**Title page**

# Feasibility and efficacy of telerehabilitation in the management of patients with head and neck cancer during and after oncological treatment: A systematic review.

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**Purpose:** The aim in this review was to evaluate recent advances in telerehabilitation for the management of patients with head and neck cancer (HNC) during and after their oncological treatment.

**Methods:** A systematic review was carried out in three databases (Medline, Web of Science and Scopus) in July 2022. The methodological quality of randomised clinical trials and quasi-experimental ones was assessed using the Cochrane tool (RoB 2.0) and the Critical Appraisal Checklists of the Joanna Briggs Institute, respectively.

**Results:** 14 out of 819 studies met the inclusion criteria: 6 studies were randomised clinical trials, 1 was a single-arm study with historical controls and 7 were feasibility studies. Most studies reported high participant satisfaction and efficacy of telerehabilitation used, in addition, no adverse effects were reported. None of the randomised clinical trials achieved a low overall risk of bias, whereas the methodological risk of bias of the quasi-experimental studies was low.

**Conclusions:** This systematic review demonstrates that telerehabilitation offers feasible and effective interventions for the patients with HNC follow-up, during and after their oncological treatment. It was observed that telerehabilitation interventions should be personalized according to the patient's characteristics and the stage of the disease. Further research on telerehabilitation to support caregivers as well as to carry out studies with a long-term follow-up of these patients are imperative.

**Keywords:** Adverse Effect; Head and Neck Neoplasm; Systematic Review; Telerehabilitation.

## INTRODUCTION

Head and neck cancer (HNC) is the ninth most common cancer worldwide, with a global incidence of over 963,000 new cases per year (International Agency for Research on Cancer, 2020). The 5-year overall survival rate in two Italian cohorts ranged between 60% and 64% combined across HNC sites (Cadoni et al., 2017; Leoncini et al., 2015). However, survival is not without consequences, both the disease and its treatment, which generally involves surgery, chemotherapy (CT) and radiotherapy (RT), produce disfiguring and permanent functional changes. This is due to the location of the structures involved and interferes with the ability to swallow, speak, eat, and taste and with neck and shoulder movement (Goldstein et al., 2014; Russi et al., 2012; Wang et al., 2013; Zhang et al., 2016). In addition, it is a completely neglected population in terms of rehabilitation strategies when compared to other cancers, such as breast or colorectal cancer (Giuliani et al., 2019, 2016).

Patients and survivors with HNC see their quality of life (QoL) diminished and most of the time feel lost about how to cope with the consequences of cancer (Manne et al., 2020). The treatments they demand require a multidisciplinary approach involving different health care professionals, such as physicians, nurses, psychologists, physiotherapists, or speech therapists (Bouaoud et al., 2021). These professionals, especially those dedicated to the field of rehabilitation (Burgos-Mansilla et al., 2021; Galiano-Castillo et al., 2020), have become an indispensable part of cancer care, and their presence is relevant from diagnosis to survival. This multidisciplinary approach could considerably reduce the economic impact of this disease (Giuliani et al., 2016), although more interventions based on scientific evidence are needed. During the last few years, digitized health care has become a great tool for the management and treatment of these patients (Bouaoud et al., 2021).

Currently, information and communication technologies (ICT) are part of our daily lives as a comfortable and easy-to-use intervention, which can have numerous applications and utilities. Its use is increasing within the field of health care due, in part, to COVID-19. Because of ICT, there are telerehabilitation interventions that allow us to carry out digitized health care by means of the delivery of rehabilitation via a variety of technologies and encompasses a range of rehabilitation services that include evaluation, assessment, monitoring, prevention, intervention, supervision, education, consultation, and coaching (Shem et al., 2022). The ICT that may be used to deliver these services include diversity of technological interactions such as text messaging, telephone follow-up, videoconferencing, wearable devices, mobile health applications, therapeutic games, etc.(Galea, 2019; Tenforde et al., 2017) to support clinical practice by expanding accessibility (Davidoff and Maltser, 2022) and improving communication (Ariza-Garcia et al., 2019; Bouaoud et al., 2021; Lozano-Lozano et al., 2019). These interventions can be highly beneficial in patients with cancer and survivors to control symptoms and the evolution of the disease and its sequelae (Galiano-Castillo et al., 2016; Postigo-Martin et al., 2022; Prasad et al., 2020).

Given the need for long-term follow-up of patients and survivors with HNC and the rise of new technologies, some research has begun regarding the ability to treat patients' symptoms and sequelae through e-Health or telehealth systems. In 2021, Bouaoud et al. (Bouaoud et al., 2021) conducted a review of digitized health care for patients with HNC, concluding that patients are very satisfied with this type of health care, which is also effective in terms of time and costs. However, this review has certain limitations, since the methodological quality of the included studies was not reviewed, and some studies were more than 10 years old, making them obsolete. Consequently, this new systematic review of the literature will fill the mentioned gaps considering the

methodological quality of the most current clinical trials on the topic.

Therefore, the main objective of this systematic review was to evaluate the efficacy of telerehabilitation in the management of patients with HNC during and after oncological treatment.

## METHODS

*Design and research question*

The methodology and data reporting in this systematic review were performed in accordance with the guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement (Amir-Behghadami and Janati, 2021) and following the population, intervention, comparison, outcomes, and study (PICOS) design (Methley et al., 2014). In accordance with the PRISMA guidelines, the question posed for this review was 'Is telerehabilitation effective for clinical and psychological variables and self-care skills?' To reduce duplication of effort and publication bias (Booth et al., 2012; Heinemann et al., 2021), this study was registered and accepted in the International Prospective Register of Ongoing Systematic Reviews (PROSPERO) with the following registration code: CRD42022356763.

*Search strategy*

The PICOS strategy was used to establish the research question and the eligibility criteria, as shown in **Table 1**. Subsequently, a structured search was carried out in three databases (MEDLINE [PubMed], Web of Science [WoS] and Scopus) filtering by year (last 5 years, due to the increase in cases in recent years and to update the most recent nonsystematic review mentioned above) and language (Spanish and English). This search was performed during July 2022.

