Optimising Survivorship in Oral Cavity Cancer: A Scoping Review of Functional Impairments and Early Rehabilitation Interventions

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Abstract: ***Background*****:** Oral mucosal cancer poses a major global health concern, with South Asia, particularly India, experiencing the highest incidence and mortality rates. Advances in surgical, chemotherapeutic, and radiotherapeutic management have improved survival, but these treatments often lead to functional impairments such as trismus, neck–shoulder disabilities and swallowing dysfunction, which markedly reduce quality of life. Prehabilitation and early rehabilitation interventions have emerged as promising approaches to address post-surgical or radiation complications.This scoping review is intended to synthesise evidence on functional impairments following oral cavity cancer treatment

Materials and Methods**:** The review was started with registration in open access (Doi: 10.17605/osf.io/krmdw), and in accordance with PRISMA-SCR guidelines. A systematic search of Medline (PubMed), Scopus, and Web of Science was conducted up to April 2024 without lower date limits. Eleven studies were included after screening 80 records.

Results**:** Across the included studies, patients constantly experienced postoperative impairments such as reduced mouth opening (trismus), swallowing dysfunction, cervical stiffness, and shoulder mobility limitations. Neck dissections and reconstructive procedures were strongly related to long-term musculoskeletal impairments, while radiation intensified swallowing difficulties. The intervention included rehabilitation with oral exercises, range of motion programs, and a structured physiotherapy protocol that improved swallowing, neck-shoulder function, and quality of life, while early and prehabilitation programs showed feasibility, compliance, and potential to reduce treatment-related complications.

Conclusion**:** Functional impairments present after post-oral cavity cancer treatment force the need for proactive multidisciplinary rehabilitation strategies involving oncologists, surgeons, and specialists. Integrating prehabilitation, including early preoperative exercises along with other therapy, can optimise survivorship care, enhancing recovery, preserving function, and improving quality of life.

Keywords: Oral cavity cancer, Functional impairments, Prehabilitation, Oral health,Early rehabilitation.

1. INTRODUCTION

Oral mucosal cancer originates from the epithelial lining of the oral cavity, including the lips, buccal mucosa, gingiva, tongue, floor of the mouth, hard palate, and retromolar trigone, and remains a significant health concern worldwide [1]. Its burden is excessively high in South Asia, particularly in India, which accounts the greatest age-standardised incidence, mortality, and disability-adjusted life years (DALYs) related to this cancer [2-4]. The high prevalence in India is largely ascribed to tobacco consumption, with projections indicating further increases by 2030, especially in southern and eastern regions [5]. The buccal mucosa (65%) and tongue (28%) are the most commonly affected subsites [6, 7]. Alarmingly, India positions second in Asia for oral cancer incidence among both men and women, with a lethality rate approaching 50% [8]. These epidemiological truths highlight the urgent need not only for prevention and early detection but also for effective management of treatment-related impairments.

Treatment for oral cavity cancer typically comprises surgery, radiotherapy, chemotherapy, or multimodal combinations. While these therapies are lifesaving, they frequently result in long-term functional impairments such as oral dysfunction, trismus, swallowing difficulties, and compromised neck–shoulder mobility [9, 10]. Fibrosis is a challenging late

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consequence, contributing to progressive loss of mobility and quality of life [11]. Surgical approaches vary along withtumour size and complexity. Smaller lesions are generally treated with surgery alone, whereas larger tumours often need microvascular free flap reconstructionssuch as subscapular or osseous fibula flaps and adjuvant chemoradiation [12-17]. Though these extensive procedures are necessary, they can lead to unpredictable secondary musculoskeletal and functional deficits, underscoring the need for anticipatory and supportive interventions.

In recent years, prehabilitation, demarcated as interventions commenced before treatment. It can enhance physiological reserve and gain prominence as an approach to minimise cancer-related morbidity. Preoperative interventionincludes structured exercise programs, nutritional optimisation, and psychological support, which are increasingly recognised for their role in improving postoperative recovery, functional outcomes, and treatment tolerance [18]. Early assessment and targeted rehabilitation at the time of diagnosis can help to prevent or mitigate impairments, empowering patients to maintain independence and resume daily activities [19, 20].

The literature on functional impairments and rehabilitation in oral cavity cancer is dispersed, with varied patient populations, interventions, and outcomes, resulting in limited consolidated evidence to inform clinical guidelines or standardise prehabilitation protocols. Given these gaps, a scoping review provides an ideal methodological framework to systematically map existing evidence, identify functional impairments, assess the role of exercise and physiotherapy interventions, and provide ways for future research.

