake of sugary beverages (AOR=1.67, 95% CI: 1.232.27, p=0.001) were also The relationship between dose and response was found to be strong with the more the number of failed restorations the worse the OHRQoL scores were found to be (p<0.001). The results clearly show that modifiable behavioral risks that are modifiable are the leading causes of restoration failure in this context, and thus the necessity to incorporate a comprehensive clinical strategy that emphasizes behavioral management that focuses on patients and the technical restorative care that enhances long-term outcomes.
Keywords: Dental Restoration Failure; Oral Health-Related Quality of Life; Prevalence; Risk Factors; Saudi Arabia

INTRODUCTION

The durability and functional integrity of direct dental restorations are considered to be the success criteria of restorative dentistry in the long run. Procedures on materials like composite resin and dental amalgam are among the foundations of oral rehabilitation that are intended to repair morphology, function, and aesthetics after dental caries or trauma [1]. There are, however, no fixed components within the dynamic oral environment; these restorations are vulnerable to both clinical failures on a scale, such as fracture, secondary caries, marginal deterioration, and loss of retention [2,3]. Such problems are a major clinical and economic problem, and they may require complicated re-interventions, which may undermine the tooth structure and patient

satisfaction [4]. Restoration failure is a significant healthcare burden worldwide, and the results of the research show that during the period of five years after the insertion, the probability of failure is high, and due to the multifactorial interaction of materials and operator experience, and patient-specific factors, it is necessary to replace it [5].

There is wide-scale research carried out internationally to clarify the etiology of the pathways related to restoration failure. The background work created a framework for categorizing failure modes, with secondary caries and fracture as the main reasons for failure [6]. Later meta-analyses like the one by have summarized evidence worldwide and proved that recurrent decay is a major cause of failure in diverse populations. The scientific discourse has developed to understand that the existence of failure can hardly be caused by a single factor but is the result of multifactorial processes [7,8]. Material science studies have outlined the potential inherent constraints of restorative materials, the shrinkage of polymerization of composite resins, and wear properties against the corrosion potential of amalgam, and clinical studies have continued to hint at the essential influence of patient-specific variables [8]. It is worth noting that parafunctional habits such as bruxism have catastrophic cyclic loads and that behavioral factors such as dietary habits and oral hygiene effectiveness are directly related to the biochemical environment of the restoration margin, which facilitates demineralization, failures caused by biofilm [9].

In spite of this strong international body of knowledge, there is a strong gap evident in the context of the Kingdom of Saudi Arabia. There is a paucity of epidemiological data in the form of quantitative measurements of the targeted prevalence, distribution, and above all, the contextually pertinent determinants of dental restoration issues [10]. The Saudi population offers a distinctive demographic and cultural profile with the recorded large levels of risks to the diet and unevenly spread levels of oral health awareness that can affect the failure patterns differently as compared to Western cohorts that constitute most available data [11]. Carries prevalence or the complications of prosthetics have often been studied in previous national studies, which may have neglected the particular area of direct restoration failure. Such absence of contextualized data prevents the creation of specific, evidence-based preventive measures and clinical guidelines in the context of the Saudi healthcare system [12]. In the absence of a clear picture of the most salient risk factors, including material, technical, and behavioral risk factors, in this population, clinical practice can be based on generalized protocols that do not consider the underlying causes of failure effectively.

Therefore, the main driving force of this study was to create this contextual evidence that was missing. The objective of the study was not to list down failures, but rather to deconstruct their etiology and quantify their downstream effect. To fill this gap, the central research questions were developed as follows: What is the prevalence and pattern of dental restoration problems in patients in major Saudi dental centers? What patient factors (e.g., oral hygiene, parafunctional habits, diet) and restoration factors (e.g., material, age, location) are most closely related to failure in this environment? More importantly, how can the quantifiable effects of these restoration problems on the oral health-related quality of life of the patient be determined? These questions are critical in helping transition to a preventative, patient-centred, and proactive method of restorative care as opposed to a reactive model of repair.