Six search formulas were created for each database, in which the common descriptors were 'head and neck neoplasms' and 'randomized controlled trial' as topics, and the six descriptors that changed in each formula were 'medical informatics applications', 'mobile applications', 'internet-based intervention', 'telemedicine', 'text messaging' and 'user-centered design'. All terms were registered by Medical Subjects Heading (MeSH) and related to their corresponding entry term through the Boolean operators

AND/OR, as appropriate. Supplementary material presents the formulas used for the search in PubMed (**Supplementary material 1**).

*Eligibility Criteria*

***Table 1.*** *PICOS (Search Criteria).*

*Selection of studies*

The systematic selection of the articles was carried out in four phases. In the first phase, the articles duplicated in the different databases were removed. In the second phase, two rounds were done: 1) records published more than ten years ago were excluded; 2) those records published more than five years ago and those that were not related to the PICOS question according to title and abstract were excluded (**Supplementary material 2**). In the third phase, the full-text articles were evaluated according to the eligibility criteria, and from these, those that did not use any telerehabilitation in their intervention were excluded. In the fourth phase, the reference lists of the selected articles were searched for additional records. An Excel spreadsheet was used for the retrieved data.

*Risk of bias assessment*

All studies were assessed for risk of bias (RoB) based on their study design (Ma et al., 2020) by two blinded reviewers (MLG and MLL). The second version of the Cochrane tool (RoB 2.0) (Sterne et al., 2019) was used to assess and rate the RoB in the included randomised controlled trials (RCTs) in terms of randomisation process, intended interventions, completeness of outcome data, outcome measurement, and selective reporting, using grades of low, high, or some concerns. The Critical Appraisal Checklists of the Joanna Briggs Institute (JBI) were used to assess the methodological RoB of the included quasi-experimental studies (Munn et al., 2020). In cases of disagreement, a third external researcher (NGC) was consulted to make the final decision.

## RESULTS

Once the data comprising the search formula were entered, a total of 819 articles were found, of which 570 were from PubMed, 192 from WoS, and 57 from Scopus. Then, as shown in **Figure 1**, duplicate records were removed with the help of the Zotero bibliographic manager (https://www.zotero.org/), leaving 711 articles for screening. Next, a screening was performed according to inclusion and exclusion criteria. In the first round, 238 articles were eliminated as they were older than ten years; in the second round, 213 articles were eliminated for being published more than five years ago, and 239 were excluded after review of titles and abstracts. Filtering by study design eliminated 4 trial protocols, 1 literature review, 1 comment, and 2 usability studies. Thus, the full texts of 13 studies were assessed, of which 1 was excluded for not describing any intervention with telerehabilitation. Finally, the reference lists of the 12 selected articles were reviewed, and 2 more articles that met the inclusion criteria were found. Finally, 14 records were included in this review. Because few records were retrieved that met the study design (RCT) according to PICOS, the full texts of those records based on feasibility (quasi-experimental studies) were analysed as well, adding value to our results.

*Descriptive analysis of feasibility studies*

**Table 2** presents the main characteristics of the studies. First, seven single-arm feasibility studies were analysed (Cheng et al., 2020; Fang et al., 2020; Graboyes et al., 2020; Manne et al., 2020; Sterba et al., 2019; H.-L. Wang et al., 2019; Zini et al., 2019) with a total of 222 subjects, of whom 3 were clinicians, 25 were caregivers of patients with HNC, and the rest were patients. All of them participated in the intervention offered. The sample size ranged from 3 to 66 subjects, and the majority of patients were male (65.3%). The overall mean age of all participants was 59.5 years, with a range between 32 and 77 years. The most common location of study was the United States, (Graboyes et al., 2020; Manne et al., 2020; Sterba et al., 2019; H.-L. Wang et al., 2019), followed by China (Cheng et al., 2020), Italy (Zini et al., 2019) and Iran (Fang et al., 2020). In the seven articles, 36.9% of the patients had stage I-II disease at the time of diagnosis, and 63.1% had stage III-IV disease. The most frequent tumour locations were the oral cavity, oropharynx, nasopharynx and larynx. The most frequent oncological treatment was RT (82.06%), followed by surgery (68.5%) and CT (31.9%). The mean duration of telerehabilitation interventions was 2.5 months, with a range from 2 weeks to 6 months. Finally, the outcomes common to all studies were the feasibility and acceptability of the telerehabilitation intervention used, as well as other measures such as QoL, cancer-related fatigue or physical performance.

*Descriptive analysis of RCTs* (efficacy) *and single-arm studies with historical controls*

For the remaining articles (**Table 2**), there were six RCTs (Liao et al., 2022; Starmer et al., 2022; van der Hout et al., 2021, 2020; Wall et al., 2020; T.-J. Wang et al., 2019) and a single-arm study with historical controls (Shah et al., 2021). All of them comprised a total of 1138 subjects (568 in the experimental group (EG) and 570 in the control group (CG)), and the majority were male (76.1%). The sample size ranged from 60 to 625

147 subjects. The overall mean age of all participants was 59.5 years, with a range between
148 32 and 81 years. The location where each study took place was different for each study:
149 The Netherlands (van der Hout et al., 2021, 2020), Taiwan (T.-J. Wang et al., 2019),
150 Australia (Wall et al., 2020), China (Liao et al., 2022), and the United States (Shah et
151 al., 2021; Starmer et al., 2022). When analysing all subjects in the included studies,
152 47.5% had stage I-II disease at diagnosis, and 52.5% had stage III-IV disease. The HNC
153 sites included the oral mucosa, gingival tissue and hard palate. The most frequent
154 oncological treatment was surgery (50%), followed by concomitant chemoradiotherapy
155 (27%) and RT alone (3.75%). The average duration of telerehabilitation interventions
156 was 4.5 months, with a range of 3-6 months, excluding the study by Shah et al. (Shah et
157 al., 2021) that was 72 h after surgery. There was also a wide variety of assessment
158 measures reported in these articles, but the most common were QoL, swallowing,
159 nutrition and trismus. Of these seven studies, two (van der Hout et al., 2021, 2020) were
160 conducted by the same authors and presented the same methodology (patients, mobile
161 application, intervention). The only thing that changed was the outcomes assessed and,
162 therefore, the results. In addition, both had a population that included survivors of
163 different types of cancer, including HNC.
164 *Qualitative analysis of feasibility studies*
165 This group of studies assessed, among other measures, the feasibility of three web
166 applications (My Journey Ahead, Empowered Survivor and SNAP), a mobile
167 application (HeNeA®) and three models of telerehabilitation interventions: one using an
168 exergaming platform (PAfitME), one using WeChat (CIMmH) and one using a tablet
169 (BRIGHT).
170 For the abovementioned web applications, Fang et al. (Fang et al., 2020) and Sterba et
171 al. (Sterba et al., 2019) reported no significant changes in self-care and symptom

