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Factors Associated with the Clinical Outcome of Posterior Resin Composite Restorations among Patients Treated at Three Dental Facilities in Nairobi, Kenya: A Cross-sectional Study

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Abstract

Background

Posterior resin composite restorations (RCRs) are widely used in minimally invasive dentistry due to their esthetic and biomechanical advantages. However, they exhibit variable longevity, with failures often attributed to secondary caries, fractures, and marginal degradation. While material and technique-related factors have been extensively studied, patient sociodemographic and behavioral factors remain under-explored, particularly in low- and middle-income settings such as East Africa. This study aimed to investigate the influence of patient related factors on the performance of posterior RCRs in a Kenyan cohort using modified United States Public Health Service (USPHS) criteria.

Methods

This cross-sectional study examined 286 posterior RCRs in 95 participants (aged ≥ 18 years) from three dental facilities in Nairobi, Kenya (a public hospital, a teaching hospital, and a private clinic), where restorations were placed between 2014 and 2019. Participants were selected via stratified random sampling by year of placement and facility, followed by convenient sampling from daily registers. Data were collected through an interviewer-administered questionnaire on sociodemographics, oral hygiene habits, dietary practices, dental visit frequency, and medical history, alongside clinical examination using the plaque index (Löe and Silness, 1964) and modified USPHS criteria for restoration evaluation. Restorations were classified as successful (Alpha or Bravo scores, except Bravo for secondary caries) or failed (Charlie scores plus Bravo for secondary caries). Data were analyzed in STATA version 19 using modified Poisson regression with clustered robust standard errors (clustering by participant). Bivariate analysis selected variables ($p < 0.2$) for multivariate modeling, with stepwise estimation retaining significant variables ($p < 0.05$).

Results

Of the 286 restorations, 191 (66.8%) were successful and 95 (33.2%) failed. The median participant age was 38 years (IQR 30–46), with near-equal gender distribution (50.5% male). Most participants had tertiary education (68.4%) and brushed twice or more daily (69.5%), but flossing was uncommon (18.9%). At multivariate analysis, restoration age (adjusted prevalence ratio [aPR] 1.23, 95% CI 1.07–1.42, $p = 0.005$) and plaque score (aPR 1.32, 95% CI 1.01–1.73, $p = 0.042$) were significantly associated with failure. For every unit increase in restoration age or plaque score, the likelihood of failure increased by 23% and 32%, respectively. No significant associations were found with sociodemographic factors (gender, employment, education), brushing frequency, dental visit patterns, grinding, tooth type, or surface configuration after adjustment.

Conclusion

In this East African cohort, older restorations and higher plaque scores were independently associated with poorer performance of posterior RCRs. These findings emphasize the importance of long-term

monitoring and patient-centered preventive strategies, including oral hygiene reinforcement, to enhance restoration longevity. Future prospective studies in similar settings should explore behavioral mediators and longer follow-up periods to better inform clinical practice in resource-constrained environments.

BACKGROUND

Resin composite restorations have gradually become the go to restoration among dental practitioners in minimally invasive dentistry.(1) This trend has come about with the advancements in the quality of the available resin composite materials which has accorded them superior qualities like strength, esthetics and adhesion.(2) The Minamata convention has also inflated the shift to RCR as amalgam use is increasingly phased out worldwide.(3, 4) Their relevance additionally stems from biomechanical compatibility with dentin, reduced cuspal deflection, and mercury-free composition, aligning with patient-driven demands for conservative, biocompatible interventions in high-caries-risk populations.(5, 4)

Despite their superior properties mentioned above, resin composite restorations are more delicate than the more traditional options when being manipulated to be used as fillings. They are highly reactive to moisture, etching time, bond material, curing mode and are thus highly technique sensitive.(6, 7) As such, the annual failure rate of composite restorations has been reported to range from 0.94% to 9.43% from different studies.(8, 9) In Sub Saharan Africa, a study among dentists in Côte d'Ivoire revealed a failure rate of 9.61% after 5 years. The cost of replacing failed restorations imposes a heavy economic burden at an astounding 2.98 billion dollars annually, which is 4.6% of the global oral health expenditure. (4)

The reasons for failure of RCR have been explored in different studies and have been postulated to be due to secondary caries at marginal interfaces, bulk fracture under occlusal stress, and postoperative hypersensitivity attributable to polymerization shrinkage and incomplete marginal seal.(10, 11, 12) Despite robust investigation into material science and operative techniques, sociodemographic and oral-behavioral determinants such as socioeconomic status, dietary acidity exposure, parafunctional habits, and oral hygiene compliance remain understudied confounders in restorative outcomes.

