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FACTORS ASSOCIATED WITH FATIGUE IN PATIENTS UNDERGOING RADIOTHERAPY: A LITERATURE REVIEW

Gian Dwi Putra*, Nelwati, Dally Rahman
Faculty of Nursing, Universitas Andalas, Limau Manis, Pauh, Padang, Sumatera Barat 25163,Indonesia
*nelwati@nrs.unand.ac.id

ABSTRACT

Fatigue is one of the most common and disturbing symptoms among cancer patients, affecting almost all individuals undergoing radiotherapy, which lasts for a long time and interferes with the quality of life in performing daily activities. There has been a lot of research on the causative factors of fatigue in cancer patients undergoing radiotherapy. However, there is still a lack of literature review that looks at what are the factors that cause fatigue in cancer patients in general who undergo radiotherapy. This study aims to review existing literature to screen for factors contributing to fatigue in breast cancer patients undergoing radiotherapy. This study is a systematic review using The Joanna Briggs Institute Guideline and Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA). Of the 220 articles found in PubMed, ScienceDirect, and JSTOR databases (years 2017-2022), 77 articles met the full-text access criteria. After rigorous selection, 7 articles were selected for analysis. These articles were reviewed using a quantitative analysis approach to identify demographic, clinical, treatment, and psychosocial factors associated with fatigue in cancer patients undergoing radiotherapy. The results showed that there are several factors that cause fatigue in cancer patients undergoing radiotherapy including demographic factors (age, occupation, education level), clinical factors (hemoglobin level, comorbidities, cancer stage), treatment factors (number of fractions, fraction dose), and psychosocial factors (insomnia, anxiety, and depression). Management of fatigue in cancer patients undergoing radiotherapy requires a comprehensive approach that considers demographic, clinical, treatment, and psychosocial factors that influence the patient's condition. Thus, effective interventions should include all these factors to improve patients' quality of life.

Keywords: cancer; factors; fatigue; radiotherapy

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INTRODUCTION

Much progress has been made in cancer treatment to improve survival rates and reduce incidence. Effective treatments speed up the healing process. Radiotherapy, which uses radiation to inhibit and kill cancer cells, is a prominent method (Mukherjee, 2020). Usually lasting for 3 to 4 weeks, radiotherapy induces a variety of bodily responses, with side effects depending on the individual patient's reaction. Fatigue emerges as a common and distressing symptom, affecting more than 80% of patients undergoing radiotherapy (Forster et al., 2020). Cancer-related fatigue manifests as a subjectively bothersome sensation, encompassing physical, emotional, and cognitive components, or fatigue arising from cancer treatment, not just activity-related fatigue, that impedes daily functioning (National Comprehensive Cancer Network, 2018). Throughout radiotherapy, fatigue in patients evolves as a complex and multifaceted phenomenon, affecting most patients from the beginning to the end of radiotherapy (Wang et al., 2013). Despite its prevalence, radiotherapy-induced fatigue often goes unnoticed by healthcare professionals due to underreporting. Only about 50% of cancer patients disclose fatigue-related problems. However, this condition can persist and have a major negative impact without proper intervention (Aapro et al., 2017). As a result, quality of life may decrease, interfering with daily activities (Todt et al., 2022 ; Aapro et al., 2017). This

study attempts to review the existing literature to screen for factors contributing to fatigue in breast cancer patients undergoing radiotherapy.

According by Berger et al., (2015) Fatigue is one of the most common and debilitating side effects experienced by patients undergoing radiation therapy. It is estimated that up to 80% of cancer patients receiving radiotherapy experience fatigue at varying levels. Radiotherapy-related fatigue (RRF) not only affects the physical abilities of patients but also has a significant impact on emotional and social aspects, potentially reducing the overall quality of life. Despite the widely recognized prevalence of radiotherapy-induced fatigue, the underlying mechanisms are not fully understood, and effective interventions remain limited**.** Several factors are believed to contribute to fatigue in radiotherapy patients, including clinical aspects such as the dose and duration of therapy, as well as the location of radiation applied to the body. Additionally, psychosocial factors like depression, anxiety, and social support play a role in influencing the level of fatigue experienced by patients. Recent research also highlights the importance of physical activity, nutrition, and the status of inflammation and immune systems as key determinants in affecting fatigue levels in cancer patients(Bower & Bak, 2020).

