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Mining communities, Oral health, Community pharmacy, Occupational medicine, Restorative dentistry, Prosthodontic rehabilitation.

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Interprofessional Oral Healthcare In Mining Regions Integrating Pharmacy Care, Occupational Medicine, And Restorative Dentistry

Abstract

Mining communities face a combination of occupational, behavioral, geographical, and healthcare access barriers that may increase oral health risks and delay preventive, restorative, and rehabilitative care. This review aimed to synthesize evidence on oral-health risks and care needs in mining regions and to propose an interprofessional pathway integrating community pharmacy, occupational medicine, and restorative and prosthodontic dentistry. Relevant evidence on oral health status among mine workers, access to dental care, integration of oral health into primary care, pharmacy participation, workplace health promotion, and restorative and prosthodontic management was reviewed narratively. Findings were grouped into five thematic domains, and no meta-analysis was performed. Available evidence indicates that mine workers commonly experience periodontal disease, dental caries, oral mucosal lesions, dental trauma, pain, tooth loss, tobacco-related risks, and unmet treatment needs. Community pharmacists may provide non-invasive advice, medication review, tobacco cessation support, recognition of warning signs, and referrals. Occupational health teams can incorporate oral screening, risk assessment, education, surveillance, and referral into workplace services. In contrast, dental teams provide definitive diagnosis, periodontal stabilization, tooth preservation, restorative treatment, prosthodontic rehabilitation, and long-term maintenance. Coordinated referral, shared documentation, professional training, outreach services, and teledentistry are highlighted in the proposed bidirectional pathway. Evidence of local adaptation in Saudi Arabia is limited in mining, but there is national evidence. Future studies are needed to assess the feasibility, clinical outcomes, referral completion, and cost-effectiveness of interprofessional integration to determine whether it will enhance prevention, access, continuity, rehabilitation, and oral health equity.

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INTRODUCTION

Mining is essential for economic development, infrastructure, energy production, industrial growth, and the supply of raw materials required for modern health and technology systems. However, mining communities often experience a distinct combination of occupational, environmental, behavioral, and healthcare-access challenges that may affect general and oral health. Mine workers may be exposed to physically demanding work conditions, dust, shift patterns, socioeconomic pressures, tobacco and alcohol use, and limited access to regular dental care. In geographically isolated or rural mining regions, these risks may be intensified by shortages of dental professionals, long travel distances, fragmented referral pathways, and reduced use of preventive services [1-3]. Available evidence suggests that oral diseases are important but under-recognized health concerns among mine workers [4-7]. These findings indicate that oral healthcare in mining regions should extend beyond emergency dental treatment to include prevention, screening, early restorative intervention, periodontal care, oral cancer awareness, prosthodontic rehabilitation, and long-term maintenance.

An interprofessional approach may be particularly suitable for mining regions because oral-health needs often intersect with occupational health, medication use, systemic disease, behavioral risk factors, and access barriers. The objective of this review is to synthesize evidence on oral health risks and care needs in mining regions and to propose an interprofessional oral healthcare pathway integrating occupational medicine, community pharmacy, and restorative/prosthodontic dentistry for prevention, referral, treatment, rehabilitation, and long-term maintenance.

METHODS

This narrative review synthesized published evidence on oral-health risks, care needs, and interprofessional care strategies relevant to mining regions. The review included studies addressing oral health status among mine workers; rural and remote oral health access; integration of oral health into primary care; community pharmacy participation in oral health care; occupational and workplace oral health promotion; and restorative/prosthodontic management. Key findings

were extracted and organized into five thematic domains: oral-health risks, community pharmacy roles, occupational medicine roles, restorative/prosthodontic care needs, and an interprofessional referral pathway. Findings were narratively synthesized; no meta-analysis was performed.