Accordingly, this review aims to synthesise current knowledge regarding treatment-related impairments in oral cavity cancer, evaluate the effectiveness of rehabilitation and prehabilitation strategies, and provide insights for developing integrated survivorship care models. By doing so, it seeks to inform clinical practice and guide the design of comprehensive rehabilitation programs tailored to the unique needs of oral cavity cancer patients.

2. MATERIALS AND METHODS

This scoping review was initiated by registering an open-access DOI-https://doi.org/10.17605/osf.io/krmdw. It was conducted by following the guidelines and recommendations of the Preferred Reporting Items for systematic reviews and meta-analyses extension for scoping reviews [PRISMA-SCR] framework [21]. Search databases included: Medline (via PubMed), Scopus, and Web of Science. A literature search was conducted up to April 2024 with no lower date limit, and duplicates were removed using the Covidence review management system for reference management.

2.1. Eligibility Criteria

A clear research question has been formulated to guide the scoping review of studies concerning impairments and therapeutic interventions associated with individuals having oral cavity cancer. This analysis specifically examines the impact of exercise-based rehabilitation strategies in ameliorating functional deficits commonly observed in this population. A comprehensive search of peer-reviewed studies was done using Medical Subject Headings (MeSH) terms including: "oral cavity cancers", "functional impairments," "neck and shoulder dysfunction," "exercise rehabilitation", "physiotherapy," "neck dissections," AND "management of oral cavity cancer." The Boolean operator "AND" was strategically applied to ensure the rigorous inclusion of studies directly relevant to the intersection of oncologic impairment and rehabilitative care.

2.2. Study Selection Process and Data Variables with Extraction

The study selection process for the present review is shown in Fig. (**1**), we found a total of 80 records from the predetermined databases, of which 14 were duplicates and 17 records were excluded for reasons cited in the flowchart for the study selection process (Fig. **1**). 11 articles were included with 100% reviewer agreement. Data extraction involved methodical charting of variables such as citations, design, demographics, interventions, outcomes, and findings. Descriptive statistics summarised the study title, cancer type, intervention, follow-up, and impairment.

3. RESULTS

3.1. Characteristics of Included Studies

The data abstracted from the included studies are detailed in Table **1**. The studies span multiple geographic locations: one study originates from Spain [22], two from the Dutch [23, 24], one from the United Kingdom [25], two from China [26, 27] one from New York [28], one from Sweden [29], Netherlands [30, 31] and one from Denmark [32].This review synthesised findings from 11 studies (case–control, prospective cohort, retrospective, and randomised controlled trials) investigating impairments following oral and head and neck cancer treatment. Across studies, sample sizes ranged from 23 to 145 patients, with follow-up durations from 2 months to 5 years. The main impairments identified were reduced mouth opening, dysphagia, cervical and shoulder dysfunction, and their downstream impact on health-related quality of life.

3.2. Neck and Shoulder Impairments

A case-control cross-sectional study analysed 32 head and neck cancer patients who underwent surgery followed by either radiation therapy or chemoradiation, compared to 32 healthy individuals. Participants with an average age of 58±12years were monitored over 36 months. The study concluded that head and neck cancer patients exhibited significant reductions in mouth opening and cervical and shoulder function. These impairments further contribute to pronounced swallowing difficulties [22].

A prospective cohort study examined patients with primary oral carcinoma who received surgery followed by radiation therapy, with follow-up periods of 6 months to one year. Extended neck dissections are associated with a rapid decline in neck and shoulder function. Tumour size, location, and extent of reconstructive surgery significantly impacted shoulder mobility, both before and after intervention [23, 24].

