

Oral cancer burden and mortality in India: a GLOBOCAN 2022 analysis with regional comparison

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Abstract

Background: India bears a disproportionate burden of oral cancer globally. We aimed to provide an updated epidemiological assessment of oral cancer incidence, mortality and prevalence in India using GLOBOCAN 2022 data, contextualised within the WHO South-East Asia Region (SEARO).

Methods: A descriptive cross-sectional analysis was done using GLOBOCAN 2022 data from the International Agency for Research on Cancer. India was compared with other SEARO countries and temporal trends (1992–2017) were analysed using cancer in five continents data and Indian National Cancer Registry Programme data. Age-standardised rates (ASRs) were calculated per 100,000 population using the World Standard Population and 5-year prevalence and cumulative lifetime risk before age 75 were estimated.

Results: In 2022, India reported 143,759 new oral cancer cases (10.2% of all cancers) with an ASR of 10.1 per 100,000 population. Males accounted for 75% of cases (ASR: 15.6 versus 5.0 per 100,000 in females). India recorded 79,979 deaths (8.7% of all cancer deaths) with mortality ASR of 6.4 per 100,000. The cumulative lifetime risk was 1.1%. India accounted for 81% of SEARO's oral cancer burden despite representing 68% of the population. India's incidence rates were 33% higher than the regional average (10.1 versus 7.5 per 100,000). Long-term trends (1992–2017) showed stabilising ASRs but increasing absolute numbers due to population growth. Tobacco and areca nut use account for approximately 70%–80% of cases.

Conclusion: India has the highest oral cancer incidence globally, with persistent age and gender disparities. The disproportionate burden relative to population size reflects entrenched behavioural risk factors and systemic gaps in prevention, screening and treatment. Urgent priorities include enhanced tobacco control legislation, targeted risk-based screening expansion and leveraging digital health innovations to reduce oral cancer morbidity and mortality.

Keywords: oral cancer, India, SEARO, mortality

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Introduction

Globally, oral cancer, which encompasses malignant neoplasms of the lip, oral cavity and oropharynx, ranks the sixth most common cancer, with an estimated 380,000 new cases and 178,000 deaths annually [1]. Low-income and middle-income countries bear a disproportionate amount of the burden, with India being the most severely impacted [2]. This discrepancy results from widespread consumption patterns of tobacco and areca nuts that are ingrained in Indian subcontinental culture [3].

The oral cancer epidemiology in India presents a unique public health challenge. Incidence and mortality rates continuously surpass the global averages, even with ongoing tobacco control efforts and cancer prevention programs [4]. In 2022, the country recorded about 143,759 new cases of oral cancer, which accounted for 10.2% of all incident cancers [5]. It ranks the second most common among men and women, after prostate cancer and breast cancer, respectively. India has a significantly higher cumulative lifetime risk of 1.1% for oral cancer before the age of 75 than the regional average [6]. The epidemic of oral cancer in India is primarily caused by a variety of tobacco use patterns and widespread use of both smokeless tobacco products (gutkha, khaini and betel quid with tobacco) and combustible tobacco products (bidis, cigarettes) [7]. According to the Global Adult Tobacco Survey 2016–17, about 28% of Indian adults smoke, with state-level prevalence rising to 40% in high-burden areas [8]. It is concerning that high prevalence also affects traditionally lower-risk groups, such as rural women and adolescents [9]. Tobacco users are at least six times more likely to develop oral cancer than non-users, according to extensive Indian case-control and cohort studies [10]. Through synergistic mechanisms, the concurrent use of areca nut products, which are frequently combined with tobacco in traditional preparations, further increases the carcinogenic potential [11].

