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Review

Oral Cancer Disease among the Poor: A Sri Lankan Context

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Abstract: Oral cancer (OC) is the 16th most common cancer worldwide. In Sri Lanka, OC is the most prevalent cancer among men and the eighth among women. In most instances, OC is preceded by clinically recognizable disorders appearing on the oral mucosa, termed oral potentially malignant disorders (OPMD). The distribution of OC among low- and middle-income socioeconomic groups contributes to various factors. Poor oral health literacy, a lower quality of higher education, and the economic burden results in neglected oral health. The further economic recession has led to the formation of risk habits, such as chewing betel quid, smoking and the consumption of alcohol, among these groups to minimize stress levels. But with a lack of oral health awareness, the incidences of OC increase in this category. This review elaborates on a few cross-sectional studies conducted in various locations in Sri Lanka, discussing the low awareness of neglected oral health, the usage of tobacco in a smokeless and non-smokeless manner, consuming alcohol, and the chewing of betel nuts. This review aims to overcome the barriers in these low- and middle-income socioeconomic groups in developing nations such as Sri Lanka by creating more awareness and minimizing the incidence and diagnosis and treatment at early stages to improve the quality of life as well as longevity.

Keywords: oral cancer; oral potentially malignant disorders; low- and middle-income groups; risk habits

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1. Introduction

A malignant tumor of the lip, tongue, and mouth is termed Oral Cancer (OC), and it has become a significant threat to individuals' health globally, and it is predominant in South Asia. In 2020, it was estimated that these malignancies collectively claimed 177,757 deaths and affected 377,713 people worldwide [1]. Asia accounts for 56% of the world's oral and pharyngeal cancer burden, except for nasopharyngeal carcinoma as it comprises a different etiology and biology [1]. In 2018, the incidence of OC in men was predicted to be 14.8 per 100,000 population per annum in Asia; in Sri Lanka, OC is the most prevalent malignancy among men, eighth among women, and second overall [2,3]. Nearly 8.66% of reported malignancies in Sri Lanka are OC, with the highest mortality rate of all cancers [4].

Oral potentially malignant disorders (OPMD) typically precede OC; thus, OC is totally preventable. Oral squamous cell carcinoma (OSCC) is more likely to develop in the presence of OPMDs, which is a clinical disease often characterized by visible changes in the oral mucosa [5]. OPMDs are conditions categorized as lesions with dysplastic characteristics. These conditions include oral lichen planus (OLP), oral leukoplakia, erythroplakia, oral submucous fibrosis (OSF), and proliferative verrucous leukoplakia (Figure 1). As per records, South-Asian nations have a high incidence and prevalence of OPMDs [6,7].

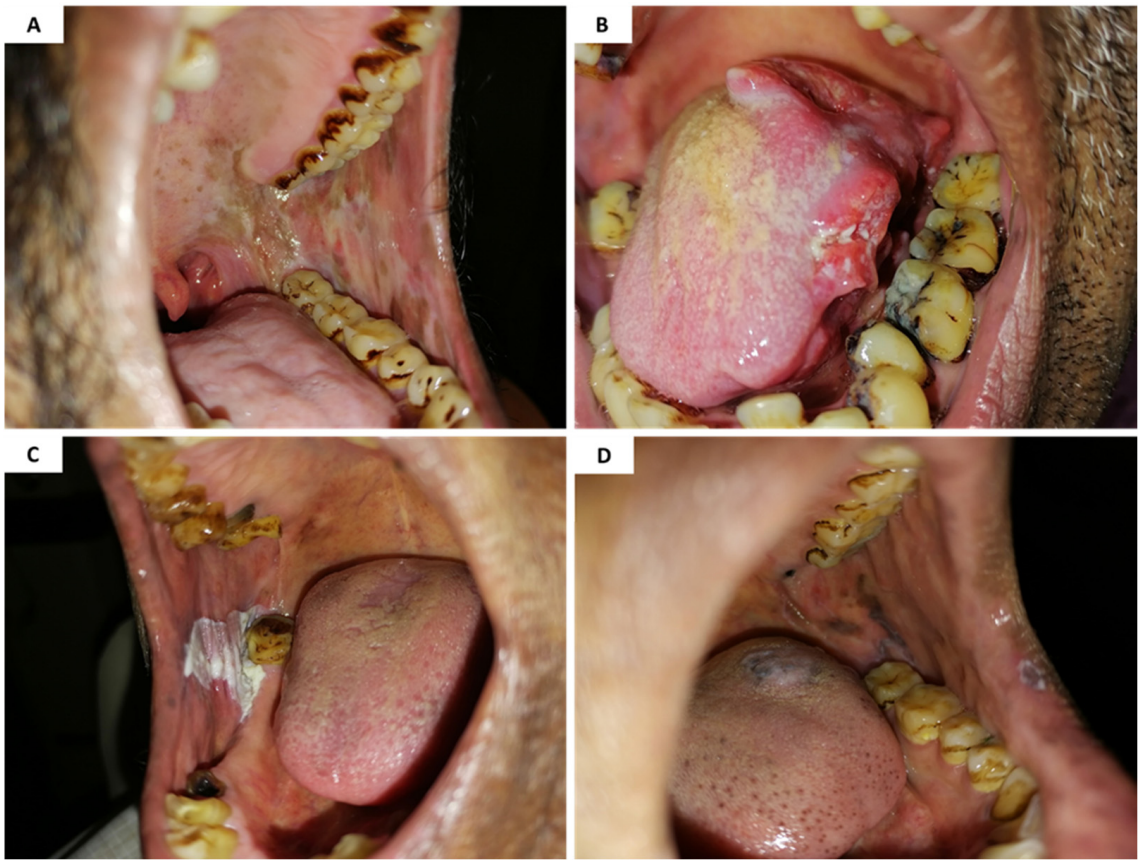

Figure 1. Clinical features associated with oral cancer and oral potentially malignant disorders: (**A**) Oral submucous fibrosis (OSF); (**B**) oral cancer (OC); (**C**) homogenous oral leukoplakia; and (**D**) oral lichen planus (OLP).

