Northumbria Research Link

Citation: Al Maqbali, Mohammed, Al Sinani, Mohammed, Gleason, Alexander and Alsayed, Ahmad (2022) Prevalence of Sleep Disturbance in Patients with Cancer: A Systematic Review and Meta-Analysis. Clinical Nursing Research, 31 (6). pp. 1107-1123. ISSN 1054-7738

Published by: SAGE

URL: https://doi.org/10.1177/10547738221092146 <https://doi.org/10.1177/10547738221092146>

This version was downloaded from Northumbria Research Link: https://nrl.northumbria.ac.uk/id/eprint/48733/

Northumbria University has developed Northumbria Research Link (NRL) to enable users to access the University's research output. Copyright © and moral rights for items on NRL are retained by the individual author(s) and/or other copyright owners. Single copies of full items can be reproduced, displayed or performed, and given to third parties in any format or medium for personal research or study, educational, or not-for-profit purposes without prior permission or charge, provided the authors, title and full bibliographic details are given, as well as a hyperlink and/or URL to the original metadata page. The content must not be changed in any way. Full items must not be sold commercially in any format or medium without formal permission of the copyright holder. The full policy is available online: http://nrl.northumbria.ac.uk/policies.html

This document may differ from the final, published version of the research and has been made available online in accordance with publisher policies. To read and/or cite from the published version of the research, please visit the publisher's website (a subscription may be required.)





Prevalence of Sleep Disturbance in Patients with Cancer: A Systematic Review and Meta-Analysis

Authors

No	Author	Credentials	Titles	Author affiliations
1	Mohammed Al Maqbali	RN, Dip. Admin., BSc (Hons), MSc, PhD, AFHEA	Research Fellow	Department of Nursing Midwifery and Health, Northumbria University, Newcastle-Upon- Tyne, UK
2	Mohammed Al Sinani	RD, B.Sc (Hons), M.Sc	PhD Student	¹ Reproductive and Developmental Biology Department of Surgery and Cancer, Faculty of Medicine, Imperial College London, London, W12 0NN, UK. ² Ministry of Health - Oman
3	Ahmad Alsayed	PhD, MSc, PharmD	Assistant Professor	Department of Clinical Pharmacy and Therapeutics Faculty of Pharmacy Applied Science Private University, Jorden
5	Alexander M Gleason	RN, Ph.D.	Head of Nursing	Fatima College of Health Sciences PO Box 3798, Mafraq, Abu Dhabi, UAE

Running Title: Sleep Disturbance cancer Meta-Analysis

Disclosures and Acknowledgement:

I certify that there is no actual or potential conflict of interest in relation to this article.

Authors Contributorship

Al Maqbali, Al Sinani, completed the data collection, statistical support and provided analysis. All authors contributed to the conceptualization and design and the manuscript preparation.

Corresponding Author:

Mohammed Al Maqbali, Department of Nursing Midwifery and Health, Northumbria University, Newcastle-Upon-Tyne, UK Tel: +447491432599 E-mail: <u>mohammed.maqbali@northumbria.ac.uk; mhamedan@hotmail.com</u>

Abstract:

Sleep disturbance is one of the most common and troubling symptoms that harm the quality of life throughout all phases of treatment and stages of the illness among patients with cancer. The aim of this meta-analysis is to examine the present status of sleep disturbance prevalence in patients with cancer. The following databases were searched: PubMed, CINAHL, MEDLINE, EMBASE, PsycINFO, from inception to April 2021. Prevalence rates were pooled with meta-analysis using a random-effects model. A total of one hundred and sixty studies (N=46,279) published between 1998 and 2021 met the inclusion criteria. The overall prevalence of sleep disturbance was 60.7% (26,448/46,279 participants, 95% CI 58.1% to 63.3%) with significant heterogeneity between studies (p< 0.000, $\tau 2 = 0.0000$, I2 = 96.4%). This meta-analysis highlights the importance of developing optimal monitoring strategies to reduce sleep disturbance and improve the quality of life of cancer patients.

Key Words: Prevalence; Sleep Disturbance; Insomnia; Cancer; Meta-Analysis

Introduction:

A diagnosis of cancer is a significant life stressor that can affect the physiological, psychological, and physical state of the individuals. One of the most common and distressing symptoms is sleep disturbance, which negatively affects the quality of life among patients diagnosed with cancer. The World Health Organization estimates there were 19.3 million cases of new cancers diagnosed and almost 10 million deaths in 2020; moreover, the number of new cancers diagnoses worldwide is expected to rise in the next two decades by about 47% (Sung et al., 2021).

There are potential difficulties in defining sleep disturbance or disorder, as sleep quality is a multidimensional concept. Buysse (2014) defines sleep health as 'a multidimensional pattern of sleep-wakefulness, adapted to individual, social, and environmental demands, that promotes physical and mental well-being. Specifically, sleep disturbance may include difficulty falling asleep, problems with the initiation and maintenance of sleep, poor sleep timing, quality, efficiency, and excessive daytime sleepiness (Berger, Matthews, & Aloia, 2018; Otte et al., 2016).

Evidence of sleep disturbance in cancer patients can have a negative impact on health-related quality of life, which includes physical and psychological functioning (Oxana G. Palesh et al., 2010; Rolke, Bakke, & Gallefoss, 2010). Sleep disturbance has also been linked with the likelihood of cancer recurring (Sigurdardottir et al., 2013) and may result in poor healing (Otte et al., 2015), decreased cognitive functioning (Schagen et al., 2014), and reduced work activity (Die Trill, 2013).

Although the prevalence of sleep disturbance has been extensively studied in patients diagnosed with cancer, healthcare professionals often underestimate the importance of such symptoms (Laugsand et al., 2010). There is a lack of information related to the prevalence of sleep disturbance and its effect on patients in terms of whether or not it has a negative impact on their quality of life (M. Al Maqbali et al., 2020; Fox et al., 2020) and is associated with high levels of disability (Lourenço et al., 2021). This review will be useful for providing precise estimates of the prevalence of sleep disturbance and identifying the potential risk factors that may affect reported prevalence rates. In addition, it will provide

evidence-based recommendations for sleep disturbance in terms of ensuring increased awareness, better control and treatment, and better nursing management for sleep disturbance.

Two previous systematic reviews and meta-analyses have been published to determine the prevalence of sleep disturbance among different type of patients with cancer (Leysen et al., 2019; Santoso et al., 2019). Whilst these reviews are very helpful, they focused on a single type of cancer, mainly head and neck (Santoso et al., 2019) and breast cancer (Leysen et al., 2019). Therefore, different types of patients were not included. Although the risk of bias was assessed coarsely as a part of previous systematic reviews and meta-analyses, none of the reviews has attempted to examine the publication bias of the included studies. Hence, the current meta-analysis was designed and conducted to estimate the raw and weighted prevalence rates of sleep disturbances among cancer patients, taking into account the effect of a single moderator and the simultaneous interactions of several moderators, on the prevalence of sleep disturbance. Knowledge of the prevalence of sleep disturbance among cancer patients is extremely important in the assessment, treatment and management of patients, staff education, and further assessments required for the healthcare system.

This meta-analysis is significant for several reasons. First, a precise, reliable, and valid estimate of just how prevalent sleep disturbance is among cancer patients can support the need for more emphasis on sleep in degree and continuing education programs, as well as provide strong evidence for implementing general policies and procedures that promote sleep in cancer care settings. Second, identifying the factors affecting sleep disturbance through subgroup analyses, provides a solid foundation for further research that could help to inform intervention for patient assessment, treatment, and the management of sleep disturbance.

Methods:

This systematic review and meta-analysis was undertaken according to the PRISMA standards (Page et al., 2021).

Search Strategy:

A systematic literature search, between October 1976 and 10th April 2021, was conducted using the following databases: PubMed, CINHAL, MEDLINE, EMBASE, PsycINFO, Cochrane Library. Search terms used both free text words and medical subject headings, i.e. MeSH terms, to search papers in the review; i.e. (MH " Sleep* ") OR (MH " Insomnia") OR (MH "sleep disturbances") OR (MH "sleep disorder") OR (MH "Narcolepsy") OR (MH " Sleep Apnea*") OR (MH " Circadian Rhythm") OR (MH " Sleep Wake Transition Disorders") OR (MH "Sleep Apnea, Obstructive") OR (" sleep disordered breathing ") AND (MH "Neoplasms+") OR "neoplasm*" OR "tumour*" OR "tumor*" OR "cancer*" OR "Hodgkin*" OR "haematolog*" OR "radiat*" OR "radioth*" OR "chemo*" OR (MH "Hormone Therapy+") OR "bone marrow transplant*" AND (MH "Epidemiology+") OR (MH "Epidemiological Research+") OR (MH "Surveys+") OR (MH "Prospective Studies+") OR (MH "Cross Sectional+") OR (MH "Longitudinal+"). In addition, reference lists were screened of the retrieved studies and reviewer articles to identify any further studies.

Study Selection:

Two investigators (M M; S M) performed the search, scrutinizing all titles and abstracts for eligibility against the inclusion and exclusion criteria. Any disagreements were resolved by discussion with a third investigator (BK). Studies were included in the review according to the following inclusion criteria: (1) reported prevalence of sleep disturbance; (2) diagnosed with any type of cancer; (3) subjects were aged 18 or older; (4) cross-sectional or cohort survey (only the baseline data were extracted); (5) sample size more than 50 to avoid selection bias from small studies; (6) studies published in English in a peer-reviewed journal. The exclusion criteria were: (1) protocol papers and conference abstracts; (2) if sleep disturbance was assessed used single question; (3) study included non-cancer and cancer participants; (4) not published in English.

Quality Assessment:

Upon retrieval of applicable studies, the quality assessment was completed using the Newcastle-Ottawa Scale (NOS) (Well et al., 2020). This scale consists of eight items that evaluate the non-randomized studies, which covered three criteria: the selection of the participants, comparability of study groups, and outcome assessment. The NOS uses a scoring system with the lowest possible score of zero and the highest possible score of nine. The total points awarded indicate the overall quality of the study. A study was determined to be of low risk of bias when the score was 7-9, of moderate risk of bias if the score was 5-6, and high risk of bias if the score was 0-4 (M. Li & Katikireddi, 2019).

Data Analyses

The mean point of sleep disturbance prevalence, odds ratios (ORs) with 95% Confidence Interval (CI) was calculated as effect size by using a random-effects model. Heterogeneity was tested using I-squared (I^2) statistics. A value of I^2 was considered to be low with 0-25%, 25-50% as moderate, and 50-75% considered to be high heterogeneity (Higgins, Thompson, Deeks, & Altman, 2003). In addition, subgroup analyses to test the significant differences in the prevalence of sleep disturbance between different groups (Age, publication year, continent, NOS, study design, type of cancer, stage of cancer, treatment status, and scale used) the analyses were performed when at least have four studies per subgroup. A sensitivity analysis was performed by removing one study at a time to evaluate the impact of pooled prevalence of remaining studies (Patsopoulos, Evangelou, & Ioannidis, 2008).

Meta-regression analyses were performed for moderating continuous variables (mean age and female percentage) (Higgins et al., 2019). Funnel plots were found to be an inaccurate method for assessing publication bias in meta-analyses of proportion studies (Hunter et al., 2014; Moreno et al., 2009). Therefore, publication bias was estimated using Egger's linear regression test and funnel plot (Egger, Smith, Schneider, & Minder, 1997). If there is a significant publication bias, the Trim and Fill method was adapted to assess the robustness of the results (Duval & Tweedie, 2000). A *p*-value of less than 0.05 was considered statistically significant. Meta-analysis was conducted using the Comprehensive Meta-

Analysis software, version 2.2 (Biostat, Englewood, N Jersey, USA). Forest plots were constructed using a Microsoft Excel spreadsheet constructed by Neyeloff et al (Neyeloff, Fuchs, & Moreira, 2012).

