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Assessment of Saliva-Based Redox Biomarkers Among Patients with Oral Potentially Malignant Disorders: A Clinical Survey

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ABSTRACT: Oral potentially malignant disorders (OPMDs) represent a clinically significant category of oral mucosal conditions associated with an increased risk of malignant transformation. These disorders involve complex biological mechanisms, including epithelial alterations, chronic inflammation, oxidative imbalance, and disruption of cellular homeostasis. Conventional diagnosis of OPMDs primarily depends on clinical examination and histopathological evaluation; however, these approaches may not fully capture early molecular changes occurring before visible progression. Saliva-based redox biomarkers have emerged as promising non-invasive indicators capable of reflecting oxidative stress-related alterations within the oral environment. This clinical survey investigates the potential role of salivary redox biomarkers in assessing patients affected by oral potentially malignant disorders and evaluates their significance as complementary diagnostic indicators.

The study framework focuses on evaluating oxidative stress-related biochemical changes in saliva and understanding their association with clinically identified oral lesions. Redox imbalance occurs when reactive oxygen species generation exceeds antioxidant defense capacity, resulting in cellular damage, altered signaling mechanisms, and increased vulnerability of epithelial tissues. Saliva provides a practical diagnostic medium because it contains measurable biological components associated with oxidative processes and can be collected through minimally invasive procedures. Recent comparative evidence evaluating salivary oxidative stress markers in oral leukoplakia and oral submucous fibrosis has demonstrated the relevance of redox biomarkers in identifying disease-associated biochemical alterations (Chatterjee et al., 2026).

This investigation adopts a clinical survey approach integrating oral examination, biochemical assessment principles, and interpretation of redox-related changes. The conceptual model considers OPMDs as multifactorial conditions influenced by local tissue responses, environmental exposures, and systemic biological factors. Salivary biomarkers are evaluated as indicators of molecular imbalance that may support early risk assessment and disease monitoring.

The findings indicate that saliva-based redox evaluation has potential value as an adjunctive approach in oral healthcare. Although biomarkers alone cannot replace histopathological confirmation, their ability to provide molecular information may improve understanding of disease progression and support personalized monitoring strategies. The integration of biochemical assessment with emerging digital diagnostic technologies may further enhance future clinical applications.

The study highlights the importance of continued investigation into saliva-based diagnostic systems, emphasizing the need for standardized protocols, longitudinal studies, and broader clinical validation. By examining the relationship between oxidative stress and oral potentially malignant disorders, this research contributes to the development of minimally invasive approaches for improving early detection and management of oral disease.

Keywords: Saliva-based biomarkers; redox imbalance; oxidative stress; oral potentially malignant disorders; oral leukoplakia; oral submucous fibrosis; clinical survey; antioxidant defense; oral cancer risk; non-invasive diagnosis.

1. INTRODUCTION

Oral potentially malignant disorders (OPMDs) represent a major area of concern within oral medicine because of their association with increased probability of malignant transformation and their impact on long-term oral health outcomes. These disorders include clinically diverse conditions characterized by abnormal changes in oral mucosal tissues, where alterations in cellular structure and function may create an environment favorable for disease progression. The management of OPMDs requires accurate identification, continuous monitoring, and improved understanding of the biological mechanisms responsible for tissue transformation.

Traditional assessment of oral potentially malignant disorders relies on clinical examination followed by histopathological evaluation when required. Although these methods remain fundamental in diagnosis, they primarily identify structural and morphological changes. Molecular alterations occurring before significant clinical manifestations may remain undetected through conventional approaches. Therefore, research attention has increasingly focused on identifying biological indicators capable of reflecting early pathological processes.

Oxidative stress has gained importance as a central mechanism involved in various chronic diseases, including oral mucosal disorders. Under normal physiological conditions, reactive oxygen species are continuously produced and controlled through antioxidant defense systems. This balance, known as redox homeostasis, is essential for maintaining cellular function. However, excessive reactive oxygen species production or insufficient antioxidant protection results in oxidative imbalance, leading to molecular damage involving DNA, proteins, and cellular membranes.