OSF is a condition causing a burning sensation in the oral mucosa from its early stages, and has a significant risk of malignancy. It is a chronic disease with progressive fibrosis in the sub mucosal tissues leading to restriction in opening the mouth. Oral leukoplakia is a white plaque that can be considered clinically as homogeneous or nonhomogeneous. Homogeneous lesions are thin, flat, uniform, smooth, and white. Nonhomogeneous lesions may have a white and red appearance or tiny, white, pinhead-size raised nodules on a reddish background or a proliferative, warty appearance. OLPs are a common chronic inflammatory mucocutaneous disorder that generally affect the skin and/or mouth. It may present as interlacing white lines (known as Wickham's striae) with a reddish border, or as a mix of reddish and ulcerated areas [5–8].

OC occurrence and progression are closely linked to several factors, including genetic, epigenetic, microbial, habitual, and lifestyle factors [6]. It is a multifactorial disease and the risk factors include tobacco, areca nut and alcohol, chronic inflammation, ultraviolet radiation (for lip cancer), human papillomavirus (HPV) or candida infections, immunosuppression, genetic predisposition, and diet [9]. The main contributing factors to OC in Sri Lanka are the usage of tobacco in a smokeless and non-smokeless manner, consuming alcohol, and the chewing of betel nuts [10]. Chewing betel nut alone, commercially prepared areca nuts such as pan parag, mawa, babul beeda, and thul, or combined with tobacco powder such as Gutka, as well as betel nut chewing with or without tobacco, are the key contributing factors that develop into OPMD and later progress into OC [10]. Moreover, tobacco is used in several ways, including smoking cigarettes, cigars, beedis, and reverse smoking, as well as chewing, snuffing, and dipping smokeless tobacco (Figure 2).