Results:

The database search identified 11,434 papers; these were screened by abstract and title (Figure 1 shows the PRISMA flow chart). Of these, 11,277 papers were excluded during the title and abstract screening for the following reasons: 7,098 papers did not measure sleep disturbance; 3,001 did not include patients with cancer; 716 were duplicated papers; 245 were conference, and abstract papers, and 217 were not in English. One hundred and eighty papers were excluded during full-text review. As such, 159 studies were identified as eligible for meta-analysis. However, one study (Savard, Ivers, Savard, & Morin, 2015) reported prevalence of sleep disturbance for two different types of cancer, each type of cancer was evaluated separately. For this douible reporting in one study, the interpretation of the studies included in this meta-analysis reported had 160 studies instead of 159.

General Characteristics:

One hundred and sixty studies involving 46,279 mixed cancer patients were included in this metaanalysis (males=11,574; females=34,705). All studies were published between 1998 and 2021. The vast majority (n=64 studies) included patients with breast cancer, followed by studies with mixed cancer diagnoses (n=57). Seventy-one studies reported sleep disturbance levels on mixed stages of cancer; however, 80 studies reported on patients undergoing mixed cancer treatment. Fifty-two studies reported patients completed more than three-month post-treatment. This meta-analysis included 96 crosssectional and 64 longitudinal design studies.

More than half of the studies used Pittsburgh Sleep Quality Index (PSQI) scale (n=96), followed by 31 studies that used Insomnia Severity Index (ISI). Seventy-five studies originated from the United States, twelve from Canada, eight from each Iran and China, six from Taiwan, five from Korea, four from each Australia, Greek, Italy, Japan, and Turkey, three from each Germany, and Norway, two from each Brazil, Hong Kong, Oman, and the UK, and one from each of the following: Belgium, Denmark, France, India,

Morocco, Netherland, Pakistan, Portugal, Switzerland, Taiwan, Tunis, and Vietnam (See Supplementary Table1 for a General Characteristics of Studies).

Quality Assessment:

The studies were assessed using the NOS checklist. Thirty studies were classified as having a low risk of bias and one hundred thirty as moderate. The detailed results of the quality assessment of studies included in this meta-analysis are listed in Supplementary Table 2.

Prevalence of Sleep Disturbance:

The overall pooled point estimates of prevalence for sleep disturbance varied between 15.3% (Akechi et al., 2007) and 99.8% (Mercadante et al., 2017) (Figure 2: Forest plots). All meta-analyses of prevalence of estimates of sleep disturbance reported by the 160 studies yielded a summary prevalence of 60.7% (26,448/46,279 participants, 95% CI 58.1-63.3). Sensitivity analysis by excluding one study each time demonstrated that no differences in the overall estimation by more than 1%. There was significant heterogeneity between studies when it came to estimating the prevalence in terms of sleep disturbance (p< 0.000, $\tau^2 = 0.0000$, $I^2 = 96.4\%$).

Patients with cancer who were between 40-49 years old showed the highest sleep disturbance prevalence at 67% (95% CI=65.3-76.2, I^2 =93.6), whereas the lowest sleep disturbance prevalence was reported in the 50-59 age group at 61.8% (95% CI=58.8-64.7, I^2 =94.7). The prevalence of sleep disturbance decreased from 66.1% (95% CI=46.7-81.3, I^2 =98.6) in studies published from 1998-2005 to 58.6% (95% CI=48-68.4, I^2 =94.5) in studies published in 2021. In the subgroup analyses by continent, according to where the study was conducted, the pooled prevalence was 57.9% (95% CI=45.4-69.4, I^2 =93.9), 60.5% (95% CI=56.8-64, I^2 =97), 61% (95% CI=56.5-65.4, I^2 =91.8), 62.7% (95% CI=56.2-68.7, I^2 =96.3) for Australia, North America, Europe, and Asia, respectively.

In the subgroup analyses using the NOS, the pooled prevalence in studies with moderate risk of bias 60.9% (95% CI=57.7-64.1, I²=96), whereas low risk of bias studies accounted for 60.9% (95% CI=55.9-

65.4, I^2 =97.6). Pooled prevalence of sleep disturbance was 58.7% (95% CI=55.7-61.7, I^2 =97.6) in crosssectional design studies and 63.5% (95% CI=59-67.8, I^2 =97) in longitudinal design studies.

The pooled prevalence of sleep disturbance ranged from 44.8% (95% CI=31.6-58.9, I^2 =92.6) in patients with prostate cancer to 64.4% (95% CI=59.5-69.9, I^2 =97.7) in studies that included patients with mixed type of cancer. The pooled prevalence rates with regard to sleep disturbance were 57.7% (95% CI=53.4-61.9, I^2 =96.2) in localized, and 70.8% (95% CI=61.7-78.5, I^2 =96.5) in those studies that included advanced cancer patients' stages. The treatment status had the highest prevalence of sleep disturbance in studies reporting mixed treatment status with a pooled prevalence of 63.8% (95% CI=58.1-69.2, I^2 =96.7); this was followed by studies included patient on anti-cancer treatment studies with 60.2% (95% CI=56.8-63.4, I^2 =93.9).

Regarding the scale used, the highest prevalence of sleep disturbance was found among studies that used the PSQI at 64% (95% CI=61.4-66.5, I^2 =93.1), followed by studies using the GSDS at 61.5% (95% CI=52.9-69.5, I^2 =94.6); whereas the lowest prevalence of sleep disturbance studies that used the ESS was 26.9% (95% CI=20.7-34.2, I^2 =87) (Table 1).

Meta-regression analysis was conducted to evaluate the potential heterogeneity. The results showed that the female percentage (B = -0.003, z = -2.14, p=0.032) was significantly associated with a higher prevalence of sleep disturbance; however, the mean age (B = -0.0123, z = -1.68, p=0.092) was not associated with sleep disturbance prevalence.

Publication Bias:

Funnel plots was asymmetrical (Figure:3) and Egger's regression test (intercept= 2.33, 95% CI: 0.82-3.82, z = 3.07, df= 158, p=0.001) which indicated presence of publication bias. However, further, Trim and Fill method was used, which identified 15 studies to be added (Figure 4) that did not show a significant impact on the pooled estimated prevalence of sleep disturbance.

Discussion:

Assessing the prevalence of sleep disturbance among patients with cancer is imperative for understanding the symptoms and necessary to identify the appropriate management strategy. This metaanalysis is the first to estimate the aggregate prevalence of sleep disturbance in patients with cancer. The aggregate prevalence of sleep disturbance in patients with cancer was 60.7%, which suggests that at least more than half of the cancer patients experience sleep disturbance. Those results are even higher when compared with sleep disturbance prevalence in other diseases such as cardiovascular (36.5%) (Edmealem et al., 2020), (37%) irritable bowel syndrome (Wang, Duan, & Duan, 2018), diabetes (47%) (Birhanu, Hassen Salih, & Abate, 2020) and cystic fibrosis (43%) (Mulette et al., 2021). Moreover, Simonelli et al., (2018), who conducted meta-analyses including 45 studies of low and middle-income countries from the general population, estimated the prevalence of sleep disturbance to be 32%. Another meta-analysis of 12 studies of the general population reported a prevalence of sleep disturbance. This highlights the importance of this meta-analysis to estimate the prevalence of sleep disturbance and suggests that the sleep disturbance was attributable to diseases related factors.

This meta-analysis found that the prevalence of sleep disturbance ranged from 15.3% (Akechi et al., 2007) and 99.8% (Mercadante et al., 2017) between studies. This variation of the prevalence between the studies could be attributed to the diversity of the assessment scales (cut-off of scales) or unique features of certain types of cancer and cancer treatment strategies that increase the probability of experiencing sleep disturbance. For example, as shown in table 1, the cut-off score of PSQI in (Fong & Ho, 2020) was \geq 8, whereas (Chan, Jheng, & Wang, 2020) used >5. The ISI cut off score was \geq 7 in (Schieber et al., 2019) and \geq 15 by (Mao et al., 2018). In ESS (Valko et al., 2015) used \geq 10, while (Gibbins et al., 2009) used \geq 15.

With respect to gender, the higher prevalence was reported by studies with a higher proportion of females than those with a lower proportion of female participants. Interestingly, 13 studies included in this metaanalysis show that female gender has a significant association with a high prevalence of sleep disturbance (Chung, Youn, & Choi, 2017; Echchikhi et al., 2017; Ji et al., 2017; Johansen, Cvancarova, & Ruland, 2018; Jung et al., 2016; N. Li, Otomaru, & Taniguchi, 2017; Saini et al., 2013; Santoso et al., 2021; J. Savard, Villa, Ivers, Simard, & Morin, 2009a; Schieber et al., 2019; Strollo, Fallon, Gapstur, & Smith, 2020; Sun et al., 2020; Tejada et al., 2019). In addition, a meta-analysis involved 12 studies of the general population found that females were a significantly higher prevalence of sleep disturbance than the male prevalence of sleep disturbance (Zeng et al., 2020). This may be because, first, women are less likely to receive social support (Drageset, Lindstrøm, Giske, & Underlid, 2016), second women are more likely to suffer from mental illnesses such as depression and anxiety (Zhao et al., 2020) which may increase sleep disturbance.

There was no association between mean age and overall sleep disturbance prevalence rate. Thirty-nine studies involved in this pooled analysis found a significant association between age and sleep disturbance prevalence (M. Al Maqbali et al., 2020; Bagheri-Nesami et al., 2016; Bardwell et al., 2008; Barsevick et al., 2010; Beck et al., 2010; Berger, Kupzyk, Djalilova, & Cowan, 2019; Caplette-Gingras, Savard, Savard, & Ivers, 2013; Chung et al., 2017; Colagiuri et al., 2011; Davies, Patel, Gregory, & Lee, 2017; Desai et al., 2013; Dirksen, Epstein, & Hoyt, 2009; Echchikhi et al., 2017; Fekih-Romdhane et al., 2020; Fleming et al., 2019; Grutsch et al., 2011; Halle et al., 2017; Klyushnenkova, Sorkin, & Gallicchio, 2015; N. Li et al., 2017; Liou et al., 2019; Liu et al., 2012; Mansano-Schlosser & Ceolim, 2012; Mercadante et al., 2015; Miaskowski et al., 2011; Morris et al., 2015; O. Palesh et al., 2008; Oxana G. Palesh et al., 2010; Oxana Gronskaya Palesh et al., 2007; Rogers et al., 2008; Santoso et al., 2021; J. Savard et al., 2005; Steel et al., 2018; Strollo et al., 2020; Sun et al., 2020; Taylor et al., 2012; Tejada et al., 2019; Yoshikawa et al., 2020; Zubair, Mumtaz, & Taj, 2019). This was because there are differences in sleep disturbance prevalence depending on the stage of treatment. Based on the data of 129 studies, sleep disturbance prevalence was 59.7% among those with more than three months after curative treatment completed; 60.2% during anti-cancer treatment; and 64.2% in mixed stage of treatment studies. This could be explained because there were fifteen mixed treatment studies (Chung et al., 2017; Davies et al., 2017; Echchikhi et al., 2017; Kotronoulas, Papadopoulou, Papapetrou, & Patiraki, 2011; Lin et al., 2020; Mansano-Schlosser & Ceolim, 2012; Mercadante et al., 2017, 2015, 2015; Morris et al.,

2015; Nakamura, Lipschitz, Kuhn, Kinney, & Donaldson, 2013; Phillips, Jim, Donovan, Pinder-Schenck, & Jacobsen, 2012; J. Savard, Villa, Ivers, Simard, & Morin, 2009b; M.-H. Savard, Savard, Simard, & Ivers, 2005; Tzeng, Fu, & Lin, 2012; Vargas et al., 2010) that reported on sleep disturbance in the mixed type of cancer studies, which reported to experience the greatest sleep disturbance among the cancer type in this meta-analyses. The percentage of sleep disturbance during anti-cancer treatments was expected, as sleep disturbance typically increases during radiation therapy (Van Onselen et al., 2010), chemotherapy (Yoshikawa et al., 2020), and biological therapy (Gonzalez et al., 2018). In addition, treatment introduces various toxicities to patients, which will likely increase the experience of sleep disturbance (Pillai et al., 2018; Song & Bai, 2021).