Various studies have demonstrated that patient related characteristics play a significant role in the success of RCR, often independent of clinical variables.(13) These factors range from age, oral hygiene habits, dietary habits, parafunctional habits, socioeconomic status and even gender has been highlighted to play a role in a 2016 study conducted by Laske.(14) Behavioral factors such as tooth brushing habits and dietary tendencies influence the survival of RCR by modifying the oral environment.(15, 16) Snacking and excessive consumption of cariogenic foods causes prolonged exposure to sugar and other fermentable carbohydrates which leads to protracted acidification.(17) The resulting biochemical challenges create harsh environmental conditions for the tooth structure and adhesive interfaces and lead to processes like hydrolysis, leaching, fatigue, and cracking which negatively affects the success of RCR.(18)

The use of fluoride containing dentifrices has been repeatedly validated to provide a protective effect against dental caries. By extension, patients who practice oral hygiene habits are more likely to have successful RCR because increased exposure to fluoride protects the remaining tooth structure and prevents recurrent and secondary caries which are hallmark signs of RCR failure.(19, 20)

Age and gender have also been found to affect the success of RCR in various studies. Increased failure rates for direct resin composite restorations were observed during adolescence and after age 65.(11) Older individuals are likely to have a more compromised oral environment due to an aging periodontium, xerostomia inducing medication, various systemic illnesses, impaired motor function and inability to maintain their oral hygiene.(21, 22) Laske also suggested that the higher prevalence of partial prostheses in the older populations could cause increased failure of RCR as patients with removable dentures frequently struggle to clean them effectively, leading to plaque accumulation. However, some research indicates that patient gender alone does not influence the durability of composite restorations, suggesting that other patient factors play a more substantial role (8). Indeed, the interplay of several patient-specific variables, rather than a single demographic marker, likely dictates restoration longevity (23). For instance, a study found that females exhibited a lower risk of restoration failure compared to males, while teens and adults over 70 years of age had a higher risk (13).

Clinical characteristics, including restoration age, plaque accumulation, chronic diseases, and patient satisfaction, also warrant attention as potential predictors of RCR performance. Longitudinal studies indicate that restoration longevity diminishes over time, with survival rates dropping markedly beyond 4 years due to cumulative wear, marginal degradation, and environmental stressors (24, 25). For instance, meta-analyses report reduced odds of success for older restorations (OR approximating 0.3 for those > 4 years compared to newer ones), highlighting time-dependent failure risks independent of initial placement quality (26). Plaque scores, as indicators of oral hygiene, may correlate with secondary caries risk, though bivariate associations are often non-significant ($p > 0.2$), suggesting indirect mediation through behavioral factors (27). Chronic conditions like diabetes and hypertension could exacerbate failures via impaired healing or xerostomia, but evidence remains equivocal, with odds ratios showing no clear associations in some cohorts (OR 1.22–3.6, $p > 0.2$) (28). Patient satisfaction, potentially reflecting perceived functionality and esthetics, has not consistently predicted objective outcomes, with non-significant bivariate links ($p > 0.3$) across satisfaction levels (29).

Despite robust evidence on clinical predictors, few studies in East Africa have investigated the influence of examined patient sociodemographic and behavioral factors and their possible influence on RCR using standardized clinical criteria such as modified USPHS. Most studies are limited to high-income settings with homogeneous populations, restricting generalizability to diverse socioeconomic contexts. Moreover, it remains unclear whether behavioral variables mediate socioeconomic effects or exert independent influence.

This study addresses critical gaps in the literature on posterior resin composite restoration outcomes by being the first to simultaneously examine sociodemographic factors, oral habits, dental health-seeking

behaviors, and detailed clinical characteristics (dental arch, tooth type, and restoration surface configuration) within a Kenyan cohort in East Africa. While prior research has predominantly focused on clinical predictors in high-income settings or isolated patient-related factors in middle-income contexts, none have integrated these multidimensional variables using standardized USPHS criteria. Drawing observations from three settings, a teaching hospital, a private dental clinic and a public hospital's dental clinic, this study aimed to provide novel insight on how sociodemographic factors, oral habits, dental health-seeking behaviors influence restoration survival.