distress in patients after web use ($p>0.05$). However, patients who used Empowered Survivor (Manne et al., 2020) showed significant changes in self-efficacy, survival readiness and QoL ($p<0.05$). In the case of SNAP (Sterba et al., 2019), a significant decrease in depression ($p=0.001$) and a significant increase in survival knowledge ($p=0.03$) were observed.

Three models of interventions were developed: BRIGHT, PAfitME and CIMmH. Graboyes et al. (Graboyes et al., 2020) reported that 8 out of 9 patients had improved severity of body image disturbance after BRIGHT therapy. Wang et al. (H.-L. Wang et al., 2019) reported a significant improvement in fatigue, balance, dependence on activities of daily living, cardiorespiratory fitness and strength ($p<0.05$) after the PAfitME intervention. In contrast, Cheng et al. (Cheng et al., 2020) did not observe significant improvements in any of their measures ($p>0.05$) (QoL, weight, physical fitness and depression, among others) three months after surgery with respect to preoperative measures, although it was indicated that some measures were equal to those in the preoperative stage, so CIMmH offered a faster recovery than other conventional rehabilitation programs.

Finally, Zini et al. (Zini et al., 2019) developed the Android application HeNeA®. In this case, the results were measured by online questionnaires (via the app) completed by patients after use. They observed overall positive results in terms of satisfaction and acceptability, as in the other feasibility studies reviewed above. Therefore, all telerehabilitation interventions obtained positive feasibility results.

*Qualitative analysis of RCTs (*efficacy) *and single-arm studies with historical controls*

In these 7 articles, two types of telerehabilitation were studied: phone and mobile application (SwallowIt®, Oncokompas®, HNC Virtual Coach® and mHealth platform). Wang et al. (T.-J. Wang et al., 2019) and Shah et al. (Shah et al., 2021) found that

telephone support and follow-up of patients after surgery provided significant differences in favour of the EG for adherence to the postsurgery recovery intervention ($p<0.001$), mouth opening ($p<0.001$), deterioration of jaw function ($p<0.001$) and fewer hospital visits ($p<0.05$); in contrast, the number of hospital readmissions did not differ significantly between groups ($p>0.05$). Van der Hout et al. (van der Hout et al., 2021, 2020) developed an e-health application called Oncokompas®, which supported survivors of different types of cancer in self-management of the disease. The results of patient activation as a primary measure (knowledge, skills and self-confidence) showed no significant differences between groups ($p>0.05$); however, there were significant improvements in some QoL measures of patients with HNC ($p<0.05$) (mouth pain, social eating, swallowing, cough and trismus) in the EG compared to the CG. Finally, the mobile applications (SwallowIt®, HNC Virtual Coach® and mHealth platform) developed by Wall et al. (Wall et al., 2020), Starmer et al. (Starmer et al., 2022) and Liao et al. (Liao et al., 2022) were studied. After the SwallowIt® and HNC Virtual Coach® interventions, no significant differences were observed between groups for swallowing, nutrition and general function ($p>0.05$); in contrast, the use of the mHealth platform developed by Liao et al. (Liao et al., 2022) resulted in significant improvements ($p<0.05$) for the EG compared to the CG in RT-related side effects, QoL and fatigue.

***Table 2.*** *Results and most relevant characteristics of the studies analysed.*

*Adverse effects*

No adverse effects were reported in any study. In the studies by Wang et al. (H.-L. Wang et al., 2019) and Starmer et al. (Starmer et al., 2022), adverse effects were controlled according to the Common Terminology Criteria for Adverse Events (CTCAE), and in the study by Zini et al. (Zini et al., 2019), the physicians suggested implementing the PRO-CTCAE scale in the application to allow patients to report possible adverse events.

*Risk of bias*

The results of the RoB assessment of the six included RCTs are shown in **Figures 2-3**. Overall, most of the included studies had a high RoB in the overall bias assessment. The main methodological quality issue was measurement of the outcome, which was graded high risk for a total of four of the six studies (66.7%). Similarly, most of the included studies presented some concerns or a high RoB in the deviations from intended interventions (50%). Therefore, none of the studies achieved a low overall RoB (**Figure 2-3**).

Overall, the methodological RoB of the quasi-experimental studies (nonrandomised) was low because most of the assessment criteria were met (**Table 3**). Only one of these studies adopted an independent CG (historical) (Shah et al., 2021), and only one properly reported drop out data (Cheng et al., 2020). However, none of these studies described similar treatment/care for the patients, other than the exposure or intervention of interest.

***Table 3.*** *Risk of bias of the quasi-experimental studies (non-randomised).*

## DISCUSSION

The aim of this systematic review was to assess the efficacy of telerehabilitation in the management of patients with HNC during and after their oncological treatment. In view of the results, feasibility designs retrieved through the search formulas were also analysed to some extent.

All interventions analysed in terms of feasibility showed positive results, and most experimental results supported the efficacy of telerehabilitation interventions for different clinical variables. Wang et al. (T.-J. Wang et al., 2019) and Shah et al. (Shah et al., 2021) obtained significant differences in favour of the EG in adherence to the postsurgery recovery intervention, mouth opening, deterioration of jaw function and decreased hospital visits after the intervention. Manne et al. (Manne et al., 2020), Sterba et al. (Sterba et al., 2019) and Liao et al. (Liao et al., 2022) showed significant improvements for self-efficacy, survival preparedness, QoL, depression and side effects of RT. In addition, Graboyes et al. (Graboyes et al., 2020) and Wang et al. (H.-L. Wang et al., 2019) reported improvements in body image disturbance, fatigue, balance, dependence on activities of daily living, cardiorespiratory fitness and strength after the intervention. On the other hand, inconclusive results were also obtained, e.g., by Van der Hout et al. (van der Hout et al., 2021, 2020), Wall et al. (Wall et al., 2020) and Starmer et al. (Starmer et al., 2022), where no significant differences between groups were demonstrated for the outcomes of patient activation, swallowing, nutrition and general function. Fang et al. (Fang et al., 2020) and Sterba et al. (Sterba et al., 2019) did not find a significant change in self-efficacy or symptom distress in patients after web use.