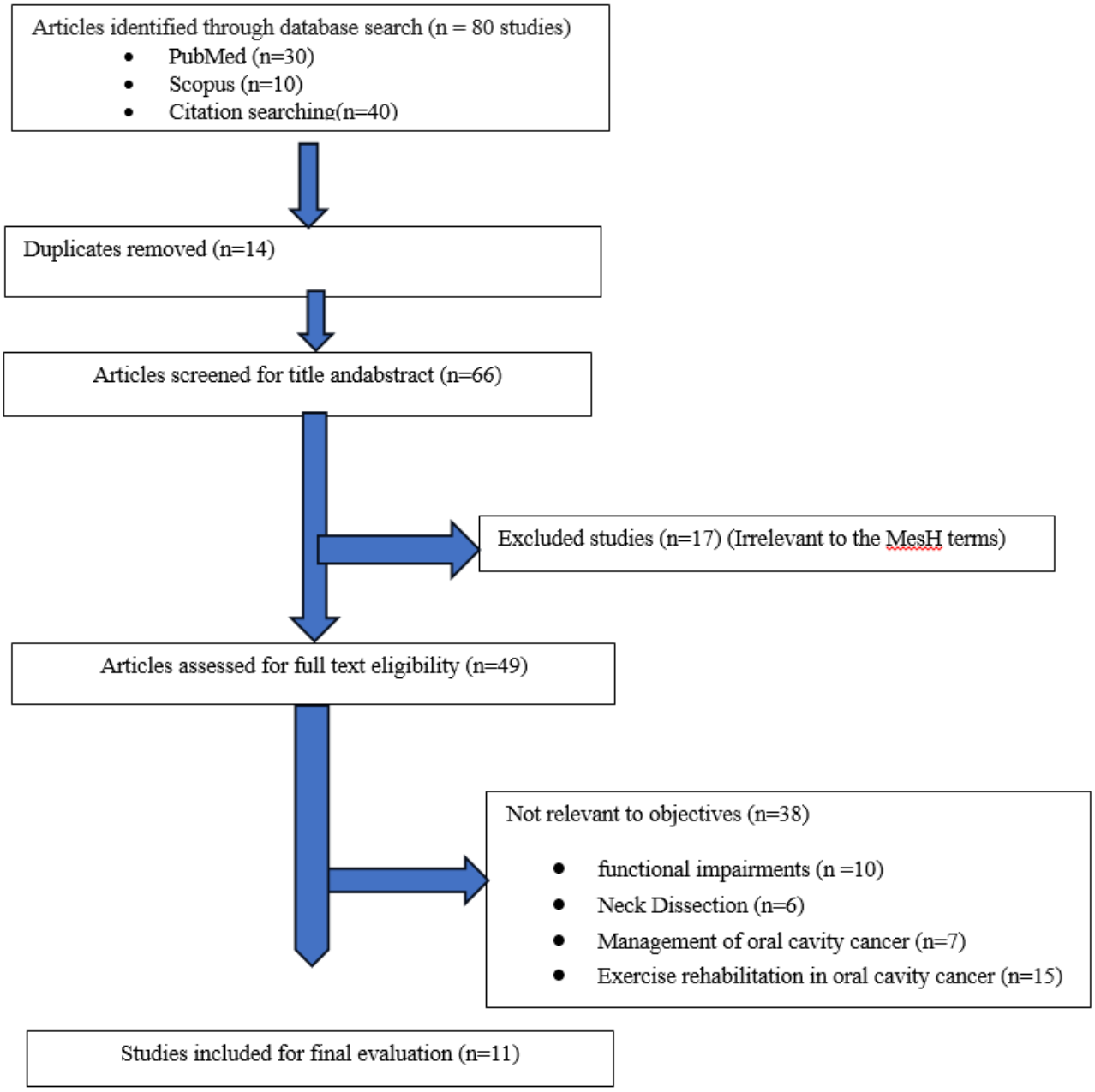

Fig. (1). Methodology as per Preferred Reporting Items For Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) framework.

Table 1. Results of the article analysed.

S. No	Citations	Design	Objectives	Study Population	Sample Size/Age group	Duration	Intervention	Impairments	Measurable Outcome & Results	Authors Conclusion	Comments
1.	5(22)	Case-control (cross-sectional study)	To test if there are differences between sHNC and healthy age- and sex-matched controls for MMO, TMD, cervical and	a tumor located in the nasal cavity, either paranasal sinus, nasopharynx, oral cavity	Thirty-two sHNC, 12 women and 20 men, and 32 healthy age(mean age was 58.8±11.9 for the sHNC group and 58.4±12	6-36 months	Surgery and radiation therapy, chemoradiation therapy	Cervical, and shoulder mobility which leads to swallowing impairment	MMO, cervical active range of motion (AROM) and muscle strength and shoulder AROM and	HNC patients demonstrate lower muscle mass outcomes (MMO), a greater perception of temporal	From this study we infer proper preparation of shoulder, neck jaw muscles before surgery can help us to

