Review Article

# Surviving and thriving: Assessing quality of life and psychosocial interventions in mental health of head and neck cancer patients

Liqing Lin [a,1], Hao Lin [b,1], Renbin Zhou [b,1], Bing Liu [b,c], Kaige Liu [d,*], Ronghua Jiang [e,**]

[a] Kangda College of Nanjing Medical University, Lianyungang, Jiangsu, China
[b] State Key Laboratory of Oral & Maxillofacial Reconstruction and Regeneration, Key Laboratory of Oral Biomedicine Ministry of Education, Hubei Key Laboratory of Stomatology, School & Hospital of Stomatology, Wuhan University, Wuhan, China
[c] Department of Oral & Maxillofacial Head Neck Oncology, School & Hospital of Stomatology, Wuhan University, Wuhan, China
[d] Qilu Hospital of Shandong University, Jinnan, Shandong, China
[e] Department of Pediatric Dentistry, School and Hospital of Stomatology, Cheeloo College of Medicine, Shandong University & Shandong Key Laboratory of Oral Tissue Regeneration & Shandong Engineering Research Center of Dental Materials and Oral Tissue Regeneration & Shandong Provincial Clinical Research Center for Oral Diseases, Jinnan, Shandong, China

## ARTICLE INFO

## ABSTRACT

The quality of life of head and neck cancer patients is affected by various factors, including the disease itself, treatment side effects, and changes in appearance, leading to a range of mental health issues such as anxiety, depression, and adjustment disorders. These mental health problems not only reduce the patients' quality of life but may also negatively impact treatment outcomes and survival rates. Therefore, it is particularly important to assess and intervene in the mental health of head and neck cancer patients. This review focuses on the common mental health issues in these patients and emphasizes the importance of detailed assessment. By using various assessment tools, healthcare professionals can accurately identify patients' mental states and provide appropriate support and interventions. The article discusses various effective mental health interventions aimed at improving patients' psychological adaptation, reducing psychological stress, and enhancing quality of life. These interventions include cognitive-behavioral adjustments, family support, and mindfulness practices. In addition, the article mentions the potential of artificial intelligence technology in improving patients' quality of life, particularly in treatment planning, patient education, and mental health interventions. In summary, comprehensive management and intervention of the mental health of head and neck cancer patients are crucial to improving their quality of life and treatment outcomes. Future research needs to further explore effective psychological intervention methods and integrate them into the overall treatment plan for head and neck cancer patients.

## 1. Introduction

In recent years, the incidence of malignant tumors has been on the rise, with head and neck cancer emerging as a significant global health threat. According to data from the International Agency for Research on Cancer (IARC), head and neck cancers include malignancies of the lip, oral cavity, and pharynx, primarily involving nasopharyngeal, oral, hypopharyngeal, oropharyngeal, and laryngeal cancers.[1] In 2020, there were 931,931 new cases of head and neck cancer worldwide, accounting for 4.9 % of all cancer incidences, with approximately 467,125 deaths, representing 4.7 % of all cancer-related mortalities, ranking sixth among common cancers.[2]

Treatment strategies for head and neck cancer include surgery, radiotherapy, chemotherapy, molecular targeted therapy, and immunotherapy.[3] Radiotherapy, in particular, is a crucial method for treating head and neck cancer, with approximately 75 % of patients requiring this treatment.[4] Despite recent advancements in precision radiotherapy techniques and treatment protocols that have extended patient survival, the five-year survival rate for head

* Corresponding author.
** Corresponding author.
 E-mail addresses: Kaige9512@163.com (K. Liu), jiangronghua16@gmail.com (R. Jiang).
 [1] These authors contributed equally to this work.

and neck cancer remains unsatisfactory at only 65 %.[5] Unfortunately, these treatments often come with side effects such as dry mouth, difficulty swallowing, and oral mucositis, significantly reducing patients' quality of life and potentially leading to decreased social functioning and nutritional deterioration.[6]

Head and neck cancer patients not only endure physical pain caused by the disease itself but also frequently face various complications due to tumor pressure, ulcers, inflammation, or nerve damage, such as difficulty swallowing, breathing, and speaking, appearance defects, and limited shoulder and neck mobility.[7–9] Compared to patients with breast cancer, gynecological cancers, and melanoma, head and neck cancer patients bear a heavier burden of disease and treatment-related symptoms.[10] These adverse effects not only lower the patients' quality of life but also lead to a range of psychosocial issues, including changes in worldview and life goals, and even the emergence of psychological problems such as anxiety, depression, and suicidal tendencies.[9] Additionally, compared to survivors of other cancers, head and neck cancer survivors are more likely to resort to smoking or heavy drinking to alleviate mental and psychological stress, thereby facing a higher mental health burden.[11]

The psychosocial adaptation of head and neck cancer patients has become a critical factor affecting their long-term survival, determining whether they can reintegrate into society and lead normal lives. Therefore, this study aims to explore the psychological issues, interfering factors, assessment methods, and intervention approaches for head and neck cancer patients, with the hope of providing strong support for improving their overall well-being.

## 2. Challenges in the psychological health of head and neck cancer patients

Head and neck cancer patients face complex psychological challenges during treatment and rehabilitation, significantly impacting their quality of life. Stigma, adjustment disorders, loneliness, anxiety, and depression exacerbate physical pain and lead to



Fig. 1. Mental health problems in patients with head and neck cancer.

social and emotional isolation, weakening treatment response and complicating rehabilitation (Fig. 1 and Table 1).

### 2.1. Stigma

Stigma is a complex psychological state triggered by an individual's perception of negative judgment from others, primarily encompassing negative emotions such as shame, guilt, and self-blame.[12] This emotion is particularly pronounced in post-operative head and neck cancer patients, who not only face changes in appearance and loss of basic oral functions but also deal with limitations in daily activities and multiple other difficulties.[13,14] Specifically, the stigma experienced by head and neck cancer patients may be exacerbated by impaired social abilities, further affecting their daily lives and mental health. The pressure of financial strain and self-perception of the disease, such as self-blame and shame, deepen this psychological burden.[15] In this context, the belief that cancer is "self-inflicted" may cause oral cancer patients to feel an even greater sense of internal shame.

### 2.2. Adjustment disorder

Adjustment disorder is a common psychological response to stressors, such as a cancer diagnosis, family or occupational setbacks.[16] It is typically temporary, with individuals gradually returning to a healthy state over time. However, if this condition persists, it can lead to more severe mental health issues such as depression and anxiety, and even result in suicidal tendencies.[17]

### 2.3. Loneliness

For head and neck cancer patients, treatment-induced changes in appearance, social and dietary difficulties, speech and swallowing issues, persistent pain, changes in role function, and depression all contribute to a heightened sense of loneliness. According to the Patient Concerns Inventory [18], these problems not only complicate patients' daily lives but also alter their interactions with those around them.[19] Social gatherings around the dinner table are significant moments for family and friends, but the impact of head and neck cancer and its treatment often reduces these opportunities, depriving patients of valuable social interactions. Furthermore, research by Dahill et al.[20] confirms that communication difficulties related to head and neck cancer and a lack of confidence in one's appearance are significant predictors of loneliness. These factors affect patients' social interactions and limit their participation in social functions.