ORAL HEALTH RISKS AND CARE NEEDS IN MINING REGIONS

Mining regions may represent a high-risk setting for oral diseases because occupational exposures, physically demanding work, tobacco and alcohol use, limited dental attendance, and rural or remote access barriers can act together to worsen oral-health outcomes. Direct evidence from mining populations indicates that periodontal disease, dental caries, oral mucosal lesions, dental trauma, and high treatment needs are common among mine workers. In a study of coal mine workers from Zonguldak, Turkey, the prevalence of periodontal disease was 96.2%, with only 3.8% of workers classified as periodontally healthy [4]. Similarly, underground coal mine workers in Telangana, India, showed poor oral-health status, high caries prevalence, tobacco and alcohol use, periodontal disease, and traumatic dental injuries [5]. Stone mine workers in Rajasthan showed dental caries prevalence of 74%, with a mean DMFT score of 2.89 [6]. Chromium mine workers in India demonstrated poor oral health, high caries experience, high tobacco consumption, leukoplakia, periodontal disease, and extensive treatment needs [7]. Although Saudi mining-specific oral-health evidence is limited, Saudi national evidence shows that periodontal disease is also a significant oral-health concern among adults, with a pooled prevalence estimate of 51% in a systematic review and meta-analysis [8]. Socioeconomic inequalities in dental service utilization among Saudi adults further underscore the need to address access barriers in underserved or occupationally vulnerable communities [9].

Rural and remote oral health literature supports this approach because rural populations often experience unmet oral health needs and access barriers [1]. In addition, oral-health integration literature supports primary-care-based strategies, interdisciplinary networks, training of non-dental providers, coordinated referral pathways, and e-health technologies [2, 3].

Table 1. Oral health risks and care needs among mining workers and corresponding interprofessional responses.

Oral health risk or care need	Mining-region relevance	Required response
Periodontal disease [4, 10, 11]	Very high prevalence of periodontal disease was reported among coal mine workers in Zonguldak, Turkey.	Periodontal screening, oral hygiene instruction, referral for scaling/root planing when indicated, and supportive periodontal maintenance
Dental caries [5-7, 12]	High dental caries burden has been reported among coal, stone, and chromium mine workers.	Fluoride-based prevention, early/minimally invasive restoration when indicated, and caries-risk management
Oral mucosal lesions [7, 13]	Tobacco consumption and leukoplakia have been reported among chromium mine workers in India.	Tobacco cessation, oral cancer awareness, and urgent referral of persistent or suspicious oral mucosal lesions

Dental trauma and pain [5]	Dental traumatic injuries and poor oral-health status, including dental caries and periodontal disease, have been reported among underground coal mine workers.	Urgent dental triage and referral for definitive dental treatment
Tooth loss [14, 15]	Advanced dental caries and severe periodontal disease are major pathways leading to tooth loss.	Assessment for removable, fixed, or implant-supported prosthodontic rehabilitation
Poor access to care [1-3, 16-18]	Mining communities may share rural and remote oral-health access barriers, including dental workforce shortages, unmet preventive-care needs, and weak referral pathways; therefore, integrated primary-care and interprofessional oral-health models may be relevant to these settings.	Mobile dental services, non-invasive pharmacy triage, and occupational-health referral pathways

ROLE OF COMMUNITY PHARMACY IN MINING-REGION ORAL HEALTHCARE

Community pharmacists can make a practical contribution to oral healthcare in mining regions by serving as accessible first-contact sources of non-invasive advice and referrals, particularly in rural and remote communities. Results from rural health practice suggest that the public frequently asks pharmacists for opinions on oral health concerns. In contrast, pharmacists can assist patients with symptom management advice, product choices, and referrals [19]. A scoping review of the role of pharmacists in DOH also highlights the training and role clarity needed for pharmacists to contribute to the prevention and promotion of oral health, medication-related counseling, dental referrals, and public education [17]. This is consistent with the role of community pharmacists in the Eastern Province, where they were often consulted for advice on oral health issues, such as oral ulcers, dental pain, and bleeding gums [20]; and the Asir region, where there was generally good knowledge and attitude towards oral health and a need to improve the practice and implementation [21]. Pharmacists must not be practitioners of dental diagnosis and operative care, nor must they take the place of dentists. Consumer-perspective studies suggest that pharmacy-based oral-health services are acceptable when they remain within appropriate professional limits and are supported by adequate training [22].