			shoulder motor function, and swallowing impairments.		for the control group)				muscle strength were measured by objective tests SPADI,VAS, Eating Assess-ment Tool (EAT-10)	mandibular disorders (TMD), and reduced cervical and shoulder function, all of which are interconnected. Additionally, they experience more significant swallowing impairments compared to healthy controls. Physiotherapy may help improve these factors, poten-tially reducing the perception of swallowing difficulties.	reduce furthry impairment of swallowing
2.	40(24)	Prospective cohort study	To examine and quantify the effect of neck and shoulder function of patients with malignancies in the oral cavity treated with and without a selective, modified, or radical neck dissection.	Primary oral carcinoma from Jan 2007 toAugust 2009	145	4 weeks before oncological intervention, shortly (4–6 weeks) after surgery and/or radiotherapy, and 6 months and 1 year after surgery or radiotherapy	Surgery and radiation therapy	Neck and shoulder mobility impairment	Goniometry (Range of motion of cervical spine and shoulder)	The author concluded that more extensive neck dissections resulted in a greater decline in neck and shoulder function shortly after the procedure. The reduction in shoulder mobility, from before to shortly after the intervention, was influenced not only by the neck dissection but also by the tumor location and the extent of the reconstructive surgery.	From this study we infer that shoulder and neck mobility deteriorated at one year follow up. If preopera-tive exercises given effectively and prepared with proper strength may help patients to recover earlier
3.	178(38)	Randomized controlled clinical trial	To assess the effect of (preventive) rehabilitation on swallowing and mouth opening after concomitant chemoradiotherapy (CCRT)	Head and neck cancer Stage III and IV	49(24-SRG)(25ERG) (32-78years)	10weeks/ 16 weeks post treat(last RT)	chemoradiation therapy	1. Swallowing problems 2. reduced tongue strength 3. slowed/ delayed laryngeal vestibule	1. Maximum interincisal mouth opening (MIO) 2. weight changes 3. body mass	Pretreatment rehabilitation is feasible, and acceptable compliance can be achieved despite the burdensome	From this study helps us to understand the beneficial effect of exercise-based rehabilita-tion to minimize the complica-

								4. laryngeal elevation and 5. problems with mouth opening	index (BMI) 4. Functional oral intake scale (FOIS) 5.Study-specific questionnaire for quality-of-life evaluation 6. Visual analog scale (VAS) for pain assessment	effects of CCRT	tions thereby confirms the importance of prehabilitation
4.	99(25)	Retrospective study	1.To investigate cervical spine and shoulder movements following unilateral selective neck dissection 2. To compare functional outcomes between objective physiotherapy assessments of neck and shoulder movements and patient self-completed question-naires.	63 patients Head and neck cancer patients undergoing unilateral selective neck dissection were recruited at the outpatient clinic	63 patients, 33 males and 30 females, (55-68years)	1. Post-surgery from 1 month to 12 years. 2.median (inter-quartile range)-10 months (3-32 months)	Surgery	1. Shoulder flexion and abduction, 2. cervical lateral rotation and forward flexion affected.	1.Goniometry 2. UW-QoL shoulder function 3. SDQ shoulder disability 4. NDII neck dissection	Cervical spine and shoulder dysfunction are evident in patients who have undergone post-operative selective neck dissection.	From this study we infer that post op duration may be small or larger but neck and shoulder function is noticeable for affecting QOL
5	25(26)	Single-blind randomized controlled trial	To determine the effect of oral exercise in addition to standard general care and diet counseling on the physiology of swallowing. F	Oral or oropha-ryngeal squamous cell carcinoma who were presched-uled for an en bloc resection o the primary tumor, neck dissection, and reconstruction	50 patients (25 patients in each group) Between 18 and75 years	3 months- 3 sessions per day for 12 weeks	Surgery	1. Formation of irreversible restrictive scarring and fibrosis 2. Swallowing dysfunction	1. Modified barium swallow study (MBSS) 2. Rosenbek penetration-aspiration scale 3. Secondary outcomes included improvements in oral and pharyngeal residue.	Oral exercise improved swallowing function in patients who had been surgically treated.	From this study, mobility and strengthening exercises when given appropri-ately in oral cavity patients will prevent swallowing dysfunction.
6	13(28)	Prospective cohort pilot study (Randomized)	To inform clinical practice as to preferential timing of exercise interven-tion to optimize jaw function and QOL.	head and neck cancer, particu-larly with tumors in the oral cavity and oropharynx	23 patients with early intervention and late interven-tion (18 years and older)	2-3months and 9 months	Surgery	1. Problems in opening mouth, 2. dysphagia 3. speech-related quality of life (QOL)	1. The primary outcome of this study was jaw ROM (ie, MIO) 2. Pain Numeric Rating Scales (NRS) 3. Neck (PSS-HN), and patient-rated QOL	The early intervention group had significantly more oral cavity patients than the late intervention group.	From this study, we infer that even with variations in surgery and location of the tumor, the early intervention of exercises provides beneficial effect