Managing radiotherapy-related fatigue remains a clinical challenge, particularly since fatigue can persist for months after treatment ends. Therefore, a deeper understanding of the factors associated with fatigue in patients undergoing radiotherapy is crucial to developing more effective interventions. This study aims to identify these factors and provide insights that can support the comprehensive care of radiotherapy patients(Mustian et al., 2017). This study aims to understand and analyze the factors associated with fatigue in patients undergoing radiotherapy, in order to support the development of effective interventions to reduce fatigue and improve patients' quality of life.

METHOD

This study used the *Systematic Literature Review (SLR)* method by following the guidelines of *The Joanna Briggs Institute Guideline* as the main reference. Article assessment was conducted using the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) 2015 checklist to ensure that the literature review process was systematic and transparent. Articles for this review were retrieved from various online databases, namely PubMed, ScienceDirect, and JSTOR. The search was conducted using the keywords: *Factors Associated AND Fatigue AND Breast Cancer AND Radiotherapy*. The selected articles had to meet the following inclusion criteria: the main topic of the article related to factors affecting fatigue in cancer patients undergoing radiotherapy, research methods included *cross-sectional*, *prospective study*, *cohort study*, or *observational study*, English language articles, published in the period 2017-2022, and had full text access. Exclusion criteria included studies that were only *literature reviews* or other *systematic reviews*. The initial search yielded 104 articles relevant to the specified keywords. After a rigorous selection and screening process based on the inclusion criteria, seven articles were selected for further analysis. The selected articles included studies from international journals that addressed fatigue factors in cancer patients undergoing radiotherapy with samples from different regions such as Europe, the United States, Iran and Korea. In the analysis process, each selected article was extracted based on study characteristics, such as research design, sample size, data collection methods, measurement tools used, and relevant main results. These extractions were organized into tables for easy pattern identification and comparison between articles. This analysis aimed to develop evidence-based conclusions regarding the demographic,

clinical, treatment and psychosocial factors that contribute to fatigue in cancer patients during radiotherapy.

RESULT

After the researcher conducted a search through publications in three databases and using predetermined keywords, the researcher obtained 104 articles that matched the keywords. The results of the study articles can be depicted in the PRISMA. Based on the analysis of seven articles that will be reviewed by researchers. The journal consists of six international articles published by; Journal of Integrative cancer therapy, Journal of Clinical Medicine, Journal of The American Society For Radiation Oncology, Indian Journal of Palliative Care, Journal of Enviroment Research and Public Health. The six articles that the researchers reviewed, in general, all articles have the same research objectives, namely to determine the causes of fatigue in cancer patients undergoing radiotherapy. The place where the research was conducted varied, namely Europe, Iran, the United States, India, New York. This proves that there is a lack of knowledge about the real causes of fatigue that occur among patients undergoing radiotherapy in various countries and is a problem for cancer patients undergoing radiotherapy. All research articles reviewed used cross-sectional studies. The studies were conducted on cancer patients in general, prostate cancer, breast cancer etc. The research instrument used is using a questionnaire that has been processed by researchers and adopted from previous studies that have been tested for validity. Then researchers also use secondary data obtained from medical records at the hospital.