STUDY DESIGN

This was a cross-sectional study.

Study Area

The study was conducted at three different dental clinics located in Nairobi Kenya. The clinics represented a public setting:Kenyatta National Hospital dental department, a teaching hospital:UoN Dental School and a private clinic:UoN Dental Plaza.

Study Population

The study population consisted of patients who had had posterior resin composite restorations placed at the three dental clinics between 2014 and 2019. The patients should have met the eligibility criteria before getting recruited and patient records were used to select those who had had their restorations placed within the 5 year time frame.

Sample size estimation and sampling method

The sample size was calculated using the Kish Leslie method for single proportion. A total of 286 posterior RCRs distributed among 95 participants were examined. Sampling was done by stratified random sampling by year of placement of the resin composite restoration and the facility where it was placed. Thereafter, an equal sample was conveniently selected from each of the facilities' daily work registers until the sample size was met.

Inclusion Criteria

- All participants who consented to the study.
- Participants in the three hospitals who had direct posterior composite restorations placed on permanent posterior teeth in the last 5 years (2014–2019) with proper records of these restorations.
- Participants above 18 years of age.

Exclusion Criteria

- Participants with incomplete records about the resin-composite restorations.
- Participants who did not consent for the study.
- Indirect resin-composite restorations as per the patients' dental records.
- Posterior resin composite restorations on deciduous teeth and other permanent teeth apart from premolars, molars.

Data Collection instruments and techniques

95 participants were selected from a list of all patients who had had posterior composite restorations placed at the different study sites. This list was formulated from patient records manually after obtaining permission from the site administrations. The participants were contacted via telephone call and were given appropriate appointments depending on mutual convenience and availability with the lead investigator. Written informed consent in either Swahili or English was sought from the participants after thorough explanation of the study, its risks and benefits.

Participants' data was treated with confidentiality including the information from their dental records but were at liberty to decline participation without any coercion.

The dependent variable is a categorical variable whose binary outcome is success or failure. This is the success of a posterior composite restoration, scored according to the USPHS criteria. The independent variables are the factors under investigation for their potential effect on the success of the PCR. These include sociodemographic characteristics (gender, employment, education, hospital), oral hygiene and behavioral characteristics(flossing, toothbrush use, brushing frequency, dental visit, and grinding), and clinical characteristics(chronic diseases, tooth type, tooth surface, satisfaction).

Questionnaire

An interviewer-administered questionnaire with socio-demographic data, oral hygiene practices, dietary habits, frequency of dental visits and medical history of systemic illnesses was used, Appendix II.

Clinical Examination

Clinical examination was done in a fully functional clinical setting, using a dental examination set with a dental mirror, a dental explorer and a WHO periodontal probe, and plaque score values were recorded using plaque index by Loe and Silness (1964). Evaluation of the posterior RCRs was then done using the USPHS tool, with data being recorded on the data collection tool appropriately.

Clinical data collection tool

The USPHS criteria (United States Public Health Service criteria), often called the Ryge criteria or Cvar and Ryge criteria, were originally developed in 1971 by John F. Cvar and Gunnar Ryge. It provides a standardized clinical evaluation system for assessing the quality and performance of dental restorations, including composite resin restorations. Presently, the more commonly used is the modified UHSPHS criteria which includes the Alpha, Bravo, Charlie and Delta as scoring points.

Alpha (A): Clinically ideal or excellent. This is scored when the restoration fully meets the highest standards for that category with no clinically detectable deficiencies.

Bravo (B): Clinically acceptable but with minor deviations from the ideal. This is scored when the restoration is still functional and does not require immediate replacement or repair.

Charlie (C): Clinically unacceptable (or unsatisfactory). This is scored when the restoration shows significant deficiencies that require repair or replacement to prevent future damage, progression, or failure.

Delta (D): Immediate failure or unacceptable. This is scored when the restoration requires immediate replacement due to severe issues that compromise tooth health, restoration integrity, or patient safety.

The USPHS tool was used for the Alpha (A) Bravo (B) Charlie (C) charting of the posterior RCRs. A modified version of the USPHS tool for tooth colored restorations was used and details were recorded using visual observation and clinical examination of the restorations. The following parameters were assessed:

- The restoration surface texture
- The anatomical contour of the restorations
- The colour match of the restoration to the shade of the tooth or difference there of
- The cavosurface marginal discoloration
- The marginal adaptation
- Presence or absence of secondary caries
- Gross fracture

Additional information on the particulars of the scoring of each of these parameters is available in appendix 1.