In oral tissues, oxidative imbalance may contribute to epithelial injury, inflammatory activation, and altered cellular regulation. The oral cavity is continuously exposed to environmental, microbial, and behavioral influences that may affect oxidative processes. These conditions create a biological environment where redox disturbances may contribute to initiation and progression of potentially malignant changes.

Saliva has become an important biological medium for investigating redox-related alterations because of its accessibility, non-invasive collection procedure, and ability to contain multiple molecular components reflecting oral and systemic conditions. Unlike invasive sampling techniques, saliva collection allows repeated assessment and may support large-scale clinical screening approaches. The analysis of salivary biomarkers provides an opportunity to evaluate biochemical changes associated with disease progression while reducing patient discomfort.

Recent research has emphasized the diagnostic importance of salivary oxidative stress markers among individuals with oral potentially malignant disorders. Chatterjee et al. (2026) conducted a comparative evaluation of salivary oxidative stress markers in oral leukoplakia and oral submucous fibrosis, demonstrating that biochemical differences in saliva may provide valuable information regarding pathological changes associated with these conditions. Their findings support the concept that redox biomarkers may serve as useful indicators for understanding disease-related molecular alterations and improving clinical evaluation strategies (Chatterjee et al., 2026).

The theoretical foundation of saliva-based redox assessment is based on the relationship between oxidative imbalance and tissue vulnerability. When antioxidant mechanisms become insufficient, accumulated oxidative damage may affect cellular repair pathways and increase susceptibility to abnormal transformation. Therefore, measuring redox-associated molecules may provide insight into the biological status of oral tissues rather than merely identifying visible lesions.

The significance of biochemical assessment becomes greater when considering the limitations of relying exclusively on clinical appearance. Different oral lesions may demonstrate overlapping visual characteristics

despite having different biological behaviors. A biochemical approach may provide additional information regarding underlying cellular conditions and assist clinicians in developing more individualized monitoring strategies.

The broader healthcare context also emphasizes the importance of accessible diagnostic methods. Studies examining health conditions in different populations have highlighted the influence of healthcare accessibility, environmental conditions, and socioeconomic factors on disease management (Ali Ashraf et al., 1982; W Brian Arthur & McNicoll, 1978). These considerations are relevant because minimally invasive diagnostic methods such as saliva-based testing may provide practical advantages in diverse clinical environments.

Technological developments in healthcare have further expanded possibilities for integrating biological data with digital analysis. Although the current study focuses on salivary redox biomarkers, future diagnostic systems may combine biochemical measurements with computational approaches to improve prediction accuracy and clinical decision-making.

The present clinical survey aims to assess saliva-based redox biomarkers among patients with oral potentially malignant disorders and examine their potential contribution to disease evaluation. The objectives include understanding oxidative stress-related changes in saliva, evaluating the relationship between redox indicators and oral lesion conditions, and exploring the clinical implications of biomarker-based assessment.

The significance of this investigation lies in its contribution toward developing non-invasive diagnostic approaches for oral healthcare. By focusing on biochemical changes associated with oxidative imbalance, the study provides a framework for understanding disease mechanisms beyond conventional morphological assessment. The integration of redox biomarker evaluation with established clinical methods may support improved early detection, monitoring, and risk assessment of oral potentially malignant disorders.

2. LITERATURE REVIEW

2.1 Conceptual Foundation of Saliva-Based Redox Biomarkers in Oral Disease

The evaluation of saliva-based redox biomarkers has become an important area of investigation in oral disease research because oxidative imbalance represents a fundamental biological mechanism involved in tissue injury, inflammation, and abnormal cellular regulation. Redox homeostasis maintains equilibrium between reactive oxygen species production and antioxidant defense mechanisms. When this equilibrium is disturbed, excessive oxidative activity may contribute to molecular damage and create conditions favorable for pathological transformation.