Some studies also use interviews to complete the data. Most researchers used the chi-square test, logistic regression test to analyze the results of the study so as to obtain three factors causing fatigue, namely demographic factors, clinical factors and treatment factors. From the results of the article search, the researcher describes in a flat or tabular structure and is organized by publication with the format of the researcher's name, year of publication, research title, research objectives, methods and research results to classify important information in the article for more details the researcher explains using the table below:

Table 1.
Extraction of Related Articles

Title and Author	Methods	Outcome
Fatigue During Cancer-Related Radiotherapy and Associations with Activities, Work Ability and Quality of Life: Paying Attention to Subgroups more Likely to Experience Fatigue Year: 2022 Author : Kristina Todt, Maria Engstrom, Magnus Ekstrom, Anna Efverman Place: Europe	This study used the cross-sectional study method 450 cancer patients undergoing radiotherapy; 1. Breast cancer 171(38%) 2. Prostate cancer 145 (32%) 3. Head and brain cancer 57(13%) 4. Colon, rectal and gynecologic cancers 43 (10%) 5. Lymphoma and supporting tissue cancers 19(4%) 6. Lung cancer 15 (3%)	The results of this study showed that 72% of the total 448 subjects experienced fatigue. the presence of anxiety and depression is a psychological factor that affects fatigue. However, patients who experienced fatigue were more likely to have comorbidities and depressive symptoms. Furthermore, occupation was also shown to affect the level of fatigue during radiation therapy.
Cancer Related Fatigue in Breast Cancer Survivors: in Correlation to Demographic Factors Year: 2017 Author : Fatemeh Moghaddam, Saeedeh Place :Iran	This study used the cross-sectional study method 150 breast cancer patients without comorbidities	The results from this study showed that among the demographic factors age (0.30, p=0.006), respondents' mean age 47.9 (SD=11.4) and employment status (0.35, p=0.009) correlated with the physical aspects, while marital status (-4.0, p=0.001) and education level (-0.59, p=0.005) correlated with the

Title and Author	Methods	Outcome
		affective and cognitive aspects of the fatigue score.
Factors associated with fatigue in breast cancer patients undergoing external beam radiation therapy Year: 2020 Author : Michael J. LaRiviere, Hann-Hsiang Chao, Abigail Doucette, Timothy P. Kegelman, Neil K. Taunk, Gary M. Freedman, Neha Vapiwala Place: America	This study used the cohort study method 1286 breast cancer patients (2010-2017)	The results showed that fatigue tended to be higher in younger patients (<60 years old). Cancer stage showed a significant association with increased fatigue, where early stages of the disease tended to have lower levels of fatigue. Then, dose per fraction and fraction size were significantly associated with increased fatigue. Multivariable analysis showed that only smaller fraction sizes, such as conventionally fractionated radiation, were significantly associated with higher levels of fatigue during treatment.
Factors Associated with Fatigue in Prostate Cancer (PC) Patients Undergoing External Beam Radiation Therapy (EBRT) Year : 2018 Author : Hann-Hsiang Chao, Abigail Doucette, David M. Raizen, Neha Vapiwala Place : AS	This study used the cohort study method 681 prostate cancer patients	The results showed that age <60 years was significantly associated with fatigue level (p=0.006). And there is a significant relationship of depressive symptoms with fatigue level (p=0.001)
Fatigue in Breast Cancer Patients on Adjuvant Treatment: Course and Prevalence Year: 2017 Author: Kazi Sazzad Manir Place: India	This study used observational study method 110 breast cancer patients	The results showed that homoglobin level was a significant factor causing fatigue, the lower the Hb level, the lower the FACT-G and FACIT-F scores (Pearson correlation coefficient 0.2957) (p<0.005). The frequency of patient-reported fatigue increased during the course of radiotherapy, peaking in the last week of treatment and affecting three-quarters of patients. In addition, fraction amount of 40 Gy or more was a significant predictor of increased fatigue during radiotherapy, whereas breast volume receiving 5 Gy was not a significant predictor of increased fatigue during radiotherapy
Factors Affecting the Severity of Fatigue during Radiotherapy for Prostate Cancer; an Exploratory Study Year: 2020 Author: Velda gonzalez mercado Place: Newyork	This study used a cross-sectional study method 26 prostate cancer respondents	The results showed that insomnia was significantly associated with fatigue (p=0.001). And depressive symptoms were strongly correlated with fatigue (p=0.001). The linear combination of sleep disturbance and depressive symptoms was significantly associated with fatigue.
Impact of Psycho-Social Factors on Fatigue among Breast Cancer Patients Who Are Currently Undergoing Radiotherapy Year: 2020 Autor: Hyesun Park and Kisoon Kim Place: Korea	This study used a cross-sectional study method 210 breast cancer respondents	The results showed that symptom assessment, anxiety and depression had a direct effect on fatigue of breast cancer patients receiving radiotherapy, while social support had an indirect effect on fatigue of breast cancer patients receiving radiotherapy.