The prevalence of oral cancer in India varies significantly by region and is impacted by socioeconomic, medical and cultural factors. There is a strong correlation between higher tobacco and areca nut consumption patterns and high-incidence clusters in northeastern states, Uttar Pradesh, West Bengal and Andhra Pradesh [12]. Because of ingrained cultural customs, insufficient tobacco control enforcement and restricted access to early detection and treatment services, marginalised populations, especially those living in rural and tribal areas, are disproportionately at risk [13]. More than half of oral cancer cases present at advanced stages (III or IV), with 5-year survival rates below 50%, according to population-based cancer registries [14]. Significant economic repercussions result from the high out-of-pocket costs, which, even in national health insurance systems, cause financial hardship [15].

The potential of oral cancer screening to lower mortality is strongly supported by data from meta-analyses and randomised controlled trials. Oral cancer screening has shown potential to reduce mortality in high-risk populations, particularly when based on visual examination by trained health workers. However, screening coverage at the population level remains limited, and implementation challenges persist in referral pathways, programme quality and integration within primary healthcare systems [16]. Less than 15% of high-risk adults have ever been screened, indicating that population-level screening coverage is still insufficient [17]. Poor integration of oral cancer awareness within primary healthcare systems, insufficient referral pathways and uneven screening program quality are some of the obstacles [18].

Emerging epidemiological trends include increased smokeless tobacco use, lifestyle modifications and urbanisation effects. Flavoured, commercially packaged smokeless tobacco products marketed to women and teenagers have contributed to early initiation of use and consumption more of them, which is in line with the rising prevalence among those under 50 [19, 20]. Services for cancer screening, diagnosis and treatment were further disrupted throughout healthcare systems by the COVID-19 pandemic [21]. Although digital health interventions, including telemedicine, mobile health messaging and artificial intelligence-assisted lesion detection, show promise, these remain in early pilot phases requiring scale-up and evaluation [22].

In stark contrast to neighbouring countries like Bangladesh, Myanmar and Nepal, which report significantly lower incidence and cumulative risks, India accounts for over 80% of regional oral cancer cases and deaths despite making up roughly 68% of the South-East Asia Region (SEARO) population [23–25]. While offering insights for larger Southeast Asian contexts, this sharp regional disparity highlights the need for evidence-based cancer control strategies tailored to India [26]. There are still gaps in nationally representative epidemiological data that include recent GLOBOCAN estimates and thorough regional comparisons, despite prior research. This study aims to address these gaps by providing a detailed epidemiological profile of oral cancer in India using GLOBOCAN 2022 data, contextualising findings within regional trends and deriving actionable insights for tobacco control, screening and prevention strategies.

Methods

Study design and setting

A descriptive cross-sectional epidemiological study was conducted to assess oral cancer burden in India and the WHO SEARO for 2022. Oral cancer was defined as malignant neoplasms of the lip and oral cavity classified under International Classification of Diseases, 10th revision (ICD-10) codes C00–C06. The analysis encompassed incidence, mortality, prevalence and cumulative risk estimates, with temporal trend analysis of age-standardised rates (ASRs) from 1992 to 2017.

Data sources

Primary data were obtained from the Global Cancer Observatory (GLOBOCAN 2022) database maintained by the International Agency for Research on Cancer [27]. GLOBOCAN provides modelled estimates of cancer incidence, mortality and 5-year prevalence for 185 countries using standardised methodologies combining population-based cancer registry data, mortality data and population data. For temporal trend analysis (1992–2017), data from the Cancer in Five Continents (CI5plus) database were used, which compiles high-quality population-based cancer registry data worldwide [28]. This was supplemented with National Cancer Registry Programme (NCRP) data from India to enhance representativeness for subnational and sex-specific analyses [29]. Population denominators were derived from United Nations Population Division mid-year 2022 estimates for standardisation purposes [30].

Case definition and eligibility

All primary malignant neoplasms of the lip and oral cavity (ICD-10 codes C00–C06) across all age groups and both sexes were included. Secondary malignancies, benign lesions and carcinomas *in situ* were excluded to maintain consistency with GLOBOCAN methodology.