In this regard, the aims of this research were clearly formulated to be responsive to using a rigorous methodological approach. First, to establish the prevalence and typology of dental restoration issues through a standardized clinical examination, and to give a background epidemiological profile [13]. Second, to determine and examine the relationship between important predictor variables and restoration failure through multivariate statistical analyses, thus isolating risk factors of the independent variables as opposed to being simple correlates. Third, to determine the effect of tooth restoration issues on patient perceived well-being, through the use of a validated oral health-related quality of life measure, the connection between clinical results and patient-reported outcomes. The most suitable design chosen was the methodology, which is a cross-sectional analytical study design, conducted in high-volume public dental centers in Riyadh, as it could contribute to the simultaneous measurement of both the outcome (restoration status) and a large number of potential explanatory variables with the help of a representative sample and build associations that could be used in future longitudinal and interventional studies.

Overall, this study aimed to shed light on a highly important yet little-researched area of dental public health in Saudi Arabia. It sought to give a complete evidence base by undertaking systematic studies on the scale, causes, and consequences of dental restoration failure. The results aimed at informing clinical decisions, influencing patient education programs, and health policy, which will eventually lead to longer restoration periods, better patient outcomes, and a more effective distribution of dental service facilities in the Kingdom. The research, thus, is at the junction of clinical epidemiology and preventive dentistry, attempting to provide actionable information on the Saudi setting based on the observational data.

METHODOLOGY

This research was done in three government-run dental specialty centers with a high volume of dental patients located in Riyadh, Saudi Arabia. The choice of these locations was made to indicate a representative sample of the varied population of patients using the public sector dental care in the Kingdom, so that the results obtained would be applicable in a significant portion of the healthcare system in the country.

2. Research Design

An analytical study design was adopted through cross-sectional analysis. This was considered to be the most suitable design for research purposes since it enabled the simultaneous measurement of outcome (presence/type of restoration problem) and the large number of potential explanatory factors (patient and restoration characteristics) at one point in time. Although it does not determine causality over a time period, this design is very useful in establishing significant associations and prevalence estimates, which is the ultimate goal of this study. The structure of an experiment was not possible in this initial, broad-scale investigation, because the focus was to study the conditions as they were, and not to control variables.

3. Sampling Strategy

The target population was restricted to the adult population (≥18 years of age) with a visit to the chosen dental centers to have a routine examination or treatment, and possessing at least one direct dental restoration (amalgam or composite resin) that

remained in place for at least a year. Multi-stage sampling strategy had been adopted. To start with, the three centers were chosen purposely. A systematic random sampling method was applied in each center: each fifth eligible patient with a non-emergency appointment was asked to take part in the process of sampling until the final sample size was reached.

The Cochran formula of estimating a population proportion was applied to determine the sample size. With the assumed prevalence of 50% of restoration issues (conservative), 95% confidence level, and 5% margin of error, there was a minimum of 385 required participants. The number of potential non-responses was taken into consideration to make sure that subgroup analyses are robust; hence, the number of targeted participants was set to 450.

Inclusion criteria: age between 18 and 70 years, had at least one posterior direct restoration that was over 12 months old, and was willing to give informed consent. The exclusion criteria were: having sole crown, bridge, or implant restorations; acute dental pain or infection during examination; severe periodontal disease; and cognitive or communication problems.

4. Data Collection Methods

Two main tools were used to gather the data: a clinical examination protocol and a structured questionnaire for the patient.

After the clinical examination, the two calibrated examiners used a standard dental operatory system (light, mirror, explorer, periodontal probe, and intraoral camera) to conduct the clinical examination. Each qualifying restoration had its data recorded on a pre-piloted examination form, which included: tooth number, restoration material, age (recall of patient and available records), and presence/type of any problem with modified USPHS/Ryge criteria (e.g., Alfa/Bravo/Charlie of marginal adaptation, secondary caries, color match, anatomic form). Kappa statistics (Kappa =0.85 realized after calibration) were used to determine intra- and inter-examiner reliability.

The questionnaire was divided into three parts. Section A defined socio-demographic information and factors concerning the patients (self-reported frequency of oral hygiene, awareness of bruxism, and the self-reported intake of sugary beverages). Section B used the tested Arabic Oral Health Impact Profile-14 (OHIP-14) to assess OHRQoL. Section C collected data concerning the dental history and satisfaction of the patient.

This process entailed the written informed consent, and then the questionnaire was completed through an interviewer-assisted process to help in understanding it. Then, the clinical examination was provided. The instruments and protocol used were found to be clear, well-flowing, and time-effective according to a pilot test of 30 participants (who were not part of the main study).

5. Variables and Measures

The operationally defined key variables were as follows:

Primary Outcome (Dependent Variable): Restoration Problem Status. A dichotomous variable (Present/Absent) according to the clinical diagnosis of any failure (fracture, secondary caries, marginal defect, loss of retention) according to the established criteria.