DISCUSSION

The results of the study describe the factors that cause fatigue in cancer patients who are undergoing radiotherapy Data presentation was carried out in four ways, namely: 1) Article characteristics, 2) Factors causing fatigue in cancer patients undergoing radiotherapy.

Article Characteristics

One study was published in 2022, three studies in 2020, one study in 2018 and two studies in 2017. The studies were conducted in various locations, namely in Europe, Iran, America, India, New York, USA, and Korea. All research articles used a cross-sectional study method. The research results from the review of seven articles, one article used a general cancer sample, four articles with breast cancer samples and two articles using prostate cancer samples. The study with the largest sample was 1,286 with a study duration of 7 years while the smallest sample was 110. Of the seven articles, researchers saw 4 factors that correlated with fatigue in cancer patients undergoing radiotherapy, two articles found demographic factors (age, occupation, education level), three articles found clinical factors (hemoglobin level, comorbidities, cancer stage), two articles found treatment factors (number of fractions, fraction dose) and four articles found psychosocial factors (insomnia, anxiety, depression).

Factors causing fatigue in cancer patients undergoing radiotherapy

Fatigue is a complex and variable phenomenon in cancer patients undergoing radiotherapy. In a study conducted by Lariviere et al., (2020) dan Park & Kim, (2020) revealed that fatigue is influenced by a range of factors involving demographic factors, clinical factors, treatment factors and psychosocial factors.

Demographic factors

Age is one of the main determinants affecting fatigue in cancer patients undergoing radiotherapy. With age comes a decrease in the body's physiological capacity to cope with stressors such as radiotherapy, resulting in more significant fatigue compared to younger patients Siegel et al., (2012). In elderly patients, changes in hormonal levels, including decreases in thyroid hormones, sex hormones, and adrenocortical hormones, impact their metabolism and energy levels (Hidayati & Arifah, 2020). This causes the regeneration of normal healthy cells after irradiation to be slower, worsening the symptoms of fatigue. Hsiao et al, (2016) showed that younger patients (<60 years old) tend to experience higher fatigue during radiotherapy. Stronger immune and inflammatory responses in young patients and high levels of physical and psychological activity at that age may be factors that exacerbate their fatigue. In contrast, in older patients, naturally lower physical activity and better adaptation to the disease condition and treatment may make fatigue more likely to be felt in the physical rather than psychological aspects.

Sleep quality in elderly patients also plays a role in exacerbating fatigue. Sleep disorders are common in older cancer patients, which directly affects their ability to recover energy during treatment. Maqbali et al, (2022). In addition, comorbidities that are more common in elderly patients, such as heart disease, diabetes or hypertension, may exacerbate fatigue, as radiotherapy itself may worsen existing comorbid clinical conditions. Employment status also significantly affected fatigue levels in cancer patients undergoing radiotherapy. Patients who remained employed during treatment were reported to experience higher fatigue compared to patients who were not employed (Todt et al., 2022a). This is especially true in patients who are in physically or mentally demanding jobs, where the stress of heavy work, combined with the side effects of radiotherapy, can exacerbate fatigue symptoms. Study by Moghaddam tabrizi & Alizadeh, (2017) showed that occupation has a significant correlation with physical

fatigue. Patients who continue to work during treatment often report greater physical fatigue, especially those who work in fields that demand physical or mental activity.