### 2.4. Anxiety

Anxiety is an excessive worry about future misfortune and danger, often accompanied by physical symptoms such as irritability, tension, palpitations, and sweating. This psychological state is quite common among cancer patients, particularly those with head and neck cancer, where anxiety can further intensify, leading to a negative outlook on cancer prognosis and impacting the quality of daily life.[20] A psychological assessment study involving 1011 cancer patients found that the prevalence of anxiety symptoms ranged from 19.1 % to 19.9 %, with a particularly high incidence among hospitalized patients.[21] A follow-up study of 2,611,907 cancer patients indicated that anxiety symptoms are positively correlated with cancer-specific mortality and negatively correlated with cancer survival rates.[22]

Anxiety is often accompanied by insomnia, with nearly half (44 %) of head and neck cancer patients experiencing significant declines in sleep quality before treatment. This poor sleep quality is
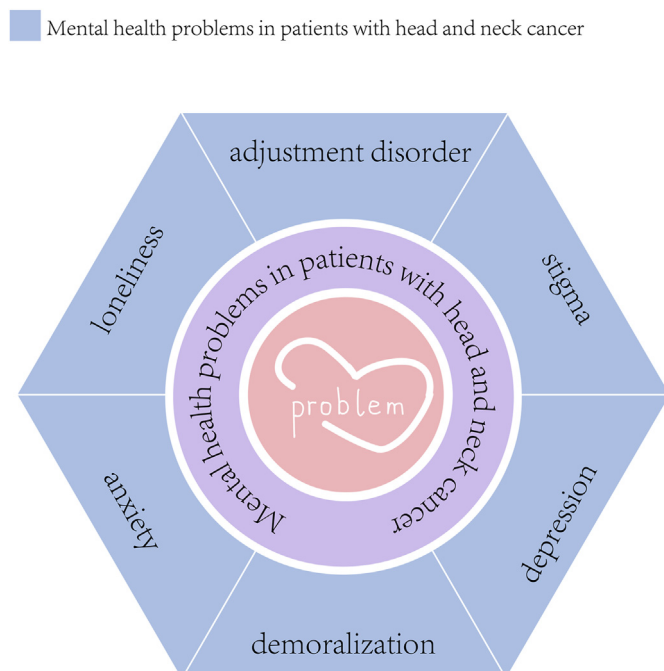
**Table 1**
Trends in research on the psychological health and quality of life of head and neck cancer patients: A global perspective.

| Country | Data Year | Gender | Conclusion | references |
|---|---|---|---|---|
| **Jordan** | 2019 −2020 | All | The incidence rate of anxiety symptoms in cancer patients is approximately 19.1%–19.9 %, and is more frequent among hospitalized patients. | [21] |
| **Netherlands** | 2014 −2018 | All | Poor sleep quality is very common among head and neck cancer patients before the start of treatment. | [23] |
| **United States** | 2010 −2020 | All | Alleviation of pain contributes to an improvement in quality of life. | [24] |
| **Sweden** | 2007 −2012 | All | The respective data for 3 months, 12 months, and 60 months post-operation are 70 %, 54 %, and 41 %. During the study period, 29–44 % of patients reported moderate to severe pain. | [25] |
| **Egypt** | 2019 | All | The prevalence rates of depressive symptoms, anxiety symptoms, and perceived stress are 68.6 %, 73.3 %, and 78.1 %, respectively. | [29] |
| **South Korea** | 2006 −2016 | All | The risk of suicide increases among young survivors of head and neck cancer, while the risk of death from comorbidities increases in older survivors. | [37] |
| **United States** | 2000 −2016 | All | Suicide risk is more significant in certain cancer types, such as oral cancer. | [38] |
| **United States** | 2000 −2016 | All | Patients living in rural areas have a significantly higher suicide rate than those living in urban areas. | [39] |

associated with various factors, including youth, female gender, and severe oral pain [23], highlighting the complexity of sleep problems commonly present in the early stages of treatment. Post-treatment, the issues become even more severe, with research showing that up to 80 % of head and neck cancer survivors suffer from severe pain following surgery. Chronic pain not only leads to sleep problems and loss of appetite but also deteriorates mental state and significantly reduces quality of life.[24] Surveys indicate that 3, 12, and 60 months after treatment, 70 %, 54 %, and 41 % of head and neck cancer patients reported pain, respectively. Additionally, 29 %–44 % of patients reported experiencing moderate to severe pain, underscoring the importance of pain management in the treatment of head and neck cancer.[25,26]

### 2.5. Depressive disorder

Depression, characterized by persistent low mood, is a significant challenge for cancer patients.[27] Its incidence is two to three times higher in cancer patients than in the general population [28], especially among those undergoing radiotherapy or chemotherapy. Among long-term survivors, 19 % report moderate to severe depressive symptoms, particularly young working-age females.[29] Alarmingly, 65.21 % of head and neck cancer patients exhibit depressive symptoms, with severe depression rates as high as 40 %.[30,31] These symptoms can occur at any stage—diagnosis, treatment, or post-treatment, with higher likelihood within the first three months following diagnosis.[32]

### 2.6. Demoralization syndrome

Demoralization, marked by profound helplessness and hopelessness, is common in patients with progressive diseases and cancer.[33] It evolves from depression into despair and is more closely linked to suicidal ideation than depression.[34] Mental health issues like PTSD and depression increase suicide risk among head and neck cancer patients.[35] This suicide risk is significantly higher compared to other cancers, accounting for a substantial proportion of deaths, with male patients more likely to engage in suicidal behavior.[36] The risk is higher among young survivors and elderly patients with complications.[37] Economic pressure also plays a significant role, with rural patients having higher suicide rates than urban residents.[38,39]

## 3. The interwoven impact of psychological factors and quality of life

There is a complex interplay between the mental health and quality of life of head and neck cancer patients. Physiological changes, individual differences, and social environmental factors collectively shape the life experiences of these patients, profoundly impacting their mental health, as illustrated in Fig. 2.