Data analysis

The collected data was tested for completeness and imported into STATA version 19 for cleaning and analysis. Continuous variables were summarized with medians and interquartile ranges while

categorical variables were summarized using frequencies and percentages.

The proportion of participants with successful and failed restorations was determined. The successful restorations were taken as combined Alpha or Bravo frequencies except for secondary caries where Bravo indicated restoration failure. Restoration failure was taken to be Charlie for all the USPHS parameters in addition to Bravo scores for secondary caries.

To determine factors associated with the clinical outcome of RCRs, modified poisson regression with clustered robust standard errors (clustering within participant identification number) was utilized. Bivariate analysis was done to select variables to include in the model at a p-values less than 0.2 as the criteria for inclusion. Interaction terms were formed between significant variables at bivariate and a likelihood ratio test was used to check for the significance of interaction. There was no significant interaction. Stepwise estimation was used to maintain significant variables at 0.05 level of significance. To check for the presence of confounding, a percentage change in prevalence ratios of > 10% was used to confirm confounding. There were no confounders present. The final model, including significant variables, their p-values and confidence intervals was reported.

Ethical considerations

Written informed consent was sought from participants in either Swahili or English after thorough explanation of the study, its risks, and benefits. Ethical approval was obtained from The Kenyatta National Hospital-University of Nairobi Ethics and Research Committee **(Protocol No. P760/08/2019).**

RESULTS

Clinical outcome of 286 posterior RCRs

Success of RCRs was taken to be combined Alpha or Bravo frequencies except for secondary caries where Bravo indicated restoration failure. Restoration failure was taken to be Charlie for all the USPHS parameters in addition to Bravo scores for secondary caries. The number of failed restorations was 95 (33.2%) whereas 191 (66.7%) were successful. As shown in Figure 1 below.

Socio-demographic characteristics

The median age of study participants was 38 (IQR 30, 46). The gender distribution was nearly equal with 49.5% females and 50.5% males. Most of the participants were employed (n=45, 47.4%), and a larger proportion had achieved tertiary level education (n=65, 68.4%). The majority of the participants were treated at UoNDS (n=44, 46.3%). The socio-demographic characteristics are summarized in Table 1.

Table 1: Socio-demographic characteristics of 95 participants treated at 3 dental facilities in Nairobi, Kenya

Variable	Frequency(N=95)	Percentage(%)
Gender		
Male	48	50.5
Female	47	49.5
Employment		
Employed	45	47.4
Self employed	35	36.8
Unemployed	15	15.8
Education		
Tertiary	65	68.4
Secondary	26	27.4
Primary	4	4.2
Hospital		
UoNDS	44	46.3
UoNDP	28	29.5
KNHDD	23	24.2

Oral hygiene and behavioural characteristics

The majority of the participants reported using a toothbrush to brush their teeth (n=93, 97.9%). Flossing was reported by 81.1% (n=77), while 69.5% (n=66) reported brushing their teeth more than once daily. Grinding was reported by 5.3% (n=5) of the participants, and 89.5% (n=85) reported visiting the dentist only on need basis. The oral hygiene and behavioural characteristics are summarized in Table 2.

Table 2: Oral hygiene and behavioural characteristics of 95 participants treated at 3 dental facilities in Nairobi, Kenya

Variable	Frequency(N=95)	Percentage(%)
Floss		
No	77	81.1
Yes	18	18.9
Toothbrush		
Yes	93	97.9
No	2	2.1
Brushing frequency		
Twice or more daily	66	69.5
Once daily	29	30.5
Dental visit		
On need basis	85	89.5
Once annually	6	6.3
Twice annually	4	4.2
Grinding		
No	90	94.7
Yes	5	5.3

Clinical characteristics

The median age of the restoration was 3 years (IQR 1,4) and the median plaque score was 0.75 (IQR 0.66, 0.92). Molars were the larger proportion of the teeth (71.3%, n=204) and mesio/disto- occlusal surfaces (n=145, 50.7%) were the majority of filled surfaces.The majority of the participants had no diagnosed chronic diseases (n=87, 91.5%), while 79% (n=75) reported being satisfied with the restoration done. The clinical characteristics are summarized in Table 3.