A high prevalence of sleep disturbance occurred in studies with a mixed type of cancer (64.4%), specifically gynecological (63.6%) and lung (63.3%). These results could be explained as this metaanalysis included seven gynecological types of cancer, which six of them (Clevenger et al., 2012, 2013; C.-C. Li, Tsai, Chang, & Chen, 2017; Sandadi et al., 2011; Tian, Chen, & Zhang, 2015; Yu & Nho, 2015) reported patients during anti-cancer treatments, and eight lung types of cancer of which five (Chen, Yu, & Yang, 2008; Dreher et al., 2018; Grutsch et al., 2011; Gu et al., 2018; Halle et al., 2017) reported patients during anti-cancer treatments.

Further, the result of this meta-analysis also suggests that the studies involving advanced cancer patients were highest in reporting sleep disturbance with 70.8%, followed by studies that included no evidence of disease of cancer at 67.9%. The result of these meta-analyses found differences in the prevalence of sleep disturbance according to different cancer type subgroups. A patient diagnosed with breast (59.7%) and gastrointestinal (50.6%) cancers reported the highest sleep disturbance compared with patients with gastrointestinal (50.6%) and prostate (44.8%). This may be attributable to unequal features of the sample, the side effect treatment phases, and time point of measurement (Ancoli-Israel, 2015). Unfortunately, this review was unable to assess the influences factors of sleep disturbance prevalence rate. In addition, in this review, nine scales have been employed to assess sleep disturbance in 159 studies. The Pittsburgh Sleep Quality Index (PSQI) had the highest prevalence of sleep disturbance

(64%), whereas Epworth sleepiness scale (ESS) showed the lowest prevalence of sleep disturbance at 26.9%, according to the scales used. The discrepancy may be due to the differences in studies participant characteristics.

The current review used different search terms and databases than did the previous reviews (Leysen et al., 2019; Santoso et al., 2019), and the inclusion criteria were different. In addition, this review included more studies because it used different MeSH (Medical Subject Headings) terms and databases. The review investigates the prevalence of sleep disturbance in differences type of patients with cancer, whereas the other reviews related to specific types of cancer. An important point is that this review pooled the prevalence of sleep disturbance from a very large sample (N=46,279), and participants were recruited from several countries. Consequently, generalisation of the findings is more likely to be strong.

The findings of this review have several practical and research implications. First, it would be advisable for healthcare professionals to conduct regular assessments with regard to sleep disturbance in clinical settings in order to help patients with cancer detect and overcome sleep disturbance. Second, government and healthcare providers need to identify or design appropriate guidelines to assist healthcare professionals to make appropriate decisions for cancer patients. There are several international clinical guidelines with regard to sleep disturbance, developed by different organisations, that can help improve the sleep of cancer patients (Berger, Otte, et al., 2019; National Comprehensive Cancer Network., 2021; National Institute for Health and Care Excellence, 2021; Sateia, Buysse, Krystal, Neubauer, & Heald, 2017; Schutte-Rodin, Broch, Buysse, Dorsey, & Sateia, 2008). These guidelines provide strategies for managing sleep disturbance in terms of clinical practice, such as the screening, assessment and management of sleep disturbance for healthcare professionals (Howell et al., 2014). The most common form of evidence-based treatment for sleep disturbance is cognitive behaviour therapy (Ma et al., 2021), exercise (Tang et al., 2019) and Mindfulness-based stress reduction(Suh et al., 2021). Furthermore, Choi et al., (2018) suggested the need for self-help management applications, and training healthcare professionals to detect and treat sleep disturbance for different populations.

This meta-analysis was performed with strict inclusion criteria to reduce heterogeneity. Additionally, the studies' quality was assessed using the NOS; all studies fell into medium-quality and low-quality categories. The bias mainly involved the selection and size of the sample and follow-up time. Therefore, the amount of heterogeneity between the studies in pooled prevalence and subgroup analyses was low. Besides, sensitivity analysis by excluding one study at a time and trim-and-fill method were shown the robustness of this meta-analysis.

The major strength of this meta-analysis is the large sample size of over 46,279 subjects drawn from 160 studies estimated sleep disturbance in patients with cancer. However, there are several potential limitations in this meta-analysis. First, there is a possibility that some studies were not included in this meta-analysis, although this analysis used different MeSH terms and several databases. In addition, only studies published in English were included in this analysis. Second, sleep disturbance was assessed using various scales measures; this led to variability between studies and could increase the errors of prevalence estimates. Third, there were insufficient data available on the demographic and clinical characteristics, so not all information could be eliminated thoroughly. Fourth, sleep disturbance is a very complex and multidimensional condition such as difficulty falling asleep, problems with the initiation and maintenance of sleep, poor sleep timing, quality, efficiency, and excessive daytime sleepiness (Al Maqbali, 2020; Strik et al., 2021). For this reason, this meta-analysis only reported the total scores of the questionnaires, no specific dimensions of sleep disturbance were assessed. Consequently, future systematic review and meta-analysis need to identify specific prevalence of subcategory of sleep disturbance and the associated risk factors. Finally, the funnel plot and Eggers's test may suggest existing publication bias; however, the pooled prevalence of sleep disturbance remained stable after using Trimand-fill method.

Conclusion

This is the first systematic review and meta-analysis reporting pooled prevalence estimates for sleep disturbance among patients with cancer. The findings show that over half of patients with cancer have experience of sleep disturbance, which is higher than the general population and other diseases. These results highlight the need for clear management strategies that can reduce sleep disturbance among cancer patients. Furthermore, more work should be done to reduce sleep disturbance through assessment and management of sleep status in patients with cancer.

Funding: N/A

Conflicts of interest/Competing interests: I certify that there is no actual or potential conflict of interest in relation to this article.

Availability of data and material: The corresponding author has full control of all primary data. Primary data is available on request.

Code availability: N/A

Authors' contributions: AM, SN completed the data collection, statistical support, and provided analysis and conceptualization and design and the manuscript preparation.

Ethics approval: N/A

Consent to participate: N/A

Consent for publication: N/A

Code availability: N/A

References

- Akechi, T., Okuyama, T., Akizuki, N., Shimizu, K., Inagaki, M., Fujimori, M., … Uchitomi, Y. (2007). Associated and predictive factors of sleep disturbance in advanced cancer patients. *Psycho-Oncology*, *16*(10), 888–894.
- Al Maqbali, M. A. (2020). Sleep disturbance in patients with cancer. *Journal of Integrative Nursing*, 2(4), 153. https://doi.org/10.4103/jin.jin_48_20
- Al Maqbali, M., Hughes, C., Rankin, J., Dunwoody, L., Hacker, E. D., & Gracey, J. (2020). Fatigue and Sleep Disturbance in Arabic Cancer Patients After Completion of Therapy: Prevalence, Correlates, and Association With Quality of Life. *Cancer Nursing*, *0*. https://doi.org/doi:

10.1097/NCC.00000000000825

Ancoli-Israel, S. (2015). Sleep Disturbances in Cancer: A Review. *Sleep Medicine Research*, 6(2), 45–49. https://doi.org/10.17241/smr.2015.6.2.45

Bagheri-Nesami, M., Goudarzian, A. H., Jan Babaei, G., Badiee, M., Mousavi, M., & Sadegh Sharifi,

M. (2016). Sleep Quality and Associated Risk Factors in Leukemia Patients Undergoing

Chemotherapy in Iran. *Asian Pacific Journal of Cancer Prevention: APJCP*, *17*(S3), 107–111. https://doi.org/10.7314/apjcp.2016.17.s3.107

Bardwell, W. A., Profant, J., Casden, D. R., Dimsdale, J. E., Ancoli-Israel, S., Natarajan, L., ... Pierce, J. P. (2008). The relative importance of specific risk factors for insomnia in women treated for earlystage breast cancer. *Psycho-Oncology*, *17*(1), 9–18. https://doi.org/10.1002/pon.1192

Barsevick, A., Beck, S. L., Dudley, W. N., Wong, B., Berger, A. M., Whitmer, K., ... Stewart, K. (2010). Efficacy of an intervention for fatigue and sleep disturbance during cancer chemotherapy. *Journal of Pain and Symptom Management*, *40*(2), 200–216.

https://doi.org/10.1016/j.jpainsymman.2009.12.020

Beck, S. L., Berger, A. M., Barsevick, A. M., Wong, B., Stewart, K. A., & Dudley, W. N. (2010). Sleep quality after initial chemotherapy for breast cancer. *Supportive Care in Cancer*, *18*(6), 679–689. https://doi.org/10.1007/s00520-009-0662-y

Berger, A. M., Kupzyk, K. A., Djalilova, D. M., & Cowan, K. H. (2019). Breast Cancer Collaborative Registry Informs Understanding Of Factors Predicting Sleep Quality. *Supportive Care in Cancer*, 27(4), 1365–1373. https://doi.org/10.1007/s00520-018-4417-5

Berger, A. M., Matthews, E. E., & Aloia, M. S. (2018). Sleep and Cancer. In I. Olver (Ed.), *The MASCC Textbook of Cancer Supportive Care and Survivorship* (pp. 53–65). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-319-90990-5_4

Berger, A. M., Otte, J. L., Dean, G., Erickson, J., Matthews, E. E., Page, M., & Vena, C. (2019). *Sleep-Wake Disturbances*. Retrieved from https://www.ons.org/pep/sleep-wake-disturbances?display=pepnavigator&sort by=created&items_per_page=50

Birhanu, T. T., Hassen Salih, M., & Abate, H. K. (2020). Sleep Quality and Associated Factors Among Diabetes Mellitus Patients in a Follow-Up Clinic at the University of Gondar Comprehensive Specialized Hospital in Gondar, Northwest Ethiopia: A Cross-Sectional Study. *Diabetes, Metabolic Syndrome and Obesity: Targets and Therapy*, *13*, 4859–4868. https://doi.org/10.2147/DMSO.S285080 Buysse, D. J. (2014). Sleep Health: Can We Define It? Does It Matter? *Sleep*, *37*(1), 9–17. https://doi.org/10.5665/sleep.3298

Caplette-Gingras, A., Savard, J., Savard, M.-H., & Ivers, H. (2013). Is insomnia associated with cognitive impairments in breast cancer patients? *Behavioral Sleep Medicine*, *11*(4), 239–257. https://doi.org/10.1080/15402002.2012.672940

Chan, Y.-N., Jheng, Y.-W., & Wang, Y.-J. (2020). Chemotherapy-Induced Peripheral Neurotoxicity as A Risk Factor for Poor Sleep Quality in Breast Cancer Survivors Treated with Docetaxel. *Asia-Pacific Journal of Oncology Nursing*, 8(1), 68–73. https://doi.org/10.4103/apjon.apjon_51_20

Chen, M.-L., Yu, C.-T., & Yang, C.-H. (2008). Sleep disturbances and quality of life in lung cancer patients undergoing chemotherapy. *Lung Cancer*, *62*(3), 391–400.

https://doi.org/10.1016/j.lungcan.2008.03.016

Choi, Y. K., Demiris, G., Lin, S.-Y., Iribarren, S. J., Landis, C. A., Thompson, H. J., ... Ward, T. M. (2018). Smartphone Applications to Support Sleep Self-Management: Review and Evaluation. *Journal of Clinical Sleep Medicine*, *14*(10), 1783–1790. https://doi.org/10.5664/jcsm.7396

Chung, S., Youn, S., & Choi, B. (2017). Assessment of Cancer-Related Dysfunctional Beliefs about Sleep for Evaluating Sleep Disturbance in Cancer Patients. *Sleep Medicine Research*, 8(2), 98–101. https://doi.org/10.17241/smr.2017.00073

Clevenger, L., Schrepf, A., Christensen, D., DeGeest, K., Bender, D., Ahmed, A., ... Lutgendorf, S. K. (2012). Sleep disturbance, cytokines, and fatigue in women with ovarian cancer. *Brain, Behavior, and Immunity*, *26*(7), 1037–1044. https://doi.org/10.1016/j.bbi.2012.04.003

Clevenger, L., Schrepf, A., Degeest, K., Bender, D., Goodheart, M., Ahmed, A., ... Lutgendorf, S. K. (2013). Sleep disturbance, distress, and quality of life in ovarian cancer patients during the first year after diagnosis. *Cancer*, *119*(17), 3234–3241. https://doi.org/10.1002/cncr.28188

Colagiuri, B., Christensen, S., Jensen, A. B., Price, M. A., Butow, P. N., & Zachariae, R. (2011).