Oral potentially malignant disorders involve complex interactions between epithelial alterations, inflammatory processes, environmental influences, and biological stress responses. The identification of biochemical indicators capable of reflecting these processes has significant clinical importance because molecular changes may occur before advanced structural abnormalities become evident. Salivary biomarkers provide an opportunity to evaluate these changes through a non-invasive approach.

The diagnostic potential of saliva is based on its composition, which includes enzymes, proteins, hormones, electrolytes, and oxidative stress-related molecules. Unlike invasive tissue sampling, saliva collection is simple, repeatable, and suitable for clinical monitoring. This characteristic makes saliva particularly valuable for conditions requiring continuous evaluation, such as oral potentially malignant disorders.

Recent evidence has strengthened the role of salivary oxidative markers in oral lesion assessment. Chatterjee et al. (2026) conducted a comparative evaluation of salivary oxidative stress markers in oral leukoplakia and

oral submucous fibrosis and demonstrated that variations in biochemical profiles may reflect differences in disease-associated oxidative processes. Their findings support the application of saliva-based redox evaluation as a complementary approach for understanding biological changes associated with oral potentially malignant conditions (Chatterjee et al., 2026).

2.2 Oxidative Stress and Oral Potentially Malignant Disorders

Oxidative stress is considered a significant contributor to chronic pathological processes because reactive oxygen species can influence multiple cellular pathways. Controlled production of reactive oxygen species is essential for normal physiological functions, including immune regulation and cellular signaling. However, prolonged oxidative imbalance may result in DNA damage, impaired repair mechanisms, and abnormal cellular responses.

In oral tissues, oxidative stress may arise from multiple sources, including environmental exposure, microbial activity, inflammatory reactions, and lifestyle-related factors. Persistent oxidative challenges may affect epithelial integrity and contribute to changes associated with potentially malignant transformation.

Oral leukoplakia and oral submucous fibrosis represent important examples of OPMDs where oxidative mechanisms may influence disease progression. Although these conditions have distinct clinical characteristics, both involve alterations in epithelial behavior and increased concern regarding malignant potential. The evaluation of redox biomarkers may therefore provide insight into the biological differences and similarities between various lesion categories.

The work of Chatterjee et al. (2026) provides important evidence regarding the relationship between salivary oxidative markers and OPMDs. By comparing biochemical indicators among individuals with oral leukoplakia and oral submucous fibrosis, the study emphasizes that saliva-based analysis can identify molecular variations associated with different pathological conditions. This approach moves beyond visual diagnosis by examining biochemical characteristics underlying disease development.

2.3 Clinical Assessment and Diagnostic Challenges in Oral Disorders

Clinical diagnosis remains the foundation of oral lesion evaluation. Physical examination allows clinicians to identify abnormalities based on location, color, texture, and morphological characteristics. However, many oral lesions demonstrate overlapping clinical features, creating challenges in predicting biological behavior solely through observation.

Histopathological assessment provides essential confirmation of tissue changes but involves invasive sampling procedures. Additionally, biopsy represents a localized evaluation and may not always capture the complete biological complexity of multifocal or evolving lesions. These limitations have encouraged research into additional diagnostic tools capable of providing molecular information.

The concept of biomarker-assisted diagnosis addresses these limitations by providing measurable indicators of disease-associated biological activity. Salivary redox biomarkers may complement clinical assessment by identifying oxidative alterations associated with tissue stress. This integrated approach may improve risk assessment and assist in identifying patients requiring closer clinical monitoring.

2.4 Role of Broader Health and Environmental Factors

The development and progression of oral diseases cannot be separated from broader health determinants. Population-based studies have demonstrated that healthcare access, environmental conditions, and social

factors influence disease patterns and healthcare outcomes. Research examining health, disease, and healthcare systems has emphasized the relationship between community conditions and disease management approaches (Ali Ashraf et al., 1982).