*Analysis of telerehabilitation*

Five types of telerehabilitation were described in the studies analysed: phone call, mobile application, web application, tablet and exergame platform. With the data obtained, it is difficult to establish if any intervention is better than another, although it was observed

that 50% of the studies with intervention through mobile applications (Cheng et al., 2020; Starmer et al., 2022; Wall et al., 2020) did not achieve statistically significant results for most of the measures analysed. In contrast, most of the authors showed positive results with the other telerehabilitation interventions.

The telerehabilitation interventions described in this review involved both single-component interventions and multicomponent interventions with content that varied considerably. Examples of single-component interventions are websites that only provide information about the disease or treatments. Multicomponent interventions, for example, offer information and the possibility of direct contact with health professionals; therefore, they are more personal and adapted to the patient (Slev et al., 2016). This review includes 14 articles, 2 of which were single-component interventions, and the rest offered telerehabilitation interventions and personalized information to the patient, that is, multicomponent interventions. This prevalence of multicomponent interventions may be due to the need expressed by patients for individualized practical advice on sequelae and communication with other survivors for support (Badr et al., 2016). However, with current research, it is difficult to determine whether multicomponent interventions are more effective than single-component interventions (Slev et al., 2016).

*Analysis of patient characteristics*

One parameter to consider is the patients' disease stage; according to Slev et al. (Slev et al., 2016), this determines the type of telerehabilitation intervention needed, since at each stage the patient requires different information and treatments. We have been able to verify in this review, for example, that no relevant results were found in patients who had undergone surgery. This can be seen in the study by Cheng et al. (Cheng et al., 2020), which indicated no significant improvement in QoL and symptoms at the third month post-surgery (after the telerehabilitation intervention) with respect to the preoperative measurements. In the study by Shah et al. (Shah et al., 2021), hospital visits after surgery

decreased significantly in the EG compared to the CG; however, readmissions did not. This may be due to the difficulty of the operation and the significant sequelae it causes. On the other hand, inconclusive results have also been reported in investigations where patients undergo telerehabilitation intervention during treatment with RT or CT, as in the case of Wall et al. (Wall et al., 2020) and Starmer et al. (Starmer et al., 2022) for measures of nutrition, swallowing and function. However, studies in which patients have already finished CT or RT showed more positive results. This informs us that there is a need to personalize the content and interventions offered by the interventions to each type of patient according to their disease stage and that the best time to perform telerehabilitation interventions is after overcoming the disease.

It should be noted that the studies by Van der Hout et al. (van der Hout et al., 2021, 2020) included patients with various types of cancer, and most of the significant improvements after the telerehabilitation intervention were found in patients with HNC. The authors explain this according to the differences in cancer effect, treatment, and the availability of online information since, as mentioned in the introduction of this review, it is an underserved and underresourced population compared to those of other cancers. This indicates that patients with HNC are an appropriate population for this type of rehabilitation and that they should receive help in the recovery process.

This help is also demonstrated in the present review since most of the results obtained suggest positive changes for patients with HNC, and although there are some articles in which these results were not as significant, in all the studies analysed, high degrees of satisfaction were observed, which translates into positive results in terms of viability. Just as satisfaction was high in all studies, adherence to treatment was also higher when this process was performed in an interactive and fun way, as in the case of PAfitME (H.-L. Wang et al., 2019). In other studies, such as those by Zini et al. (Zini et al., 2019), Fang et al. (Fang et al., 2020) and Manne et al. (Manne et al., 2020), from which the qualitative

assessment of the telehealth intervention by patients was obtained, most comments were positive (useful, interesting, easy to use, etc.). Furthermore, no adverse effects were reported in any of the studies, so these telerehabilitation interventions can offer valuable resources and information to help patients with HNC cope with sequelae.

*Future lines of research*

Surprisingly, only one article (Sterba et al., 2019) aimed to consider the effects of telerehabilitation for both patients and caregivers, who play a key role in the recovery of patients. Furthermore, research has shown that distress among caregivers is comparable to that of patients (Verdonck-de Leeuw et al., 2007) and that HNC can be a challenge for couples, compromising communication and social support between partners (Badr et al., 2015; Sterba et al., 2016). Survivors are instructed to perform oral care at home to improve sequelae (Badr et al., 2016). However, 81% of them do not comply with the recommendations (Thariat et al., 2012). Therefore, the caregiver is in an excellent position to encourage this self-management, as they see the survivors every day (Williams et al., 2006). The study by Badr et al. (Badr et al., 2016) described the development of CARES (computer-assisted oral cancer rehabilitation and support), which was designed to provide information, skills development, and support services to reinforce the autonomy, competence and relationship of survivors and caregivers. Due to the importance of the caregiver in the recovery process of patients with HNC and the lack of research in this regard, more studies are needed to develop support for caregivers in terms of telerehabilitation (Bouaoud et al., 2021).

Another need detected was to carry out research with a long-term follow-up to assess the sequelae that remain in patients with HNC when they are no longer in direct contact with the health service. This is because the maximum evaluation time found in the included studies was 12 months, which is insufficient to obtain all the necessary information and assess whether these telerehabilitation interventions truly offer long-term improvements.

*Proposal for the improvement of telerehabilitation systems*

The field of digital health care is still largely unknown and poorly used by many health care professionals, which is why more training is needed within the health field to ensure its proper functioning, as well as to develop good e-Health programs (Bouaoud et al., 2021). To this end, Gemert-Pijnen et al. (van Gemert-Pijnen et al., 2011) proposed a framework to improve the development of telehealth systems called 'the ceHRes Roadmap'. This framework is based on several key concepts: 1) the development of telehealth systems is a participatory process; 2) it involves continuous evaluation (feedback); 3) implementation from the start; 4) it adapts to changes in health care; 5) it should include persuasive design techniques; and 6) it needs innovative methods to assess its impact.