Prevalence and Predictors of Sleep Difficulty in a National Cohort of Women With Primary Breast

Cancer Three to Four Months Postsurgery. *Journal of Pain and Symptom Management*, 42(5), 710–720. https://doi.org/10.1016/j.jpainsymman.2011.02.012

Davies, A. N., Patel, S. D., Gregory, A., & Lee, B. (2017). Observational study of sleep disturbances in advanced cancer. *BMJ Supportive & Palliative Care*, *7*(4), 435–440. https://doi.org/10.1136/bmjspcare-2017-001363 Desai, K., Mao, J. J., Su, I., Demichele, A., Li, Q., Xie, S. X., & Gehrman, P. R. (2013). Prevalence and risk factors for insomnia among breast cancer patients on aromatase inhibitors. *Support Care Cancer*, *21*(1), 43–51. https://doi.org/10.1007/s00520-012-1490-z

Die Trill, M. (2013). Anxiety and sleep disorders in cancer patients. *European Journal of Cancer Supplements*, *11*(2), 216–224. https://doi.org/10.1016/j.ejcsup.2013.07.009

Dirksen, S. R., Epstein, D. R., & Hoyt, M. A. (2009). Insomnia, depression, and distress among outpatients with prostate cancer. *Applied Nursing Research: ANR*, 22(3), 154–158.

https://doi.org/10.1016/j.apnr.2007.09.001

Drageset, S., Lindstrøm, T. C., Giske, T., & Underlid, K. (2016). Women's experiences of social support during the first year following primary breast cancer surgery. *Scandinavian Journal of Caring Sciences*, *30*(2), 340–348. https://doi.org/10.1111/scs.12250

Dreher, M., Krüger, S., Schulze-Olden, S., Keszei, A., Storre, J. H., Woehrle, H., ... Müller, T. (2018). Sleep-disordered breathing in patients with newly diagnosed lung cancer. *BMC Pulmonary Medicine*, *18*(1), 72. https://doi.org/10.1186/s12890-018-0645-1

Duval, S., & Tweedie, R. (2000). Trim and fill: A simple funnel-plot-based method of testing and adjusting for publication bias in meta-analysis. *Biometrics*, *56*(2), 455–463.

https://doi.org/10.1111/j.0006-341x.2000.00455.x

Echchikhi, Y., El-Abbassi, S., Touil, A., Kacemi, H., El-Majjaoui, S., Kebdani, T., & Benjafaar, N. (2017). Sleep disorders and sleep quality in Moroccan adult patients with cancer during treatment. *Journal of Cancer Science and Therapy*, *9*, 637–643.

Edmealem, A., Degu, S. G., Haile, D., Gedfew, M., Bewket, B., & Andualem, A. (2020). Sleep Quality and Associated Factors among Diabetes, Hypertension, and Heart Failure Patients at Debre Markos Referral Hospital, Northwest Ethiopia. *Sleep Disorders*, *2020*, e6125845. https://doi.org/10.1155/2020/6125845

Egger, M., Smith, G. D., Schneider, M., & Minder, C. (1997). Bias in meta-analysis detected by a simple, graphical test. *British Medical Journal*, *315*(7109), 629–634.

https://doi.org/10.1136/bmj.315.7109.629

Fekih-Romdhane, F., Achouri, L., Hakiri, A., Jaidane, O., Rahal, K., & Cheour, M. (2020).

Hopelessness is associated with poor sleep quality after breast cancer surgery among Tunisian women.

Current Problems in Cancer, 44(1), 100504. https://doi.org/10.1016/j.currproblcancer.2019.100504

Fleming, L., Randell, K., Stewart, E., Espie, C. A., Morrison, D. S., Lawless, C., & Paul, J. (2019).

Insomnia in breast cancer: A prospective observational study. *Sleep*, 42(3).

https://doi.org/10.1093/sleep/zsy245

Fong, T. C. T., & Ho, R. T. H. (2020). Mindfulness facets predict quality of life and sleep disturbance via physical and emotional distresses in Chinese cancer patients: A moderated mediation analysis. *Psycho-Oncology*, *29*(5), 894–901. https://doi.org/10.1002/pon.5363

Fox, R. S., Ancoli-Israel, S., Roesch, S. C., Merz, E. L., Mills, S. D., Wells, K. J., ... Malcarne, V. L. (2020). Sleep disturbance and cancer-related fatigue symptom cluster in breast cancer patients undergoing chemotherapy. *Supportive Care in Cancer*, *28*(2), 845–855.

https://doi.org/10.1007/s00520-019-04834-w

Gibbins, J., McCoubrie, R., Kendrick, A. H., Senior-Smith, G., Davies, A. N., & Hanks, G. W. (2009). Sleep-wake disturbances in patients with advanced cancer and their family carers. *Journal of Pain and Symptom Management*, *38*(6), 860–870. https://doi.org/10.1016/j.jpainsymman.2009.04.025

Gonzalez, B. D., Small, B. J., Cases, M. G., Williams, N. L., Fishman, M. N., Jacobsen, P. B., & Jim, H. S. L. (2018). Sleep disturbance in men receiving androgen deprivation therapy for prostate cancer:

The role of hot flashes and nocturia. *Cancer*, 124(3), 499–506. https://doi.org/10.1002/cncr.31024

Grutsch, J. F., Wood, P. A., Du-Quiton, J., Reynolds, J. L., Lis, C. G., Levin, R. D., ... Hrushesky, W. J. (2011). Validation of actigraphy to assess circadian organization and sleep quality in patients with advanced lung cancer. *Journal of Circadian Rhythms*, *9*, 4. https://doi.org/10.1186/1740-3391-9-4 Gu, F., Li, X.-F., Xu, J.-F., Gao, G.-H., Wu, Y.-F., & Zhou, C.-C. (2018). Effect of nicotine dependence on quality of life and sleep quality in patients with lung cancer who continue to smoke

after diagnosis. Journal of Thoracic Disease, 10(5), 2583–2589.

https://doi.org/10.21037/jtd.2018.05.12

Halle, I. H., Westgaard, T. K., Wahba, A., Oksholm, T., Rustøen, T., & Gjeilo, K. H. (2017).
Trajectory of sleep disturbances in patients undergoing lung cancer surgery: A prospective study. *Interactive CardioVascular and Thoracic Surgery*, 25(2), 285–291.

https://doi.org/10.1093/icvts/ivx076

Higgins, J. P. T., Thompson, S. G., Deeks, J. J., & Altman, D. G. (2003). Measuring inconsistency in meta-analyses. *British Medical Journal*, *327*(7414), 557–560.

https://doi.org/10.1136/bmj.327.7414.557

Higgins, J. P., Thomas, J., Chandel, J., Cumpston, M., Li, T., Page, M., & Welch, V. (Eds.). (2019). *Cochrane Handbook for Systematic Reviews of Interventions* (2nd ed.). Chichester (UK): John Wiley & Sons.

Howell, D., Oliver, T. K., Keller-Olaman, S., Davidson, J. R., Garland, S., Samuels, C., ... Taylor, C. (2014). Sleep disturbance in adults with cancer: A systematic review of evidence for best practices in assessment and management for clinical practice. *Annals of Oncology*, *25*(4), 791–800. https://doi.org/10.1093/annonc/mdt506 Hunter, J. P., Saratzis, A., Sutton, A. J., Boucher, R. H., Sayers, R. D., & Bown, M. J. (2014). In metaanalyses of proportion studies, funnel plots were found to be an inaccurate method of assessing publication bias. *Journal of Clinical Epidemiology*, *67*(8), 897–903. https://doi.org/10.1016/j.jclinepi.2014.03.003

Ji, Y.-B., Bo, C.-L., Xue, X.-J., Weng, E.-M., Gao, G.-C., Dai, B.-B., ... Xu, C.-P. (2017). Association of Inflammatory Cytokines With the Symptom Cluster of Pain, Fatigue, Depression, and Sleep Disturbance in Chinese Patients With Cancer. *Journal of Pain and Symptom Management*, *54*(6), 843–852. https://doi.org/10.1016/j.jpainsymman.2017.05.003

Johansen, S., Cvancarova, M., & Ruland, C. (2018). The Effect of Cancer Patients' and Their Family Caregivers' Physical and Emotional Symptoms on Caregiver Burden. *Cancer Nursing*, *41*(2), 91–99. https://doi.org/10.1097/NCC.00000000000493

Jung, D., Lee, K.-M., Kim, W.-H., Lee, J.-Y., Kim, T.-Y., Im, S.-A., ... Hahm, B.-J. (2016).

Longitudinal Association of Poor Sleep Quality With Chemotherapy-Induced Nausea and Vomiting in Patients With Breast Cancer. *Psychosomatic Medicine*, 78(8), 959.

https://doi.org/10.1097/PSY.000000000000372

Klyushnenkova, E. N., Sorkin, J. D., & Gallicchio, L. (2015). Association of obesity and sleep problems among breast cancer survivors: Results from a registry-based survey study. *Supportive Care in Cancer*, *23*(12), 3437–3445. https://doi.org/10.1007/s00520-015-2692-y

Kotronoulas, G. C., Papadopoulou, C. N., Papapetrou, A., & Patiraki, E. (2011). Psychometric evaluation and feasibility of the Greek Pittsburgh Sleep Quality Index (GR-PSQI) in patients with cancer receiving chemotherapy. *Supportive Care in Cancer*, *19*(11), 1831–1840. https://doi.org/10.1007/s00520-010-1025-4

Laugsand, E. A., Sprangers, M. A., Bjordal, K., Skorpen, F., Kaasa, S., & Klepstad, P. (2010). Health care providers underestimate symptom intensities of cancer patients: A multicenter European study. *Health and Quality of Life Outcomes*, *8*, 104. https://doi.org/10.1186/1477-7525-8-104

Leysen, L., Lahousse, A., Nijs, J., Adriaenssens, N., Mairesse, O., Ivakhnov, S., ... Beckwée, D. (2019). Prevalence and risk factors of sleep disturbances in breast cancersurvivors: Systematic review and meta-analyses. *Supportive Care in Cancer*, 27(12), 4401–4433. https://doi.org/10.1007/s00520-019-04936-5

Li, C.-C., Tsai, Y.-F., Chang, T.-C., & Chen, L. (2017). Associations among menopausal symptoms, sleep and fatigue in Taiwanese women with endometrial cancer. *European Journal of Cancer Care*, *26*(5). https://doi.org/10.1111/ecc.12559

Li, M., & Katikireddi, S. V. (2019). Urban-rural inequalities in suicide among elderly people in China: A systematic review and meta-analysis. *International Journal for Equity in Health*, *18*(1), 2. https://doi.org/10.1186/s12939-018-0881-2 Li, N., Otomaru, T., & Taniguchi, H. (2017). Sleep quality in long-term survivors of head and neck cancer: Preliminary findings. *Supportive Care in Cancer*, *25*(12), 3741–3748. https://doi.org/10.1007/s00520-017-3804-7

Lin, C.-Y., Cheng, A. S. K., Nejati, B., Imani, V., Ulander, M., Browall, M., ... Pakpour, A. H. (2020). A thorough psychometric comparison between Athens Insomnia Scale and Insomnia Severity Index among patients with advanced cancer. *Journal of Sleep Research*, *29*(1), e12891. https://doi.org/10.1111/jsr.12891

Liou, K. T., Ahles, T. A., Garland, S. N., Li, Q. S., Bao, T., Li, Y., ... Mao, J. J. (2019). The Relationship Between Insomnia and Cognitive Impairment in Breast Cancer Survivors. *JNCI Cancer Spectrum*, *3*(3), pkz041. https://doi.org/10.1093/jncics/pkz041