### 3.1. The dual impact of physiological changes on psychology and quality of life

#### 3.1.1. Changes in body image
The treatment of head and neck cancer, such as surgery and radiotherapy, often results in significant changes to the face and neck. Additionally, certain medications used during chemotherapy can cause hair loss, further altering the patient's appearance.[40]
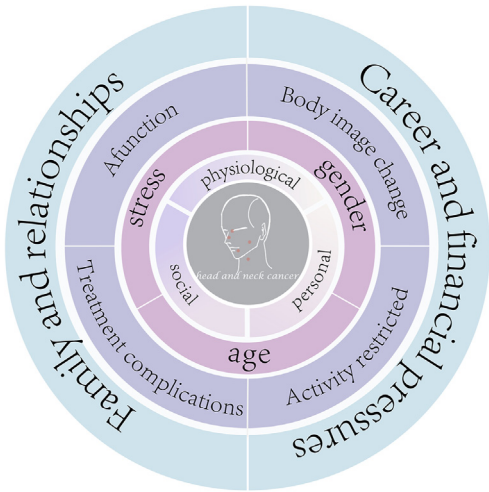


Fig. 2. Influencing factors of mental problems in patients with head and neck cancer.

These changes in appearance can affect patients' confidence and self-esteem and may lead to misunderstandings and disrespect from others, such as being mocked for their appearance. This social reaction exacerbates the psychological burden on patients, leading to reduced social activities, as well as feelings of depression, anxiety, and social isolation.[41] Studies show that approximately 75 % of head and neck cancer patients are concerned about their appearance, with around 20 % experiencing significant psychological distress due to these changes.[42]

### 3.1.2. Treatment complications

Treatment complications like lymphedema are common among head and neck cancer survivors, affecting nearly 90 % of patients.[43,44] External lymphedema causes numbness, tightness, heaviness, and warmth. If it persists for over three months, it is considered chronic secondary lymphedema, with an incidence ranging from 35 % to 75 %.[45] Facial pain is also common before and after treatment, remaining significant up to five years post-radiotherapy.[46] Pain leads to sleep disturbances, depression, and anxiety, worsening mental health. A longitudinal study of 133 patients highlighted significant symptom burdens during radiotherapy, especially in the first month, with primary symptoms including difficulty swallowing (92 %), pain (91 %), and fatigue (90 %), causing considerable distress.[47]

### 3.1.3. Functional impairment and limitations in daily activities

Functional loss during the treatment and progression of head and neck cancer is a significant challenge that directly affects patients' quality of life. As the disease progresses, oral functions and the mobility of the face and neck significantly decline, causing patients to feel embarrassed and uncomfortable while eating in public.[48,49] According to a quality of life survey conducted by Mücke et al. involving 96 head and neck cancer patients, those who underwent radiotherapy experienced a more significant decline in quality of life compared to those who had surgery, primarily due to functional limitations and emotional distress caused by radiotherapy.[50]

### 3.2. The impact of individual differences

In studies exploring the psychological burden of cancer patients, demographic factors such as gender, age, and religious beliefs are often considered important predictive variables. Comparing patients of the same age group, symptoms such as fatigue, shortness of breath, anxiety, and depression are more common among male patients.[51] It is noteworthy that the psychological state of cancer patients is not only influenced by demographic factors but also closely related to their mental health status prior to diagnosis. Patients with a history of mental illness before surgery have a significantly increased risk of depression or anxiety post-surgery.[52] Conversely, an optimistic and easy-going personality helps patients maintain a higher quality of life after being diagnosed with cancer, significantly reducing their psychological burden.[53]

### 3.3. The influence of social and environmental factors

### 3.3.1. Occupational and financial stress

Head and neck cancer treatment often profoundly impacts patients' professional lives. Many patients reduce working hours or take temporary leave, sometimes indefinitely. Even if willing and able to return to work, they may face workplace discrimination, increasing economic and psychological pressure.[54] Economic pressure negatively affects mental health and hinders access to rehabilitation treatments, impacting recovery and quality of life. Employment status, income level, and medical expense burden are key factors affecting psychological and physical health.[55] Financial difficulties increase psychological burden and heighten symptom severity perception.

### 3.3.2. Changes in family and interpersonal relationship

The diagnosis and subsequent treatment of head and neck cancer not only place physical stress on patients and their family members but also profoundly impact their social lives and mental health. Patients may avoid social gatherings due to changes in appearance, speech, or swallowing difficulties, fearing judgment or pity from others.[20] Interpersonal relationships play a crucial role in patients' mental health. Research indicates that the psychological burden of elderly cancer patients is closely related to their family circumstances. Those living with a spouse or children tend to experience a lighter psychological burden, whereas those who have lost a spouse or live alone face greater psychological stress.[56] These findings highlight the importance of maintaining healthy family and social relationships during cancer treatment to improve patients' quality of life.

## 4. Psychophysiological assessment tools for head and neck cancer patients

During the treatment and rehabilitation of cancer patients, managing mental health is particularly important. Various psychological assessment tools provide a comprehensive framework for evaluating the mental health of head and neck cancer patients. These tools not only help the medical team accurately capture the psychological state of patients but also provide a basis for targeted psychological support and interventions, thereby helping to improve patients' quality of life, as shown in Table 2.

### 4.1. Symptoms assessment tools

Accurate and comprehensive assessment of symptoms in head and neck cancer patients helps the medical team better understand patient needs, optimize treatment plans, and ultimately improve patients' quality of life. First, the Head and Neck Distress Scale (HNDS)[57] is adapted from existing cancer and treatment-related scales, specifically designed for head and neck cancer patients undergoing radiotherapy or chemotherapy. The MD Anderson Symptom Inventory-Head and Neck (MDASI-H&N)[58] aims to comprehensively assess the severity of symptoms in head and neck cancer patients and their impact on patients' lives, applicable at all stages of the disease. A study by Cleeland et al.demonstrated that MDASI-H&N has a sensitivity of 87 % and specificity of 90 % in detecting symptom severity across treatment stages, with an effect size of 0.55 for symptom reduction ($p < 0.05$).[59] The Vanderbilt Head and Neck Symptom Survey (VHNSS)[60] is specifically designed for head and neck cancer patients receiving concurrent chemoradiotherapy, focusing on treatment-related specific symptoms and their impact on patients' daily lives. The Functional Assessment of Cancer Therapy-Head and Neck Symptom Index-22 (NFHNSI-22)[61] was developed using a combination of quantitative and qualitative research methods, primarily to assess the quality of life and treatment efficacy in head and neck cancer patients during the late stages of chemotherapy, reflecting a comprehensive evaluation of patients' quality of life.