Outcome measures

Primary outcomes included:

- Incident oral cancer cases and age-standardised incidence rates (ASIR) per 100,000 population.
- Oral cancer deaths and age-standardised mortality rates (ASMR) per 100,000 population.
- 5-year prevalence of oral cancer survivors.
- Cumulative lifetime risk of developing or dying from oral cancer before age 75.

Secondary outcomes comprised annual ASR values for incidence and mortality by sex for temporal trend analysis and proportional contributions to overall cancer burden.

Statistical analysis

Data management and analysis were performed using R software (version 4.3.0). ASIR and ASMR were calculated using direct standardisation with the 1966 World Standard Population to enable cross-population and temporal comparability [31]. Separate ASRs for males, females and combined populations were estimated.

Proportions of oral cancer cases and deaths relative to all cancers nationally and regionally were calculated. For temporal trend analysis, join point regression was used to identify significant trend changes, reporting annual percent change and average annual percent change (AAPC) [32]. The regional burden was expressed through proportional analysis, risk ratios and excess case calculations. Literature-derived population attributable fractions were applied for tobacco and areca nut use to estimate preventable case fractions [33–35].

Quality assurance

Cross-validation of key epidemiological metrics was performed across GLOBOCAN, CI5plus, NCRP registries and peer-reviewed literature to ensure data consistency. Modelling assumptions, including incidence-mortality ratios and prevalence estimation methods, documenting limitations related to registry coverage and estimation methodologies were reviewed.

Results

National oral cancer burden in India, 2022

India recorded 143,759 new lip and oral cavity cancer cases in 2022, constituting 10.2% of all incident cancers nationally (Table 1). The overall ASIR was 10.1 per 100,000 population, with males disproportionately affected (107,812 cases [75%] versus 35,947 females [25%]). Among male cancers, oral cancer represented 15.6% of cases compared with 5.0% among females. The cumulative lifetime risk of developing oral cancer before age 75 was 1.1%. Mortality was substantial, with 79,979 deaths recorded, representing 8.7% of all cancer fatalities. The ASMR was 6.4 per 100,000, with higher rates in males (9.8 per 100,000) than females (3.2 per 100,000). Five-year prevalence data revealed 370,106 survivors, indicating significant ongoing healthcare needs.

Regional comparison: India versus SEARO

India contributed disproportionately to the regional burden, accounting for 81.1% of incident cases (143,759/177,258), 81.0% of deaths (79,979/98,735) and 81.1% of 5-year prevalent cases (370,106/456,270) within SEARO, despite comprising 68.3% of the regional population. India's ASIR was 33% higher than the SEARO average (10.1 versus 7.5 per 100,000), its ASMR was 42% higher (6.4 versus 4.5 per 100,000) and its cumulative lifetime risk was 18% higher (1.1% versus 0.93%) (Table 2, Figure 1).

Temporal trends (1992–2017)

Long-term trend analysis revealed that ASIRs were relatively stable to moderately declining for males and stable for females (Figure 2). Population growth and demographic shifts caused a significant increase in absolute case numbers despite stable ASRs. While female ASIR rates stayed constant (AAPC: -0.2%, 95% CI -0.7 to +0.3), male ASIRs displayed a moderate declining trend (AAPC: -0.8%, 95% CI -1.2 to -0.4). Compared to regional peers, overall mortality rates remain high, but after 2,000, mortality trends showed moderate declines, particularly among females (AAPC: -1.4%, 95% CI -2.1 to -0.7). Over the course of the observation period, India's ASRs continuously outperformed those of its neighbouring SEARO nations (Figure 3).

Demographic and geographic patterns

The male-to-female incidence ratio was approximately 3:1, driven by differential tobacco and areca nut exposure patterns. Emerging evidence indicates increasing incidence among adults aged under 50 years, particularly in high-burden states including Uttar Pradesh (ASR: 12.8 per 100,000), West Bengal (ASR: 11.4 per 100,000) and Andhra Pradesh (ASR: 13.2 per 100,000).