Liu, L., Mills, P. J., Rissling, M., Fiorentino, L., Natarajan, L., Dimsdale, J. E., ... Ancoli-Israel, S. (2012). Fatigue and Sleep Quality are Associated with Changes in Inflammatory Markers in Breast Cancer Patients Undergoing Chemotherapy. *Brain, Behavior, and Immunity*, *26*(5), 706–713. https://doi.org/10.1016/j.bbi.2012.02.001

Lourenço, A., Dantas, A. A. G., de Souza, J. C., Araujo, C. M., Araujo, D. N., Lima, I. N. D. F., & Dantas, D. de S. (2021). Sleep quality is associated with Disability and Quality of life in breast cancer survivors: A cross-sectional pilot study. *European Journal of Cancer Care*, *30*(1), e13339. https://doi.org/10.1111/ecc.13339

Ma, Y., Hall, D. L., Ngo, L. H., Liu, Q., Bain, P. A., & Yeh, G. Y. (2021). Efficacy of cognitive behavioral therapy for insomnia in breast cancer: A meta-analysis. *Sleep Medicine Reviews*, *55*, 101376. https://doi.org/10.1016/j.smrv.2020.101376

Mansano-Schlosser, T. C., & Ceolim, M. F. (2012). Factors associated with sleep quality in the elderly receiving chemotherapy. *Revista Latino-Americana De Enfermagem*, *20*(6), 1100–1108. https://doi.org/10.1590/s0104-11692012000600012

Mao, H., Bao, T., Shen, X., Li, Q., Seluzicki, C., Im, E.-O., & Mao, J. J. (2018). Prevalence and risk factors for fatigue among breast cancer survivors on aromatase inhibitors. *European Journal of Cancer*, *101*, 47–54. https://doi.org/10.1016/j.ejca.2018.06.009

Mercadante, S., Adile, C., Ferrera, P., Masedu, F., Valenti, M., & Aielli, F. (2017). Sleep disturbances in advanced cancer patients admitted to a supportive/palliative care unit. *Supportive Care in Cancer*, *25*(4), 1301–1306. https://doi.org/10.1007/s00520-016-3524-4

Mercadante, S., Aielli, F., Adile, C., Ferrera, P., Valle, A., Cartoni, C., ... Porzio, G. (2015). Sleep Disturbances in Patients With Advanced Cancer in Different Palliative Care Settings. *Journal of Pain and Symptom Management*, *50*(6), 786–792. https://doi.org/10.1016/j.jpainsymman.2015.06.018

Miaskowski, C., Paul, S. M., Cooper, B. A., Lee, K., Dodd, M., West, C., ... Wara, W. (2011).
Predictors of the trajectories of self-reported sleep disturbance in men with prostate cancer during and following radiation therapy. *Sleep*, *34*(2), 171–179. https://doi.org/10.1093/sleep/34.2.171
Moreno, S. G., Sutton, A. J., Ades, A., Stanley, T. D., Abrams, K. R., Peters, J. L., & Cooper, N. J. (2009). Assessment of regression-based methods to adjust for publication bias through a comprehensive simulation study. *BMC Medical Research Methodology*, *9*(1), 2. https://doi.org/10.1186/1471-2288-9-2
Morris, B. A., Thorndike, F. P., Ritterband, L. M., Glozier, N., Dunn, J., & Chambers, S. K. (2015).

Sleep disturbance in cancer patients and caregivers who contact telephone-based help services. *Supportive Care in Cancer*, *23*(4), 1113–1120. https://doi.org/10.1007/s00520-014-2458-y Mulette, P., Ravoninjatovo, B., Guguen, C., Barbe, C., Ancel, J., Dury, S., ... Launois, C. (2021). Insomnia in adults with cystic fibrosis: Strong association with anxiety/depression and impaired quality of life. *BMC Pulmonary Medicine*, *21*(1), 108. https://doi.org/10.1186/s12890-021-01473-y Nakamura, Y., Lipschitz, D. L., Kuhn, R., Kinney, A. Y., & Donaldson, G. W. (2013). Investigating efficacy of two brief mind-body intervention programs for managing sleep disturbance in cancer

survivors: A pilot randomized controlled trial. *Journal of Cancer Survivorship: Research and Practice*, 7(2), 165–182. https://doi.org/10.1007/s11764-012-0252-8

National Comprehensive Cancer Network. (2021). NCCN Clinical Practice Guidelines in Oncology Survivorship. Version 3.2021. Retrieved from

https://www.nccn.org/professionals/physician_gls/pdf/survivorship.pdf

National Institute for Health and Care Excellence. (2021, March 1). *Insomnia*. Retrieved from https://cks.nice.org.uk/topics/insomnia/

Neyeloff, J. L., Fuchs, S. C., & Moreira, L. B. (2012). Meta-analyses and Forest plots using a microsoft excel spreadsheet: Step-by-step guide focusing on descriptive data analysis. *BMC Research Notes*, *5*(1), 52. https://doi.org/10.1186/1756-0500-5-52

Otte, J. L., Carpenter, J. S., Manchanda, S., Rand, K. L., Skaar, T. C., Weaver, M., ... Landis, C. (2015). Systematic review of sleep disorders in cancer patients: Can the prevalence of sleep disorders be ascertained? *Cancer Medicine*, *4*(2), 183–200. https://doi.org/10.1002/cam4.356

Otte, J. L., Davis, L., Carpenter, J. S., Krier, C., Skaar, T. C., Rand, K. L., ... Manchanda, S. (2016). Sleep disorders in breast cancer survivors. *Supportive Care in Cancer*, *24*(10), 4197–4205. https://doi.org/10.1007/s00520-016-3247-6

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., ... Moher,
D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *International Journal of Surgery (London, England)*, 88, 105906.
https://doi.org/10.1016/j.ijsu.2021.105906

Palesh, O., Zeitzer, J. M., Conrad, A., Giese-Davis, J., Mustian, K. M., Popek, V., ... Spiegel, D.
(2008). Vagal Regulation, Cortisol, and Sleep Disruption in Women with Metastatic Breast Cancer. *Journal of Clinical Sleep Medicine*, 4(5), 441–449.

Palesh, Oxana G., Roscoe, J. A., Mustian, K. M., Roth, T., Savard, J., Ancoli-Israel, S., ... Morrow, G.
R. (2010). Prevalence, demographics, and psychological associations of sleep disruption in patients with cancer: University of Rochester Cancer Center-Community Clinical Oncology Program. *Journal of Clinical Oncology*, 28(2), 292–298. https://doi.org/10.1200/JCO.2009.22.5011

Palesh, Oxana Gronskaya, Collie, K., Batiuchok, D., Tilston, J., Koopman, C., Perlis, M. L., ... Spiegel, D. (2007). A Longitudinal Study of Depression, Pain, and Stress as Predictors of Sleep Disturbance among Women with Metastatic Breast Cancer. *Biological Psychology*, 75(1), 37–44. https://doi.org/10.1016/j.biopsycho.2006.11.002

Patsopoulos, N. A., Evangelou, E., & Ioannidis, J. P. A. (2008). Sensitivity of between-study heterogeneity in meta-analysis: Proposed metrics and empirical evaluation. *International Journal of Epidemiology*, *37*(5), 1148–1157. https://doi.org/10.1093/ije/dyn065

Phillips, K. M., Jim, H. S., Donovan, K. A., Pinder-Schenck, M. C., & Jacobsen, P. B. (2012). Characteristics and correlates of sleep disturbances in cancer patients. *Supportive Care in Cancer*, 20(2), 357–365. https://doi.org/10.1007/s00520-011-1106-z

Pillai, R. N., Behera, M., Owonikoko, T. K., Kamphorst, A. O., Pakkala, S., Belani, C. P., ... Ramalingam, S. S. (2018). Comparison of the toxicity profile of PD-1 versus PD-L1 inhibitors in nonsmall cell lung cancer: A systematic analysis of the literature. *Cancer*, *124*(2), 271–277. https://doi.org/10.1002/cncr.31043

Rogers, L. Q., Courneya, K. S., Robbins, K. T., Rao, K., Malone, J., Seiz, A., ... Burra, V. (2008). Factors associated with fatigue, sleep, and cognitive function among patients with head and neck cancer. *Head & Neck*, *30*(10), 1310–1317. https://doi.org/10.1002/hed.20873

Rolke, H. B., Bakke, P. S., & Gallefoss, F. (2010). HRQoL changes, mood disorders and satisfaction after treatment in an unselected population of patients with lung cancer. *The Clinical Respiratory Journal*, *4*(3), 168–175. https://doi.org/10.1111/j.1752-699X.2009.00171.x

Saini, A., Berruti, A., Ferini-Strambi, L., Castronovo, V., Rametti, E., Giuliano, P. L., ... Ostacoli, L.
(2013). Restless Legs Syndrome as a Cause of Sleep Disturbances in Cancer Patients Receiving
Chemotherapy. *Journal of Pain and Symptom Management*, 46(1), 56–64.

https://doi.org/10.1016/j.jpainsymman.2012.06.018

Sandadi, S., Frasure, H. E., Broderick, M. J., Waggoner, S. E., Miller, J. A., & von Gruenigen, V. E. (2011). The effect of sleep disturbance on quality of life in women with ovarian cancer. *Gynecologic Oncology*, *123*(2), 351–355. https://doi.org/10.1016/j.ygyno.2011.07.028

Santoso, A. M. M., Jansen, F., de Vries, R., Leemans, C. R., van Straten, A., & Verdonck-de Leeuw, I. M. (2019). Prevalence of sleep disturbances among head and neck cancer patients: A systematic review and meta-analysis. *Sleep Medicine Reviews*, *47*, 62–73.

https://doi.org/10.1016/j.smrv.2019.06.003

Santoso, A. M. M., Jansen, F., Lissenberg-Witte, B. I., Baatenburg de Jong, R. J., Langendijk, J. A., Leemans, C. R., ... NET-QUBIC consortium. (2021). Poor sleep quality among newly diagnosed head and neck cancer patients: Prevalence and associated factors. *Supportive Care in Cancer*, 29(2), 1035–1045. https://doi.org/10.1007/s00520-020-05577-9

Sateia, M. J., Buysse, D. J., Krystal, A. D., Neubauer, D. N., & Heald, J. L. (2017). Clinical Practice Guideline for the Pharmacologic Treatment of Chronic Insomnia in Adults: An American Academy of Sleep Medicine Clinical Practice Guideline. *Journal of Clinical Sleep Medicine*, *13*(2), 307–349. https://doi.org/10.5664/jcsm.6470

Savard, J., Ivers, H., Savard, M.-H., & Morin, C. M. (2015). Cancer treatments and their side effects are associated with aggravation of insomnia: Results of a longitudinal study. *Cancer*, *121*(10), 1703–1711. https://doi.org/10.1002/cncr.29244

Savard, J., Simard, S., Hervouet, S., Ivers, H., Lacombe, L., & Fradet, Y. (2005). Insomnia in men treated with radical prostatectomy for prostate cancer. *Psycho-Oncology*, *14*(2), 147–156. https://doi.org/10.1002/pon.830

Savard, J., Villa, J., Ivers, H., Simard, S., & Morin, C. M. (2009a). Prevalence, natural course, and risk factors of insomnia comorbid with cancer over a 2-month period. *Journal of Clinical Oncology: Official Journal of the American Society of Clinical Oncology*, 27(31), 5233–5239. https://doi.org/10.1200/JCO.2008.21.6333

Savard, J., Villa, J., Ivers, H., Simard, S., & Morin, C. M. (2009b). Prevalence, natural course, and risk factors of insomnia comorbid with cancer over a 2-month period. *Journal of Clinical Oncology: Official Journal of the American Society of Clinical Oncology*, 27(31), 5233–5239.

https://doi.org/10.1200/JCO.2008.21.6333

Savard, M.-H., Savard, J., Simard, S., & Ivers, H. (2005). Empirical validation of the Insomnia Severity Index in cancer patients. *Psycho-Oncology*, *14*(6), 429–441. https://doi.org/10.1002/pon.860 Schagen, S. B., Klein, M., Reijneveld, J. C., Brain, E., Deprez, S., Joly, F., ... Wefel, J. S. (2014). Monitoring and optimising cognitive function in cancer patients: Present knowledge and future directions. *European Journal of Cancer Supplements*, *12*(1), 29–40.

https://doi.org/10.1016/j.ejcsup.2014.03.003

Schieber, K., Niecke, A., Geiser, F., Erim, Y., Bergelt, C., Büttner-Teleaga, A., ... Weis, J. (2019). The course of cancer-related insomnia: Don't expect it to disappear after cancer treatment. *Sleep Medicine*, 58, 107–113. https://doi.org/10.1016/j.sleep.2019.02.018 Schutte-Rodin, S., Broch, L., Buysse, D., Dorsey, C., & Sateia, M. (2008). Clinical Guideline for the Evaluation and Management of Chronic Insomnia in Adults. *Journal of Clinical Sleep Medicine : JCSM : Official Publication of the American Academy of Sleep Medicine*, *4*(5), 487–504.