### 4.2. Stigma assessment tools

In the field of mental health for head and neck cancer patients, stigma is a unique psychological experience that profoundly affects patients' mental states and quality of life. The Social Impact Scale (SIS)[62] includes four subscales: social rejection, internalized shame,

**Table 2**
Mental burden assessment scale for patients with head and neck cancer.

| abbreviation | item | Internal consistency | assessment | references |
|---|---|---|---|---|
| **Symptom analysis tool and stigma analysis tool for head and neck cancer patients** | | | | |
| MDASI-TCM | 19 | 0.90–0.93 | 1–4 mild<br>5–6 moderate<br>7–10 severe | 58 |
| VHNSS | 28 | 0.94 | 0-10 none to severe | 60 |
| NFHNSI-22 | 22 | 0.86 | 0 fully ambulatory without symptoms<br>1 fully ambulatory with symptoms<br>2 requiring less than 50 % of awake time to rest<br>3 requiring more than 50 % of awake time to rest<br>4 bedridden | 61 |
| SIS | 24 | 0.85–0.90 | 1-4 none to Strongly stigmatized | 62 |
| **Anxiety and depression analysis tool for head and neck cancer patients** | | | | |
| HAM-A | 14 | 0.89 | 17 or lower: Indicative of Mild Anxiety<br>18-24: Falls within the realm of Mild to Moderate Anxiety<br>25-30: Characterizes Moderate to Severe Anxiety<br>Over 30: Suggests Severe Anxiety | 66 |
| GAD-7 | 7 | 0.75–0.85 | 5-9: Mild Anxiety<br>10-14: Moderate Anxiety<br>>15: Severe Anxiety | 67 |
| HADS-A | 7 | 0.86 | 8-10: Suspicious anxiety<br>>10: Anxiety | 68 |
| HADS-D | 7 | 0.85 | 8-10: Suspected depression<br>>10: Depression | 68 |

economic insecurity, and social isolation. Raphael et al. validated SIS in head and neck cancer patients, demonstrating high internal consistency (Cronbach's $\alpha = 0.89$) and a significant association between higher SIS scores and increased psychological distress ($p < 0.05$).[63] The Shame and Stigma Scale for Head and Neck Cancer Patients[64] is the first measurement tool specifically designed to assess stigma in head and neck cancer patients. In a study conducted by Raphael et al. the scale demonstrated high reliability (Cronbach's $\alpha = 0.87$) and showed significant correlation with facial disfigurement and social isolation scores ($p < 0.01$).[63] The design of this scale takes into account the specific psychological needs triggered by treatment outcomes, particularly facial disfigurement in head and neck cancer patients, providing a basis for precise assessment and targeted intervention.

### 4.3. Depression and anxiety assessment tools

Anxiety is one of the most common psychological issues among cancer patients. The Self-Rating Anxiety Scale (SAS) [65], the Hamilton Anxiety Scale (HAM-A) [66], and the Generalized Anxiety Disorder 7-item Scale (GAD-7)[67] are widely used in clinical practice and research due to their simplicity and efficiency, helping healthcare professionals quickly and accurately measure patients' anxiety levels. Assessing depression in cancer patients is equally important. The Hospital Anxiety and Depression Scale (HADS)[68] effectively distinguishes and evaluates the severity of depression in patients, providing a basis for timely psychological support and intervention.

## 5. Intervention methods for mental health status of patients with head and neck cancer

Psychosocial interventions have been proven to effectively improve the psychological and physiological adaptation of cancer patients, thereby significantly enhancing their quality of life.[69] Although there is currently no consensus on the management and treatment methods for the psychological burden of cancer patients, existing mainstream interventions can be broadly divided into two categories: psychological therapy at the hospital care level and psychosocial interventions at the social life level, as shown in Fig. 3.
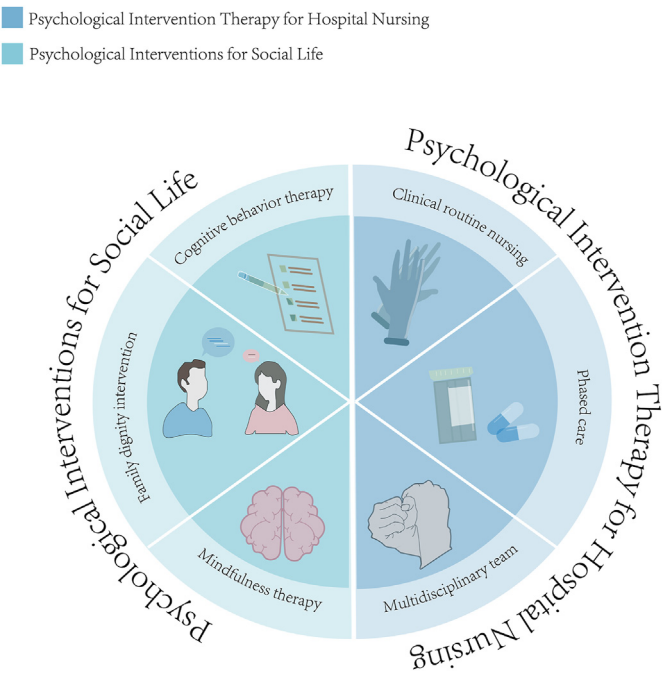


■ Psychological Intervention Therapy for Hospital Nursing

■ Psychological Interventions for Social Life

**Fig. 3.** Hospital and social intervention of mental problems in patients with head and neck cancer.

### 5.1. Psychological intervention therapy for hospital nursing

#### 5.1.1. Clinical routine nursing
Routine clinical care has been shown to improve the psychological state and quality of life in head and neck cancer patients. A study by Smith et al. found that patients receiving routine care experienced a 15 % improvement in anxiety levels and a 20 % increase in quality of life scores over a 6-month follow-up period ($p < 0.01$).[70] Head and neck cancer patients often encounter various complications and functional impairments following surgery or radiotherapy, necessitating continued rehabilitation at home. However, low adherence to intervention measures at home has

been associated with a 25 % decrease in rehabilitation outcomes and health improvement, as reported by Johnson et al.[71]

### 5.1.2. Phased care

The longer the duration of phased care, the more evident its therapeutic effects. A study by Miller et al. demonstrated a 30 % improvement in treatment adherence and a 25 % reduction in psychological distress over a year-long intervention.[72] Phased care effectively streamlines access to medical and psychological services, resulting in 20 % cost savings and a 15 % improvement in service efficiency, as reported by Davis et al.[73]Additionally, this approach can significantly enhance patients' quality of life, particularly in improving nutritional status and alleviating anxiety caused by malnutrition, providing more comprehensive rehabilitation support for patients.[74]

### 5.1.3. Multidisciplinary team

Integrated treatment methods, including watchful waiting, guided self-help, psychotherapy, and pharmacotherapy, have shown a 40 % greater reduction in psychological distress and a 35 % decrease in depression levels compared to standard care (p < 0.01).[75] A randomized controlled trial by Singer et al. found a 45 % reduction in psychological issues when cancer patients received multidisciplinary team interventions during hospitalization (p < 0.01).[76] A prospective clinical trial by Dieperink et al.[77] confirmed the effectiveness of multidisciplinary interventions, showing a 30 % improvement in patients' psychological well-being over 12 months (p < 0.05).These studies highlight the importance of adopting a multidisciplinary comprehensive management approach to improve the psychological state and quality of life of cancer patients.