*Strengths and limitations*

The strengths of this review were that the reporting was made according to the PRISMA guidelines, RoB assessment was included (Ma et al., 2020) and the review was registered prospectively in PROSPERO. In addition, the selected studies are from the last 5 years, so they show the most recent results obtained. However, some limitations should be noted; for example, none of the studies achieved low overall RoB assessments (RCTs). The most important limitation observed in this review is the heterogeneity of the data, since within telehealth systems, there are a number of possible rehabilitation interventions, each with different objectives and variables. Unexpectedly, quasi-experimental studies were retrieved from different research formulas whose target design was RCT; nevertheless, these studies were included and analysed as long as they met the rest of the PICO criteria.

## CONCLUSIONS

In relation to the scientific evidence collected after the analysis was performed, it can be concluded that telerehabilitation offer viable and effective interventions for the management of patients with HNC during and after their oncological treatment. It was also observed that telerehabilitation interventions should be personalized according to the characteristics of the patient and the stage of the disease. Moreover, these interventions were more effective when the patient had already finished treatment with CT and/or RT. On the other hand, we found the need for further research on telerehabilitation interventions to support the caregivers of patients with HNC, who are so important in the recovery process, along with the need to develop studies with a long-term follow-up of these patients to assess sequelae with more months of evolution.

## Declarations of interest

None.

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**Figure legends**

**Figure 1.** Flow chart of search results. PRISMA 2020.

**Figure 2.** Risk of bias of included randomised controlled trials.

**Figure 3.** Risk of bias graph: review authors' judgements about each risk of bias item presented as percentages across all included studies.

659 **Table 1.** PICOS (Search Criteria).

| | INCLUSION CRITERIA | EXCLUSION CRITERIA |
|---|---|---|
| P | Patients with HNC or survivors | Minors |
| I | Telerehabilitation | Any other intervention without use of telerehabilitation |
| C | Indifferent | NA |
| O | Indifferent | NA |
| S | RCT | Literature reviews and meta-analyses<br>Trial protocols<br>Comments<br>Usability studies |

660 C: comparison, HNC: head and neck cancer; I: intervention NA: not applicable; O: outcomes; P: population;
661 RCT: randomized controlled trial; S: study design.
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**Table 2.** Results and most relevant characteristics of the studies analysed.

| LEAD AUTHOR, YEAR | STUDY DESIGN | OBJECTIVE | POPULATION | PROGRAMME CHARACTERISTICS | INTERVENTION | RESULTS |
|---|---|---|---|---|---|---|
| **Cheng et al., 2020** | Single-arm feasibility study | To examine the feasibility and safety of CIMmH for 12 weeks. | N= 20 Patients with esophageal cancer scheduled for surgery. | CIMmH is a comprehensive intervention model supported by mHealth and integrated into the WeChat platform, which provides strategies for post-operative recovery, nutrition, physical exercise, and psychological support. | Patients were provided with CIMmH after surgery. QoL, body weight, physical and psychological status were assessed. Assessment times: 1 week before surgery, 1 and 3 months after surgery. | CIMmH is feasible and safe without serious adverse effects. QoL and all other measures worsened in the first month, however, by the third month most of these measures returned to pre-operative levels. |
| **Fang et al., 2020** | Single-arm feasibility study | To assess patient acceptability and satisfaction with the My Journey Ahead programme. | N= 55 Patients with HNC. | My Journey Ahead is a web application developed to facilitate self-care for patients with HNC, provide strategies and exercises to improve functional skills, and to share personal experiences with other survivors. | The program has 9 topics in which they have various information such as oral health, psychological therapy, pain management, etc. Psychological distress, self-efficacy in coping with cancer and satisfaction with the program were assessed. Assessment times: before using the program and 2 weeks later. | Patients indicated a high degree of satisfaction and interest in the program, especially older patients, who highlighted the ease of use. There are no significant differences in self-efficacy and distress between pre- and post-intervention. |
| **Graboyes et al., 2020** | Single-arm feasibility study | To assess the feasibility and acceptability of BRIGHT and to evaluate its clinical impact on BID among survivors with HNC. | N=10 survivors with BID. | BRIGHT individualised telecognitive behavioural therapy, developed to target the cognitive, behavioural and attitudinal components of the BID related to HNC. | BRIGHT consists of 5 weekly 60-minute sessions delivered individually via tablet. The feasibility and acceptability of BRIGHT was evaluated, as well as changes in body image. Assessment times: at start-up, 1 and 3 months after the intervention. | BRIGHT is feasible and acceptable for survivors with HNC and was associated with improvements in body image 1 month and 3 months post-intervention. |

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| **Liao et al., 2022** | RCT | To build an mHealth platform for patients with nasopharyngeal carcinoma and investigate its impact on healthcare in terms of RT, fatigue and QoL. | N=114 Patients with nasopharyngeal carcinoma.<br><br>EG. Healthcare through the mHealth platform.<br>n= 57<br><br>CG. Traditional health care. n= 57 | mHealth is a mobile health platform based on WeChat that enables personalised healthcare. It has a database to search for information, and three modules: 1. Patient-health staff interaction, 2. Patient health data record, 3. Basic information on patients with their health files. | Patients were followed up after discharge. An individualised patient assessment was made in the EG through the platform, materials were provided to improve knowledge and health information, and personalised care was provided. QoL, fatigue and side effects of RT were measured.<br>Assessment time: before and 3, 6 and 12 months after the intervention. | A significant improvement in RT side effects, fatigue and QoL was demonstrated for EG patients compared to CG patients at 6- and 12-months post-intervention. |
| **Manne et al., 2020** | Single-arm feasibility study | To assess the feasibility and acceptability of ES and its clinical impact among cancer survivors oropharyngeal. | N=66 Survivors of primary oral or oropharyngeal cancer. | ES is an interactive, web-based intervention to help cancer survivors self-manage the aftermath of cancer. It features interactive information on oral care, swallowing, muscle strength and long-term follow-up, among others. | ES consists of 4 modules which patients have to complete over 6 months, by watching videos and completing questionnaires and activities. QoL, the effectiveness of self-care and whether the information received was sufficient were assessed.<br>Assessment times: pre-intervention, 2 and 6 months after intervention. | Subjects evaluated ES positively. It was shown to have a beneficial impact on self-care, information received and QoL.<br>It also improved subjects' participation in oral self-examinations and neck strengthening exercises. |
| **Shah et al., 2021** | Single-arm study with historical control | To assess the impact and quality of telephone calls within 72 hours of post-operative discharge to reduce unnecessary hospital visits and readmissions. | N=169 Patients operated on for HNC or laryngectomy.<br><br>EG. Telephone follow-up (2017-2018) n=91<br>Retrospective CG. No telephone follow-up (2016-2017) n=78 | For virtual communication, a telephone number has been designated as a ‘wound care phone’. This had a password known only to the surgeon and the patient's nurse. | EG patients were called 72 hours after discharge from the hospital by a doctor, who asks them a questionnaire to determine the state of the post-surgery wound. They also have the possibility to send videos or photos of the wound, or to make videoconferences with the doctor, in order to solve any problems, they may have doubts. | There was a significant reduction in hospital visits for EG compared to the previous year (CG).<br>In contrast, re-admissions did not decrease significantly from the previous year. |