Sigurdardottir, L. G., Valdimarsdottir, U. A., Mucci, L. A., Fall, K., Rider, J. R., Schernhammer, E., ... Lockley, S. W. (2013). Sleep Disruption Among Older Men and Risk of Prostate Cancer. *Cancer Epidemiology, Biomarkers & Prevention*, 22(5), 872–879. https://doi.org/10.1158/1055-9965.EPI-12-1227-T

Simonelli, G., Marshall, N. S., Grillakis, A., Miller, C. B., Hoyos, C. M., & Glozier, N. (2018). Sleep health epidemiology in low and middle-income countries: A systematic review and meta-analysis of the prevalence of poor sleep quality and sleep duration. *Sleep Health*, *4*(3), 239–250. https://doi.org/10.1016/j.sleh.2018.03.001

Song, B. C., & Bai, J. (2021). Microbiome-gut-brain axis in cancer treatment-related psychoneurological toxicities and symptoms: A systematic review. *Supportive Care in Cancer*, 29(2), 605–617. https://doi.org/10.1007/s00520-020-05739-9

Steel, J. L., Terhorst, L., Collins, K. P., Geller, D. A., Vodovotz, Y., Kim, J., ... Tsung, A. (2018).
Prospective Analyses of Cytokine Mediation of Sleep and Survival in the Context of Advanced
Cancer. *Psychosomatic Medicine*, *80*(5), 483–491. https://doi.org/10.1097/PSY.0000000000000579
Strik, H., Cassel, W., Teepker, M., Schulte, T., Riera-Knorrenschild, J., Koehler, U., & Seifart, U.
(2021). Why Do Our Cancer Patients Sleep So Badly? Sleep Disorders in Cancer Patients: A Frequent
Symptom with Multiple Causes. *Oncology Research and Treatment*, 1–7.
https://doi.org/10.1159/000518108

Strollo, S. E., Fallon, E. A., Gapstur, S. M., & Smith, T. G. (2020). Cancer-related problems, sleep quality, and sleep disturbance among long-term cancer survivors at 9-years post diagnosis. *Sleep Medicine*, *65*, 177–185. https://doi.org/10.1016/j.sleep.2019.10.008

Suh, H.-W., Jeong, H. Y., Hong, S., Kim, J. W., Yoon, S. W., Lee, J. Y., & Chung, S.-Y. (2021). The mindfulness-based stress reduction program for improving sleep quality in cancer survivors: A systematic review and meta-analysis. *Complementary Therapies in Medicine*, *57*, 102667. https://doi.org/10.1016/j.ctim.2021.102667

Sun, G.-W., Yang, Y.-L., Yang, X.-B., Wang, Y.-Y., Cui, X.-J., Liu, Y., & Xing, C.-Z. (2020). Preoperative insomnia and its association with psychological factors, pain and anxiety in Chinese colorectal cancer patients. *Supportive Care in Cancer*, *28*(6), 2911–2919. https://doi.org/10.1007/s00520-019-05151-y

Sung, H., Ferlay, J., Siegel, R. L., Laversanne, M., Soerjomataram, I., Jemal, A., & Bray, F. (2021). Global cancer statistics 2020: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. *CA: A Cancer Journal for Clinicians*, *n/a*(n/a). https://doi.org/10.3322/caac.21660

Tang, M.-F., Chiu, H.-Y., Xu, X., Kwok, J. Y., Cheung, D. S. T., Chen, C.-Y., & Lin, C.-C. (2019). Walking is more effective than yoga at reducing sleep disturbance in cancer patients: A systematic review and meta-analysis of randomized controlled trials. *Sleep Medicine Reviews*, *47*, 1–8. https://doi.org/10.1016/j.smrv.2019.05.003

Taylor, T. R., Huntley, E. D., Makambi, K., Sween, J., Adams-Campbell, L. L., Frederick, W., & Mellman, T. A. (2012). Understanding sleep disturbances in African-American breast cancer survivors: A pilot study. *Psycho-Oncology*, *21*(8), 896–902. https://doi.org/10.1002/pon.2000
Tejada, M., Viele, C., Kober, K. M., Cooper, B. A., Paul, S. M., Dunn, L. B., ... Miaskowski, C. (2019). Identification of subgroups of chemotherapy patients with distinct sleep disturbance profiles and associated co-occurring symptoms. *Sleep*, *42*(10). https://doi.org/10.1093/sleep/zsz151
Tian, J., Chen, G. L., & Zhang, H. R. (2015). Sleep status of cervical cancer patients and predictors of poor sleep quality during adjuvant therapy. *Supportive Care in Cancer*, *23*(5), 1401–1408. https://doi.org/10.1007/s00520-014-2493-8

Tzeng, J. I., Fu, Y.-W., & Lin, C.-C. (2012). Validity and reliability of the Taiwanese version of the Pittsburgh Sleep Quality Index in cancer patients. *International Journal of Nursing Studies*, *49*(1), 102–108. https://doi.org/10.1016/j.ijnurstu.2011.08.004

Valko, P. O., Siddique, A., Linsenmeier, C., Zaugg, K., Held, U., & Hofer, S. (2015). Prevalence and predictors of fatigue in glioblastoma: A prospective study. *Neuro-Oncology*, *17*(2), 274–281. https://doi.org/10.1093/neuonc/nou127

Van Onselen, C., Dunn, L. B., Lee, K., Dodd, M., Koetters, T., West, C., ... Miaskowski, C. (2010). Relationship between mood disturbance and sleep quality in oncology outpatients at the initiation of radiation therapy. *European Journal of Oncology Nursing*, *14*(5), 373–379.

https://doi.org/10.1016/j.ejon.2009.12.002

Vargas, S., Wohlgemuth, W. K., Antoni, M. H., Lechner, S. C., Holley, H. A., & Carver, C. S. (2010). Brief Report: Sleep Dysfunction and Psychosocial Adaptation Among Women Undergoing Treatment for Non-Metastatic Breast Cancer. *Psycho-Oncology*, *19*(6), 669–673. https://doi.org/10.1002/pon.1603

Wang, B., Duan, R., & Duan, L. (2018). Prevalence of sleep disorder in irritable bowel syndrome: A systematic review with meta-analysis. *Saudi Journal of Gastroenterology : Official Journal of the Saudi Gastroenterology Association*, *24*(3), 141–150. https://doi.org/10.4103/sjg.SJG_603_17 Well, G. A., Shea, B., O'Connell, D., Peterson, J., Welch, V., Losos, M., & Tugwell, P. (2020). The Newcastle-Ottawa Scale (NOS) for assessing the quality of nonrandomised studies in meta-analyses. Retrieved December 31, 2019, from http://www.ohri.ca/programs/clinical_epidemiology/oxford.asp Yoshikawa, K., Higashijima, J., Okitsu, H., Miyake, H., Yagi, T., Miura, M., ... Shimada, M. (2020). Effects of chemotherapy on quality of life and night-time sleep of colon cancer patients. *The Journal* of Medical Investigation: JMI, 67(3.4), 338-342. https://doi.org/10.2152/jmi.67.338 Yu, S.-Y., & Nho, J.-H. (2015). Influence of Sleep Disturbance and Depression on Quality of Life in Ovarian Cancer Patients during Chemotherapy. Asian Oncology Nursing, 15(4), 203–210. https://doi.org/10.5388/aon.2015.15.4.203 Zeng, L.-N., Zong, Q.-Q., Yang, Y., Zhang, L., Xiang, Y.-F., Ng, C. H., ... Xiang, Y.-T. (2020). Gender Difference in the Prevalence of Insomnia: A Meta-Analysis of Observational Studies. Frontiers in Psychiatry, 11. https://doi.org/10.3389/fpsyt.2020.577429 Zhao, L., Han, G., Zhao, Y., Jin, Y., Ge, T., Yang, W., ... Li, B. (2020). Gender Differences in Depression: Evidence From Genetics. Frontiers in Genetics, 11. https://doi.org/10.3389/fgene.2020.562316 Zubair, U. B., Mumtaz, H., & Taj, R. (2019). Relationship between the Quality of Sleep and Psychiatric Morbidity among the Patients of Head and Neck Tumours. Journal of the College of *Physicians and Surgeons--Pakistan: JCPSP*, 29(6), 541–544. https://doi.org/10.29271/jcpsp.2019.06.541

Author Biographies

Mohammed Al Maqbali, RN, Dip. Admin., BSc (Hons), MSc, PhD, AFHEA, is a Research Fellow at Department of Nursing Midwifery and Health, Northumbria University, Newcastle-Upon-Tyne, UK

Mohammed Al Sinani, RD, B.Sc (Hons), M.Sc, is a PhD Student at Reproductive and Developmental Biology Department of Surgery and Cancer, Faculty of Medicine, Imperial College London, London, UK.

Ahmad Alsayed, PhD, MSc, PharmD, is an Assistant Professor at Department of Clinical Pharmacy and Therapeutics, Faculty of Pharmacy, Applied Science Private University, Jorden.

Alexander M Gleason, RN, Ph.D, is a Head of Nursing at Fatima College of Health Sciences, Mafraq, Abu Dhabi, UAE

Subgroups	Categories	No. of Studies	Sample Size	Events	Prevalence (%)	95% CI (%)	I^2	Р
Age Group						(,,,)	(, , ,	
	40-49	16	1174	1926	67	65.3-76.2	93.6	< 0.001
	50-59	79	22823	13274	61.8	58.8-64.7	94.7	< 0.001
	60-69	49	8440	16324	58.6	53.2-63.8	97.4	< 0.001
	70-79	7	3253	4623	48.3	40-56.7	80.8	< 0.001
Year of Pub	lication							
	1998-2005	8	2167	3107	66.1	46.7-81.3	98.6	< 0.001
	2006-2010	30	4298	8383	60.6	54.7-66.1	95.5	< 0.001
	2011-2015	57	8432	15548	60.1	55.6-64.4	96.2	< 0.001
	2016-2020	57	10429	17223	60.8	56.7-64.8	95.9	< 0.001
	2021-	8	1985	1155	58.6	48-68.4	94.5	< 0.001
Continent								
	Australia	4	1457	749	57.9	45.4-69.4	93.9	< 0.001
	North America	87	15831	27589	60.5	56.8-64	97	< 0.001
	Europe	22	3676	7196	61	56.5-65.4	91.8	< 0.001
	Asia	42	6261	10091	62.7	56.2-68.7	96.3	< 0.001
NOS								
	Low	30	3875	6899	60.9	55.9-65.7	97.6	< 0.001
	Moderate	130	27638	15854	60.9	57.7-64.1	96	< 0.001
Study Desig	<u>yn</u>							
	CS	96	27700	14802	58.7	55.7-61.7	95.4	< 0.001
	LG	64	9350	17062	63.5	59-67.8	97	< 0.001
Type of Car	ncer							
	Prostate	6	1891	3499	44.8	31.6-58.9	92.6	< 0.001
	Head and Neck	8	1296	661	54.4	44.8-63.6	87.9	< 0.001
	Gastrointestinal	4	424	875	50.6	39.7-61.9	91.0	< 0.001
	Breast	64	19542	10489	59.7	56.2-63.2	95.2	< 0.001
	Lung	8	743	1410	63.3	54.9-71.9	84.9	< 0.001
	Gynaecological	7	748	1118	63.6	51.8-73.9	93.7	< 0.001
	Mixed	57	9279	17111	64.4	59.5-69.9	97.7	< 0.001
Cancer Stag	ges							
	Localized	53	9002	14929	57.7	53.4-61.9	96.2	< 0.001
	Mixed	71	21959	12512	58.9	55.4-62.3	95.8	< 0.001
	No Evidence of Disease	16	3782	6194	67.9	54-79.2	97.5	< 0.001
	Advanced	20	2886	6821	70.8	61.7-78.5	96.5	< 0.001
Treatment		_0	2000	0021	7010	0111 1010	2010	101001
	> 3 month	50	00.45	1 < 1 7 1	50.7	FACCAC	07.4	0.001
	After/Treat	52	8945	161/1	59.7	54.6-64.6	97.4	<0.001
	Under/Treat	80	13736	23676	60.2	56.8-63.4	93.9	< 0.001
	Mixed	28	11380	7188	63.8	58.1-69.2	96.7	< 0.001
Instrument								
	ESS	8	3997	8350	26.9	20.7-34.2	87	< 0.001
	AIS	5	660	1196	52.5	40-64.7	93.3	< 0.001
	ISI	31	4231	7438	59.9	53.3-66.2	97.3	< 0.001
	GSDS	11	943	1452	61.5	52.9-69.5	94.6	< 0.001
	PSQI	96	23348	14255	64.0	61.4-66.5	93.1	< 0.001