7	23(33)	A Prospective Study	clinical effective-ness of intervention with an open-mouth exercise device designed to facilitate maximal interincisal opening (MIO) and improve quality of life	H&N cancer and OSF diagnosed in 2016 or 2017	60(interventional, conventional and control group) each group 20 patients.	12-week structured exercise program involving exercise nine times per day	Surgery with /without radiation	Trismus	1.Minimal incisional opening. 2. Health-related quality of life	Consistent ehabilitation and proper device assistance help maintain improved MIO and enhance HRQL.	From this study, trismus one of the common complications o the oral cavity which prevented or reduced with passive devices like EZbite and therabite in association with active exercises
8	49(30)	Prospective	To explore relation-ships between shoulder complaints after neck dissec-tion, shoulder disability, and quality of life. To find clinical predictors for mid- to long-term shoulder disability	patients admitted for neck dissection to head and neck cancer	139 (18 years and above)	Baseline. at discharge and 4 months later	Radiation and surgical intervention(Radical, Modified radical and selective)	1. Shoulder pain 2. Shoulder mobility, and 3.Shoulderdrop (shoulder disability)	Active range of motion (AROM) was assessed for shoulder forward flexion (FF) and abduction (ABD), and for cervical rotation and extension. These values were obtained with the use of an inclinometer	Neck dissection for head and neck cancer significantly mpacts shoulder function. The deterioration of houlder function negatively influences daily activities.	From this study, shoulder complaints arising after neck dissection followed with all head and neck can-cer(more intensive physiotherapy may be required for those patients)
9	33(29)	Randomized prospective study	TA structured intervention using a jaw exercise device significantly improved mouth opening capacity, provided pain relief and reduced trismus-related symptoms in patients with head and neck cancer experiencing trismus after radiation therapy.o compare 2 different jaw exercise devices; according to measured improve-ment in mouth opening and patient-reported symptoms in patients with head and neck cancer with trismus.	Head and neck cancer patients with trismus	60(25 therabite and 25 Engstrom)	2.5 months for TheraBite, and 2.7 months after finishing radiation therapy for Engstr€om, during the first 4 weeks of exercise. During weeks 5 to 10	Radiation and surgery	Trismus	The primary endpoint was maximal interincisal opening (MIO) and the secondary endpoints were trismus-related symptoms, HRQL, and exercise compliance.	structured intervention with a jaw exercise device effective-ly improved mouth opening capacity, led to pain relief, and less trismus-related symp-toms in patients with head and neck cancer with trismus after radiation therapy.	From this study, we infer that earlier exercise intervention program for head and neck cancer patient to minimize trismus
10	10(32)	Amulticenter randomized	To investigate the effect on swallow-ing of a bimodal	Head and neck patients	69 (control group-33, intervention	at baseline, at end of radiotherapy	Radiation therapy	Dysphagia is considered the most prominent	1.Penetration Aspiration	Multi-centered intervention is accepted by both	From this, we infer that following head

		controlled trial	program of swallowing and mouth-opening exercises and progressive resistance training (PRT) during radiotherapy treatment compared to standard care. S	(cancer in larynx, hypopharynx, oral cavity, oropharynx)	group-36)	and two, five and 12 months after radiotherapy		complication to HNC treatment as it impacts physical function and reduces quality of life (QoL)	Score/FEES 2. 30 seconds sit-to-stand test (STS) 3. Therabite Range of Motion scale 4. Quality of Life Questionnaire – Head and Neck Cancer (EORTC QLQ H&N35)	health staff and patients, despite the challenges of approaching patients during their busy schedules and the short time frame between diagnosis, treatment planning, and initiation.	and neck intervention proper mouth opening and resistance exercises are helpful in minimizing dysphagia. Similarly, prehabilitation can further help reduce impairments
11	13(31)	Prospective cohort study	To identify clinical factors and patient characteristics that influence a patient's neck and shoulder function during the five years following curative oral cancer	Oral cavity cancer patients	113 patients (56 patients had been treated with primary surgery and 57 had been treated with surgery followed by radiotherapy)	4–6 weeks before intervention (T0), 4–6 weeks after surgery (T1a), and/or 4–6 weeks after radiotherapy (T1b), and 6 (T2), 12 (T3), and 60 (T4) months after intervention	Surgery and radiation therapy	Neck and shoulder dysfunction	1. active range of motion AROM) for the neck and shoulders was determined using the MicroFET 6 electronic inclinometer (Hoggan Health Industries)	This study identified patients at high risk for developing neck and/or shoulder impairments during a five-year follow-up period.	From this study we infer that, patients who are at risk for developing neck and shoulder function must be selected for proper early intervention and prehabilitation , prevents the burden of impairments in the patients.