Rural populations exhibited higher age-adjusted incidence rates compared with urban areas (11.8 versus 8.9 per 100,000), with marginalised populations including Scheduled Castes, Scheduled Tribes and socioeconomically disadvantaged groups bearing a disproportionate burden compounded by late-stage diagnosis and limited healthcare access.

Population attributable risk

Based on established risk estimates, approximately 70%–80% of oral cancer cases in India are attributable to tobacco and areca nut consumption [33]. This translates to an estimated 100,000–115,000 preventable incident cases and 56,000–64,000 preventable deaths annually with effective risk factor modification strategies.

Table 1. Oral cancer burden in India, 2022.

Metric	Total	Males	Females
New cases, <i>n</i>	143,759	107,812	35,947
Proportion of all cancers, %	10.2	15.6	5.0
ASR incidence per 100,000	10.1	15.4	5.1
Deaths, <i>n</i>	79,979	59,844	20,135
Proportion of all cancer deaths, %	8.7	12.8	4.9
ASR mortality per 100,000	6.4	9.8	3.2
5-year prevalence, <i>n</i>	370,106	274,518	95,588
Cumulative risk <75 years, %	1.1	1.4	0.8

ASR = age-standardised rate

Table 2. Regional comparison of oral cancer burden, 2022.

Country/Region	Population	New cases	ASR incidence	Deaths	ASR mortality	5-year prevalence	Cumulative risk %
India	1,406,632,000	143,759	10.1	79,979	6.4	370,106	1.1
Bangladesh	169,356,000	12,844	7.8	8,756	5.8	32,156	0.89
Indonesia	275,501,000	8,967	3.2	4,889	1.9	25,478	0.35
Myanmar	54,577,000	5,234	9.8	2,876	5.7	14,267	1.06
Thailand	71,668,000	3,456	4.8	1,987	2.8	9,876	0.52
Other SEARO*	81,713,000	2,998	3.7	1,248	1.6	4,387	0.41
SEARO Total	2,059,447,000	177,258	7.5	98,735	4.5	456,270	0.93

*Includes Bhutan, Democratic People’s Republic of Korea, Maldives, Nepal, Sri Lanka, Timor-Leste. ASR = age-standardised rate; SEARO = South-East Asia Regional Office

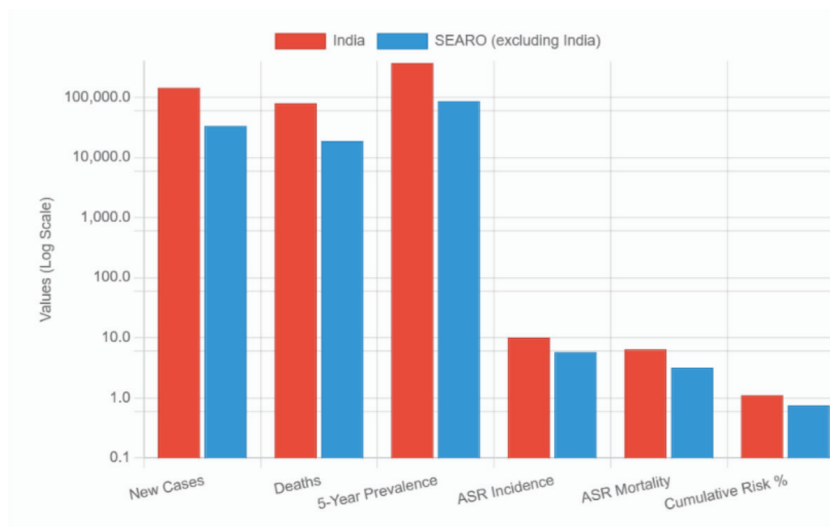


Figure 1. Oral cancer burden India versus SEARO (2022).