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| **Starmer et al., 2022** | RCT | To test the impact of HNC Virtual Coach on adherence to prophylactic swallowing exercises and to evaluate functional swallowing outcomes in patients with HNC during RT. | N=91 Patients with HNC requiring bilateral neck radiation.<br><br>EG. Use of HNC Virtual Coach. n= 44<br>CG. Recording of exercises on paper. n=47 | HNC Virtual Coach is a swallowing rehabilitation mobile app. Patients receive reminder notifications to complete exercises, as well as a link to a training video twice a day. | All patients had to do the swallowing exercises, the EG through videos and app reminders, and the CG through paper sheets where they recorded the series, pain and amount of food. Assessment time: adherence weekly, swallowing improvement at baseline, and 2-3 months after the start of RT. | Greater adherence to swallowing exercises was demonstrated by the EG, however there was no significant difference in swallowing improvement between the two groups. |
| **Sterba et al., 2019** | Single-arm feasibility study | To test the feasibility and acceptability of the SNAP system for survivors with HNC and their caregivers. To evaluate short-term changes in psychosocial outcomes and improve the system. | N=25 HNC survivors.<br><br>N=25 Caregivers. | SNAP is a web-based intervention designed to facilitate data collection. The system records assessments and data and, based on the administrator's logic considering the responses, generates a personalised care plan. | Participants completed a baseline survey by telephone, an in-person clinical session, which concluded with an evaluation survey, and a follow-up survey after 6 weeks.<br>They had to carry out the care plan created individually for each of them. | Participants reported a high degree of satisfaction with the session and the care plan.<br>Depression and unmet needs decreased, and knowledge of survival increased significantly in survivors and caregivers.<br>However, distress and symptom management did not show significant improvements. |
| **Van der Hout et al., 2021** | RCT | To investigate the effectiveness of Oncokompas on certain factors such as QoL, symptoms and need for supportive care, and to find out which types of cancer survivors benefit most from the app. | N= 625 Survivors of HNC, colorectal, breast, Hodgkin's lymphoma or non-Hodgkin's lymphoma.<br><br>EG. n=320<br>CG. n=305 | OncoKompas is a web-based e-health application that supports survivors in self-management by tracking QoL and cancer symptoms and obtaining personalised information with an overview of supportive care options. It consists of three components or objectives: measure, learn and act. | The intervention group had direct access to Oncokompas, while the control group gained access after 6 months.<br>Assessment time: at enrolment, 1 week after the intervention and at 3 and 6 months follow-up. | Oncokompas was most effective at reducing symptoms in survivors of HNC and colorectal cancer. It also appeared to be more effective in improving QoL in survivors with lower self-efficacy, in those with greater personal control and a higher self-esteem, and a higher health knowledge. |
| **Van der Hout et al., 2020** | RCT | To assess the scope, intended use and efficacy of Oncokompas in improving knowledge, skills and confidence for self-management among cancer survivors. | | | | Oncokompas did not improve knowledge, skills or confidence for self-care or other secondary outcomes, as there were no significant differences between groups. For survivors with HNC there were significant differences for mouth pain, social eating, swallowing, cough and trismus. |

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|---|---|---|---|---|---|---|
| **Wall et al., 2020** | Three arms RCT | To investigate the clinical efficacy of three different ways of providing prophylactic swallowing therapy during RT. | N =79 Patients with oropharyngeal cancer during RT.<br>EG. Telemedicine therapy 'SwallowingIT' n=26<br>CG1. Face-to-face therapy n=26<br>CG2.Patient-directed self-directed therapy n=27 | SwallowIT is a mobile application designed to help patients with HNC remotely complete swallowing therapy during RT treatment. Instructional videos, images and descriptions are included for each exercise in the protocol, as well as the functionality. | All patients received a face-to-face educational session prior to RT treatment, weekly joint sessions during RT and 6 weeks of prophylactic swallowing therapy during RT, depending on the mode of application of their group. Swallowing, nutrition and general function were assessed.<br>Assessment time: at baseline, 6 weeks and 3 months after RT. | There were no significant differences between groups for swallowing, nutrition or functional measures. SwallowIT and the face-to-face models were significantly preferred to the self-directed therapy model. |
| **Wang et al., 2019** | Single-arm feasibility study | To assess the feasibility, acceptability and safety of the PAfitME intervention, as well as to describe adherence rates and to analyse changes in CRF, ADLs and physical performance in patients with HNC after treatment | N=8 Patients with HNC. | PAfitME was implemented using an easy to transport exergames platform. These have 4 modes of physical activity: aerobics, strength training, flexibility and balance. WiiFit was used as an exergame platform to deliver the PAfitME intervention at home. | The intervention lasted 6 weeks and incorporated WiiFit exergames. In addition, weekly 1-hour home visits by a nurse and weekly 10-minute phone calls for 3 weeks were carried out.<br>CRF, ADLs and physical performance were assessed.<br>Assessment times: at the beginning of the intervention, 6 and 9 weeks after the end of the intervention. | The PAfitME intervention is feasible and acceptable with promising adherence rates. Participants' satisfaction with the mode and components of the intervention was positive. Results showed significant improvements in CRF, ADLs, and some measures of physical performance. |
| **Wang et al., 2019** | RCT | To investigate the effects of an intervention by opening of the mouth for postoperative trismus and remote support provided by telephone after hospital discharge in patients with oral cancer | N=60 Patients with oral cancer programmed for surgery.<br>EG. Intervention programme, plus additional telephone support. n=30<br>CG. Intervention programme. n=30 | The interventionist called each experimental subject in the weeks 1,2,3,4,8 and 12 for training, improve the adherence and resolve any questions and concerns. | All patients performed a programme of 12-week intervention that focused on the flexibility of the masticatory muscles and the muscles of mastication.<br>Assessment time: before surgery, 1 and 3 months after discharge from hospital. | A greater effect of the remote telephone support to improve adherence to the protocol for intervention, and the effect of the programme of intervention to alleviate trismus and alterations of the function mandibular. |