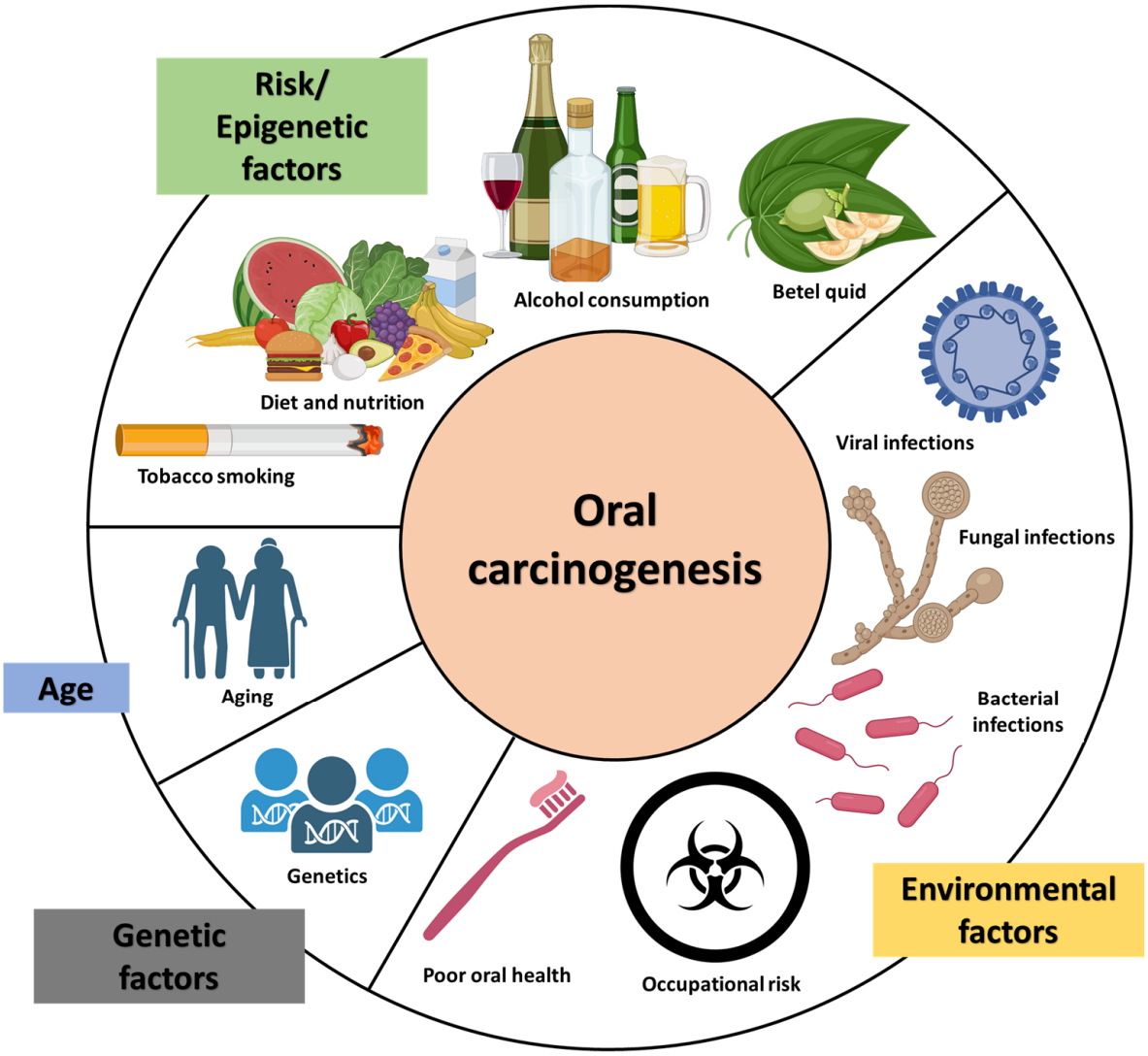

Figure 2. The link between the main risk factors related to oral carcinogenesis, including risk/epigenetic factors, environmental, genetic background, and aging.

The Global Youth Tobacco Survey, which took place in Sri Lanka in 2015, revealed that 3.2% of boys and 0.2% of girls aged between 13 to 15 had used tobacco at some point in the previous 30 days (current smokers), leading to an overall prevalence of 1.7%. This study also examined the use of smokeless tobacco among schoolchildren in Sri Lanka, and results revealed that 2.4% of students, 4.2% of boys, and 0.5% of girls in the 13–15 age group currently used smokeless tobacco [11]. In 2015, the STEPwise Approach to Surveillance (STEPS) survey in Sri Lanka evaluated alcohol and cigarette usage among Sri Lankans aged 18 to 69. This survey revealed that 29% men smoked, while 0.1% of women smoked; 26% of the time men used smokeless tobacco and 5% of women used smokeless tobacco. Further, in the same study, alcohol use among males was reported as 35%, whereas it was less than 1% in females [12]. According to the Global Adult Tobacco Survey (GATS) fact sheet, Sri Lanka 2020 [13], 19.4% overall (3.2 million adults), 36.2% of men, and 4.9% of women currently use tobacco. A proportion of 9.1% overall (1.5 million adults), 19.7% of men, and <0.1% of women currently smoke tobacco. 13.4% overall (2.2 million adults), 23.4% of men, and 4.9% of women currently use smokeless tobacco.

A study conducted in 2010 revealed that individuals with a low socioeconomic status had a higher risk of developing head and neck cancer than people from better socioeconomic statuses; this association appears to be mediated by variations in smoking and alcohol usage [14]. Additionally, compared to patients with a higher socioeconomic gradi-

ent, head and neck cancer patients from deprived backgrounds had a lower health-related quality of life (HRQoL) and poorer survival rates [15]. Health-related focus groups [16] and postal surveys [17] are less likely to be attended by patients from poor socioeconomic backgrounds. This may be because patients are less likely to communicate their concerns in research or to a healthcare practitioner due to lower health literacy, a poorer recall of symptoms, or low self-esteem [18,19].

1.1. Causes of OC and OPMD in Sri Lanka

The estate sectors of the Sri Lankan population are known to have a high OC prevalence, which has a significant negative impact on morbidity and mortality. Tamils made up 13.5% of all OC cases reported by the Cancer Registry in 2010 [20]. Most Tamil-ethnicity patients with OC came from the estate sector. Additionally, a study carried out in the central province's estate sector revealed a high prevalence of OPMD [21]. A study by Amarasinghe et al. [10] revealed that the weighted prevalence of betel chewers who did not include tobacco in their quids was 15.7%, and the prevalence of betel chewers who did was 47.4%; this prevalence was higher in the estate sector at 63%. Results potently show the lower importance of education and limited level of knowledge regarding the risk factors for OC and other potentially cancerous conditions [10].

In the corresponding study, the average prevalence of weekly alcohol consumption was 13.4%, and the estate sector had a higher prevalence (25.6%) than the villagers (12.3%). The fact was that the majority of people in the estate sector were low-educated laborers, as opposed to people in villages [10]. However, a study in the estate sector in Sri Lanka [21] reported a higher prevalence (61%) of alcohol consumption than in the previously mentioned study. In a cross-sectional study conducted by De Silva et al. [22] in 2007 in Medical Officer of Health (MOH) areas in the Colombo (urban) and Polonnaruwa (rural) districts, the reported prevalence of alcohol consumption in the rural areas was 20.8% for men. In this community, arrack was the most widely consumed alcoholic beverage; the statistics show a similar trend to the recent study conducted in Sri Lanka [10]. Arrack consumption was weighted at a 14.1% prevalence, and "Kassippu" consumption was at 2.3%. Despite the ban, Kassippu has been illegally produced and sold in the estate sector in Sri Lanka since 2006 [10]. In early Sri Lanka, kassippu was the most popular alcoholic beverage [23]. According to Perera et al. [24], the adult smoking rate in the general population of Sri Lanka was 21% in 2005, and it has gradually decreased since then. A study conducted by Amarasinghe et al. [10] revealed that the estate industry had a daily smoking prevalence of 17.3%.