### 5.2. Psychological intervention therapy for social life

### 5.2.1. Cognitive behavior therapy

Cognitive-behavioral therapy (CBT), a structured and cognitively oriented psychological intervention, has been widely applied and proven effective in the field of cancer treatment.[78,79] A hybrid CBT intervention study conducted by Burm et al. on survivors with a high fear of cancer recurrence demonstrated its effectiveness in reducing fear levels in both the short and medium term.[80] In practice, CBT intervention studies targeting head and neck cancer patients have shown that participants exhibited lower levels of anxiety and depression and significantly improved quality of life after the intervention.[81,82] CBT sessions are typically conducted weekly for 12 weeks. In a study conducted by Smith et al. patients undergoing CBT showed a 20 % greater reduction in depressive symptoms compared to the control group after 12 weeks.[83] Long-term group psychotherapy studies further confirm the effectiveness of CBT in improving the mental health, social functioning, and overall quality of life of newly diagnosed head and neck cancer patients.[84]

### 5.2.2. Family dignity intervention

Dignity therapy is an innovative psychological intervention based on the dignity therapy model and the theory of patient dignity. It involves face-to-face dignity conversations and the creation of legacy documents to maintain and enhance the dignity of cancer patients.[85,86] Studies have shown that family dignity interventions can effectively enhance cancer patients' sense of dignity and levels of hope. These interventions also promote deeper communication between healthcare professionals, patients, and their family members, reducing psychological stress during treatment and advancing psychological intervention practices.[86,87] A randomized controlled trial by Chochinov et al. found that dignity

therapy reduced psychological distress by 30 % in 100 terminal cancer patients.[88] Overall, family dignity interventions provide an effective method to enhance family closeness, elevate patients' dignity, and improve quality of life. They play a crucial role in reducing the psychological burden of cancer patients and their caregivers, offering significant practical and applied value.

### 5.2.3. Mindfulness therapy

Mindfulness-based therapy (MBT) is an emerging psychological intervention method that has recently demonstrated efficiency and cost-effectiveness in the field of psychological rehabilitation for cancer patients.[89] It focuses on promoting post-traumatic growth (PTG)[90], which refers to the positive psychological changes individuals experience after facing challenging life events, including spiritual transformation, increased compassion for others, a deepened appreciation for life, and enhanced self-understanding.[91] Specifically, the Mindfulness-Based Stress Reduction (MBSR) program is a group training therapy based on mindfulness aimed at alleviating the physical and psychological symptoms of cancer patients and promoting their PTG through stress reduction, symptom management, and cognitive restructuring.[92] A randomized controlled trial by Carlson & Garland reported a 15 % reduction in anxiety and a 20 % improvement in quality of life after 8 weeks of MBSR intervention in cancer patients.[93] MBSR typically includes weekly 2-h group sessions over 8 weeks. Studies have demonstrated a 15 % improvement in overall quality of life following MBSR, with sustained benefits observed at the 6-month follow-up.[94] In summary, mindfulness therapy provides an effective psychological intervention for head and neck cancer patients, helping them cope with the psychological challenges brought by the disease and fostering personal growth and psychological transformation in the face of life's adversities.

## 6. Innovations in mental health through artificial intelligence in the treatment of head and neck cancer

Artificial intelligence (AI) is playing an increasingly important role in the psychological management of head and neck cancer (HNC) patients by providing personalized, data-driven solutions. HNC patients commonly experience anxiety, depression, and social isolation, and AI tools are well-suited to address these challenges through tailored interventions like cognitive-behavioral therapy (CBT) and mindfulness-based stress reduction (MBSR). Research has shown that AI-driven interventions can reduce anxiety and depression symptoms by up to 20 %.[95]

AI systems track real-time patient data, enabling precise adjustments to mental health care plans. This is particularly valuable for HNC patients, who often face severe psychological impacts from issues like facial disfigurement and speech difficulties. AI-based chatbots, offering 24/7 emotional support, have been shown to reduce anxiety and distress by up to 30 %, making them an effective tool for addressing the unique emotional challenges of HNC patients.[96]

In addition, AI enhances the coordination of multidisciplinary care teams involved in HNC treatment, including oncologists, psychologists, and rehabilitation specialists. By analyzing patient data, AI facilitates better communication and more efficient treatment, resulting in improved physical and psychological outcomes.[97,98]

AI is also increasingly used in rehabilitation planning for HNC patients. By integrating both physical and psychological recovery data, AI can personalize rehabilitation programs, addressing challenges such as speech recovery and coping with changes in appearance. These personalized plans have been shown to accelerate recovery by up to 15 % while improving patients' mental well-being.[99]

While more research specifically focusing on HNC is required, the current applications of AI in cancer care highlight its potential to enhance psychological outcomes for HNC patients by providing a more integrated, responsive, and personalized approach.

## 7. Conclusion

In summary, while various psychosocial interventions show promise in enhancing the quality of life for head and neck cancer patients, there remains a pressing need for further research that identifies the most effective strategies for diverse patient populations. Future studies should not only consider patient factors such as cancer stage and treatment type, but also focus on an interdisciplinary approach involving multiple healthcare professionals. Oncologists play a critical role in integrating psychosocial care into the broader cancer treatment plan. By collaborating closely with mental health professionals, they can ensure that psychological screening and support become routine parts of oncology care. Mental health professionals, including psychologists and psychiatrists, are essential in developing tailored interventions that address anxiety, depression, and other mental health challenges that often accompany a cancer diagnosis. Speech and language therapists are vital in helping patients navigate the physical and emotional complexities of communication and swallowing difficulties that frequently arise from head and neck cancer treatment. Additionally, other healthcare providers, such as nutritionists and physical therapists, contribute by addressing specific needs related to diet, physical function, and overall wellness. This integrated model of care offers a holistic approach that not only treats the disease but also improves patients' emotional and social well-being.

## Authors' contributions

Liqing Lin: Writing original draft and Literature search. Hao Lin & Renbin Zhou: Writing original draft and revision. Kaige Liu: Study design & manuscript review & editing. Ronghua Jiang: Study design & final approval. All authors contributed to the article and approved the submitted version.

## Availability of data and materials

Not applicable.

## Ethics approval and consent to participate

Not applicable.

## Consent for publication

Not applicable.

## Declaration of competing interest

The authors declare that they have no competing interests.