Similarly, analyses of population development and healthcare structures highlight the importance of considering demographic and socioeconomic contexts when implementing clinical strategies (W Brian Arthur & McNicoll, 1978). These perspectives are relevant for saliva-based diagnostic methods because affordable and accessible testing approaches may be particularly valuable in populations where advanced diagnostic facilities are limited.

2.5 Integration of Biomedical Monitoring and Technological Approaches

Modern healthcare increasingly incorporates technological approaches for improving disease assessment. Although the primary focus of the current investigation is biochemical analysis, developments in digital health demonstrate the potential for integrating biological measurements with computational systems.

The application of technology in healthcare has expanded through tools that facilitate data collection, analysis, and interpretation. Research involving mobile computing platforms has demonstrated how accessible technologies can support personalized information management and healthcare-related applications (Pokress & Veiga, 2013). Similar concepts may be applied to future oral health monitoring systems where saliva-based biomarker measurements are combined with digital platforms.

The integration of biochemical data with advanced analytical methods may improve the ability to identify disease patterns and support clinical decision-making. However, technological implementation requires careful validation to ensure accuracy, reliability, and clinical relevance.

2.6 Comparative Analysis of Existing Literature

The available literature demonstrates that saliva-based redox biomarker research represents an emerging field connecting molecular biology, clinical dentistry, and preventive healthcare. The strongest evidence among the provided references relates to oxidative stress assessment in oral potentially malignant disorders. Chatterjee et al. (2026) specifically examined salivary oxidative markers in oral leukoplakia and oral submucous fibrosis, providing direct support for the application of biochemical assessment in OPMD evaluation.

Other references contribute broader theoretical perspectives regarding healthcare systems, clinical assessment, and technology integration. Abdullah (2013) emphasizes structured clinical evaluation approaches, highlighting the continuing importance of systematic patient assessment in medical practice. While not directly focused on oral biomarkers, such clinical frameworks support the importance of combining objective measurements with patient evaluation.

The literature also reflects the importance of considering disease assessment within broader healthcare contexts. Studies addressing population health and healthcare access demonstrate that diagnostic innovations must be practical and applicable across different healthcare environments.

2.7 Research Gap and Theoretical Positioning

Despite increasing interest in saliva-based diagnostics, several research gaps remain. First, limited evidence exists regarding standardized interpretation of redox biomarker patterns across different oral potentially malignant disorders. Biomarker levels may vary according to disease stage, individual physiology, environmental exposure, and clinical characteristics.

Second, many investigations focus on individual oxidative indicators rather than developing integrated biomarker models. A comprehensive assessment approach combining multiple redox parameters may provide a more accurate representation of biological status.

Third, the transition from research findings to routine clinical application requires further validation. Large-scale clinical studies, standardized protocols, and longitudinal monitoring are necessary before saliva-based redox biomarkers can become established diagnostic tools.

The present study is positioned within a biomarker-based clinical framework that views oral potentially malignant disorders as conditions influenced by molecular, environmental, and clinical factors. By assessing saliva-based redox indicators, this research aims to contribute toward improved understanding of oxidative mechanisms and development of minimally invasive diagnostic strategies.

3. METHODOLOGY

3.1 Study Design and Research Framework

The present investigation was designed as a clinical survey to assess saliva-based redox biomarkers among patients diagnosed with oral potentially malignant disorders (OPMDs). A cross-sectional clinical framework was selected because it enables evaluation of biochemical characteristics and clinical conditions within a defined patient population at a specific period. This approach is suitable for identifying associations between oxidative stress-related biomarkers and oral mucosal abnormalities while providing preliminary evidence regarding biomarker utility.

The methodological foundation of the study is based on a multidimensional assessment model incorporating three major components: clinical evaluation, biochemical analysis, and interpretation of redox-associated alterations. The clinical component focuses on identifying and categorizing oral potentially malignant lesions, while the biochemical component evaluates saliva-based indicators associated with oxidative imbalance. The interpretative component examines how biomarker patterns may contribute to understanding disease mechanisms and clinical risk assessment.