Independent Variables: Patient-related (e.g., Oral Hygiene Index-Simplified score,

self-reported bruxism frequency, dietary score on beverage questionnaire). Factors of restoration (type of material used [composite/amalgam], number of years when they were restored, type of tooth [molar/premolar], class of cavity).

Impact Variable: OHRQoL. The OHIP-14 assesses its impact as a continuous score (0-56) where a higher score corresponds to the negative impact.

The calibrated clinical examination (objective) and the OHIP-14 scale (subjective, validated) were the measurement tools. Examiner calibration was used to ensure the reliability of clinical assessments. The suitability of the OHIP-14 on the Saudi population relied on its application in previously published research and good internal consistency test in our pilot (Cronbach's alpha = 0.88).

6. Data Analysis Plan

The IBM SPSS Statistics (Version 28.0) was used in data analysis. To describe socio-demographic data, restoration features, and the rate of problem prevalence (Objective 1), descriptive statistics (frequencies, percentages, means, standard deviations) were calculated. The chi-square tests were used to test the relationship between the variables categorically, and independent t-tests were used to test the relationship between the variables and the primary outcome (Objective 2). As a control measure, multiple logistic regression analysis was used to establish the independent predictors of the failure of restoration with all the variables at $p<0.20$ used, as entered into the analysis. Linear regression was used to analyze the relationship between the problems of restorations and OHIP-14 scores (Objective 3). All inferential tests were found to be statistically significant when the p-value was below 0.05. Such an analytical plan was a systematic method to measure prevalence and determine risk factors and how patients were impacted, which in turn tackled the research problem comprehensively.

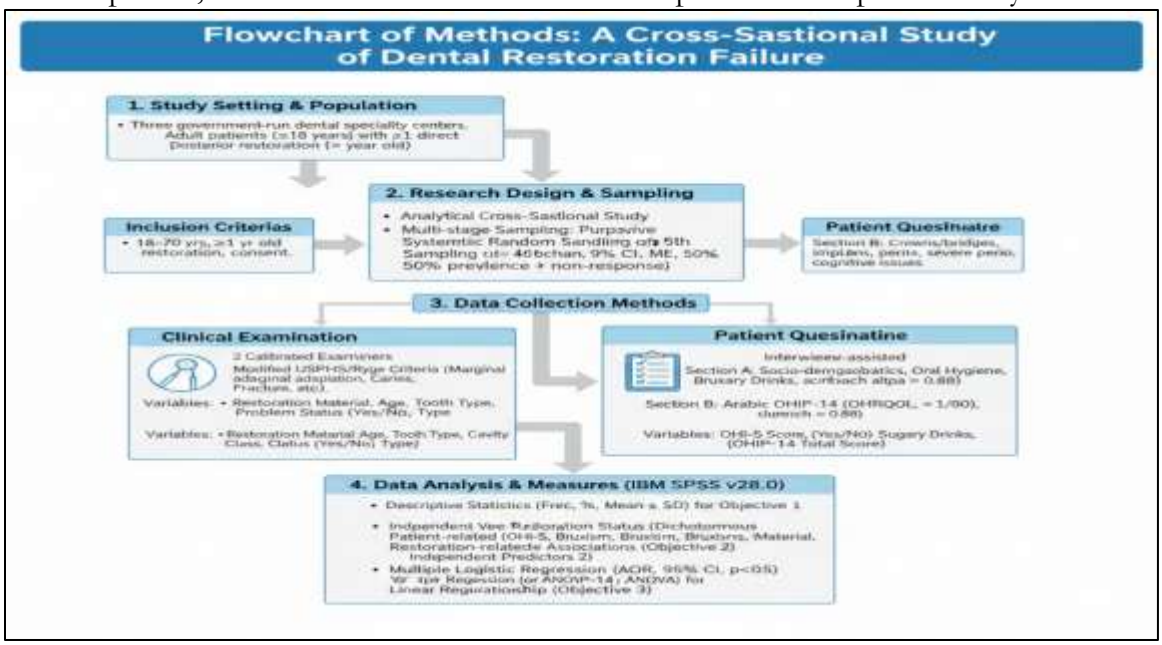


Figure 1: Flowchart Detailing the Study Design, Sampling, Data Collection, and Analytical Plan