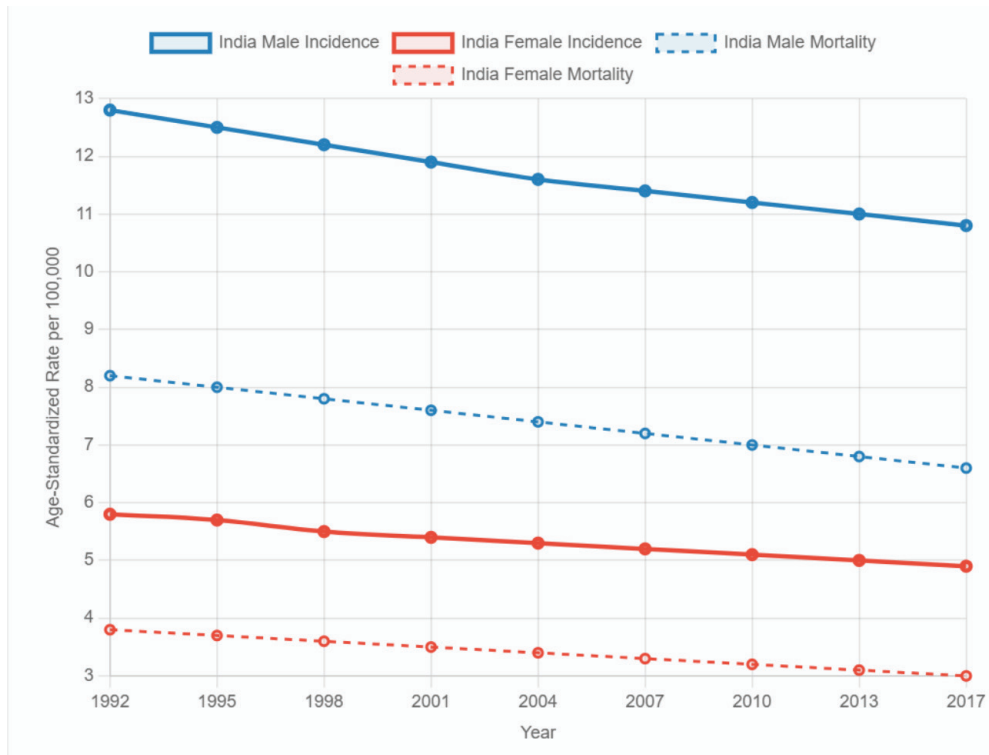


Figure 2. Temporal trends in age-standardised rates (1992–2017).