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|---|---|---|---|---|---|---|
| **Zini et al., 2019** | Single-arm feasibility study | To assess the ease of use, perceived usefulness and acceptability of HeNeA, as well as the feasibility of symptom monitoring during RT in patients with HNC. | N=10 Patients with HNC during RT.<br><br>N=3 clinicians. | HeNeA is a mobile app designed to proactively collect patients' symptoms, clinical parameters and questionnaires to assess their health status. In addition, doctors can configure the app to customise it according to the patient's data. | First of all, the patients were explained how the app works. They used the app for 65 days, at the end of which they filled in a satisfaction questionnaire. The patients were followed up by 3 clinicians who also completed a questionnaire. | Overall satisfaction with the app. Usefulness and usability were positively correlated and both aspects were predictors of acceptance. Feasibility was demonstrated by low dropout and task non-completion rates. |

**Abbreviations**: ADL: activities of daily living; BID: body image disturbance; BRIGHT: Building a Renewed Image after Head and neck cancer Treatment; CG: control group; CIMmH: Mobile Health-Supported Comprehensive Intervention Model; CRF: cancer-related fatigue; EG: experimental group; ES: Empowered Survivor; HNC: head and neck cancer; HeNeA: Head and Neck Application; mHealth: mobile health; N: sample; PAfitME: physical activity intervention with fitness graded motion exergames; QoL: Quality of Life; RCT: randomised clinical trial; RT: radiotherapy; SNAP: survivorship needs assessment planning.

**Table 3.** Risk of bias of the quasi-experimental studies (non-randomized).

| Study | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| **Shah et al. (2021)** | Y | Y | Unclear | Y | N | NA | Y | Y | Y |
| **Wang et al. (2018)** | Y | Y | Unclear | N | Y | NA | Y | Y | Y |
| **Zini et al. (2019)** | Y | N | Unclear | N | N | NA | NA | Y | Y |
| **Cheng et al. (2020)** | Y | Y | Unclear | N | Y | Y | Y | Y | Y |
| **Fang et al. (2020)** | Y | N | Unclear | N | N | NA | NA | Y | Y |
| **Mane et al. (2020)** | Y | Y | Unclear | N | Y | NA | Y | Y | Unclear |
| **Graboyes et al. (2020)** | Y | Y | Unclear | N | Y | NA | Y | Y | Y |
| **Sterba et al. (2019)** | Y | Y | Unclear | N | Y | NA | Y | Y | Y |
| **Total%** | 100 | 75 | 0 | 13 | 63 | 100 | 100 | 100 | 88 |

1. Is it clear in the study what is the 'cause' and what is the 'effect' (i.e. there is no confusion about which variable comes first)?; 2. Were the participants included in any comparisons similar?; 3. Were the participants included in any comparisons receiving similar treatment/care, other than the exposure or intervention of interest?; 4. Was there a control group?; 5. Were there multiple measurements of the outcome both pre and post the intervention/exposure?; 6. Was follow up complete and if not, were differences between groups in terms of their follow up adequately described and analyzed?; 7. Were the outcomes of participants included in any comparisons measured in the same way?; 8. Were outcomes measured in a reliable way?; 9. Was appropriate statistical analysis used?.

Y: yes; N: none, NA: not applicable.