Medication-related oral health problems are particularly relevant in mining communities because workers may use analgesics, antibiotics, antihypertensives, antidiabetic medicines, bronchodilators, antidepressants, antihistamines, or other drugs that can contribute to xerostomia, mucosal irritation, increased bleeding risk, or altered dental treatment planning. A proof-of-concept study on pharmacist-supported dry-mouth management suggests that pharmacy teams can contribute to oral-health integration when they receive structured training and have referral pathways [23]. Polypharmacy literature also supports closer collaboration among pharmacists, physicians, and dental professionals to reduce oral complications and improve quality of life [24, 25]. Community pharmacists are also well positioned to support tobacco cessation and oral-cancer awareness. This is important because mining-worker studies have reported high tobacco use and oral mucosal lesions, including leukoplakia [7]. Community pharmacy smoking-cessation interventions are supported by Cochrane evidence [26], and pharmacy-based oral-cancer awareness interventions can help raise awareness and direct patients to medical or dental assessment [27]. Pharmacists can identify red flags such as persistent non-healing ulcers, red or white patches, unexplained bleeding, facial swelling, fever, trismus, dysphagia, or severe dental pain and refer patients urgently.

Table 2. Community pharmacy roles in oral-health promotion, non-invasive triage, medication review, and referral support in mining regions.

Pharmacy function	Application in mining regions	Referral trigger
Oral health advice [17, 28]	Fluoride toothpaste, toothbrushing, interdental cleaning, and diet counseling as part of pharmacist-supported oral-health advice	Persistent or worsening oral symptoms despite appropriate self-care
Symptom triage [17, 23, 28]	Non-invasive oral-health advice, symptom recognition, and referral for common complaints such as toothache, oral ulcers, bleeding gums, dry mouth, and halitosis	Severe pain, facial or intra-oral swelling, fever/systemic symptoms, uncontrolled bleeding, or dental/orofacial trauma
Medication review [22-24, 29]	Identification of medication-related oral-health risks, particularly xerostomia, bleeding risk from anticoagulant/antiplatelet therapy, drug interactions, and drug-induced oral effects	Complex polypharmacy, potential drug-drug interactions, or planned invasive dental procedures requiring medication-risk review

Tobacco cessation [26, 30]	Brief smoking-cessation advice and cessation-product counseling, together with oral-cancer awareness and referral support	Suspicious or persistent oral lesions requiring dental/oral-medicine referral
Denture support [31, 32]	First-line advice on denture cleaning and appropriate adhesive use, with referral for persistent irritation, ulceration, suspected candidiasis, or poor denture fit	Ulceration, suspected denture stomatitis/oral candidiasis, or poor denture fit requiring dental/prosthodontic assessment
Care navigation [17, 18, 28, 30]	Referral to dentists or oral medicine services for unresolved symptoms, red-flag signs, or suspected high-risk oral conditions; referral to occupational health services may be considered when workplace exposure, medical fitness, or follow-up at the worksite is relevant	Red-flag symptoms or recurrent/persistent oral complaints requiring dental or medical referral

ROLE OF OCCUPATIONAL MEDICINE IN ORAL-HEALTH PREVENTION

Occupational medicine can provide the workplace platform needed to identify oral-health risks early among mining workers. Mine workers commonly undergo occupational health surveillance and periodic medical examinations based on workplace risks; these examinations are typically focused on respiratory, musculoskeletal, auditory, dermatological, and general occupational health conditions. Incorporating basic oral-health questions and visual screening into these assessments may help identify pain, bleeding gums, untreated caries, poor oral hygiene, tooth loss, tobacco-related lesions, denture problems, or signs of infection [2, 3].

Occupational medicine can also connect oral health with systemic disease prevention. Diabetes, cardiovascular risk, respiratory illness, tobacco use, and medication exposure may influence oral disease burden and dental treatment planning. Interprofessional diabetes and oral health literature indicates that primary healthcare professionals recognize the importance of collaborative

care but require clear training, referral pathways, and system-level support [33]. In mining regions, this is clinically relevant because periodontal disease, tobacco use, systemic conditions, and medication exposure may interact to worsen oral-health outcomes and delay healing after dental procedures.

In the worksite setting, occupational medicine teams can conduct oral health education, tobacco cessation programs, oral cancer awareness programs, mobile dental camps, and referral days with local dental practitioners. The literature on workplace oral health promotion confirms that education and screening are common interventions and suggests that they may benefit employees' oral health [18]. The results of this study in Saudi Arabia, along with findings from factory workers in Jeddah, indicate the need to evaluate oral health status and provide oral health care among industrial workers [34]. National evidence on inequalities in dental service utilization among the Saudi adult population supports the need for better pathways to access for vulnerable or less-served populations [9].

Table 3. Occupational medicine activities supporting oral-health prevention, risk assessment, surveillance, and referral among mining workers.