1.2. Undernourishment in the Lower/Middle-Income Group

Among the main etiological factors, diet is considered an important determinant of OC development. Recent research has examined the relationship between dietary supplements and the risk of developing cancer. Excluding tobacco and alcohol consumption, particular foods or food families exhibit increased risk, including ones rich in pro-inflammatory factors. However, some nutrients, micronutrients, and food components can serve as defense mechanisms. Fruits, vegetables, and specific vitamins, as well as other staples of our diet, can provide this protective effect. An increased risk of OC has been linked to low fruit and vegetable consumption. As a result, regions with limited access to these foods have a higher prevalence than those with a high consumption rate [25]. In Sri Lanka's estate sector, a substantial portion of the population is malnourished. Even so, the estate community consumes very little overall in the way of fruits, vegetables, and portions containing beta-carotene [10]. Furthermore, the study by Amarasinghe et al. [26] found that this rural population had a very low daily intake of fruits and vegetables, contributing to the undernutrition that was prevalent there. Their diets have few cancer-preventing nutrients, which are overshadowed by substances known to cause cancer, including as alcohol, cigarettes, and betel nut consumption.

1.3. OC as a Public Health Concern in Sri Lanka

In Sri Lanka, OC affects more men than any other cancer and has the highest mortality rate (three deaths per day), with more than 2500 new cases reported each year. The National Cancer Control Programme in Sri Lanka reports that the crude incidence of OC was 20.6, in 2019 with 2759 new cases [27]. According to hospital records, OSF cases have increased recently compared to red and white lesions of the oral cavity (leukoplakia, erythro-leukoplakia, and erythroplakia). The general populace in rural areas believed areca nuts to be an Ayurvedic medicine and was not aware that they were carcinogenic [28]. The public is aware of the risks associated with tobacco use; however, it indirectly led to a rise in the consumption of areca nuts without tobacco in betel quid that finally ended up causing OSF [29].

Twenty-one percent of OPMD cases with clinical diagnoses were in young adults under the age of 30. This raises concerns about the OPMD trend and lifestyle choices of the younger age group [29]. The majority of these patients had completed the ordinary level of education and worked primarily in skilled and unskilled jobs. This shows the sociodemographic makeup of OPMD patients in Sri Lanka, the majority of whom are from low socioeconomic backgrounds and live in urban and suburban areas. Similar findings were attained by a study conducted in the Sri Lankan province of Sabaragamuwa's rural and estate sector [10].

1.4. Socioeconomic Impact of OC and Reasons for OC among Low/Middle-Income Groups

The amount of poverty in Sri Lanka has significantly decreased. In 2016, the poverty headcount ratio was 4.1%, down from 15.2% in 2006–07 (Department of Census and Statistics). Although income inequality has decreased, inequality has not changed [30]. The Gini index is a gauge of inequality that shows how equally or unequally distributed income is among a nation's population. The Gini coefficient for household income in Sri Lanka in 2016 was 0.45, indicating that inequality is still a problem [31]. The income inequality in Sri Lanka is a result of a number of factors, including a lack of access to high-quality higher education, fewer employment opportunities, inadequate infrastructure, and a lack of access to healthcare, and others [30].

Prior research has identified associations between OC mortality and individual and area deprivation and associations between OC risk and low socioeconomic status [32,33]. Public health researchers constantly argue about how socioeconomic status contributes to poor health, despite some theoretical explanations for the disparity in health [34,35]. Initial OC presentations at more advanced stages in patients with a lower socioeconomic status have been suggested as a possible association with the disparity in OC burdens [36]. Additionally, inadequate or absent OC knowledge has been cited as a significant contributor to late diagnosis [36]. Therefore, it might be suggested that socioeconomic status influences OC awareness and knowledge, which in turn affects advanced-stage diagnosis [37].

Previous studies have primarily concentrated on occupation, education, and income while using a variety of indicators, either alone or in combination, to measure socioeconomic status [38–40]. Individuals with a low socioeconomic status may have less access to sources of information about their health, including OC information, and as a result, may have lower awareness of the disease. Their lower level of educational attainment, lower level of health literacy and public education, and less frequent visits to the dentist and doctor could all contribute to this.

Groups with a low socioeconomic status may have been exposed to poisonous chemicals and environments, raising their risk of developing OC [41]. Low socioeconomic status may also be accompanied by a workplace that is more closely linked to unhealthy psychological or social environments with "work stresses", ref. [42] which may also raise the risk of developing cancer. Poorer terms and conditions, an increase in temporary employment [43], and longer unemployment periods could also raise the risk [44]. Smoking, drinking, eating poorly, and having a history of HPV exposure are all linked to inequality and may contribute to the explanation of socioeconomic status gradients in OC [45]. Low socioeconomic

status and these risky behaviors interact in a complicated way. It has been documented that drinking alcohol and smoking help people cope with the stress that comes with being poor or having a low socioeconomic status [46,47]. In other words, socioeconomic factors may be more deeply ingrained in the etiology of the disease and may even act as a "cause of the cause", to use Rose's terminology. The link to low socioeconomic status, however, is still intriguing [48].