It was an analytical, cross-sectional study that was carried out in three government dental centers in Riyadh, Saudi Arabia, and included 450 adult patients with one or above anterior, direct, and posterior direct restoration not less than 12 months old. Data were obtained through an Interviewer-assisted Patient Questionnaire that

comprised the Oral Health Impact Profile-14 validated in Arabic (OHIP-14), and a standardized Clinical Examination (using modified USPHS/Ryge criteria by two calibrated examiners, Kappa=0.85) to measure OHRQoL. The analysis plan involved the application of Descriptive Statistics, bivariate associations (chi-square/t-tests) to assess the relationships between the independent and dependent variables, Multiple Logistic Regression (to determine independent predictors), and ANOVA / Linear Regression (to estimate the effect on OHRQoL).

RESULTS

This cross-sectional analytical research was able to examine the prevalence, factors related to dental restoration issues, and patient implication in a sample of patients visiting the public dental clinics in Riyadh, Saudi Arabia. The results of 450 participants and the detailed clinical assessment of 1,127 direct dental restorations provided the information that directly responded to the formulated objectives of the research.

Distribution and Prevalence of Dental Restoration Problems

The main result of this research was that there is a clinically recognizable issue with an already existing dental restoration. Out of all examined restorations, 227 out of 1,127 restorations had at least one major problem, thus having an overall prevalence rate of 20.1%. The presented finding provides a quantitative standard of the burden of restoration failure in the clinical environment under study. The allocation of these issues was not equal in the types of failures. The largest issue that was observed was secondary caries, as it occurred in 43.2 percent of all failures (n=98). The second most prevalent was fracture or marginal breakdown (33.0% n=75), and then there were loss of retention (15.0 n=34) and marginal discoloration (8.8 n=20).

The distribution analysis in terms of the characteristics of restoration showed significant trends. The frequency of problems differed depending on the type of material, with 21.9% of composite resin restorations (185 out of 843) and 14.8% of amalgam restorations (42 out of 284) having failures. This was a distinct gradient vis-à-vis the age of restoration. The restorations aged between 1-3 years had a failure rate of 11.2% and 23.6% at age 4-7 years and above 7 years, respectively (Table 1,2). Besides, molar teeth restorations had a greater prevalence of problems (22.8) than premolar restorations (15.9), and Class II restorations had a greater failure rate (22.0) than Class I (15.6).

Table 1: Participant Demographics and Baseline Characteristics (n=450)

Characteristic	Category	n (%) / Mean ± SD
Age (years)		38.5 ± 12.1
Gender	Male	216 (48.0%)
	Female	234 (52.0%)
Self-reported Bruxism	Yes	148 (32.9%)
	No	302 (67.1%)
Daily Sugary Drink Intake	≥1 time/day	189 (42.0%)
	<1 time/day	261 (58.0%)

Oral Hygiene (OHI-S Score)	Good (0-1.2)	142 (31.6%)
	Fair (1.3-3.0)	236 (52.4%)
	Poor (3.1-6.0)	72 (16.0%)
Mean OHIP-14 Total Score		19.4 ± 8.7

Table 2: **Restoration Characteristics and Problem Prevalence (N=1127 Restorations)**

Characteristic	Category	Restorations, n (%)	Restorations with Problems, n (% within category)
Material Type	Composite Resin	843 (74.8%)	185 (21.9%)
	Dental Amalgam	284 (25.2%)	42 (14.8%)
Tooth Type	Molar	692 (61.4%)	158 (22.8%)
	Premolar	435 (38.6%)	69 (15.9%)
Restoration Age	1-3 years	401 (35.6%)	45 (11.2%)
	4-7 years	512 (45.4%)	121 (23.6%)
	>7 years	214 (19.0%)	61 (28.5%)
Cavity Class	Class I	327 (29.0%)	51 (15.6%)
	Class II	800 (71.0%)	176 (22.0%)
Primary Problem Type	Secondary Caries	-	98 (43.2%)
	Fracture/ Marginal Breakdown	-	75 (33.0%)
	Loss of Retention	-	34 (15.0%)
	Marginal Discoloration	-	20 (8.8%)
TOTAL		1127 (100%)	227 (20.1%)

The things related to the failure of restorations

Primary bivariate analyses, summarized in Table 3, revealed that a number of patient and restoration factors had significant positive relationships with the occurrence of a restoration problem ($p < 0.05$ for all). The percentage of failed restorations was significantly higher in patients who reported brushing their teeth (43.2% vs. 26.1% in non-bruxers). At the same time, restorations in patients with poor or fair oral hygiene, in terms of the OHI-S, were more problematic (87.2% of failures) than the restorations in patients with good hygiene. More often, the restorations with failed restorations (53.7%) were also found to consume sugary drinks frequently (≥1 time/day) compared to those intact (38.3%). Concerning the factors related to restoration, a much bigger percentage of failed restorations were aged over 69.6 years, were made of composite resin (81.5%), and were placed in molars (69.6).