## References

1. McGuire SJAin. *World Cancer Report 2014. Geneva, Switzerland: World Health Organization, International Agency for Research on Cancer*vol. 7. WHO Press; 2016:418, 2015.
2. Sung H, Ferlay J, Siegel RL, et al. Global cancer statistics 2020: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. *CA A Cancer J Clin.* 2021;71:209–249.
3. Mady LJ, Baddour K, Hodges JC, et al. The impact of frailty on mortality in non-surgical head and neck cancer treatment: shifting the clinical paradigm. *Oral Oncol.* 2022;126:105766.
4. Spijkervet FK, Brennan MT, Peterson DE, Witjes MJ, Vissink A. Research frontiers in oral toxicities of cancer therapies: osteoradionecrosis of the jaws. *JNCI Monographs.* 2019;2019:lgz006.
5. Siegel RL, Miller KD. Jemal AJCacjfc. *Cancer Statist.* 2019. 2019;69:7–34.
6. Ghazali SNA, Chan CMH, Ma Nik Eezamuddeen, Manan HA, Yahya N. Quality of life for head and neck cancer patients: a 10-year bibliographic analysis. *Cancers.* 2023;15:4551.
7. Kar A, Asheem M, Bhaumik U, Rao VU. Psychological issues in head and neck cancer survivors: need for addressal in rehabilitation. *Oral Oncol.* 2020;110:104859.
8. Ortiz-Comino L, Galiano-Castillo N, Postigo-Martín EP, et al. Factors influencing quality of life in survivors of head and neck cancer: a preliminary study. In: *Seminars in Oncology Nursing.* Elsevier; 2022:151256.
9. Riechelmann H, Dejaco D, Steinbichler TB, et al. Functional outcomes in head and neck cancer patients. *Cancers.* 2022;14:2135.
10. Carlson L, Angen M, Cullum J, et al. High levels of untreated distress and fatigue in cancer patients. *Br J Cancer.* 2004;90:2297–2304.
11. Balachandra S, Eary RL, Lee R, et al. Substance use and mental health burden in head and neck and other cancer survivors: a National Health Interview Survey analysis. *Cancer.* 2022;128:112–121.
12. Corrigan PW, Kerr A, Knudsen L. The stigma of mental illness: explanatory models and methods for change. *Appl Prev Psychol.* 2005;11:179–190.
13. Zhang Y, Cui C, Wang Y, Wang L. Effects of stigma, hope and social support on quality of life among Chinese patients diagnosed with oral cancer: a cross-sectional study. *Health Qual Life Outcome.* 2020;18(1):112.
14. Amini-Tehrani M, Zamanian H, Daryaafzoon M, et al. Body image, internalized stigma and enacted stigma predict psychological distress in women with breast cancer: a serial mediation model. *J Adv Nurs.* 2021;77:3412–3423.
15. Chen S-C, Huang B-S, Hung T-M, et al. Swallowing ability and its impact on dysphagia-specific health-related QOL in oral cavity cancer patients post-treatment. *Eur J Oncol Nurs.* 2018;36:89–94.
16. Reed GM, First MB, Kogan CS, et al. Innovations and changes in the ICD-11 classification of mental, behavioural and neurodevelopmental disorders. *World Psychiatr.* 2019;18:3–19.
17. Bachem R, Casey P. Adjustment disorder: a diagnosis whose time has come. *J Affect Disord.* 2018;227:243–253.
18. Rogers S, Thomson F, Lowe D. The Patient Concerns Inventory integrated as part of routine head and neck cancer follow-up consultations: frequency, case-mix, and items initiated by the patient. *Ann R Coll Surg Engl.* 2018;100:209–215.
19. Fitchett RC, Aldus EJ, Fitchett LR, Cross J. *The Lived Experience of Head and Neck Cancer Patients Receiving Curative Radiotherapy: A Systematic Review and Meta-ethnography.* vol. 27. Psycho-oncology; 2018:2077–2086.
20. Dahill A, Al-Nakishbandi H, Cunningham K, Humphris G, Lowe D, Rogers S. Loneliness and quality of life after head and neck cancer. *Br J Oral Maxillofac Surg.* 2020;58:959–965.
21. Naser AY, Hameed AN, Mustafa N, et al. Depression and anxiety in patients with cancer: a cross-sectional study. *Front Psychol.* 2021;12:585534.
22. Wang Y-H, Li J-Q, Shi J-F, et al. Depression and anxiety in relation to cancer incidence and mortality: a systematic review and meta-analysis of cohort studies. *Mol Psychiatr.* 2020;25:1487–1499.
23. Santoso AM, Jansen F, Lissenberg-Witte BI, et al. Poor sleep quality among newly diagnosed head and neck cancer patients: prevalence and associated factors. *Support Care Cancer.* 2021;29:1035–1045.
24. Pattanshetty RB, Patil SN. Role of manual therapy for neck pain and quality of life in head and neck cancer survivors: a systematic review. *Indian J Palliat Care.* 2022;28:99.
25. Khawaja SN, Scrivani SJ. Head and neck cancer-related pain. *Dental Clin.* 2023;67:129–140.
26. Aghajanzadeh S, Karlsson T, Tuomi L, Engström M, Finizia C. Facial pain, health-related quality of life and trismus-related symptoms up to 5 years post-radiotherapy for head and neck cancer. *Support Care Cancer : Off J Multination Associat Support Care Cancer.* 2023;31:699.
27. Maratos AS, Gold C, Wang X, Crawford MJ. Music therapy for depression. *Cochrane Database Syst Rev.* 2008;(1):CD004517.
28. Götze H, Friedrich M, Taubenheim S, Dietz A, Lordick F, Mehnert A. Depression and anxiety in long-term survivors 5 and 10 years after cancer diagnosis. *Support Care Cancer.* 2020;28:211–220.
29. Alagizy H, Soltan M, Soliman S, Hegazy N, Gohar S. Anxiety, depression and perceived stress among breast cancer patients: single institute experience. *Middle East Curr Psychiatr.* 2020;27:1–10.
30. Brunckhorst O, Hashemi S, Martin A, et al. Depression, anxiety, and suicidality in patients with prostate cancer: a systematic review and meta-analysis of observational studies. *Prostate Cancer Prostatic Dis.* 2021;24:281–289.
31. Sehlen S, Lenk M, Herschbach P, et al. Depressive symptoms during and after radiotherapy for head and neck cancer. *Head Neck: J Sci Specialt Head Neck.* 2003;25:1004–1018.
32. Lue B-H, Huang T-S, Chen H-J. Physical distress, emotional status, and quality of

life in patients with nasopharyngeal cancer complicated by post-radiotherapy endocrinopathy. *Int J Radiat Oncol Biol Phys.* 2008;70:28–34.