The housing situation and living conditions may directly affect household income, which in turn affects health [49]. Additionally, it might impact those who have access to social services, health care, and affordable, wholesome food [50]. These elements have an impact on health and might help to explain the link to a higher risk of OC. Low SES has been said to potentially imply some type of "stress" by all measures [51]. These stresses can stem from a variety of factors, such as job insecurity, unemployment, crime-related anxiety, debt, a lack of social capital, and a lack of community cohesion [51]. Uncertainty exists regarding the biological underpinnings of the relationship between the stresses brought on by low socioeconomic status, inequality, and cancer development, but emerging theories point to the "biological aging" effects brought on by such conditions, which may be mediated by telomere shortening [52,53].

Sri Lanka has gone through a major fuel crisis due to a shortage of dollars in the country, creating miles-long vehicle queues island-wide. This has affected the day-to-day life of citizens, including their basic needs. As a result, most people restricted their travel. Apart from travel restrictions, this was influenced by expensive charges by health professionals and increased prices of medicines and increased transportation costs. Self-diagnosis, following home remedies for curing, and late hospital visits caused worsening of the condition, disease, or disorder.

A higher prevalence of the disease leads to increased economic costs that have a detrimental effect on both the healthcare system and individual families, severely harming the nation's economy. Policymakers ought to be aware of this burden and step up efforts to prevent and control this terrible illness [54]. The average annual cost to the health system of managing a single stage II OC patient was SLR 58,979 (or USD 394 at the midyear exchange rate in 2016). The average cost of a household was SLR 77,649 (USD 518). Stage III or IV patients had annual management costs of SLR 303,620 (USD 2027) and SLR 71,932 (USD 480) for household expenses [54].

1.5. OC and OPMD Awareness among Low- and Middle-Income Groups of Sri Lanka

In a descriptive cross-sectional study conducted among the Outpatients Department (OPD) of the Institute of Oral Health, Maharagama, from 2018 to 2019, there were 110 patients with OPMD and OC in total [29]. Out of the 110 patients, 40% of the population was aware of OPMD while 76.4% were aware of OC. However, the dangers of areca nut and alcohol use were largely unknown. Only 30% of the OPMD patients believed that tobacco in betel quid caused OC and OPMD, and 28.2% were aware of the danger of areca nut use. Only 23% of the study population had education beyond the advanced level examination, while 74% had education only up to the level of the ordinary examination. A sizable percentage (46.5%) worked in skilled occupations, and 40.4% belonged to the middle-income group [29].

A cross-sectional community-based study on 1029 adults over 30 years old in Sabaragamuwa province from November 2006 to November 2007 estimated the prevalence of OPMD at 11.3%, weighted by the estate sector and gender. Most participants were unaware of the signs of OPMD and OC. A total of 32% were unaware that chewing betel nuts was a risk factor for these illnesses, as were 65% for tobacco smoking and 81% for the heavy consumption of alcohol [28]. According to research, dietary factors account for about 30% of all cancers [55]. Recently, a thorough review of the protective effects of nutritional supplements was conducted for vitamin A (retinol), β-carotene, and vitamin E in lowering the risk of developing OC and OPMD [56,57]. Nearly all of the participants in the current study were not aware that micronutrient deficiency could be a risk factor for OC/OPMD [28].

A hospital-based descriptive cross-sectional study was carried out among 351 patients with histologically confirmed carcinoma of the oral cavity and pharynx cases; 49.9% of the sample population had only completed elementary school or had never attended any school [58]. Previous studies carried out in Sri Lanka have demonstrated a poor level of awareness regarding OPMD symptoms. According to a community-based study conducted in the Sri Lankan province of Sabaragamuwa, 70.0% of participants were unaware that a persistent mouth ulcer, a white patch, or a red patch were signs of OPMD [28]. Only 44.9% of the participants in another hospital-based study at the dental hospital in Peradeniya were aware that an entity known as oral pre-cancer existed [59].

Furthermore, oral cavity malignancies can be treated using a wide variety of procedures. The most frequent forms of treatment include surgery, radiation, and chemotherapy, either separately or in combination [60,61]. Stage I and stage II OC are highly treatable with surgery or radiotherapy (RT), which both have excellent long-term outcomes and improve function [62]. Additionally, radiation has demonstrated a local control rate of 65 to 90% in OCs that are moderately progressed [63]. Although RT with or without chemotherapy is not frequently used to treat OC, it is used with or without chemotherapy when organ preservation is a concern, the patient is unable to withstand surgery, it is necessary to avoid cosmetic imperfections, and it is necessary to maintain functions [64–66]. These therapies perform effectively, but they also have serious adverse effects. Mucositis (stomatitis), xerostomia (dry mouth), bacterial, fungal, or viral infections, dental caries, a loss of taste, osteoradionecrosis, nutritional deficit, anorexia, and malaise are specific side effects of RT [67–69]. Both the patients' oral health-related quality of life (OHRQOL) and health-related quality of life are impacted by these problems. OHRQOL is described as "a multidimensional construct that reflects people's comfort when eating, sleeping, and engaging in social interaction; their self-esteem; and their satisfaction with respect to their oral health" [70] in the United States Surgeon General's report on oral health. When compared to intensity-modulated RT, patients with stage III and stage IV malignancies had the worst OHRQOL for swallowing, speaking, social eating, reduced mouth opening, and dry mouth [71,72]. More than 68% of oral cancers in Sri Lanka were discovered for the first time at stages III and IV [73]. Since Sri Lanka only has a small number of linear accelerators with intensity-modulated RT, the majority of the patients were treated with conventional cobalt RT [74]. According to a prospective study carried out at the National Cancer Institute (Apeksha Hospital) among 90 OC patients [75], patients with OC who underwent radiotherapy alone or in combination with chemotherapy experienced a decline in OHRQOL from the baseline level to the final week of radiotherapy, but it then improved three months later. Three months after radiotherapy, the OHRQOL did not, however, revert to its pre-radiotherapy level. The OHRQOL at baseline, the civil status, and the sites of metastases all had an impact on OHRQOL during the final week of radiotherapy.