The combination of work pressure and body-straining treatment results in more severe fatigue. In contrast, patients who do not work or take time off during treatment tend to have more time for rest and recovery, so their fatigue levels tend to be lower. Working patients also face challenges in balancing the demands of work with the recovery process. This adds to the burden of stress that increases the production of the hormone cortisol, which can cause a greater inflammatory response in the body and worsen the condition of fatigue (Poirier, 2006). Therefore, it is important for health workers to consider interventions that not only focus on clinical aspects, but also consider the patient's social and occupational circumstances. Education level plays an important role in influencing patients' understanding of treatment and how they deal with fatigue. Patients with higher levels of education tend to have better knowledge of radiotherapy side effects and fatigue management strategies (Grusdat et al (2022). This better level of understanding allows them to more effectively implement the necessary measures to reduce fatigue, such as optimal rest time management, maintaining a healthy diet, and maintaining a balance between physical activity and rest. In addition, higher education often correlates with better access to medical resources and health information. This allows patients with higher education to be more proactive in seeking medical help and accessing supportive therapies, such as psychological counseling or relaxation therapy, which can help reduce cancer-related fatigue (Todt et al., 2022). They are also more likely to understand the importance of effective communication with health professionals, which can help them receive more targeted and personalized care.

In contrast, patients with lower levels of education tend to have limited understanding of their treatment and symptoms. This may affect their ability to cope with fatigue independently, thus prolonging the duration or exacerbating the level of fatigue they feel (Moghaddam tabrizi & Alizadeh, 2017). Research also shows that patients with lower education are more likely to experience psychological problems, such as anxiety or depression, which contribute to physical and mental fatigue. Limited access to medical information and support can also exacerbate their condition, as they may not be aware of services that can help manage fatigue symptoms.

Clinical Factors

Hemoglobin Level

Low hemoglobin (Hb) levels are a significant factor contributing to fatigue in cancer patients undergoing radiotherapy. According to research Manir et al., (2017) there is a direct correlation between decreased Hb levels and increased fatigue symptoms. Optimal hemoglobin levels are essential in the transport of oxygen throughout the body; lack of oxygen can impair organ function and reduce a patient's physical capacity. The effects of radiation on bone marrow can impair the cells' ability to produce red blood cells. This process may occur because radiation disrupts the DNA of hematopoietic cells in the bone marrow, which are responsible for the production of blood cells (Kumar et al., 2019). In addition, radiotherapy can cause damage to normal tissues that also require oxygen, worsening anemia and reducing the patient's resistance to fatigue.

Lower hemoglobin levels are often associated with tissue hypoxia, where a lack of oxygen to the tissues can increase lactic acid accumulation. This accumulation is a result of increased anaerobic metabolism, which in turn increases the fatigue experienced by the patient (Barros et al., 2022). Decreased hemoglobin levels also impact patients' physical and mental abilities,

with studies showing that patients with low Hb levels tend to report higher levels of fatigue and significantly reduced quality of life. In addition, there is an important role for the management of hemoglobin levels in cancer patients, including the use of blood transfusions and erythropoietin therapy, which can help increase Hb levels and reduce symptoms of fatigue. These efforts are important to improve patients' quality of life and facilitate better recovery during and after the treatment period.

Comorbid

Comorbidities are another factor that affects the fatigue levels of cancer patients receiving radiotherapy. The presence of other medical conditions, such as heart disease, diabetes mellitus and lung disease, can worsen the symptoms of fatigue experienced by patients. According to Rossi et al., (2021) comorbidities add to the physiological burden that the body has to deal with, which can lead to increased systemic inflammation and oxidative stress. For example, patients with heart disease may have impaired circulation that impedes adequate oxygen distribution to body tissues, reducing energy efficiency and increasing fatigue. This is due to the interaction between the side effects of radiotherapy and pre-existing cardiac conditions, which adds to the complexity of fatigue management.

In addition, diabetes mellitus can affect energy metabolism, where patients suffering from diabetes often have uncontrolled blood glucose levels, which can exacerbate fatigue symptoms (Rossi et al., 2021). Patients with these comorbidities may also be more susceptible to infections and other complications that can disrupt the healing process and increase fatigue. Therefore, concurrent management of comorbidities with cancer therapy is essential to reduce fatigue levels. A multidisciplinary approach involving the medical team to manage these conditions can help patients achieve better outcomes in terms of quality of life and post-therapy recovery. Therapies or interventions directed at the management of comorbid conditions should be considered to improve the patient's resistance to fatigue.