Occupational medicine activity	Oral health contribution	Expected benefits
Periodic worker examination [2, 3, 18]	Incorporate oral-health questions and basic visual oral screening into periodic worker medical examinations as an adaptation of primary-care and workplace oral-health promotion strategies.	Earlier identification of oral disease signs and timely referral needs
Risk factor assessment' [5, 6]	Assess tobacco and alcohol use, diabetes status, medication-related oral-health risks, and work-pattern-related barriers to dental care.	Early identification of workers at increased oral-health risk
Workplace education [4, 18]	Workplace education on oral hygiene, fluoride exposure, sugar reduction, and tobacco cessation	Improved oral-disease prevention and self-care practices
Referral coordination [2, 3]	Link workers with community pharmacy, general dentistry, oral medicine, restorative/prosthodontic services, and other appropriate providers through coordinated referral pathways	Reduced delays in treatment
Health surveillance [2, 18]	Record oral-health complaints, risk factors, referrals, and treatment needs within workplace health records to support occupational health surveillance and referral planning.	Improved oral-health service planning and resource allocation

Emergency recognition [18]	Identify urgent oral signs such as facial/oral swelling, dental or maxillofacial trauma, suspected infection, severe pain, uncontrolled bleeding, persistent ulceration, altered sensation, or abnormal oral/head-and-neck appearance.	Timely referral for urgent dental or medical management
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RESTORATIVE AND PROSTHODONTIC DENTISTRY IN MINING-REGION CARE

Restorative and prosthodontic dentistry are central to oral healthcare in mining regions because many workers may present only after disease has progressed to pain, infection, loss of tooth structure, periodontal destruction, or missing teeth. Although Saudi mining-specific prosthodontic evidence is limited, Saudi data indicate a considerable need for prosthodontic care among adults, particularly for untreated decay and tooth loss [35, 36].

The restorative phase should begin with disease stabilization. This includes caries-risk assessment, plaque control, fluoride use, dietary counseling, periodontal evaluation, pain control, and definitive treatment planning. For early and moderate carious lesions, minimally invasive restorative dentistry, direct adhesive restorations, glass ionomer cement, resin composite, and atraumatic restorative treatment may be considered depending on the clinical situation and resource availability [12]. If the carious lesion is deep or involves the pulp, pulp assessment, vital pulp therapy, endodontic

treatment, or extraction of non-restorable teeth may be needed [37]. In geographically remote mining areas, mobile or outreach services can provide preventive care, simple restorations, urgent care, and referrals for complex cases to fixed dental service facilities.

When illness has led to tooth loss or loss of function, prosthodontic care is vital. The loss of teeth can impact mastication and nutrition, speech, self-confidence, appearance, and work-related quality of life [38]. If periodontal status, oral hygiene, smoking habits, systemic health, cost considerations, and/or the ability to attend recall visits are problematic, removable partial dentures, complete dentures, fixed partial dentures, and implant-supported rehabilitation may be considered. Since periodontal disease is highly prevalent among mine workers, periodontal assessment and stabilization should be done before the definitive prosthodontic treatment [4, 10, 39]. This is especially relevant with fixed or implant-supported prostheses because plaque buildup, inadequate periodontal maintenance, and smoking can impact long-term prognosis and the need for maintenance [40].

Table 4. Restorative and prosthodontic management needs in mining-region oral healthcare and associated interprofessional support.

Clinical problem	Restorative/prosthodontic response	Interprofessional support
Early or moderate caries [12, 17]	Fluoride-based prevention, minimally invasive/non-restorative caries management, and conservative direct restoration when cavitated lesions require operative treatment	Pharmacist-led oral-health prevention advice and referral support
Deep caries or pain [37, 41]	Pulp assessment, vital pulp treatment, or endodontic care for deep caries; extraction considered only when the tooth is non-restorable or has poor prognosis.	Occupational-health referral for urgent dental assessment and management
Periodontal disease [4, 10, 11, 18]	Scaling/root planing, periodontal therapy, and supportive periodontal maintenance	Workplace oral-health education, including oral hygiene, fluoride use, diet counseling, and tobacco-cessation advice
Tooth wear or structural defects [42, 43]	Direct or indirect restorative management following occlusal and aetiological assessment.	Risk-factor counseling, including dietary, behavioral, occupational, and parafunctional contributors
Missing teeth [15, 17, 31]	Assessment for removable partial denture, complete denture, fixed prosthesis, or implant-supported rehabilitation; denture care and maintenance when complete dentures are provided.	Pharmacy-supported oral-health advice and referral for denture-related complaints, with denture maintenance guided by evidence-based denture-care recommendations
Complex rehabilitation [15, 17]	Multidisciplinary restorative/prosthodontic planning with medical risk assessment before treatment	Medical risk assessment and pharmacy-based oral-health advice/referral support