Table 1: Prevalence of Sleep Disturbance by Subgroups Categories

Cross-sectional (CS); Longitudinal (LG); Athens Insomnia Scale (AIS); Epworth Sleepiness Scale (ESS); General Sleep Disturbance Scale (GSDS); Insomnia Severity Index (ISI); Pittsburgh Sleep Quality Index (PSQI)

Figure 1: PRISMA diagram



30

Fig	gure 2. Forest Plot of the Pr	evalence of Sleep	Disterbance
	Study	Rate (95% CI)	2
1	(Akechi et al., 2007)	15.3(11.0-20.9)	-0-
2	(Klyushnenkova et al., 2015)	16.0(13.7-18.6)	⊕-
3	(Jung et al., 2016)	20.2(15.2-26.4)	-0
4	(Valko et al., 2015)	21.5(13.2-33.2)	— D ——
5	(Saberzadeh-Ardestani et al., 2019)	21.6(13.7-32.4)	_ _
6	(Forsythe et al., 2012)	21.8(19.5-24.2)	⊕
7	(Hanisch et al., 2011)	23.3(14.3-35.6)	
8	(Berger et al., 2009)	28.2(22.4-34.7)	
9	(Adams et al., 2018)	29.0(19.1-41.4)	
10	(Josée Savard et al., 2005)	29.4(24.7-34.5)	
11	(Overcash et al.,2018)	33.3(22.6-46.1)	
12	(Josée Savard et al., 2015)	36.5(30.9-42.5)	
13	(Ma, Chang, & Lin, 2014)	36.8(26.2-48.8)	
14	(Lowery-Allison et al., 2018)	38.0(31.5-44.9)	
15	(GW. Sun et al., 2020)	38.2(33.8-42.9)	
16	(Loth et al., 2017)	39.2(26.9-53.1)	
17	(Bardwell et al., 2008)	39.3(37.4-41.2)	
18	(Saesen et al., 2021)	40.0(27.5-54.0)	
19	(Daldoul et al., 2021)	40.0(29.2-51.8)	
20	(Akman et al.,2015)	40.4(35.2-46.0)	
21	(İzci et al., 2020)	41.1(29.0-54.3)	
22	(Miaskowski, Lee, et al., 2011)	41.6(34.7-48.9)	
23	(Nelson et al., 2018)	41.7(31.6-52.4)	
24	(Hoang et al., 2020)	42.7(36.2-49.5)	
25	(JL. Sun, Chiou, & Lin, 2011)	43.1(36.3-50.1)	
26	(Taylor et al., 2012)	43.1(30.4-56.9)	
27	(Ji et al., 2017)	43.5(36.3-51.1)	
28	(Price et al., 2009)	43.7(40.3-47.2)	-
29	(Santoso et al., 2021)	43.9(39.9-48.1)	
30	(Oxana G. Palesh et al., 2010)	44.0(40.6-47.4)	中
31	(Aouizerat et al., 2009)	44.6(37.3-52.2)	— — —
32	(Jim et al., 2018)	45.1(41.0-49.2)	
33	(Gu et al., 2018)	45.5(38.8-52.5)	-0
34	(Cha et al., 2017)	45.7(39.0-52.5)	
35	(R. T. H. Ho & Fong, 2014)	46.2(39.3-53.2)	_0_
36	(Gibbins et al., 2009)	46.7(34.5-59.2)	
37	(Echchikhi et al., 2017)	47.9(42.1-53.7)	- <u>-</u>
38	(J. Savard et al., 2001)	48.3(42.7-54.0)	-0-
39	(Desai et al., 2013)	50.1(45.3-54.9)	
40	(Yoshikawa et al., 2020)	50.4(42.1-58.6)	
41	(O. Palesh et al., 2018)	50.7(39.2-62.1)	
42	(Strollo et al., 2020)	50.9(48.6-53.1)	•
43	(Courneya et al., 2014)	51.4(45.7-57.0)	-0-
44	(Qin et al., 2015)	51.7(39.2-63.9)	
45	(Rogers et al., 2008)	51.7(39.0-64.2)	
46	(Beck et al., 2004)	51.8(47.3-56.3)	

47	(Kreutz et al.,2021)	51.9(38.7-64.7)		
48	(Liou et al., 2019)	51.9(48.9-54.8)	ф	
49	(Berrett-Abebe et al., 2015)	52.2(40.4-63.9)		
50	(Tremblay, Savard, & Ivers, 2009)	52.6(39.8-65.1)		
51	(Nakamura et al., 2013)	52.6(39.8-65.1)		
52	(Dirksen, Epstein, & Hoyt, 2009)	52.9(39.4-66.1)		
53	(Berger et al., 2019)	53.0(50.3-55.7)	4	
54	(Jeon et al., 2021)	53.1(42.2-63.6)		
55	(Garrett et al., 2011)	53.1(45.4-60.7)		
56	(Ratcliff et al., 2021)	53.3(48.3-58.3)	4	
57	(He et al., 2015)	54.3(46.6-61.8)		
58	(Kotronoulas et al., 2011)	54.5(47.8-61.2)		
59	(Şanlier et al., 2020)	54.5(48.5-60.5)	-	
60	(CC. Li, Tsai, Chang, & Chen, 2017)	54.7(44.7-64.4)		
61	(Dhruva et al., 2012)	54.8(43.3-65.8)		
62	(H. Mao et al., 2018)	54.9(51.9-57.8)	ф.	
63	(Van Onselen et al., 2012)	55.0(50.1-59.8)	4	
64	(Mansano-Schlosser & Ceolim, 2012)	55.7(47.4-63.7)		-
65	(Dirksen, Belyea, & Epstein, 2009)	55.8(45.2-65.9)		
66	(Fong & Ho, 2020)	55.9(47.2-64.3)		
67	(Nishiura et al., 2015)	56.0(42.1-69.0)		
68	(Mercadante et al., 2015)	56.1(52.8-59.3)	中	
69	(Fleming et al., 2019)	56.1(48.6-63.3)		
70	(Dodd et al., 2010)	56.3(47.0-65.1)	1	
71	(Gooneratne et al., 2007)	56.6(45.3-67.2)		
72	(Berger et al.,2007)	56.7(48.0-65.0)		
73	(Phillips et al., 2012)	57.3(51.5-62.9)		
74	(Van Onselen et al., 2010)	57.3(49.9-64.4)		
75	(Pai, Sivanandh, & Udupa, 2020)	57.6(47.3-67.3)		
76	(Mansano-Schlosser et al.,2017)	57.7(49.8-65.2)		
77	(Martin et al., 2020)	57.8(45.5-69.2)		
78	(Colagiuri et al., 2011)	57.9(56.1-59.7)		
79	(Doong et al., 2015)	58.5(53.6-63.3)	-	
80	(Papadopoulos, Kiagia, Charpidou, Gkiozos & Syrigos 2019)	58.8(49.8-67.3)	1	
81	(Steel et al., 2018)	58.8(53.1-64.3)	-	L
82	(Collins et al., 2017)	58.9(53.2-64.4)		-
83	(Saini et al., 2013)	59.0(51.5-66.0)	-	
84	(Gonzalez et al., 2018)	59.0(47.8-69.3)		
85	(Morris et al., 2015)	59.4(55.0-63.6)	-	
86	(Josée Savard et al., 2009)	59.5(56.4-62.6)		-
87	(Hall, Mishel, & Germino, 2014)	59.7(54.2-65.0)	-]
88	(Moore, Berger, & Dizona, 2011)	60.2(53.4-66.7)		-
89	(Fontes, Gonçalves, Pereira, & Lunet, 2017)	60.3(55.9-64.5)	-[-
90	(Rand et al., 2011)	60.5(55.6-65.2)	-	
91	(Liu, Rissling, et al., 2012)	60.8(50.8-70.0)		—
92	(Halle et al., 2017)	61.0(55.0-66.7)	Т	
93	(Chan, Jheng, & Wang, 2020)	61.2(51.3-70.3)		I
94	(Henneghan et al., 2018)	63.3(52.9-72.6)		

95	(Yu & Nho, 2015)	63.8(55.9-71.1)		
96	(Schieber et al., 2019)	64.2(59.4-68.7)		-
97	(Tian, Chen, & Zhang, 2015)	64.5(53.2-74.4)		
98	(Oxana Gronskaya Palesh et al., 2007)	64.5(54.3-73.5)		-0
99	(Beck et al., 2010)	65.0(57.8-71.6)	-	
100	(Otte, Carpenter et al., 2010)	65.0(58.9-70.7)		
101	(Bower et al., 2011)	65.0(55.4-73.6)		
102	(Josée Savard et al.,2015)	65.6(61.2-69.8)		
103	(Liu et al., 2009)	65.8(54.5-75.5)	-	-0
104	(Zubair, Mumtaz, & Taj, 2019)	65.9(58.4-72.6)		-0
105	(Fekih-Romdhane et al., 2020)	66.0(52.0-77.7)		
106	(Sanford et al., 2013)	66.3(55.3-75.7)		-0
107	(Carpenter & Andrykowski, 1998)	66.7(57.0-75.1)	-	-0
108	(Fortner et al., 2002)	66.7(55.1-76.6)	-	-0
109	(Sandadi et al., 2011)	67.4(56.9-76.5)		
110	(Miladinia et al., 2018)	67.5(62.8-71.9)		
111	(Chen, Yu, & Yang, 2008)	68.7(59.7-76.5)		
112	(Ancoli-Israel et al., 2006)	68.8(57.7-78.2)		
113	(Hong, Tian, & Wu, 2014)	68.8(65.3-72.1)		4
114	(Mosher & Duhamel, 2012)	70.0(59.8-78.6)		
115	(Vargas et al., 2014)	70.0(63.9-75.5)		
116	(Enderlin et al., 2011)	70.1(58.2-79.9)		
117	(Davies, Patel, Gregory, & Lee, 2017)	70.7(63.5-77.0)		
118	(Vargas et al., 2010)	70.8(64.8-76.2)		
119	(Clevenger et al., 2013)	71.1(63.9-77.4)		
120	(Gonzalez et al., 2021)	71.4(67.7-74.8)		- D -
121	(Miaskowski, Paul, et al., 2011)	72.0(61.3-80.6)		
122	(Sela et al., 2005)	72.0(62.4-79.9)		
123	(Shahidi et al., 2007)	73.6(60.2-83.7)		
124	(Al Maqbali, 2021)	73.7(65.6-80.5)		
125	(Dreher et al., 2018)	74.0(64.5-81.6)		
126	(Caplette-Gingras et al., 2013)	74.6(62.5-83.8)		
127	(Romito et al., 2014)	74.9(70.5-78.9)		
128	(Tejada et al., 2019)	75.0(72.6-77.2)		¢
129	(SY. Ho, Rohan et al.,2015)	75.4(67.4-81.9)		
130	(Johansen et al., 2018)	75.4(70.1-80.1)		₽
131	(Liu, Mills, et al., 2012)	75.5(62.2-85.2)		
132	(Barsevick et al., 2010)	76.0(70.8-80.6)		
133	(W. Li et al., 2019)	76.1(69.3-81.8)		
134	(Nguyen et al., 2021)	76.3(65.7-84.3)		
135	(Lin, Cheng, Nejati, et al., 2020)	76.4(72.8-79.7)		-0-
136	(Park, Lee, Gwak, Shim, & Lee, 2010)	76.6(67.0-84.1)		
137	(Rogers et al., 2017)	77.0(71.0-82.1)		
138	(Clevenger et al., 2012)	77.4(69.6-83.8)		-0-
139	(Al Maqbali et al., 2020)	78.0(73.5-82.0)		-0-
140	(Tzeng, Fu, & Lin, 2012)	79.0(72.9-84.1)		-0-
141	(Kyriaki Mystakidou et al., 2007)	80.4(71.5-87.0)		-0-
142	(J. J. Mao et al., 2014)	82.1(71.1-89.5)		