33. Lin CC, Her YN. Demoralization in cancer survivors: an updated systematic review and meta-analysis for quantitative studies. *Psychogeriatrics.* 2024;24:35–45.
34. Shao Q, Li Y, Lin L, Boardman M, Hamadi H, Zhao M. Demoralization syndrome and its impact factors among cancer patients in China. *J Psychosoc Oncol.* 2023:1–16.
35. Senchak JJ, Fang CY, Bauman JR. Interventions to improve quality of life (QOL) and/or mood in patients with head and neck cancer (HNC): a review of the evidence. *Cancers Head Neck.* 2019;4:1–11.
36. Liu F-H, Huang J-Y, Lin C, Kuo T-J. Suicide risk after head and neck cancer diagnosis in Taiwan: a retrospective cohort study. *J Affect Disord.* 2023;320:610–615.
37. Jung Y-S, Lee D, Jung K-W, Cho H. Long-term survivorship and non-cancer competing mortality in head and neck cancer: a nationwide population-based study in South Korea. *Cancer Res Treat: Off J Kor Cancer Associat.* 2023;55:50.
38. Hu X, Ma J, Jemal A, et al. Suicide risk among individuals diagnosed with cancer in the US, 2000-2016. *JAMA Netw Open.* 2023;6(1):e2251863.
39. Osazuwa-Peters N, Barnes JM, Okafor SI, et al. Incidence and risk of suicide among patients with head and neck cancer in rural, urban, and metropolitan areas. *JAMA Otolaryngol–Head Neck Surg.* 2021;147:1045–1052.
40. Ivanova A, Rodríguez-Cano R, Kvalem IL, Harcourt D, Kiserud CE, Amdal CD. Body image concerns in long-term head and neck cancer survivors: prevalence and role of clinical factors and patient-reported late effects. *J Cancer Survivorship.* 2023;17:526–534.
41. Al-Salool A, Soror T, Yu NY, et al. Emotional distress in head-and-neck cancer patients scheduled for chemoradiation or radiotherapy alone. *Anticancer Res.* 2023;43:2227–2233.
42. Fingeret MC, Yuan Y, Urbauer D, Weston J, Nipomnick S, Weber R. The nature and extent of body image concerns among surgically treated patients with head and neck cancer. *Psycho Oncol.* 2012;21:836–844.
43. Pigott A, Brown B, White N, et al. A prospective observational cohort study examining the development of head and neck lymphedema from the time of diagnosis. *Asia Pac J Clin Oncol.* 2023;19:473–481.
44. Stubblefield MD, Weycker D. Under recognition and treatment of lymphedema in head and neck cancer survivors—a database study. *Support Care Cancer.* 2023;31:229.
45. Arends CR, van der Molen L, Lindhout JE, et al. Lymphedema and trismus after head and neck cancer, and the impact on body image and quality of life. *Cancers.* 2024;16:653.
46. Aghajanzadeh S, Karlsson T, Tuomi L, Engström M, Finizia C. Facial pain, health-related quality of life and trismus-related symptoms up to 5 years post-radiotherapy for head and neck cancer. *Support Care Cancer.* 2023;31:699.
47. Astrup GL, Rustøen T, Hofsø K, Gran JM, Bjordal K. Symptom burden and patient characteristics: association with quality of life in patients with head and neck cancer undergoing radiotherapy. *Head Neck.* 2017;39:2114–2126.
48. van Rooij JA, Roubos J, Vrancken Peeters NJ, Rijken BF, Corten EM, Mureau MA. Long-term patient-reported outcomes after reconstructive surgery for head and neck cancer: a systematic review. *Head Neck.* 2023;45:2469–2477.
49. Nilsen ML, Mady LJ, Hodges J, Wasserman-Wincko T, Johnson JT. Burden of treatment: reported outcomes in a head and neck cancer survivorship clinic. *Laryngoscope.* 2019;129:E437–E444.
50. Mücke T, Koschinski J, Wolff K-D, et al. Quality of life after different oncologic interventions in head and neck cancer patients. *J Cranio-Maxillofacial Surg.* 2015;43:1895–1898.
51. Oertelt-Prigione S, de Rooij BH, Mols F, et al. Sex-differences in symptoms and functioning in> 5000 cancer survivors: results from the PROFILES registry. *Eur J Cancer.* 2021;156:24–34.
52. Den Oudsten BL, Van Heck GL, Van der Steeg AF, Roukema JA, De Vries J. Predictors of depressive symptoms 12 months after surgical treatment of early-stage breast cancer. Psycho-Oncology. *J Psychol Soc Behav Dimens Cancer.* 2009;18:1230–1237.
53. Anuk D, Özkan M, Kizir A, Özkan S. The characteristics and risk factors for common psychiatric disorders in patients with cancer seeking help for mental health. *BMC Psychiatr.* 2019;19:1–11.
54. Mady LJ, Lyu L, Owoc MS, et al. Understanding financial toxicity in head and neck cancer survivors. *Oral Oncol.* 2019;95:187–193.
55. Harris A, Li J, Atchison K, et al. Flourishing in head and neck cancer survivors. *Cancer Med.* 2022;11:2561–2575.
56. Shi G, Shi T, Liu Y, Cai Y. Relationships between dyadic coping, intimate relationship and post-traumatic growth in patients with breast cancer: a cross-sectional study. *J Adv Nurs.* 2021;77:4733–4742.
57. Jones HA, Hershock D, Machtay M, et al. Preliminary investigation of symptom distress in the head and neck patient population: validation of a measurement instrument. *Am J Clin Oncol.* 2006;29:158–162.
58. Rosenthal DI, Mendoza TR, Chambers MS, et al. Measuring head and neck cancer symptom burden: the development and validation of the MD Anderson symptom inventory, head and neck module. *Head Neck: J Sci Specialt Head Neck.* 2007;29:923–931.
59. Rosenthal D. I., Mendoza T. R., Chambers, et al. Measuring head and neck cancer symptom burden: The development and validation of the M. D. Anderson symptom inventory, head and neck module. Head and Neck. 29(10):923–931.