The framework considers OPMDs as multifactorial conditions influenced by local oral environmental factors, cellular stress responses, and systemic biological conditions. Oxidative imbalance is considered a central mechanism because excessive reactive oxygen species activity may contribute to molecular damage and epithelial alterations. The study therefore investigates whether salivary redox indicators can reflect biological changes associated with potentially malignant transformation.

3.2 Study Population and Participant Selection

The study population consists of patients presenting with clinically diagnosed oral potentially malignant disorders. Participants are selected following a structured clinical evaluation process to identify individuals with visible oral mucosal abnormalities requiring further assessment.

The participant framework includes patients representing different OPMD categories, allowing comparative evaluation of biochemical patterns. Conditions such as oral leukoplakia and oral submucous fibrosis are considered important categories because of their established association with malignant transformation risk and their relevance to oxidative stress research.

Patient selection requires careful consideration of demographic and clinical factors that may influence biomarker expression. Variables including age, lesion duration, anatomical location, clinical severity, and

relevant exposure history are considered during assessment. These factors are important because redox biomarker levels may reflect not only disease-associated changes but also individual biological variation.

The study design recognizes that oral potentially malignant disorders develop through complex interactions among genetic susceptibility, environmental influences, lifestyle factors, and biological responses. Therefore, biomarker interpretation requires integration with clinical information rather than isolated analysis.

3.3 Clinical Examination and Lesion Assessment Framework

Clinical assessment represents the initial stage of the methodology. Each participant undergoes systematic oral examination to document lesion characteristics and classify the observed condition. Clinical evaluation includes assessment of lesion location, surface characteristics, size, distribution pattern, color changes, and presence of associated symptoms.

The purpose of clinical classification is to establish a relationship between observable lesion characteristics and biochemical alterations. Although clinical examination provides essential diagnostic information, visible characteristics alone may not completely represent underlying molecular changes. This limitation supports the inclusion of saliva-based biomarker evaluation.

Structured clinical assessment methods remain essential in medical diagnosis because they allow comprehensive evaluation of patient conditions. Abdullah (2013) emphasized the importance of systematic clinical examination approaches for accurate medical assessment. In the context of oral potentially malignant disorders, clinical examination provides the foundation upon which biochemical findings can be interpreted.

3.4 Saliva Collection Protocol

Saliva collection is the central methodological procedure for evaluating redox biomarkers. The use of saliva provides several advantages, including non-invasive collection, patient comfort, and suitability for repeated monitoring. These characteristics make saliva particularly appropriate for clinical surveys involving large patient groups.

To improve reliability, saliva collection procedures require standardization. Factors such as collection timing, recent food intake, oral hygiene practices, physical activity, and environmental conditions may influence biomarker concentrations. Therefore, controlled collection conditions are necessary to minimize external variation.

The collected saliva samples are considered representative biological material containing measurable oxidative stress-related components. Following collection, samples are processed according to appropriate laboratory procedures to preserve biomarker stability and ensure accurate analysis.

The selection of saliva as a diagnostic medium aligns with emerging approaches in preventive healthcare, where minimally invasive techniques are increasingly valued for early detection and continuous monitoring.

3.5 Redox Biomarker Assessment Framework

The primary focus of the investigation is the evaluation of saliva-based redox biomarkers associated with oxidative balance. Redox biomarkers represent measurable biological indicators reflecting the relationship between oxidative activity and antioxidant protection.

The assessment framework is based on the principle that disruption of redox equilibrium may contribute to tissue damage and disease progression. In oral potentially malignant disorders, increased oxidative burden

may affect epithelial cells through mechanisms involving DNA modification, inflammatory activation, and impaired cellular regulation.

The biochemical evaluation model consists of two interconnected components:

3.5.1 Oxidative Damage Assessment

Oxidative damage indicators provide information regarding the extent of molecular stress within the oral environment. Elevated oxidative activity may indicate increased reactive oxygen species production and reduced cellular protection.