1.6. Future Recommendations

Globally, heavy drinking, various forms of tobacco use, and certain types of HPV infection are still the leading contributors to OC. OC is mostly a disease of the poor, despite the relative impact of risk factors varying from population to population [76]. Fundamental changes in socioeconomic position as well as initiatives to lower the demand, production, marketing, and use of tobacco products and alcohol can contribute to the prevention of this devastating disease [76]. Referring patients to cancer treatment centers for early diagnosis and treatment should be a major responsibility of primary care dentists and general practitioners. Strengthening the abilities of these primary care physicians is crucial in enhancing the chances for early detection for patients who use tobacco or alcohol in any form. Regular biopsy in those clinically presenting with symptoms of precancerous lesions may lead to the early identification of underlying aggressive mouth cancer. Because patients with OC have a high chance of getting malignancies in other head and neck sites as well as the lungs, a simultaneous assessment of the upper aerodigestive tract is required in addition to a patient's medical history, physical examination, and biopsy [77]. A thorough

examination of the head and neck is carried out in addition to the history to carefully analyze the location and spread of the main tumor and find metastases. It is interesting that early stage malignant lesions might be red or white plaques and non-ulcerative. More advanced malignant tumors are ulcerative, aggressive, fungal, conspicuous, or both. Precancerous lesions like oral leukoplakia or erythroplakia may evolve into OC. Thus, it is crucial to raise dentists' awareness to obtain a thorough history and examination of the head and neck [78].

Standard population-based screening programs for OC are not financially viable and cannot be advised, in contrast to those for other common malignancies (such as colon or cervical cancer) [79]. Those in high-risk categories (smokers and alcoholics) or those who have already been diagnosed with cancer beyond the head and neck may benefit from screening programs [80]. In nations with regular dental practice attendance, opportunistic screening for oral mucosal lesions (early stage cancer or precancerous lesions) in general dentistry practice may also be relevant in reducing diagnostic delay [81]. OC is a particularly fine fit for population screening due to known risk factors, a long natural history, and the ease with which precancerous lesions can be identified by oral examination. OC typically develops in areas that are easily accessible and can be detected early by self-examination (eye inspection and touch). Because it is a strategy for the early diagnosis of precancerous oral lesions without the requirement for a simple, non-invasive, or expensive healthcare expert, oral self-examination is feasible for everyone [82]. High-risk individuals should have strong assistance [83]. Oral self-examination is crucial in lowering the incidence and mortality of oral malignancies, according to a quasi-experimental study conducted in Australia [84].

Attempts should be made to stop modifiable risk behaviors, and patients should receive proper counselling as soon as possible, to reduce the risk of malignant transformation. These patients need to be followed up frequently because they continue to have a chance of developing malignancy. Currently, follow-up intervals are entirely determined by clinicians' subjective assessments of clinical appearance and reported dysplasia in the specimens and are not based on evidence. The likelihood of malignant transformation is probably highest in the first two years, and after that, 1% of cases may change annually. However, patients should continue to receive routine follow-ups, and if a skilled physician deems it necessary, clinically suspicious areas should undergo a second biopsy [85].

Secondary prevention targeted at high-risk individuals and primary prevention, particularly focused on the cessation of smoking, are likely to be affordable and cost-effective in low- and middle-income groups/countries. The target population's participation will be key to the program's success once cancer screening policies are put in place. Patients might not be able to afford to skip a day of work to travel to screening clinics or to health centers for follow-up diagnostic testing or treatments, even if screening and follow-up care are free. Patients from lower socioeconomic tiers may find it particularly difficult to bear the indirect costs. These are individuals who are likely to be at higher risk for developing OCs. It is crucial to identify strategies to encourage and sustain participation among this potentially hard-to-reach, high-risk population [77].

Rural Sri Lankan populations were poorly aware of OC and OPMD. These findings are supported by several research studies conducted throughout the world, particularly regarding early symptoms, indicators, risk factors, and preventative strategies. Those who are most at risk must be made more aware. In Sri Lanka, there is an urgent need for ongoing national health education and promotion initiatives that emphasize OC while also integrating broader health messaging and utilizing a common risk factor approach. They need to consider the disparities in knowledge as well as the preferred or available communication channels for the various populations [86].