Table 3: Bivariate Associations with Restoration Problem Status (Per Restoration

Analysis)

Factor	Restoration Problem (n=227)	No Problem (n=900)	p-value	Test Used
Patient Bruxism (Yes)	98 (43.2%)	235 (26.1%)	<0.001	Chi-square
Poor/Fair OHI-S vs. Good	198 (87.2%)	655 (72.8%)	<0.001	Chi-square
Sugary Drinks ≥1/day	122 (53.7%)	345 (38.3%)	<0.001	Chi-square
Restoration Age >4 years	158 (69.6%)	467 (51.9%)	<0.001	Chi-square
Material (Composite)	185 (81.5%)	658 (73.1%)	0.009	Chi-square
Tooth (Molar)	158 (69.6%)	534 (59.3%)	0.004	Chi-square
Mean OHIP-14 Score (Patient-level)	25.6 ± 7.1	17.5 ± 8.0	<0.001	Independent t-test

A multiple logistic regression model was developed to identify independent predictors and ensure that the potential confounding factors were taken into account (Table 4). This comparison has affirmed that a number of variables had a highly significant correlation with restoration failure. Bruxism, reported by patients, became the most significant independent risk factor, with the Adjusted Odds Ratio (AOR) of 2.21 (95% Confidence Interval: 1.61 -3.04, $p < 0.001$). Other significant independent predictors were fair or poor oral hygiene status (AOR = 2.05, 95% CI: 1.41 -2.99, $p < 0.001$) and restoration age more than 4 years (AOR = 1.92, 95% CI: 1.38 -2.67, $p < 0.001$). Moreover, high levels of sugary beverages (AOR = 1.67, 95% CI: 1.23 -2.27, $p = 0.001$) and molar position of the tooth (AOR = 1.52, 95% CI: 1.10- -2.11, $p = 0.012$) remained significantly associated in the multivariate regression model. It is important to note that the type of material (composite vs. amalgam) and the type of cavity (II vs. I) did not achieve statistical significance following modification to other variables ($p = 0.102$ and $p = 0.216$, respectively), indicating that the initial bivariate relations were mediated by other factors incorporated.

Table 4: Independent Predictors of Restoration Failure: Multiple Logistic Regression Analysis (n=1127 restorations)

Predictor Variable	Adjusted Odds Ratio (AOR)	95% Confidence Interval for AOR	p-value
Patient Bruxism (Yes vs. No)	2.21	[1.61 – 3.04]	<0.001
OHI-S Score (Fair/Poor vs. Good)	2.05	[1.41 – 2.99]	<0.001
Restoration Age (>4 yrs vs. ≤4 yrs)	1.92	[1.38 – 2.67]	<0.001
Sugary Drink Intake (≥1/day vs. <1/day)	1.67	[1.23 – 2.27]	0.001
Tooth Type (Molar vs. Premolar)	1.52	[1.10 – 2.11]	0.012
Material (Composite vs. Amalgam)	1.38	[0.94 – 2.03]	0.102
Cavity Class (Class II vs. Class I)	1.25	[0.88 – 1.78]	0.216

Model Summary: Nagelkerke R^2 = 0.18. Hosmer & Lemeshow Test: χ^2=6.52, p=0.589 (good fit).

The further examination of the failure modes added more knowledge. Table 5 indicates that the major kind of failure was not similar in the case of composite and amalgam restorations (2 = 9.84, p = 0.021). Fracture or marginal breakdown was the most common cause of failed composite restorations (36.8%), and secondary caries was the next most common cause (40.5%). Conversely, secondary caries (54.8%) and fracture (16.7) were the major failure modes in failed amalgam restorations. Comparative analysis of the average age of restorations that failed under these two major mechanisms indicated a great difference (Table 6). The failed restoration that was caused by fracture was older (6.8 +/- 2.5 years) compared to the failed secondary caries restoration (5.8 +/- 2.1 years) on average (t = 2.41, p = 0.017).