A retrospective study inspected patients with head and neck cancer, aged 55 to 68 years, who underwent unilateral neck dissection. Follow-up assessments were directed over a period ranging from one month to 12 years after surgery. The research revealed deficits in shoulder flexion and abduction, along with limitations in cervical lateral rotation and forward flexion. These results highlight significant dysfunction in both the cervical spine and shoulder following selective neck dissection [25].

A prospective study analysed patients with head and neck cancer who underwent surgical procedures.The research revealed a prominent incidence of shoulder disabilities among these patients. The results highlighted a significant effect on postoperative quality of life, directing the necessity for focused rehabilitation programs. This emphasisesthe importance of addressing shoulder functionality in the post-surgical care of head and neck cancer patients to enhance long-term outcomes [30].

A prospective cohort study investigated patients with oral cavity cancer who received both surgery and radiation therapy. Five years after treatment, many patients experienced neck and shoulder dysfunctions. It gave an insight into the long-term impact of combined surgical and radiotherapeutic interventions on musculoskeletal health. The findings emphasise the need for ongoing rehabilitative support to reduce these chronic impairments and improve patient's rolein quality of life [31].

3.3. Swallowing Impairments

A single-blind randomised controlled trial was conducted in patients with oral and/or oropharyngeal cancer aged 18 to 75 years. These patients underwent complete en bloc resection of the primary tumour, neck dissection, and subsequent reconstruction, with a follow-up period of 3 months. Several significant impairments, including irreversible restrictive scarring, fibrosis, and swallowing dysfunction, were identified in this study [26].

Sandler ML et al. had done a prospective cohort pilot study involving patients with head and neck cancer (oral cavity and oropharynx) who underwent surgical treatment. The results found significant impairments in the patients, including restricted mouth opening, and difficulties with swallowing and speech after 9 months of the follow-up period [28].

Hajdú et al. had shown results in a Multicentre randomised controlled trial, highlighting dysphagia as a significant impairment arising during and after radiotherapy for head and neck cancer patients. The study involved 69 participants with cancers of the larynx, hypopharynx, oral cavity, or oropharynx, who observed that dysphagia adversely affected physical function and quality of life (QoL) [32].

3.4. Trismus

A prospective study tracked head and neck cancer patients who underwent surgery, either alone or with radiation therapy. After 12 weeks, many patients experienced limited mouth opening. These results show that trismus is a common problem after surgery and highlight the need for early intervention and management [33].

Pauli et al. (2015) had done a randomised prospective study on patients with head and neck cancer who underwent radiation and surgical treatments. With a 3-month follow-up period, the study observed complications related to restricted mouth opening [29].

A randomised controlled clinical trial analyses the impact of preventive rehabilitation on swallowing and mouth opening for individuals with stage III and IV head and neck cancer who underwent concomitant chemoradiation therapy (CCRT). The study included 178 participants aged 32 to 78 years and evaluated their condition at 10 and 16 weeks after completion of the treatment. Impairments identified were swallowing difficulties, reduced tongue strength, delayed laryngeal movements, and mouth opening [23].

3.5. Mouth Opening and Trismus

Multiple randomised and prospective studies consistently revealed a decline in maximum interincisal opening (MIO) after surgery and radiotherapy. Structured oral exercise programs and jaw-mobilisation devices (*e.g.*, Therabite, Engstrom, ezbite) significantly improved MIO, reduced trismus severity and enhanced quality of life. Early commencement of exercises improved outcomes compared to delayed rehabilitation

3.6. Swallowing Function

Swallowing impairments were prevalent after both surgery and chemoradiation therapy. preventive rehabilitation, swallowing exercise programs, and bimodal approaches(swallowing + resistance training) amended swallowing physiology, reduced aspiration risk and facilitated maintaining body mass index and oral intake levels. Prehabilitation given before the initiation of oncological treatment improved compliance and minimised long-term swallowing dysfunction.

3.7. Cervical and Shoulder Function

Neck dissection consistently resulted in significant short-term and long-term deficits in cervical mobility, shoulder abduction and flexion. Impairment severity was influenced by operating extent, tumour location, and reconstructive complexity. Longitudinal studies demonstrated that impairments persisted even at five years, with negative effects on daily function and quality of life. Importantly, preoperative and early physiotherapy interventions were associated with better recovery trajectories.