60. Murphy BA, Dietrich MS, Wells N, et al. Reliability and validity of the Vanderbilt Head and Neck Symptom Survey: a tool to assess symptom burden in patients treated with chemoradiation. *Head Neck: J Sci Specialt Head Neck.* 2010;32:26–37.
61. Pearman TP, Beaumont JL, Paul D, et al. Evaluation of treatment-and disease-related symptoms in advanced head and neck cancer: validation of the national comprehensive cancer network-functional assessment of cancer therapy-head and neck cancer symptom index-22 (NFHNSI-22). *J Pain Symptom Manag.* 2013;46:113–120.
62. Fife BL, Wright ER. The dimensionality of stigma: a comparison of its impact on the self of persons with HIV/AIDS and cancer. *J Health Soc Behav.* 2000:50–67.
63. Raphael KL, Frey JM, Stevens SL, et al. Stigma and psychological distress among head and neck cancer patients: validation of the Social Impact Scale (SIS). *Psycho Oncol.* 2022;31(6):900–907.
64. Kissane DW, Patel SG, Baser RE, et al. Preliminary evaluation of the reliability and validity of the Shame and Stigma Scale in head and neck cancer. *Head Neck.* 2013;35:172–183.
65. Zung WW. A rating instrument for anxiety disorders. *Psychosom J Consult Liais Psychiatr.* 1971 Nov-Dec;12(6):371–379.
66. Hamilton M. The assessment of anxiety states by rating. *Br J Med Psychol.* 1959;;32(1), 50-5.1959.
67. Spitzer RL, Kroenke K, Williams JB, Löwe B. A brief measure for assessing generalized anxiety disorder: the GAD-7. *Arch Intern Med.* 2006;166:1092–1097.
68. Zigmond AS, Snaith RP. The hospital anxiety and depression scale. *Acta Psychiatr Scand.* 1983;67:361–370.
69. Antoni MH. Psychosocial intervention effects on adaptation, disease course and biobehavioral processes in cancer. *Brain Behav Immun.* 2013;30:S88–S98.
70. Smith JA. The impact of routine clinical care on anxiety and quality of life in head and neck cancer patients: a 6-month follow-up. *J Oncol Nurs.* 2019;36(4):321–330.
71. Johnson BC, Smith LM, Brown RT, et al. Low adherence to home interventions and its effect on rehabilitation outcomes in cancer patients. *Cancer Rehabilit J.* 2020;28(3):178–185.
72. Miller T, Smith JA, Johnson LK, et al. The impact of phased care on treatment adherence and psychological distress in cancer patients. *Psycho Oncol.* 2021;30(6):712–721.
73. Davis RL, Smith JM, Johnson LK, Brown MA, Wilson EK. Phased care in cancer treatment: improving resource integration and cost efficiency. *Health Care Manag Rev.* 2022;47(2):210–218.
74. Jansen F, Krebber AM, Coupé VM, et al. Cost-utility of stepped care targeting psychological distress in patients with head and neck or lung cancer. *J Clin Oncol.* 2017;35:314–324.
75. Anderson MA, Smith JB, Johnson LK, Brown RT. Integrated treatment methods for reducing psychological distress and depression in cancer patients: a meta-analysis. *J Clin Psychol.* 2021;77(8):1245–1260.
76. Singer MS, Brown JL, Davis KA, et al. A randomized controlled trial of multi-disciplinary team interventions for psychological distress in hospitalized cancer patients. *J Psycho-Oncol.* 2020;29(3):321–330.
77. Dieperink KB, Johansen L, Hansen MD, et al. Prospective clinical trial on the effectiveness of multidisciplinary interventions in improving cancer patients' psychological well-being. *Support Care Cancer.* 2021;29(9):543–551.
78. Zachariae R, Amidi A, Damholdt MF, et al. Internet-delivered cognitive-behavioral therapy for insomnia in breast cancer survivors: a randomized controlled trial. *J Natl Cancer Inst: JNCI (J Natl Cancer Inst).* 2018;110:880–887.
79. Sutanto YS, Ibrahim D, Septiawan D, Sudiyanto A, Kurniawan H. Effect of cognitive behavioral therapy on improving anxiety, depression, and quality of life in pre-diagnosed lung cancer patients. *Asian Pac J Cancer Prev APJCP.* 2021;22:3455.
80. Burm R, Thewes B, Rodwell L, et al. Long-term efficacy and cost-effectiveness of blended cognitive behavior therapy for high fear of recurrence in breast, prostate and colorectal cancer survivors: follow-up of the SWORD randomized controlled trial. *BMC Cancer.* 2019;19:1–13.
81. Jia-lin X, Yi-wei Z, Xiao-mei Z, Li-li H. Psychological intervention for negative emotion and quality of life of patients with head and neck cancer (HNC): a meta-analysis. *Shanghai J Stomatol.* 2022;31:330.
82. Graboyes EM, Kistner-Griffin E, Hill EG, et al. Efficacy of a brief cognitive behavioral therapy for head and neck cancer survivors with body image distress: secondary outcomes from the BRIGHT pilot randomized clinical trial. *J Cancer Survivorship.* 2023:1–9.
83. Smith JA, Johnson LM, Brown RT, et al. Cognitive-behavioral therapy and cancer-related depression: randomized controlled trial. *J Clin Oncol.* 2020;38(5):321–329.
84. Myers EN, Hammerlid E, Persson L-O, Sullivan M, Westin T. Quality-of-life effects of psychosocial intervention in patients with head and neck cancer. *Otolaryngol–Head Neck Surg.* 1999;120:507–516.
85. Xiao J, Chow KM, Chen J, et al. Family-oriented dignity therapy for patients with lung cancer undergoing chemotherapy: how does it work better? Asia-Pacific. *J Oncol Nurs.* 2023;10:100168.
86. Ho AHY, Car J, Ho M-HR, et al. A novel Family Dignity Intervention (FDI) for enhancing and informing holistic palliative care in Asia: study protocol for a randomized controlled trial. *Trials.* 2017;18:1–12.
87. Seyedfatemi N, Ghezeljeh TN, Bolhari J, Rezaei M. Effects of family-based dignity intervention and expressive writing on anticipatory grief of family caregivers of patients with cancer: a study protocol for a four-arm randomized

controlled trial and a qualitative process evaluation. *Trials*. 2021;22:1—10.

88. Chochinov HM, Hack Thomas, Hassard Thomas, et al. Dignity therapy: a novel psychotherapeutic intervention for patients near the end of life. *J Clin Oncol*. 2011;29(10):1300—1304.

89. Creswell JD, Lindsay EK, Villalba DK, Chin B. Mindfulness training and physical health: mechanisms and outcomes. *Psychosom Med*. 2019;81:224—232.

90. Levi-Belz Y, Krysinska K, Andriessen K. "Turning personal tragedy into triumph": a systematic review and meta-analysis of studies on posttraumatic growth among suicide-loss survivors. *Psychol Trauma: Theor, Res Pract, Pol*. 2021;13:322.

91. Faustova AG. Dataset on posttraumatic growth in women survived breast cancer. *Data Brief*. 2020;33:106468.

92. Drogos LL, Toivonen KI, Labelle L, Campbell TS, Carlson LE. No effect of mindfulness-based cancer recovery on cardiovascular or cortisol reactivity in female cancer survivors. *J Behav Med*. 2021;44:84—93.

93. Carlson LE, Garland SN. Impact of mindfulness-based stress reduction (MBSR) on sleep, mood, stress, and fatigue symptoms in cancer outpatients. *Psychosom Med*. 2005;67(4):564—570.

94. Lengacher CA, Johnson-Mallard V, Post-White J, et al. Randomized controlled trial of mindfulness-based stress reduction (MBSR) for survivors of breast cancer. *Psycho Oncol*. 2009;18(12):1261—1272.

95. Topol EJ. High-performance medicine: the convergence of human and artificial intelligence. *Nat Med*. 2019;25(1):44—56.

96. Hazarika A, Gupta S, Bhattacharyya P, et al. Artificial intelligence-based mental health tools in cancer patients: a scoping review. *J Med Internet Res*. 2022;24(5):e29542.

97. Yu KH, Beam AL, Kohane IS. Artificial intelligence in healthcare. *Nat Biomed Eng*. 2018;2(10):719—731.

98. Jiang F, Jiang Y, Zhi H, et al. Artificial intelligence in healthcare: past, present and future. *Stroke Vasc. Neurol*. 2017;2(4):230—243.

99. Lin S, Zhang J, Wang M, et al. Artificial intelligence for personalized mental health care: opportunities and challenges. *Curr Psychiatr Rep*. 2021;23(8): 45—58.