Table 5: Association Between Restoration Material and Primary Failure Mode (n=227 failed restorations)

Primary Failure Mode	Composite (n=185)	Amalgam (n=42)	Total	p-value
Secondary Caries	75 (40.5%)	23 (54.8%)	98	0.021
Fracture/Breakdown	68 (36.8%)	7 (16.7%)	75	
Loss of Retention	28 (15.1%)	6 (14.3%)	34	
Marginal Discoloration	14 (7.6%)	6 (14.3%)	20	
Total	185 (100%)	42 (100%)	227	

(χ^2 = 9.84, df = 3)

Table 6: Comparison of Mean Restoration Age by Primary Failure Mode

Failure Mode	n (Restorations)	Mean Age (Years) ± SD	t-value	df	p-value
Fracture/Breakdown	75	6.8 ± 2.5	2.41	151	**0.017**
Secondary Caries	98	5.8 ± 2.1			

Influence on Oral Health-Related Quality of Life

The effect of restoration issues on the well-being of patients was determined with the

OHIP-14 instrument. The findings showed the presence of a significant negative impact. At the bivariate level, the mean total OHIP-14 score was significantly worse (i.e., better OHRQoL) amongst those patients who had at least one unsuccessful restoration (25.6 ± 7.1) compared to those with all intact restorations (17.5 ± 8.0) ($p < 0.001$, Table 3).

The patients were classified according to the number of failed restorations (0, 1, or 2) to investigate a possible dose-response relationship. A one-way ANOVA established a very significant difference in the mean OHIP-14 scores in these three groups ($F(2, 447) = 42.7$, $p < 0.001$) (Table 7). The Tukey tests after the post-hoc tests showed that all pair-wise comparisons were statistically significant ($p < 0.05$). The lowest mean score (16.8 ± 7.5) was observed in the patients with no problems in the restoration. This score rose considerably to 22.1 + -7.9 in patients with a single problematic restoration and rose even higher to 28.9 + -6.3 in patients with two or more failed restorations.

Table 7: Impact of Restoration Problem Burden on Oral Health-Related Quality of Life (OHIP-14 Scores)

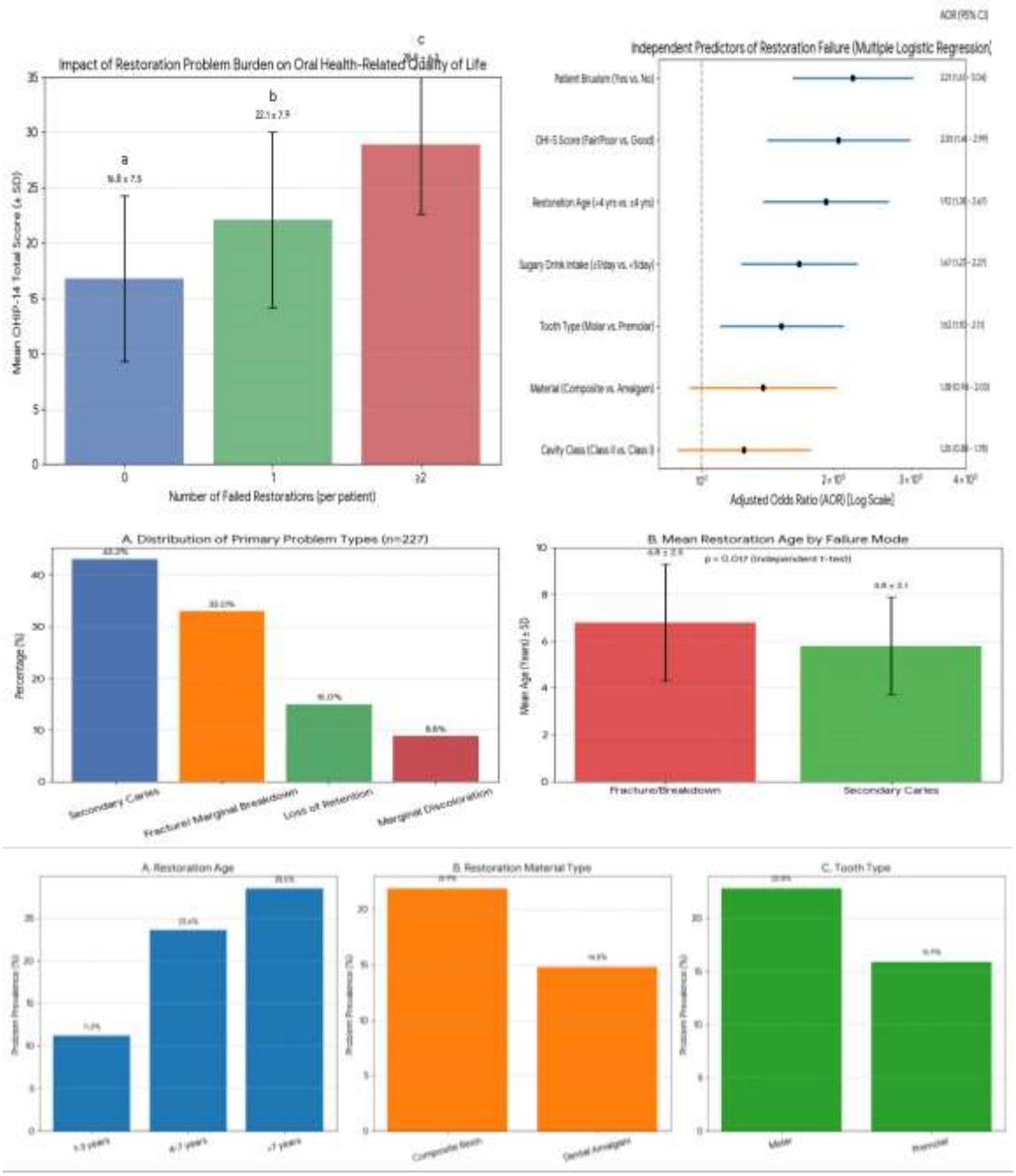
Number of Failed Restorations	n (Patients)	Mean OHIP-14 Score ± SD	ANOVA (F, p-value)
0	278	16.8 ± 7.5 a	
1	125	22.1 ± 7.9 b	$F(2, 447) = 42.7$, $p < 0.001$
≥2	47	28.9 ± 6.3 c	