3.8. Quality of Life Outcomes

Patient-reported quality of life measures(UW-QoL, EORTC OLQ H&N35, VAS, EATING ASSESSMENT TOOL) consistently indicated reductions in physical function, oral intake and pain-related interference. However, structured rehabilitation programs were able to mitigate these declines, particularly in swallowing, mouth opening and shoulder mobility domains.

The overall evidence from both preventive and therapeutic interventions strongly supports the beneficial role of physiotherapy and structured rehabilitation in preserving and restoring function in survivors of oral cavity cancer

4. DISCUSSION

The present amalgamation of studies on head and neck cancers, with a particular emphasis on oral cavity malignancies, discloses a consistent pattern of post-treatment impairments affecting the stomatognathic system, cervical–shoulder complex, and overall functional independence. Surgical intervention, with or without adjuvant therapy, has a profound influence on orofacial mobility, swallowing, speech, and shoulder biomechanics across diverse populations, which comprises common impairments like trismus, dysphagia, dysarthria, and scapulohumeral dysfunction. These impairments persist for months to years post-treatment, despite advances in oncological care.

4.1. Chronicity and Mechanisms of Impairment

The duration and severity of functional impairments vary depending on the intensity and modality of the oncological intervention. Prolonged follow-up in studies such as Ortiz-Comino et al. and Hinte *et al.* reveals that restrictions in mouth opening and shoulder mobility can persist for up to five years, suggesting the presence of chronic fibrotic sequelae that outspread beyond the acute recovery phase. Similarly, the Dutch and Scandinavian cohorts highlight the high incidence of neck and shoulder impairments after a combination of both surgical disruption of the spinal accessory nerve and radiotherapy-induced soft-tissue fibrosis. These findings align with automatic data showing that radiotherapy initiates a cascade of fibroblast activation, vascular compromise, and collagen deposition in the masticatory and cervical musculature, strengthening the argument for early, proactive intervention [34, 35].

Patients undergoing neck dissections often experience significant functional impairments, with shoulder droop reported in up to 57% of cases, with disability scores increasing over time [22, 24]. Pain during daily activities worsens with more extensive dissections, and bilateral neck dissection is related to the most prolonged impairments, persisting beyond one year. Neck tightness is commonly reported and frequently hinders with daily life, with more radical dissections producing greater long-term limitations. Clinical predictors of shoulder disability have been shown to associate

with perceived disability at one-year follow-up, suggesting that early identification of high-risk patients is essential for targeted physiotherapy interventions.

4.2. Swallowing Dysfunction and Quality of Life

Swallowing dysfunction emerges as a recurrent and clinically significant issue across the literature. Whether attributable to irreversible scarring and fibrosis [26] or the cumulative toxicity of chemoradiation [29, 32]. Dysphagia carries profound implications for nutritional status, pulmonary health, and quality of life. Neck and shoulder dysfunction have a direct impact on swallowing mechanics, as impaired hyoid elevation, altered cervical posture, and restricted mandibular mobility compound aspiration risk.

Among 105 survivors assessed by Ortiz-Comino *et al*. (2020), those with nerve damage had the lowest quality of life and the most restricted shoulder mobility, while concurrent radiation treatment significantly worsened swallowing scores on the University of Washington Quality of Life (UW QoL) assessment. Evidence from (Scott et al andSpeksnijder et al) highlights that preoperative preparation of the shoulder, neck, and jaw musculature may reduce the severity of swallowing impairments. Hsiang et al. demonstrated that oral exercises significantly improved swallowing function in surgically treated patients, suggesting that targeted mobility and strengthening exercises can prevent or mitigate swallowing-related morbidity.

4.3. Mandibular Mobility and Orofacial Function

Active range of motion measurements using a goniometer have provided valuable insights into recovery trajectories for mandibular and shoulder mobility in patients treated for oral cavity cancer. A randomised prospective study with 50 patients (Sandler *et al*., n.d.-a) employed the European Organisation for Research and Treatment of Cancer (EORTC) quality-of-life questionnaire, demonstrating improvements in mouth opening, although pain remained a limiting factor. This underscores the need for pain-modulated rehabilitation approaches to maximise compliance and functional gains.