Cancer Stage

The stage of cancer plays an important role in determining the level of fatigue experienced by patients. Research by Bower., (2014) showed that patients at higher stages of cancer often experience more severe fatigue compared to patients at earlier stages. This is due to the more aggressive growth of cancer cells, which triggers a significant inflammatory response in the body. As the cancer spreads to other tissues and organs, the body has to deal with greater metabolic demands, resulting in more intense fatigue. The rapid proliferation of cancer cells can increase energy requirements, which are out of proportion to the body's capacity to produce energy, especially in the context of side effects from radiotherapy (Ardhiansyah, 2021).

Metabolic stress brought on by the interaction between growing cancer cells, activation of the immune system, and the side effects of radiotherapy contribute to ongoing fatigue, affecting patients' energy levels and overall quality of life. Management of fatigue in patients with advanced cancer may also include management of other symptoms that may be present, such as pain, sleep problems, and psychological symptoms, all of which can contribute to the experience of fatigue. Therefore, a comprehensive approach is needed to address all aspects related to fatigue, especially in patients with higher stages of cancer, so that they can achieve optimal recovery and improve their quality of life (Ardhiansyah, 2021; Rossi et al., 2021).

Treatment Factors

The number of fractions in radiotherapy refers to the total radiotherapy sessions given to the patient during the entire treatment process. Each radiotherapy session, or fraction, is designed to destroy cancer cells while allowing time for normal cells to recover. However, the scheduling and number of fractions can affect the level of fatigue a patient experiences. The time interval between radiotherapy sessions is critical for the recovery of healthy tissue exposed to radiation. If radiotherapy sessions are scheduled too close together without allowing enough time for normal cells to recover, cumulative damage to healthy cells may occur (Goldhirsch et al., 2017). Jamora et al., (2022) suggests that increasing the frequency and number of fractions may result in the accumulation of damage to normal cells which, in turn, contributes to the increased fatigue felt by patients. In the same study, patients who received high-frequency radiotherapy experienced significantly more fatigue than those who had longer breaks between sessions. One study indicated that fatigue was more prevalent among patients who received more fractions over a shorter period of time, suggesting that increasing the number of fractions without careful planning may result in decreased quality of life due to prolonged fatigue. The optimal number of fractions needs to be considered in the treatment plan to minimize side effects, including fatigue (*Mayo Foundation for Medical Education and Research, 2023)*.

The dose fraction is the amount of radiation given in each radiotherapy session. This dose is very important as it can have a direct effect on the extent to which cancer cells can be destroyed as well as the extent to which normal cells can be preserved. Higher doses of radiation are often associated with an increased risk of fatigue. Ardhiansyah, (2021) noted that high doses of radiation not only damage cancer cells but can also cause damage to normal cells. When normal cells are damaged, the body responds by triggering inflammatory processes and immune reactions, which contribute to greater fatigue. High fraction doses can cause changes in healthy tissues, ultimately affecting the patient's energy levels (Rizkiyah et al., 2023). Inflammatory processes that occur due to high fraction doses can lead to the accumulation of inflammatory metabolites that contribute to fatigue. Hsiao et al., (2016) showed that damage to normal cells due to high radiation doses can result in changes to the body's metabolism, which makes patients feel more tired. This study emphasizes the importance of adjusting radiation doses so as not to compromise patient well-being. Therefore, adjusting the dose and number of fractions in radiotherapy treatment is key to minimizing fatigue. A good strategy involves delivering a dose that is sufficient to effectively kill cancer cells, but not so high that it causes significant damage to healthy tissue. This requires close collaboration between doctors, nurses and the rest of the medical team to monitor the patient's reaction to the therapy and make necessary adjustments (Prastiwi et al., 2023).