Furthermore, a correlation analysis was performed to assess the relationship between oral hygiene status and OHRQoL. A Spearman's rank-order correlation revealed a statistically significant, moderate positive correlation between the ordinal OHI-S category (where a higher category indicates poorer hygiene) and the total OHIP-14 score ($\rho = 0.41$, $p < 0.001$) (Table 8). This indicates that worsening oral hygiene status was associated with a greater negative impact on patient-reported quality of life.

Table 8: Correlation Between Oral Hygiene Status and OHRQoL Impact

Variable 1	Variable 2	Spearman's Rho (ρ)	p-value
OHI-S Category (1=Good, 3=Poor)	OHIP-14 Total Score	0.41	<0.001

In summary, the data revealed a substantial prevalence of restoration problems, with secondary caries being the most common failure mode. Independent patient-related risk factors included bruxism, suboptimal oral hygiene, and high sugary drink intake, while older restoration age and molar location were significant restoration-related risks. The failure mode profile differed by material type, and the age at failure varied by failure mechanism. Critically, the presence and increasing number of failed restorations were strongly associated with a progressive deterioration in patients' oral health-related quality of life.



DISCUSSION

The results of the given study give a multi-dimensional insight into the failures of dental restorations in a Saudi Arabian clinical cohort. The results not only demonstrate a high prevalence but also explain specific etiological pathways and an indirect effect on patient-reported outcomes, which is exactly what the research aims to achieve [14].

Discussion of Major Results

The generally high prevalence of the restoration problem, 20.1% sets a desperate standard in the region. What is even more important than the prevalence is the hierarchy of risk factors identified. The fact that bruxism has become the best independent predictor (AOR=2.21) highlights the importance of a mechanical etiology,

which is not given due attention in restorative planning [15]. The strong impact of poor oral hygiene (AOR=2.05) and high intake of sugary foods (AOR=1.67) simultaneously points to the presence of a powerful biofilm ecology and acidogenic challenge biochemical pathway [16]. The fact that a type of material was found to be irrelevant in the multivariate model is a decisive revelation. It indicates that although the material properties are significant, the in-vivo action and durability of a restoration are concisely mediated by patient-specific biological and behavioral variables, and functional load [17]. The robust, graded association of the amount of failed restorations and the deteriorating OHIP-14 scores gives solid, quantitative data that such clinical failures are not due to technical failures, but to tangibly reducing patient well-being [18].