In addition, strategies to promote cancer-preventing nutrients among the poor population can be beneficial for their overall health. It is important to focus on affordable, native, and easily accessible food products that are rich in nutrients known for their potential cancer-preventing properties. Here are some examples:

1. Cruciferous Vegetables: Vegetables like cabbage, cauliflower, broccoli, and kale are rich in vitamins, minerals, and antioxidants that have been linked to a reduced risk of certain cancers.
2. Tomatoes: Tomatoes contain lycopene, a powerful antioxidant that has been associated with a lower risk of prostate cancer. Cooking tomatoes increases the bioavailability of lycopene.
3. Garlic: Garlic contains organosulfur compounds that have been shown to have cancer-fighting properties, particularly against stomach and colorectal cancers.
4. Turmeric: Curcumin, the active compound in turmeric, has anti-inflammatory and antioxidant properties that may help in preventing certain types of cancer.
5. Beans and Lentils: Legumes are high in fiber, which can help regulate blood sugar levels and promote a healthy digestive system. Some studies have suggested that they may also have a protective effect against certain cancers.
6. Green Tea: Green tea contains catechins, which are antioxidants that have been associated with a reduced risk of certain cancers.
7. Whole Grains: Whole grains like brown rice, whole wheat, and oats are rich in fiber, vitamins, and minerals, and have been linked to a decreased risk of colorectal cancer.
8. Onions: Onions, like garlic, contain organosulfur compounds that may help in cancer prevention, especially against stomach and colorectal cancers.
9. Citrus Fruits: Citrus fruits such as oranges, lemons, and grapefruits are rich in vitamin C and other antioxidants, which may help protect against certain types of cancer.

It is important to note that while consuming these foods may contribute to a healthier lifestyle and potentially reduce the risk of cancer, they should be part of a balanced diet along with other essential nutrients. Additionally, the consumption of these foods is not a guarantee against cancer, but they can contribute to a healthier lifestyle. For individuals with limited resources, local markets, seasonal produce, and traditional recipes can be utilized to incorporate these nutrient-rich foods into their diet. Furthermore, access to healthcare, education on nutrition, and overall living conditions also play a crucial role in improving the health outcomes of the poor population. In Table 1, we summarize the OC and OPMD-related studies conducted recently in Sri Lanka.

Table 1. Summary of the key literature.

Author	Year of Publication	Inclusion and Exclusion Criteria	Research Objectives	Study Design	Sample Characteristics	Study Instrument	Conclusion
Perera et al. [24]	2005	Inclusion criteria were residents of southern district of Sri Lanka	To identify smoking prevalence rates by gender and age and respondents' attitudes toward smoking and possible associations between alcohol use and smoking.	Descriptive cross-sectional survey	Cluster sampling method was used to select respondents. Considering the time and resources, authors chose to survey nearly 1600 adults in the population.	Self-administered anonymous questionnaire	Higher prevalence rates for tobacco were observed among less educated, middle-aged men who were from underprivileged families. Alcohol use seems to be positively associated with smoking.
Ariyawardana and Vithanaarachchi [59]	2005	Inclusion criteria were outpatients attending the Dental Teaching Hospital, Faculty of Dental Sciences, University of Peradeniya, Sri Lanka	To investigate OC and precancer awareness among patients undergoing dental treatment at a university dental hospital.	Questionnaire-type survey	Subjects (n = 410) were randomly chosen	Self-administered questionnaire	According to the results of this survey, out patients were adequately informed about OC. However, precancer awareness was relatively poor. In comparison to betel chewing, knowledge of the causal links between cigarette smoking and alcohol usage was minimal.
Ariyawardana et al. [21]	2007	Inclusion criteria were residents in or attached to a nearby estate of the central province, Sri Lanka.	To obtain demographic data on risk factors associated with OC and OPMD and to conduct and report the outcome of an oral mucosal examination on tea estate laborers in Sri Lanka.	-	12,716 tea laborers over the age of 15 years employed by 73 tea estates in central Sri Lanka by estate medical officers	Questionnaires and oral examination	The prevalence of oral pre-cancer in tea estate laborers was higher than estimates reported in previous studies.

Table 1. *Cont.*

Author	Year of Publication	Inclusion and Exclusion Criteria	Research Objectives	Study Design	Sample Characteristics	Study Instrument	Conclusion
de Silva et al. [22]	2009	Inclusion criteria were males residents of Colombo and Polonnaruwa over 18 years of age	To investigate the prevalence and consumption of tobacco and alcohol among males in the Colombo and Polonnaruwa districts	A cross-sectional study based on multistage cluster sampling	The sample consisted of males over 18 years. There were 1318 from the Colombo District and 1366 from the Polonnaruwa District.	Interviewer-administered questionnaire	According to the mean alcohol intake and the number of people who consumed spirits on a regular basis, high-risk alcohol use was prevalent, particularly in urban regions. Smoking prevalence was substantially lower than in many Asian countries, but comparable to Western Europe.
Amarasinghe et al. [28]	2010	Inclusion criteria were residents of Sabaragamuwa province.	To investigate the level of public awareness of OC and OPMD and of risk factors	A cross-sectional community-based survey	A total of 1029 subjects were selected.	Interviewer-administered questionnaire	Knowledge of OC, OPMD and their associated risk factors was poor among this population, indicating an urgent need to implement public health education and promotion strategies.
Amarasinghe et al. [26]	2013	Inclusion criteria were residents of Sabaragamuwa province.	To investigated the association of OPMD (and leukoplakia as a subgroup) with the consumption of fruits, vegetables, chillis and tea.	A cross-sectional community survey	A total of 1029 subjects were selected by a multistage, stratified and clustered sampling technique.	Interviewer-administered questionnaire	This study reveals the prevalence of malnutrition in this rural population, with relatively low daily consumption of fruits and vegetables. Cancer-preventive characteristics in their diets are limited and overshadowed by known carcinogenic substances associated with betel quid, cigarette, and alcohol usage.