Psychosocial Factors

Psychological factors significantly influence fatigue in patients undergoing radiotherapy, as evidenced by various studies. Key psychological elements such as anxiety, depression, and insomnia have been shown to positively correlate with fatigue levels. For example, in breast cancer patients, anxiety and depression were associated with higher fatigue scores (r=.35)(Hwang & Kwon, 2024). Similarly, patients with hepatocellular carcinoma reported that psychological symptoms were linked to increased fatigue (Chen et al., 2024). Furthermore, a study on cancer patients revealed that those with a depressed mood were 2.57 times more likely to experience fatigue (Tödt et al., 2022). Additionally, nutritional status and physical activity also play a crucial role, with higher nutritional risk correlating with increased fatigue Overall, addressing these psychological factors is essential for effectively managing

fatigue in radiotherapy patients(Hwang & Kwon, 2024). Insomnia in cancer patients undergoing radiotherapy is one of the factors contributing to increased fatigue. Insomnia is defined as persistent difficulty falling asleep, both in initiating sleep and maintaining sleep, which ultimately leads to a decrease in overall sleep quality (Tarrasch et al., 2018). Insomnia affects the body's ability to repair radiation-damaged tissues and restore energy, resulting in decreased endurance and prolonged fatigue.

According to research (Palagni et al., 2021), Insomnia has a strong correlation with fatigue in prostate cancer patients undergoing radiotherapy. Patients with sleep disorders tend to report higher levels of fatigue, and are at greater risk of developing psychological complications such as anxiety and depression. Management of insomnia in cancer patients is important to reduce fatigue. Pharmacological interventions with sleep medications, cognitive-behavioral therapy for insomnia (CBT-I), and relaxation techniques can help improve patients' sleep quality, thereby reducing their fatigue levels. Anxiety is a common psychological problem in cancer patients, especially those undergoing radiotherapy. It can be caused by fear of the side effects of therapy, anxiety about the outcome of treatment, or even the radiotherapy procedure itself (Nikoloudi et al., 2020). Anxiety can result in an increase in cortisol in the body, which then triggers an inflammatory response that exacerbates symptoms of fatigue. Anxiety can also affect a patient's sleep patterns, which in turn exacerbates physical and mental fatigue (Chaydhury & Jain, 2019).

Research by Todt et al., (2022) mentioned that patients who experience anxiety during radiotherapy are more prone to severe fatigue than patients who do not experience anxiety. Anxiety symptoms such as insomnia, sweating and difficulty concentrating often trigger a decrease in the patient's overall quality of life. Therefore, interventions that focus on anxiety management such as psychological counseling, social support, and relaxation therapy can help reduce fatigue in cancer patients undergoing radiotherapy (Heredia-Ciuro et al., 2022). Depression is one of the most significant psychosocial factors in influencing fatigue in cancer patients undergoing radiotherapy. According to Nikoloudi et al., (2020) the prevalence of depression in cancer patients can increase to more than 50% after radiotherapy treatment is completed. Depression causes a significant decrease in motivation, interest and energy, thus exacerbating the symptoms of fatigue experienced by patients.

Depressed patients tend to feel hopeless and lack the drive to participate in self-care or treatment, ultimately worsening their physical and mental conditions. Depression can also affect immune function, leading to higher inflammation and decreased tolerance to radiation therapy (Heredia-Ciuro et al., 2022). According to research Perti et al., (2022), patients with depression are reported to have significantly higher levels of fatigue than those without depression. Therefore, management of depression in cancer patients is crucial to reduce fatigue and improve their quality of life. Pharmacological approaches with antidepressants, as well as psychological therapies such as cognitive behavioral therapy, can be effective intervention options in managing depressive symptoms in cancer patients.

CONCLUSION

The management of fatigue in cancer patients undergoing radiotherapy requires a comprehensive approach that considers the demographic, clinical, treatment and psychosocial factors that influence the patient's condition. Effective interventions must therefore encompass all of these factors to improve patients' quality of life. With a deep understanding of the factors that contribute to the incidence of burnout in cancer patients undergoing

radiotherapy, nurses can provide more effective and targeted care. Importantly, this may improve patients' quality of life and enhance efforts to meet future cancer challenges..

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