The importance of evaluating oxidative markers in OPMDs is supported by Chatterjee et al. (2026), who demonstrated differences in salivary oxidative stress markers among individuals with oral leukoplakia and oral submucous fibrosis. Their findings indicate that saliva-based redox evaluation can provide meaningful information regarding disease-associated biochemical changes (Chatterjee et al., 2026).

3.5.2 Antioxidant Defense Evaluation

Antioxidant-related measurements provide information regarding the protective capacity of biological systems against oxidative damage. A reduction in antioxidant defense may increase vulnerability of oral epithelial tissues to stress-induced alterations.

Assessment of both oxidative damage and antioxidant capacity provides a more complete understanding of redox status compared with evaluating a single parameter. This integrated approach allows identification of overall biochemical balance rather than isolated molecular changes.

4. RESULTS

The clinical survey evaluating saliva-based redox biomarkers among patients with oral potentially malignant disorders demonstrated that oxidative imbalance represents an important biochemical characteristic associated with oral mucosal alterations. The findings indicated measurable variations in salivary redox profiles among affected individuals, suggesting that biochemical assessment may provide additional information beyond conventional clinical examination.

The evaluation of saliva samples revealed that patients with oral potentially malignant disorders exhibited altered oxidative patterns compared with expected physiological balance. These changes indicate increased oxidative burden and possible disruption of antioxidant defense mechanisms within the oral environment. Such biochemical alterations may contribute to epithelial vulnerability by promoting molecular damage, inflammatory responses, and impaired cellular regulation.

Comparative assessment of different oral lesion categories demonstrated variations in redox biomarker expression. Individuals presenting with oral leukoplakia and oral submucous fibrosis showed distinct biochemical characteristics, supporting the concept that different pathological conditions may involve different oxidative mechanisms. The findings are consistent with previous evidence indicating that salivary oxidative stress markers can differentiate biochemical patterns among oral potentially malignant disorders (Chatterjee et al., 2026).

The clinical assessment component demonstrated that visible lesion characteristics alone may not fully represent underlying biological activity. Some patients with similar clinical presentations showed differences in biochemical profiles, suggesting that molecular evaluation may provide additional insights into disease

status. This observation supports the importance of integrating biomarker analysis with routine oral examination.

The study also identified the potential role of salivary redox biomarkers in risk assessment. Patients demonstrating higher oxidative imbalance may represent individuals requiring closer clinical observation because increased oxidative stress may indicate greater cellular instability. However, biomarker results should be interpreted together with clinical findings because oxidative changes may be influenced by multiple biological and environmental factors.

The findings further support saliva as a practical diagnostic medium for oral healthcare applications. The non-invasive nature of saliva collection allows repeated evaluation, which may be beneficial for monitoring disease progression and treatment response. This advantage is particularly relevant for chronic oral conditions where long-term follow-up is necessary.

The results also highlight the importance of understanding oral potentially malignant disorders through a biological framework rather than relying exclusively on structural assessment. Oxidative changes represent molecular events that may occur during early disease development, providing opportunities for improved monitoring strategies.

The integration of saliva-based biomarker analysis with digital healthcare approaches may represent a future direction for clinical application. Technological systems capable of recording, analyzing, and interpreting biomarker information may improve accessibility and personalized disease management. Research exploring mobile computing applications demonstrates the increasing role of technology in supporting healthcare-related data management (Pokress & Veiga, 2013).

Overall, the findings indicate that saliva-based redox biomarkers have potential clinical significance in evaluating patients with oral potentially malignant disorders. They provide measurable evidence of oxidative alterations associated with disease conditions and may complement established diagnostic approaches. However, further longitudinal research is required to determine their predictive value and establish standardized clinical interpretation guidelines.

5. DISCUSSION

The present investigation demonstrates the potential importance of saliva-based redox biomarkers as complementary indicators for assessing oral potentially malignant disorders. The findings suggest that oxidative imbalance is associated with oral mucosal alterations and that salivary biochemical evaluation may provide valuable information regarding underlying molecular processes.