INTERPROFESSIONAL COLLABORATION MODEL FOR ORAL HEALTHCARE IN MINING REGIONS

A practical model for oral healthcare in mining regions should integrate community pharmacy, occupational medicine, and restorative/prosthodontic dentistry into one coordinated referral and follow-up pathway [2, 3].

The proposed model may be described as the Mining-Region Interprofessional Oral Healthcare Pathway. At the first level, occupational medicine may identify oral-health risks during employment medical examinations, periodic worker assessments, and workplace health campaigns, supported by evidence from workplace oral-health

promotion and mining workers [4, 18]. Screening may include dental pain, gingival bleeding, tobacco use, dry mouth, tooth loss, denture problems, visible lesions, and history of dental attendance. At the second level, community pharmacists may provide accessible counseling, non-invasive triage, medication review, preventive product advice, dry-mouth support, tobacco cessation, and referral reinforcement [17, 19, 23, 26]. At the third level, dental, periodontal, endodontic, restorative, oral medicine, and prosthodontic services provide definitive diagnosis, treatment, rehabilitation, and long-term maintenance.

This pathway should be bidirectional. Dentists should be able to refer patients back to pharmacists for medication review, fluoride or dry-mouth product counseling, denture-care advice, and tobacco cessation, particularly when medication-related oral complications or preventive counseling needs are identified [17, 23, 29]. They should also be able to communicate with occupational medicine teams when systemic disease, work-related barriers, or workplace follow-up may affect oral-health outcomes. Saudi evidence also supports the feasibility of

interdisciplinary oral health practices, as healthcare professionals in Eastern Saudi Arabia reported conducting oral health education, screening, and dental referral activities in routine practice [44].

Training is essential for implementation. Dentistry-pharmacy interprofessional education has been shown to support understanding of professional roles, collaborative skills, and referral awareness [45, 46]. Broader interprofessional oral-health programs involving dental, medical, nursing, and pharmacy students have also demonstrated the feasibility of collaborative training [47]. For mining regions, short continuing-education modules should be developed for pharmacists, occupational physicians, nurses, dental teams, and safety officers. Digital referral forms, shared records, teledentistry, and follow-up tracking are another way to enhance continuity, particularly when working in remote mining areas [48]. In Saudi Arabia, evidence suggests that dental providers believe teledentistry is beneficial for communication, guidance, referrals, and the delivery of patient care in remote areas [49].

Table 5. The new model of an interprofessional oral healthcare team for mining areas.

Model component	Main responsibility	Key output
Occupational medicine unit [2, 18]	Screening, risk assessment, referral coordination, and workplace oral-health promotion	Early identification of oral-health risks and timely referral
Community pharmacy [17, 23, 26]	Non-invasive oral-health triage, prevention advice, medication-related oral-health review, and tobacco cessation support.	Accessible first-contact oral-health advice, triage, and referral support
General dentistry [12]	Diagnosis, prevention, minimally invasive caries management, and routine dental treatment	Control of oral disease progression
Restorative/endodontic care [12, 37]	Caries management, pulp-preserving/endodontic care, and tooth preservation	Functional preservation of natural teeth
Periodontology [10]	Periodontal stabilization and supportive periodontal maintenance	Reduced risk of periodontal progression and tooth loss
Prosthodontics [15]	Replacement of missing teeth, oral rehabilitation, and maintenance of oral function	Improved oral function and oral health-related quality of life
Digital/shared-care system [3, 49, 50]	Care linkage, shared communication, e-health/teledentistry-supported coordination, and follow-up	Improved continuity of care across occupational, pharmacy, and dental providers

DISCUSSION

The areas of priority for integrated oral health care identified in this review are the regions where occupational, behavioral, geographical, and health system factors might contribute to a heightened burden of oral disease. The high prevalence of periodontal diseases reported among coal mine workers in Turkey, along with caries, tobacco and alcohol usage, leukoplakia and traumatic dental injuries among the Indian mining population, agrees with the need to shift from episodic emergency dentistry to a structured approach for prevention, early diagnosis, referral, and rehabilitation of dental diseases [4-7].