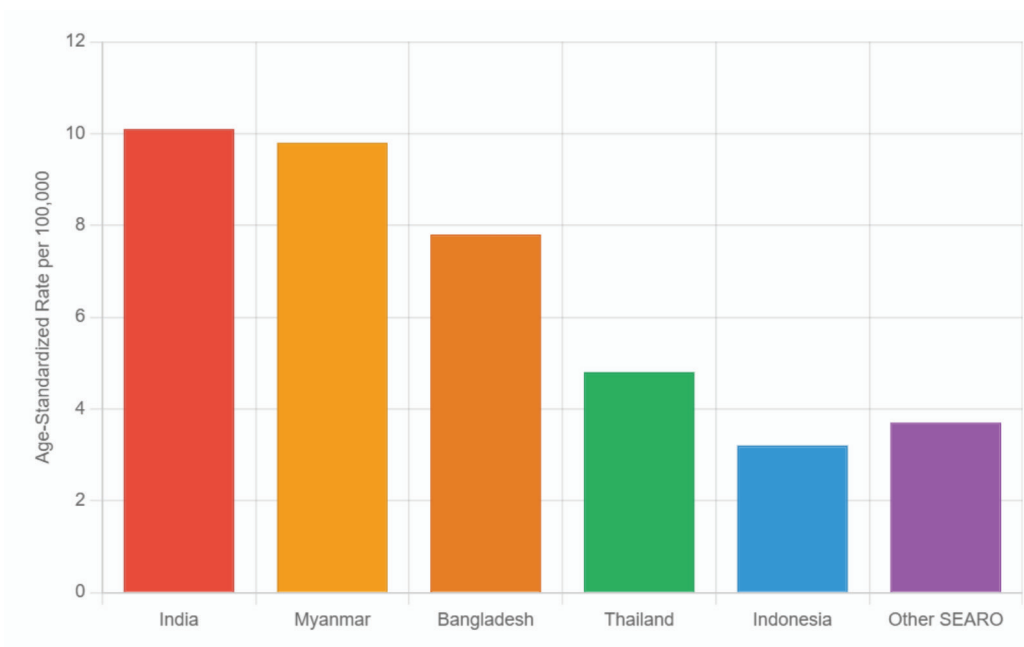


Figure 3. Regional comparison of ASIRs across SEARO countries.

Discussion

This comprehensive analysis using GLOBOCAN 2022 data confirms India as the epicentre of the global oral cancer epidemic. More than 80% of incident cases, fatalities and survivors in South-East Asia occur in India, despite the making up 68% of the population. The ASIR of 10.1 per 100,000 is 33% higher than the regional average, and the cumulative lifetime risk is 18% higher than the regional levels. These findings highlight the significant excess risk brought on by high population-level exposures and insufficient protective measures.

Epidemiological context

The persistent male predominance (75% of cases) with a 3:1 male-to-female ratio reflects long-standing tobacco use patterns, though concerning trends toward increased female and youth tobacco consumption require monitoring [19]. The rise in younger-onset disease (under 50 years of age) is associated with the availability of commercially marketed, flavour-infused smokeless tobacco products targeted at previously lower-risk groups [36].

The availability of areca nuts and smokeless tobacco, unequal tobacco control enforcement, the cultural acceptance of carcinogenic substances and a lack of proper healthcare infrastructure for early detection and treatment are some of the many factors that contribute to India's disproportionate burden when compared to its neighbours [37, 38].

Comparison with global literature

Our findings offer revised estimates that are consistent with previous epidemiological assessments while accounting for recent demographic changes [39]. In comparison to the absolute burden, which is increasing as a result of aging and population growth, age-standardised rates have stabilised. High-income nations, where organised screening programs and tobacco control measures have produced long-term incidence reductions, exhibit a different pattern [40].

The mortality-to-incidence ratio of 0.56 indicates poor survival outcomes compared with developed nations, reflecting late-stage presentation, inadequate treatment infrastructure and socioeconomic barriers to care access. Population-based registry data consistently demonstrate that over 60% of cases present at advanced stages, significantly limiting treatment options and survival prospects [41].

Public health implications

The identification of a substantial preventable burden (70%–80%) attributable to tobacco and areca nut) emphasises primary prevention potential through enhanced tobacco control measures. Successful models from other high-burden countries suggest that comprehensive approaches combining taxation, marketing restrictions, cessation support and law enforcement can achieve significant incidence reductions [42, 43].

Secondary prevention through organised screening programmes offers important mortality reduction potential. Foundational evidence comes from the landmark Kerala cluster-randomised trial, which demonstrated a 26% reduction in oral cancer mortality among high-risk individuals screened by trained health workers [16]. However, the translation of screening evidence into routine public health practice remains incomplete, with low coverage, variable quality and weak referral continuity continuing to limit programme effectiveness in real-world settings [44]. But the current screening coverage is still insufficient, underscoring the pressing need for program expansion and quality control.

Healthcare system implications and programmatic gaps

Despite the substantial burden identified, healthcare system capacity remains insufficient to deliver effective prevention, early detection and timely treatment services. Screening coverage among high-risk populations remains low, reflecting challenges in programme implementation, workforce preparedness, referral linkage and continuity of care. The mortality-to-incidence ratio of 0.56 further suggests suboptimal survival outcomes, consistent with delayed diagnosis and uneven treatment access. These findings indicate that India's oral cancer burden is not only a function of risk exposure, but also of persistent health-system limitations in screening, diagnosis, treatment and follow-up care.