Figure 1



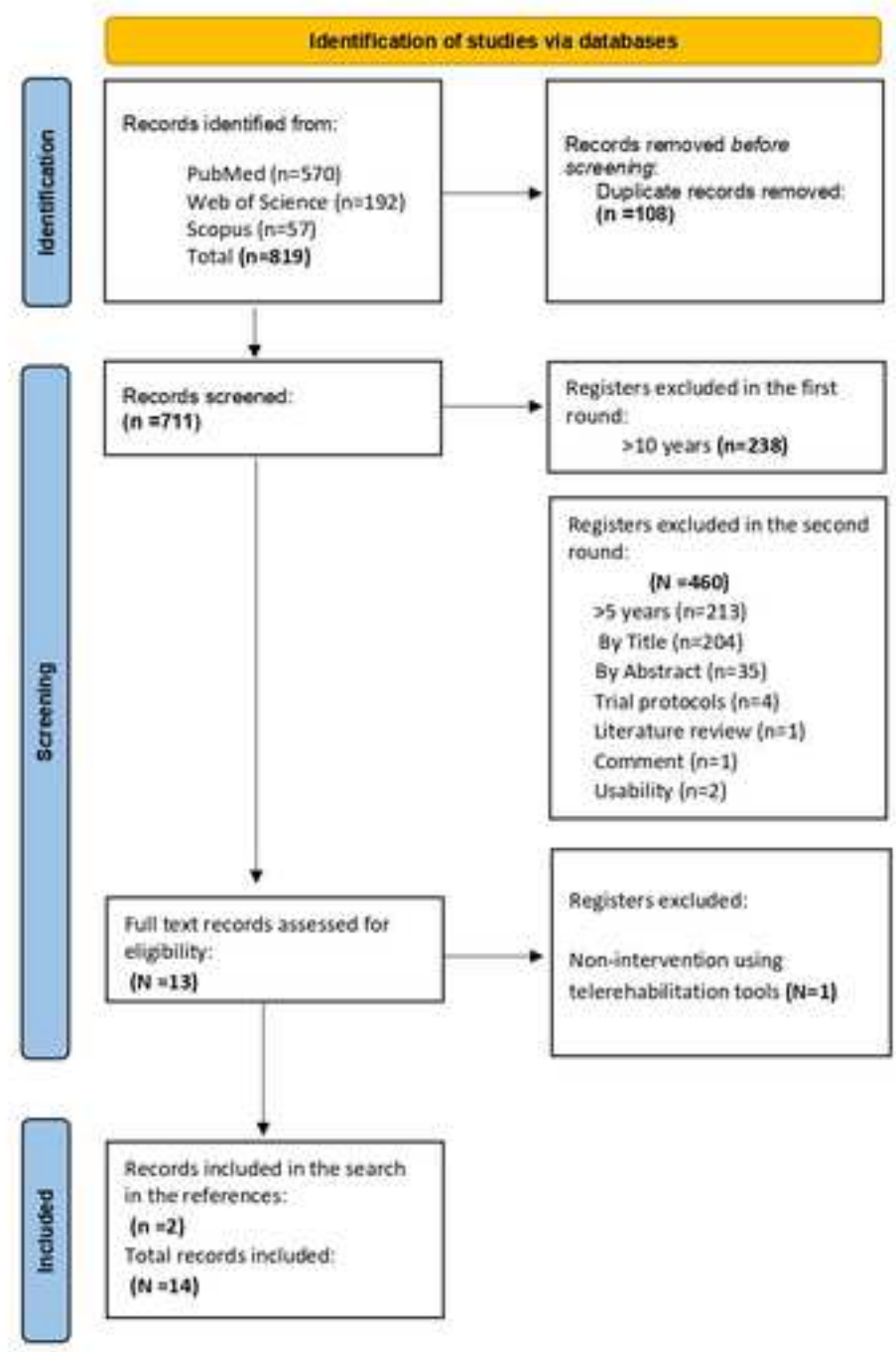


**Figure 1.** Flow chart of search results. PRISMA 2020.

Figure 2

Click here to access/download;Figure;FIGURE 2.jpeg

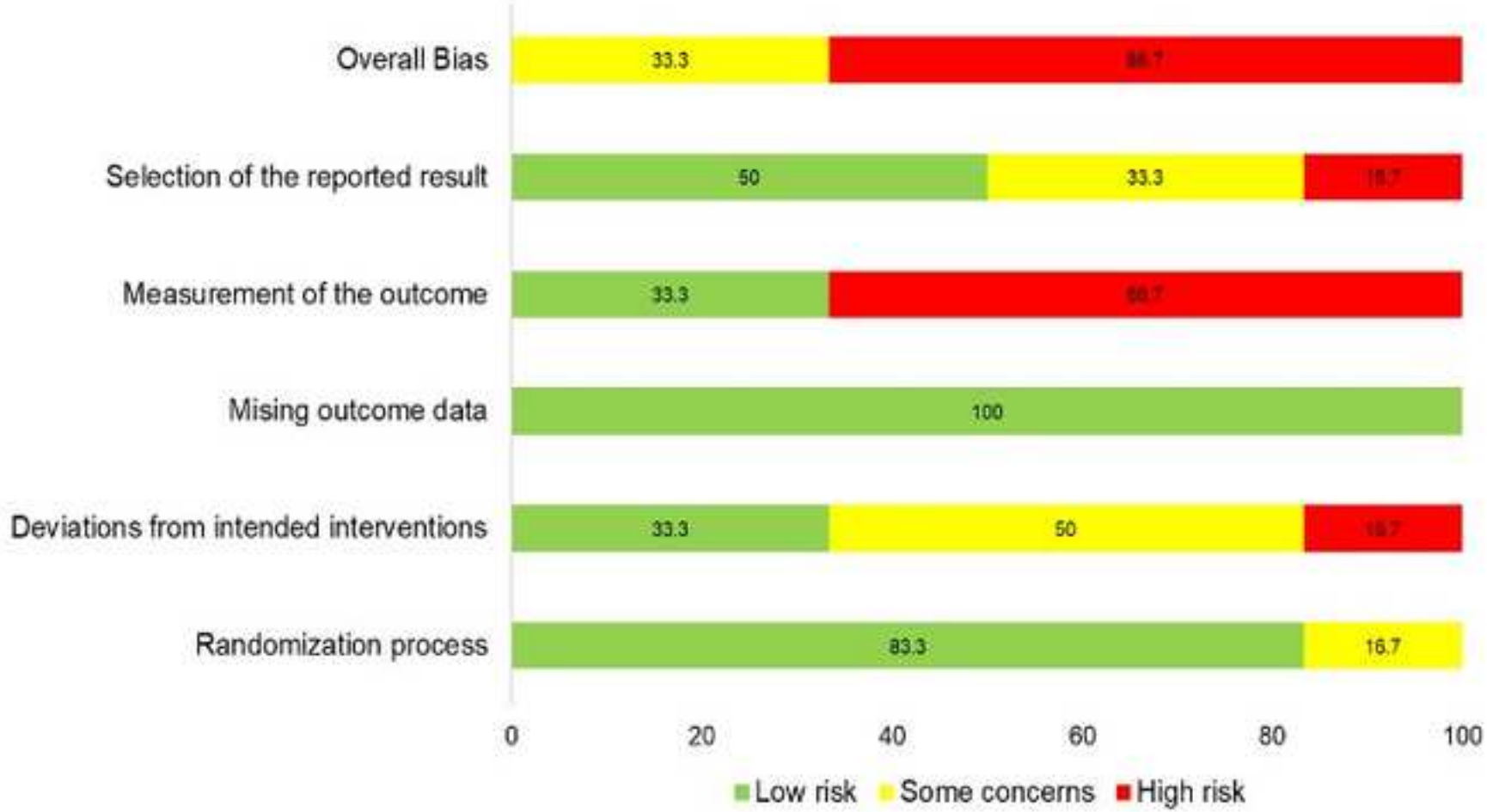

Figure 3