Table 3: Clinical characteristics of 95 participants treated at 3 dental facilities in Nairobi, Kenya

Variable	Frequency(N=95)	Percentage(%)
Chronic diseases		
None	87	91.5
Hypertension	5	5.3
Diabetes Mellitus	3	3.2
Tooth Type (n=286)		
Molar	204	71.3
Premolar	82	28.7
Tooth surface (n=286)		
Mesio/ Disto-occlusal	145	50.7
Occlusal	125	43.7
Mesio-occlusal-distal	14	4.9
Class V	2	0.7
Satisfaction		
Satisfied	75	79.0
Unsatisfied	10	10.5
Very satisfied	6	6.3
Very unsatisfied	4	4.2

Bivariate analysis of factors associated with the clinical outcome of posterior RCRs.

Variables with a p-value less than 0.2 at bivariate analysis were selected for multivariate analysis.

Socio-demographic characteristics associated with outcome of posterior RCRs

Gender had a p value less than 0.2 and was selected for multivariate analysis. The bivariate analysis for socio-demographic characteristics is summarized in Table 4

Table 4: Bivariate analysis of association between socio-demographic and the clinical outcome of posterior RCRs

Variable	Success	Failure	cPR	95% CI	P value
Age	33 (27, 42)	39 (28, 46)	1.01	0.99 - 1.03	0.213
Gender					
Male	116 (71.6%)	46 (28.4%)	1.00	Ref	Ref
Female	75 (60.5%)	49 (39.5%)	1.39	-0.11 - 0.77	0.140
Employment					
Employed	91 (66.4%)	46 (33.6%)	1.00	Ref	Ref
Self-employed	62 (62.6%)	37 (37.4%)	1.11	0.71 - 0.74	0.639
Unemployed	38 (76.0%)	12 (24.0%)	0.71	0.31 - 1.63	0.424
Education					
Tertiary	135 (67.5%)	65 (32.5%)	1.00	Ref	Ref
Secondary	47 (63.5%)	27 (36.5%)	1.12	0.71 - 1.79	0.625
Primary	9 (75.0%)	3 (25.0%)	0.77	0.13 - 4.39	0.768
Dental facility					
UoNDP	67 (65.0%)	36 (35.0%)	1.00	Ref	Ref
KNH	66 (71.7%)	26 (28.3%)	0.81	0.45 - 1.44	0.472
UoNDS	58 (63.7%)	33 (36.3%)	1.04	0.6 - 1.71	0.885

***Adjusted for clustering at participant level**

Oral hygiene and behavioural characteristics associated with the clinical outcome of posterior RCRs

The frequency of brushing had a p-value less than 0.2 and was selected for multivariate analysis. The bivariate analysis for oral hygiene and behavioural characteristics is summarized in Table 5.

Table 5: Bivariate analysis of association between oral hygiene and behavioural characteristics and the clinical outcome of the posterior RCRs.

Variable	Success	Failure	cPR	95% CI	P value
Floss					
No	160 (67.0%)	79 (33.0%)	1.00	Ref	Ref
Yes	31 (66.0%)	16 (34.0%)	1.03	0.70 - 1.53	0.883
Toothbrush					
No	4 (80%)	1 (20%)	1.00	Ref	Ref
Yes	187 (66.5%)	94 (33.5%)	1.91	0.18 - 15.71	0.653
Brushing frequency					
Twice or more	129 (63.5%)	74 (36.5%)	1.00	Ref	Ref
Once	62 (74.7%)	21 (25.3%)	0.69	0.40 - 1.21	0.198
Dental visits					
Need basis	169 (68.1%)	79 (31.9%)	1.00	Ref	Ref
Once annually	14 (56.0%)	11 (44.0%)	1.38	0.75 - 2.56	0.304
Twice annually	8 (61.5%)	5 (38.5%)	1.21	0.49 - 2.97	0.682
Grinding					
No	184 (67.4%)	89 (32.6%)	1.00	Ref	Ref
Yes	7 (53.8%)	6 (46.2%)	1.42	0.80 - 2.51	0.234

***Adjusted for clustering at participant level**

Clinical characteristics associated with the clinical outcome of posterior RCRs

The age of restoration, plaque score and tooth surface had p-values less than 0.2 and were therefore selected for multivariate analysis. The bivariate analysis for clinical characteristics is summarized in Table 6.

Table 6: Bivariate analysis of association between clinical characteristics and the clinical outcome of posterior RCRs.