Healthcare system strengthening

A thorough survivorship care plan that includes long-term follow-up care, psychosocial support and rehabilitation services is required due to the sizeable survivor population (370,106 5-year prevalent cases) [45]. For patients in advanced stages, who make up the majority of presentations, palliative care services must be integrated into primary healthcare systems [46]. Targeted interventions addressing the structural determinants of health inequality are necessary to address geographic and socioeconomic disparities. Cultural factors, healthcare access limitations and economic constraints are just a few of the obstacles marginalised populations must overcome, necessitating community-based, culturally relevant intervention strategies [47, 48].

Technological innovation

In environments with limited resources, emerging digital health technologies such as telemedicine platforms, mobile health interventions and artificial intelligence-assisted screening present promising opportunities to increase screening reach and diagnostic accuracy [21, 22]. To realize potential benefits, however, thorough assessment and long-term implementation plans are needed.

Policy recommendations

Priority policy interventions include: enhanced tobacco taxation and marketing restrictions, particularly targeting flavoured products; mandatory pictorial health warnings on all tobacco products; strengthened enforcement of existing tobacco control legislation; expansion of tobacco cessation services within healthcare systems; and implementation of organised, quality-assured oral cancer screening programmes targeting high-risk populations [49].

Healthcare system strengthening requires increased investment in cancer treatment infrastructure, healthcare workforce training and health information systems. Integration of oral cancer awareness and screening within existing public health programmes can achieve synergistic benefits while optimising resource utilisation [44].

Study limitations

Several limitations should be acknowledged. GLOBOCAN estimates rely partially on modelling from available registry data, with potential under ascertainment in underserved regions [27]. Temporal comparability may be affected by changes in registry coverage, diagnostic practices and reporting standards over time. Population attributable fractions for tobacco and areca nut are derived from literature estimates rather than individual-level exposure data within GLOBOCAN. Limited subnational data restricts detailed geographic and socioeconomic analysis capabilities.

Future research priorities

Priority research areas include: expansion of population-based cancer registries for improved surveillance; prospective studies of tobacco and areca nut cessation interventions, particularly among youth and marginalised populations; implementation science evaluations of screening programme scale-up strategies; health economic assessments of prevention and treatment interventions; and technology-enabled intervention development and evaluation [50].

Conclusion

India faces a severe oral cancer epidemic, which is mostly caused by systemic healthcare gaps and modifiable risk factors. The disproportionate burden draws attention to subpar treatment results, insufficient screening and poor prevention. The findings emphasise urgent needs

for: comprehensive tobacco and areca nut control legislation with robust enforcement mechanisms; systematic expansion of quality-assured screening programmes targeting high-risk populations; healthcare infrastructure strengthening with focus on early detection and treatment capabilities; integration of survivorship care within health systems; and continued surveillance through enhanced cancer registry networks. To reduce this avoidable burden and accomplish significant, long-term advancements in oral cancer prevention and control, sustained political commitment, resource allocation and coordinated multisectoral action are essential.

Conflicts of interest

The authors declare that there are no financial and non-financial conflicts of interest in this manuscript preparation.

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Ethical approval

The study was conducted in accordance with the Declaration of Helsinki.

Patient consent

Not applicable.

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GLOBOCAN 2022 data, which is publicly available, is used.

Clinical trial number

Not applicable.

Author contributions

- Delfin Lovelina Francis to conception, design, data acquisition and interpretation, drafted and critically revised the manuscript.
- Saravanan Sampooram Pape Reddy contributed to conception, design, data acquisition and interpretation, drafted and critically revised the manuscript.
- All authors gave their final approval and agree to be accountable for all aspects of the work.

Data availability

Data used in this study are publicly available from GLOBOCAN 2022, CI5plus database and Indian National Cancer Registry Programme.

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