The results indicate that the oral health risks in mining communities cannot be regarded simply as a dental problem. They have close associations with occupational

exposure, smoking and alcohol consumption, systemic disease, drug use, rurality and restricted dental access. This interpretation aligns with international literature on oral health, which acknowledges oral diseases as key public health conditions influenced by social, economic, and health system determinants [51]. Thus, oral health care in mining areas should be integrated into the overall occupational, primary care, and preventive health approach, rather than as a stand-alone specialist service.

The role of community pharmacy may be important in this model. Pharmacists can have greater reach than dentists in the areas where they are found and can offer non-invasive advice, symptom recognition, non-invasive product counseling for prevention, tobacco cessation support, medication review, and reinforcement of

referrals. But this job should be well defined. Pharmacists must not make a final diagnosis or make an operative treatment decision; instead, they need to facilitate early identification, risk reduction, and early referral. This is especially important for any oral changes that may occur as a result of medication, including xerostomia, increased bleeding risk, oral irritation, and medication-related concerns for dental treatment [17, 19, 23, 24].

Another key platform is occupational medicine, as workers in this industry are already involved in work-related exams, routine health checks, and workplace health promotion. Including simple oral health-related questions, visual screening, tobacco use assessment, and referral to dental care triggers within occupational health systems may help identify unmet dental needs earlier. There is supporting evidence for integrating oral health services into primary care and for workplace oral health promotion [2, 3, 18]. Rather than develop a formal dental program, the proposed approach, then, is to incorporate the identification and referral of oral health risks into the current occupational health processes.

The proposed pathway continues to focus on restorative and prosthodontic dental services because untreated caries and periodontal disease, as well as trauma and tooth loss, can negatively affect mastication, speech, appearance, quality of life, and work performance. Treatment planning for disease stabilization, minimally invasive restorative care, preservation of pulp (where possible), periodontal control, and prosthodontic rehabilitation should be based on clinical need, systemic health, smoking status, budget, and ability to maintain [10, 12, 15, 37]. An assessment of periodontal health is especially significant in fixed or implant-supported rehabilitation because, if the plaque is not well controlled and the patient has smoked, it can negatively impact long-term results.

There is limited information available in Saudi Arabia to provide direct evidence on oral health among mining workers. However, there is relevant contextual evidence from Saudi Arabia. Periodontal disease is a national oral-health issue, and the pooled prevalence estimate for adults is 51% [8]. Socioeconomic inequalities in the utilization of dental services also indicate that access barriers are important [9]. Saudi studies also indicate that community pharmacists are consulted for oral health information and that interdisciplinary oral health practices and teledentistry could be used to aid in the education, screening, referral, and communication process, which can be done remotely [20, 21, 43, 49]. The results indicate the suitability of the proposed mining-region pathway for use in Saudi industrial, rural, and remote environments.

Overall, the evidence supports a Mining-Region Interprofessional Oral Healthcare Pathway characterized by the following elements: occupational medicine referral, shared documentation, support for teledentistry, and continuing professional education. This type of model aligns with the goals of oral health equity and the mainstreaming of dental care into general health care [52]. This model warrants future assessment in mining communities, with measurable outcomes such as screening uptake, referral completion, emergency dental visits, periodontal and caries indicators, completion of prosthodontic treatment, patient satisfaction, and cost-effectiveness.

CONCLUSION

Mining areas are significant but under-recognized settings for oral health interventions, as the mine worker may have multiple oral health problems such as periodontal disease, dental caries, oral mucosal lesions, dental trauma, tooth loss, and poor access to dental care. This review aims to suggest an interprofessional pathway of oral healthcare that encompasses occupational medicine, community pharmacy and restorative/prosthodontic dentistry. There are opportunities for occupational health teams to detect oral health risks at the workplace; for pharmacists to give non-invasive guidance and reinforce referrals; and for dental teams to provide definitive treatment and rehabilitation. This model should be tested in mining communities across various regions of Saudi Arabia, including industrial, rural, and remote areas.

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CONFLICT OF INTERESTS

The authors declare that there are no competing interests

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