Variable	Success	Failure	cPR	95% CI	P value
Age of restoration	2.00 (1.00, 4.00)	3.00 (2.00, 5.00)	1.23	0.06 - 0.35	0.005
Plaque score	0.75 (0.58, 0.83)	0.75 (0.67, 0.92)	1.33	-0.05 - 0.63	0.098
Tooth surface					
Mesio/Disto-occlusal	93 (64.1%)	52 (35.9%)	1.00	Ref	Ref
Occlusal	90 (72.0%)	35 (28.0%)	0.78	0.52 - 1.17	0.229
Mesio-occluso-distal	7 (50.0%)	7 (50.0%)	1.39	0.70 - 2.79	0.349
Class V	1 (50.0%)	1 (50.0%)	1.39	1.10 - 1.77	0.007
Tooth type					
Molar	139 (68.1%)	65 (31.9%)	1.00	Ref	Ref
Premolar	52 (63.4%)	30 (36.6%)	1.15	0.75 - 1.75	0.518
Satisfaction					
Unsatisfied	19 (63.3%)	11 (36.7%)	1.09	0.61 - 1.93	0.779
Very satisfied	12 (70.6%)	5 (29.4%)	0.87	0.45 - 1.68	0.679
Very unsatisfied	11 (78.6%)	3 (21.4%)	0.63	0.11 - 3.66	0.611

***Adjusted for clustering at participant level**

Multivariate regression analysis for factors associated with the clinical outcome of posterior RCRs.

The age of the restoration and plaque score were found to be significantly associated with the clinical outcome of posterior RCRs at multivariate analysis. The results of the multivariate analysis are summarized in Table 7.

Table 7: Multivariate analysis of factors associated with the clinical outcome of RCRs.

Variable	aPR	95% CI	P value
Age of restoration	1.23	1.07 - 1.42	0.005
Plaque score	1.32	1.01 - 1.73	0.042

***Adjusted for clustering at participant level**

DISCUSSION

At multivariate analysis, the age of the restoration and plaque score were found to be significantly associated with the clinical outcome of RCRs.

For every unit increase in the age of the restoration, there was a 23% increase in the chance of having a failed RCR. This is similar to findings from a retrospective study in Brazil that evaluated the clinical performance of posterior composites up to 33 years and showed success rates dropping to 48% over that period of time. (29)(31). Similar findings were reported by Beck et al in 2015 in a meta-analysis of prospective studies. The failure of posterior RCRs over time can be attributed to a number of factors including: secondary caries, fracture, marginal gaps, endodontic complications, among others.(29)(24)(9). In literature, RCRs have been shown to have high short term success (within 5 years) and a progressive decline after that. (9). Early failures have been found to be more related to technique-sensitive factors such as marginal inadequacies and treatment factors such as selection of an incorrect indication for the restorative material whereas secondary caries and fractures become more prominent in later years. (32)(9). Although studies with short follow-up periods offer limited insights into the clinical longevity of restorations as most clinically acceptable materials do not exhibit significant failure within the initial years after placement, they still play an important role in identifying materials that demonstrate early catastrophic failure and could highlight potential issues with the techniques used by dentists in placing posterior RCRs. (9). These findings imply that restoration age should be considered an important determinant of clinical performance. However, follow up duration influences the interpretation of clinical performance. Short term studies may indicate technique- or operator-related issues but longer observation periods are essential when evaluating the true durability of posterior RCRs.

A unit increase in plaque score was found to be associated with a 32% increase in the likelihood of having a failed RCR. This is similar to findings from a study in Turkey that reported a significant relationship between plaque score and the durability of posterior RCRs, as RCRs with a lower plaque score showed longer mean survival (33). Similar findings were reported by a study from Jordan where half the failures of restorations in subjects with a poor plaque index were attributed to the high plaque index alone (34). A high plaque score is indicative of poor oral hygiene and has been associated with infrequent or ineffective brushing, allowing plaque to persist at restoration margins. Plaque, being a harbor for cariogenic bacteria such as Streptococcus mutans, creates an acidic environment around restorations, demineralizing enamel and dentin (35), hence compromising the marginal seal and enhancing the formation of secondary caries (33). These findings imply that poor oral hygiene, a modifiable factor, plays a critical role in the longevity of posterior RCRs.