Table 1. *Cont.*

Author	Year of Publication	Inclusion and Exclusion Criteria	Research Objectives	Study Design	Sample Characteristics	Study Instrument	Conclusion
Alahapperuma and Fernando [58]	2017	Inclusion criteria were those who have been diagnosed with oral and pharyngeal cancer within 3 months of the interview date. Mentally handicapped patients and patients who were debilitated and unable to respond were excluded.	To identify patient-linked delays between the time of noticing the symptoms and definitive diagnosis and its association with the stage at diagnosis and socio-demographic factors among oral and pharyngeal carcinoma patients attending the National Cancer Institute, Maharagama.	A hospital-based descriptive cross-sectional study	351 patients with histologically confirmed carcinoma of the oral cavity and pharynx.	Interviewer-administered questionnaire	Stage at diagnosis was associated with 'Patient Delay-1' ($p = 0.001$) but not with 'Patient Delay-2' ($p = 0.001$). 'Patient Delay-1' was significantly associated with education level ($p = 0.001$) and travel cost ($p = 0.048$).
Amarasinghe et al. [10]	2018	Inclusion criteria were residents of Sabaragamuwa province.	To determine the prevalence of OPMD and of lifestyle factors among the population in the Sabaragamuwa Province of Sri Lanka.	A cross-sectional community based study	A total of 1029 subjects above the age of 30 years	Interviewer-administered questionnaire	This study reveals that in these populations, OPMD and OC risk factors are highly prevalent. For the purpose of preventing OC, a comprehensive approach to manage cigarette, betel nut, and alcohol usage is urgently needed.
Amarasinghe et al. [54]	2019	The study was conducted in selected cancer treatment centers in Sri Lanka.	To estimate the costs of managing patients with OC in Sri Lanka for a 12 month period from diagnosis.	Hospital-based costing study (activity-based costing with cost apportionment and step-down costing approach was used).	Sixty-nine OC patients: 60 were males and 12 had recurrent tumors.	Interviewer-administered questionnaire	Because of the high prevalence of OC in Sri Lanka, the economic expenditures related to these diseases are significant, wreaking havoc on both the healthcare system and individual families, and severely affecting the country's economy.

Table 1. *Cont.*

Author	Year of Publication	Inclusion and Exclusion Criteria	Research Objectives	Study Design	Sample Characteristics	Study Instrument	Conclusion
Amarasinghe et al. [29]	2021	Inclusion criteria were patients who were seeking care from the Out Patients Department attendees of the Institute of Oral Health, Maharagama, Sri Lanka. Patients who refused to provide relevant information were excluded from the study.	To assess the care seeking pattern and behavior and its associated factors for OPMD among the patients' attendees and also to evaluate the impact of the existing early detection program for OC.	A hospital based descriptive cross-sectional study	A total number of 110 OPMD/oral cancer patients were recruited.	Interviewer-administered questionnaire	The general public was unaware about OPMD and its risk factors. The fact that incidental findings during dental screening are the primary route of identification of OPMD emphasizes the need of doing opportunistic screening in dental settings.
Kosgallana et al. [75]	2023	Inclusion criteria were OC patients awaiting radiotherapy alone or with chemotherapy at the National Cancer Institute (Apeksha Hospital), Maharagama, Sri Lanka.	To evaluate the OHRQOL and its changes from baseline through the last week of radiotherapy and three months after radiotherapy in patients with OC who underwent this treatment alone or in combination with chemotherapy.	A prospective longitudinal study.	90 OC patients.	The modified Sinhala version of the European Organization for Research and Treatment of Cancer Quality of Life Questionnaire Oral Health Module (EORTC QLQ-OH15) was used to gather data related to OHRQOL before radiotherapy.	The OHRQOL of oral cancer patients who received radiotherapy alone or in combination with chemotherapy worsened from baseline to the last week of radiotherapy, but subsequently improved three months later. However, three months after radiation, the OHRQOL did not revert to the baseline level. OHRQOL during the final week of radiation was affected by baseline OHRQOL, civil status, and metastatic sites.

2. Conclusions

To lessen the burden of this eminently preventable cancer, a multifaceted strategy that incorporates health education, tobacco and alcohol control, early detection, and early treatment is required. The method for doing this is known, but astonishingly, it has not been put into practice in the majority of nations, and not at all in the high-burden nations. Critically important OC control measures include raising awareness among the general public and primary care providers, making investments in health services to offer screening and early diagnosis services for tobacco and alcohol users, and providing adequate treatment for those who have been diagnosed with invasive cancer. In many low- and middle-income countries, the infrastructure and services for imaging, histopathology, cancer surgery, and RT, as well as the availability of trained professionals and chemotherapeutic agents, are insufficient, seriously jeopardizing early detection and the best possible care. The burden of OC scenarios and OPMDs in low- and middle-income socioeconomic groups can be minimized by making the target population aware about a balanced diet, and good oral and sexual hygiene, and knowledge of disease signs and symptoms is crucial. Success depends on political will, cross-sectoral cooperation, and the dissemination of culturally appropriate public health messaging through public awareness campaigns and media campaigns.

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