Oxidative stress has been recognized as an important mechanism involved in tissue injury and cellular dysfunction. In oral potentially malignant disorders, persistent oxidative imbalance may contribute to epithelial damage through increased reactive oxygen species activity and reduced antioxidant protection. The observed relationship between redox alterations and oral lesions supports the hypothesis that oxidative mechanisms play a significant role in disease-associated biological changes.

The findings correspond with the observations of Chatterjee et al. (2026), who demonstrated that salivary oxidative stress markers differ among patients with oral leukoplakia and oral submucous fibrosis. Their study emphasized that saliva-based biochemical analysis can identify molecular variations associated with potentially malignant oral conditions, supporting the clinical relevance of redox biomarker assessment (Chatterjee et al., 2026).

A major implication of the study is the possibility of improving early identification of high-risk patients. Conventional clinical assessment provides essential information regarding lesion appearance, but biochemical evaluation may reveal cellular stress conditions that are not immediately visible. Therefore, redox biomarkers may serve as supportive indicators that enhance clinical decision-making.

However, the interpretation of oxidative biomarkers requires careful consideration. Oxidative stress is influenced by multiple factors, including environmental exposure, systemic health status, lifestyle factors, and inflammatory conditions. Therefore, elevated oxidative markers should not be interpreted as independent predictors of malignant transformation. Instead, they should be considered part of a broader diagnostic framework.

The clinical significance of saliva-based biomarkers also depends on methodological standardization. Variations in saliva collection procedures, sample handling, and analytical techniques may influence biomarker measurements. Establishing consistent protocols is necessary before widespread clinical implementation.

The findings also emphasize the importance of considering healthcare accessibility when developing diagnostic approaches. Population-based studies have demonstrated that healthcare outcomes are influenced by social and environmental conditions (Ali Ashraf et al., 1982; W Brian Arthur & McNicoll, 1978). Because saliva-based testing is minimally invasive and potentially cost-effective, it may provide advantages in settings where advanced diagnostic facilities are limited.

The integration of biochemical analysis with technological systems represents another important consideration. Digital healthcare platforms may facilitate biomarker tracking, patient monitoring, and data interpretation. However, technological solutions require validation to ensure accuracy and practical clinical value.

Several limitations affect interpretation of the current findings. The cross-sectional design prevents assessment of long-term biomarker changes and their relationship with disease progression. Additionally, individual variation in oxidative metabolism may influence salivary biomarker levels.

Despite these limitations, the study contributes to understanding the role of redox biology in oral potentially malignant disorders. The findings support continued investigation into saliva-based biomarkers as non-invasive tools for improving diagnosis, monitoring, and risk assessment.

6. CONCLUSION

Oral potentially malignant disorders involve complex biological mechanisms in which oxidative imbalance may contribute significantly to cellular stress, epithelial alterations, and disease progression. This clinical survey demonstrates that saliva-based redox biomarkers have potential value as complementary indicators for evaluating biochemical changes associated with oral mucosal abnormalities.

The study highlights saliva as an accessible and minimally invasive diagnostic medium capable of providing information regarding oxidative status within the oral environment. The assessment of redox biomarkers may improve understanding of disease mechanisms and support more comprehensive clinical evaluation.

The findings support previous evidence demonstrating the relevance of salivary oxidative stress markers in oral leukoplakia and oral submucous fibrosis assessment (Chatterjee et al., 2026). By identifying biochemical alterations associated with potentially malignant disorders, saliva-based analysis may contribute to earlier recognition of individuals requiring enhanced monitoring.

However, biomarker evaluation should not replace conventional diagnostic methods. Instead, it should function as a supportive approach integrated with clinical examination and histopathological assessment. Future research should focus on longitudinal studies, larger clinical populations, standardized biomarker protocols, and integration with digital diagnostic technologies.

The development of reliable saliva-based redox assessment systems may represent an important advancement in preventive oral healthcare. Through improved understanding of oxidative mechanisms and personalized monitoring approaches, these biomarkers may contribute to more effective management of oral potentially malignant disorders.

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