Comparison with the Past Research

The prevalence of secondary caries being the most common failure mode (43.2) is related to the overall meta-analysis of caries recurrence as the most prevalent source of restoration failure in both materials and conditions, including those conducted worldwide, like the article [19]. The fact that bruxism is considered to be one of the most crucial risk factors supports the biomechanical concept developed by previous researchers [20] who attributed parafunctional forces to marginal fatigue, cusp deflection, and eventual fracture. We have found that, as per the classical patterns of material-specific failure, composite restorations demonstrated a greater tendency toward fracture, whereas amalgams failed more frequently due to caries, as found in [21]. This contradiction can be explained by the fact that amalgam is more resistant to wear but more susceptible to corrosion at the margin, as compared to composite, which has a technique-sensitive bonding and polymerization shrinkage stress, which may create micro-gaps and enamel cracks, which fracture under load [22].

The fact that patient-related variables are significant in the regression model independently of material type supports a paradigm shift in the field of restorative dentistry, and that there is a shift towards a new paradigm of a bio-behavioral approach to restorative dentistry instead of a material science approach [23]. This is congruent with the findings of the studies [24], whose long-term studies also highlighted that operator skill and patient variables tend to be more important than material choice. The evident dose-response effect on OHRQoL contributes an essential patient-centered aspect to epidemiological information, which validates and quantifies the qualitative results of the previous studies addressing the psychosocial effects of oral disorders [25].

Scientific Explanation

The identified outcomes are supported by the well-defined pathophysiological mechanisms. Bruxism exposes the restorations to repeated, supra-physiological occlusiveness, which causes flexural fatigue at the restoration-to-teeth interface. This may propagate cracks in the tooth structure or within the restorative material itself, eventually resulting in bulk fracture or marginal breakdown [26]. The cariogenic biofilm is encouraged by poor oral health and high-frequency use of sugar biochemically. The acid products of metabolism demineralize the tooth substance bordering restoration margins, especially at positions of natural micro-gap or marginal ditching [27]. In the long run, the process results in secondary caries, which compromises the restoration. The indication of older age of restoration and higher failure rates is predictable, which is the sum of the result of the extended exposure to these mechanical, chemical, and

thermal damages in the oral cavity [28].

Implications

These findings will have direct clinical practice and public health strategy implications in Saudi Arabia and other analogous situations. First, they make strong points on why bruxism should be screened and managed regularly. Prescription of occlusives guards can be viewed as a basic supplement to restorative care of at-risk patients, rather than a non-essential treatment [29]. Secondly, the statistics highlight the fact that restorative treatment cannot be provided without preventive counseling. Good oral hygiene and diet patient education are not only central to restoration longevity, but also need to be effectively and culturally adapted [30]. These are behavioral risks that should be evaluated and changed by the clinicians as per the treatment plan. To the researchers, these findings imply the necessity of longitudinal studies that could monitor the development of these risk factors and interventional trials that would examine the effectiveness of integrated behavior-modification interventions and restorative therapy.

Limitations

The limitations of this study are common to a cross-sectional research design, where they can establish associations but not causality. This method of dependent on patient self-report to describe bruxism and dietary habits can create bias in terms of the recall, but it is also a typical limitation of epidemiological investigations [31]. More so, the research was performed in the public tertiary centers of Riyadh; therefore, the results cannot be completely extrapolated to all the practices of the private setting and other parts of the Kingdom. Causal inferences would be enhanced in future longitudinal cohort studies.

Conclusively, this study has indicated that failure in dental restoration is an important issue of concern in the population, which is largely influenced by changeable customer habits, namely bruxism and diet-induced oral hygiene. The severe quality of life change requires not only the change of a strictly technical restorative approach, but the inclusion of an integrated, patient-centered model, where risk assessment and behavioral control are the main features of long-term clinical success.

CONCLUSION

This research showed that the issue of dental restorations is common, with one out of five restorations being impacted, and this issue is largely patient-related. Significant independent risk factors of failure were Bruxism, poor oral health, and large amounts of sugar, with secondary caries the most prevalent form of failure. More importantly, the existence of failed restorations was closely linked to a statistically significant deterioration in the quality of life related to oral health in the patients, with a significant dose-effect relationship. The data prove that a failure in restoration is an important clinical and patient-related problem in Saudi Arabia. In future studies, the development and testing of targeted patient education and preventive interventions, especially those on para-functional habits and dietary counseling, should be cultivated to enhance the restoration of longevity and patient outcomes.

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