4.4. Prehabilitation: An Underexplored Opportunity

While postoperative rehabilitation is widely reported in head and neck cancer care, the concept of prehabilitation, pre-treatment physiotherapeutic conditioning aimed at optimising physical capacity and mitigating future deficits, remains virtually absent from the reviewed cohorts. This omission is notable, particularly in light of compelling evidence from other oncological populations (colorectal, thoracic) where structured prehabilitation has accelerated postoperative recovery and improved patient-reported outcomes.

For oral cavity cancer, where surgical and radiotherapeutic fields often encompass critical musculature for mastication, swallowing, and cervical stability, prehabilitation offers a biologically plausible and clinically promising intervention [36, 37]. conducted a randomised controlled trial in the Netherlands involving (stage III–IV) 49 head and neck cancer patients, demonstrating that pretreatment rehabilitation is feasible, with good compliance and measurable improvements in function despite the burdensome effects of chemoradiation.

From a physiotherapeutic standpoint, prehabilitation could target three high-risk domains identified in this synthesis. Specifically, interventions targeting mandibular mobility may involve graded jaw-opening exercises and soft tissue mobilisation to mitigate the risk of trismus. For cervical-shoulder function, strategies may include scapular stabilisation, preservation of accessory nerve function, and postural retraining to prevent shoulder dysfunction. Additionally, conditioning of the swallowing musculature can be achieved through targeted isometric and isotonic exercises designed to reinforce the function of the influencing factors and tailored interventions.

Functional outcomes are influenced by a complex interplay of surgical extent, reconstruction methods, age, and radiation fibrosis [24]. Studies consistently report that patients undergoing surgical plus radiotherapy interventions have reduced contralateral neck flexion and diminished overall cervical range of motion. Functional decline is most marked in the early postoperative months, with partial recovery evident by the one-year mark. This pattern underscores the importance of early identification of high-risk patients, targeted exercise programming, and close functional monitoring.

Eickmeyer *et al.* stress that prevention and management of functional deficits after cancer therapy are best achieved through close collaboration between physiatrists, physiotherapists, and oncology specialists. Integrating physiotherapists into multidisciplinary head and neck oncology teams from the point of diagnosis could facilitate earlier rehabilitation evaluations and timely initiation of prehabilitation protocols. Van Hinte *et al*. emphasise that early identification of at-risk patients and implementation of tailored exercise programs can play a significant role in minimising the severity of long-term functional impairments.

4.5. Future Research Priorities

Given the heterogeneity in follow-up duration and outcome assessment across the reviewed studies, future research should adopt standardised metrics such as the Maximum Interincisal Opening (MIO) for trismus, the Shoulder Pain and Disability Index (SPADI) for cervical–shoulder function, and validated dysphagia scales for swallowing performanceto enable robust interstudy comparisons. Longitudinal designs incorporating pre-treatment baselines would allow for accurate quantification of prehabilitation effects on the natural trajectory of functional decline. Additionally, larger multicentre trials are warranted to evaluate the optimal timing, intensity, and content of prehabilitation programmes, with stratification by surgical extent and adjuvant therapy type.

This body of evidence unequivocally demonstrates that oral cavity cancer treatment is accompanied by predictable and functionally debilitating impairments trismus, cervical and shoulder dysfunction, and dysphagia, that persist long after the completion of oncological therapy. These impairments are mechanistically linked to surgical and radiotherapeutic injury and are amplified by fibrosis, nerve damage, and muscular deconditioning.

This predictable pattern presents a critical opportunity for physiotherapists to intervene proactively, ideally before treatment initiation. Integrating prehabilitation into multidisciplinary head and neck oncology care pathways may mitigate treatment-related morbidity and expedite restoration of functional abilities and quality of life. As survivorship gains increasing priority, proactive rehabilitation founded on early functional assessment, targeted prehabilitation, and sustained post-treatment support should be recognised as an essential component of comprehensive oral cavity cancer care.

The available information highlights the importance of prehabilitation in oral cavity cancer care, emphasising its potential to mitigate treatment-related morbidity and improve functional abilities and quality of life. Integrating prehabilitation into multidisciplinary care pathways is essential for comprehensive cancer care, prioritising proactive rehabilitation and survivorship.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest to disclose.

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[21] Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist SECTION ITEM PRISMA-ScR CHECKLIST ITEM REPORTED ON PAGE # TITLE Title 1 Identify the report as a scoping review.

[22] Ortiz-Comino L, Fernández-Lao C, Speksnijder CM, Lozano-Lozano M, Tovar-Martín I, Arroyo-Morales M, et al. Upper body motor function and swallowing impairments and its association in survivors of head and neck cancer: A cross-sectional study. PLoS One. 2020;15(6).

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