Together, these findings highlight that restoration failure is not solely material-dependent but results from an interplay between time-related factors and biological factors, which could be influenced by behavioral factors. Clinically, this reinforces the importance of patient-centered preventive strategies such as oral hygiene education, regular recall, alongside improving placement techniques, to optimize long-term survival of posterior RCRs. Future research should focus on long-term prospective studies to quantify the relationship between plaque accumulation, oral hygiene behaviors, and RCR survival over extended periods.

Strengths and Limitations

This is the first East African study combining detailed cavity mapping with sociobehavioral and clinical data using modified USPHS criteria across 286 restorations. The multicenter design and 100% follow-up bolster internal validity.

Limitations include the cross-sectional design, precluding causality; single calibration round; and absence of parafunction quantification. Selection bias may favor health-conscious participants, and low variability in plaque scores/chronic diseases could mask associations.

CONCLUSION

In conclusion, both higher plaque scores and increased age of the restoration were significantly associated with failure of posterior RCRs.

Declarations

Ethics approval and consent to participate

The study received ethical clearance and approval from the Kenyatta National Hospital-University of Nairobi Ethics and Research Committee (Protocol No. P760/08/2019). Participation was entirely voluntary, and written informed consent was obtained from all participants in either English or Swahili after a thorough explanation of the study's purpose, risks, and benefits. All procedures were conducted in accordance with relevant guidelines and regulations for research involving human participants.

Consent for publication

Not applicable.

Availability of data and materials

The datasets generated and analyzed during the current study are stored securely to maintain participant confidentiality. Access to the data used in this research are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Clinical Trial Number; Not applicable

Authors' contributions

Dr. Umaru Kizito served as the principal investigator, conceived the research idea, wrote the protocol, designed the study and data collection tools, evaluated the participants, collected the data, participated in its initial processing and was involved in writing the manuscript.

Dr. Lincoln Abraham Tentena was responsible for organizing the overall structure and flow of the manuscript. He contributed significantly to the literature review and background sections, and conducted substantive editing throughout the manuscript.

Dr. Lois Karen Kisakye performed the data analysis and was involved in writing the manuscript. She contributed significantly to drafting the discussion and editing the rest of the manuscript.

Dr. Hazel Orengo Simila and Dr. Fred Odera Otieno served as secondary supervisors. They provided input in the topic, assisted in the research, their input ensuring that the study adhered to ethical standards and provided critical feedback during the development of the manuscript.

Dr. Bernina Kyale Kisumbi was the primary supervisor working with the principal investigator to develop the topic, guiding the research process, reviewing drafts, and providing essential input regarding the study and manuscript.

All authors read and approved the final manuscript.

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Figures

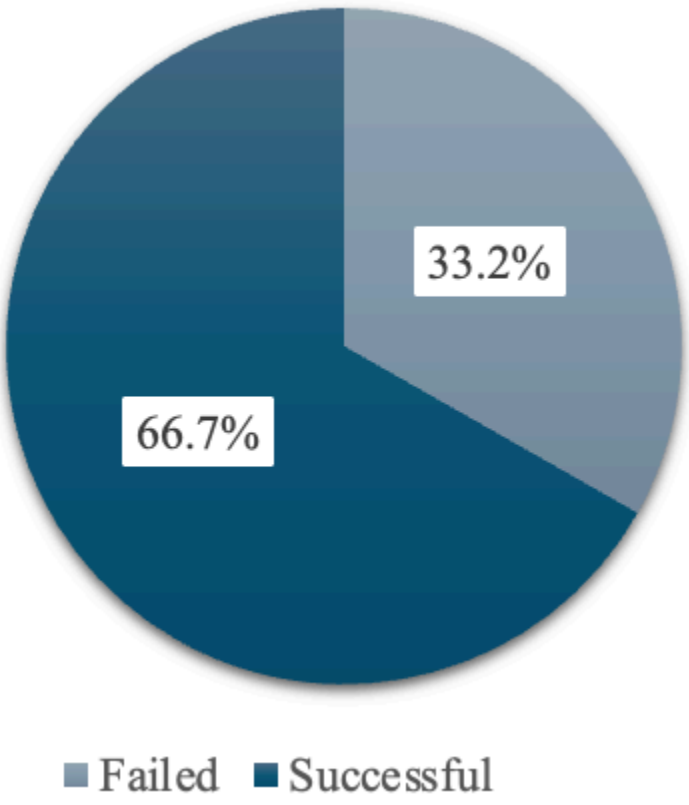


Figure 1

Proportion of failed/successful posterior RCRs.

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