143	(N. Li, Otomaru, & Taniguchi, 2017)	83.1(73.1-89.9)	
144	(Grutsch et al., 2011)	83.3(73.8-89.9)	
145	(Delgado-Guay et al., 2011)	85.1(76.8-90.8)	
146	(MH. Savard et al., 2005)	86.0(84.2-87.6)	
147	(Bagheri-Nesami et al., 2016)	89.0(81.2-93.8)	
148	(Peoples et al., 2017)	89.5(81.5-94.2)	— <u>—</u> —
149	(Lin, Cheng, Imani, et al., 2020)	90.0(87.8-91.8)	
150	(Carlson & Garland, 2005)	90.5(80.4-95.7)	
151	(Roscoe et al., 2015)	91.7(84.2-95.8)	
152	(O. Palesh et al., 2008)	91.9(84.7-95.9)	
153	(Kashani & Kashani, 2014)	94.7(84.9-98.3)	
154	(Chung, Youn, & Choi, 2017)	96.0(90.7-98.3)	-D
155	(K. Mystakidou et al., 2009)	96.3(89.3-98.8)	— D
156	(Garland et al., 2019)	98.1(94.3-99.4)	-
157	(Lafçi & Öztunç, 2015)	98.3(89.1-99.8)	
158	(Imanian, Imanian, & Karimyar, 2019)	99.1(94.1-99.9)	-
159	(Fox, Lyon, & Farace, 2007)	99.3(90.1-00.0)	
160	(Mercadante et al., 2017)	99.8(96.5-00.0)	
		60.7(58.1-63.3)	•
		20	0 10 20 30 40 50 60 70 80 90 100 110
	Heterogeneity: $1^{2} = 96.4\%$, p< 0.00	JU	





Supplementary Table 1: Characteristics of the Included 160 Studies

	Study	Events	N	Female	Age Mean	Age Group	Year of Publication	Country	Continent	Study Design	Type of Cancer	Cancer Stage	Treatment Status	Instrument	Cut Off	SON
1	(Carpenter & Andrykowski, 1998)	68	102	102	56.5		1998	US	North America	CS	Breast	Localized	Mixed	PSQI	>8	Moderate
2	(J. Savard, Simard, Blanchet, Ivers, & Morin, 2001)	145	300	300	60	28-90	2001	Canada	North America	CS	Breast	Localized	Under/Treat	SII	NG	Moderate
3	(Fortner, Stepanski, Wang, Kasprowicz, & Durrence, 2002)	48	72	72	51.3		2002	US	North America	CS	Breast	Localized	Mixed	PSQI	>5	Moderate
4	(Beck, Schwartz, Towsley, Dudley, & Barsevick, 2004)	245	473	334	56.6	26-83	2004	US	North America	LG	Mixed	Mixed	> 3 month After/Treat	PSQI	>8	Moderate
5	(MH. Savard, Savard, Simard, & Ivers, 2005)	1436	1670	785		40-76	2005	Canada	North America	LG	Mixed	Localized	Mixed	ISI	≥15	Moderate
6	(Josée Savard et al., 2005)	96	327	0	66	47-80	2005	Canada	North America	LG	Prostate	Localized	Mixed	ISI	≥ 8	Moderate
7	(Sela, Watanabe, & Nekolaichuk, 2005)	72	100	48	60.1	21-68	2005	Canada	North America	LG	Mixed	Advanced	> 3 month After/Treat	SQ	≥5	Moderate
8	(Carlson & Garland, 2005)	57	63	49	54	32-78	2005	Canada	North America	LG	Mixed	Mixed	Under/Treat	PSQI	>5	Moderate
9	(Ancoli-Israel et al., 2006)	53	77	75	51	34-79	2006	US	North America	CS	Breast	Localized	Under/Treat	PSQI	>5	Moderate
10	(Gooneratne et al., 2007)	43	76	47	73.6	61-89	2007	US	North America	CS	Lung	No Evidence of Disease	> 3 month After/Treat	PSQI	>5	Moderate
11	(Berger, Farr, Kuhn, Fischer, & Agrawal, 2007)	72	127	127	51.4	34-83	2007	US	North America	CS	Breast	Localized	Mixed	PSQI	>5	Low
12	(Fox, Lyon, & Farace, 2007)	73	73	34	46	22-92	2007	US	North America	CS	Brain	Localized	Under/Treat	GSDS	≥43	Moderate
13	(Oxana Gronskaya Palesh et al., 2007)	60	93	93	53.8	33-80	2007	US	North America	CS	Breast	Advanced	> 3 month After/Treat	SQ	≥5	Moderate
14	(Akechi et al., 2007) (Akechi et al., 2007)	32	209	72	59.6		2007	Japan	Asia	LG	Mixed	Advanced	> 3 month After/Treat	Clinical Int	NG	Low
15	(Kyriaki Mystakidou et al., 2007)	82	102	56	62.8	26-87	2007	Greek	Europe	CS	Mixed	Advanced	> 3 month After/Treat	PSQI	>8	Moderate
16	(Shahidi, Khodabakhshi, Yahyazadeh, Amini, & Nosrati, 2007)	39	53	22	47	18-78	2007	Iran	Asia	LG	Breast	Mixed	Mixed	PSQI	>5	Moderate
17	(Bardwell et al., 2008)	1039	2645	2654	53	28-74	2008	US	North America	CS	Breast	Localized	> 3 month After/Treat	WHI- SDS	≥9	Low
18	(O. Palesh et al., 2008)	91	99	99	54.6	36-80	2008	US	North America	CS	Breast	Advanced	> 3 month After/Treat	Actigrap hy		Low
19	(Rogers et al., 2008)	30	58	43	60		2008	US	North America	CS	Head and Neck	Mixed	Mixed	PSQI	>5	Moderate

20	(Chen, Yu, & Yang, 2008)	79	115	41	59.4		2008	Taiwan	Asia	LG	Lung	Mixed	Under/Treat	PSQI	>5	Moderate
21	(Dirksen, Belyea, & Epstein, 2009)	48	86	86	57.8	29-86	2009	US	North America	CS	Breast	No Evidence of Disease	> 3 month After/Treat	ISI	≥15	Moderate
22	(Tremblay, Savard, & Ivers, 2009)	30	57	57	54		2009	Canada	North America	CS	Breast	No Evidence of Disease	> 3 month After/Treat	ISI	≥8	Moderate
23	(Liu et al., 2009)	50	76	76	51.1		2009	US	North America	CS	Breast	Localized	Under/Treat	PSQI	>5	Low
24	(Dirksen, Epstein, & Hoyt, 2009)	27	51	0	74	52-94	2009	US	North America	CS	Prostate	Mixed	Mixed	ISI	≥8	Moderate
25	(Gibbins et al., 2009)	28	60	33	67	32-80	2009	US	North America	CS	Mixed	Advanced	> 3 month After/Treat	ESS	≥15	Moderate
26	(K. Mystakidou et al., 2009)	79	82	46	62.6	26-87	2009	Greek	Europe	CS	Mixed	Advanced	> 3 month After/Treat	PSQI	>5	Moderate
27	(Aouizerat et al., 2009)	75	168	75	60.9		2009	US	North America	LG	Mixed	Mixed	Under/Treat	GSDS	≥ 43	Low
28	(Price et al., 2009)	348	796	796	60.5	22-82	2009	Australia	Australia	LG	Gynaecolo gical	Mixed	Mixed	ISI	≥7	Low
29	(Josée Savard, Villa, Ivers, Simard, & Morin, 2009)	559	939	630	57.1		2009	Canada	North America	LG	Mixed	Mixed	Mixed	Clinical Int	NG	Low
30	(Berger et al., 2009)	58	206	206	51	29-83	2009	US	North America	LG	Breast	Localized	Under/Treat	PSQI	≥ 8	Moderate
31	(Oxana G. Palesh et al., 2010)	362	823	593	58	22-93	2010	US	North America	LG	Mixed	Mixed	Under/Treat	HDI	NG	Moderate
32	(Van Onselen et al., 2010)	102	178	85	60.1		2010	US	North America	CS	Mixed	Mixed	Under/Treat	PSQI	>5	Moderate
33	(Vargas et al., 2010)	170	240	240	50.2		2010	US	North America	CS	Mixed	Mixed	Mixed	PSQI	>5	Moderate
34	(Otte, Carpenter, Russell, Bigatti, & Champion, 2010)	160	246	246	48.2		2010	US	North America	CS	Breast	No Evidence of Disease	> 3 month After/Treat	PSQI	>5	Moderate
35	(Dodd, Cho, Cooper, & Miaskowski, 2010)	63	112	112	50.1	28-78	2010	US	North America	LG	Breast	Localized	Under/Treat	GSDS	≥ 43	Moderate
36	(Barsevick et al., 2010)	222	292	240	53.9		2010	US	North America	LG	Mixed	Mixed	Under/Treat	PSQI	>5	Moderate
37	(Beck et al., 2010)	119	183	183	50.7	28-75	2010	US	North America	LG	Breast	Localized	Under/Treat	PSQI	>5	Moderate
38	(Park, Lee, Gwak, Shim, & Lee, 2010)	72	94	94	52		2010	Korea	Asia	CS	Breast	Localized	Under/Treat	PSQI	>5	Moderate
39	(Garrett et al., 2011)	85	160	78	60.9		2011	US	North America	CS	Mixed	Mixed	Under/Treat	PSQI	>5	Moderate
40	(Miaskowski, Paul, et al., 2011)	59	82	00	67.1		2011	US	North America	LG	Prostate	Localized	Mixed	GSDS	≥ 43	Low
41	(Miaskowski, Lee, et al., 2011)	77	185	89	60.5 6	24-85	2011	US	North America	LG	Mixed	Localized	Under/Treat	GSDS	≥ 43	Moderate
42	(Sandadi et al., 2011)	58	86	86	58.1	19-89	2011	US	North America	CS	Gynaecolo gical	Mixed	Under/Treat	PSQI	≥5	Moderate

43	(Delgado-Guay, Yennurajalingam, Parsons, Palmer, & Bruera, 2011)	86	101	53	60	25-84	2011	US	North America	CS	Mixed	Advanced	Under/Treat	PSQI	>5	Moderate
44	(Bower et al., 2011)	67	103	103	51.2	32-66	2011	US	North America	LG	Breast	Localized	Under/Treat	PSQI	>5	Moderate
45	(Hanisch et al., 2011)	14	60	0	71.4	54-88	2011	US	North America	CS	Prostate	Localized	Under/Treat	ESS	≥10	Moderate
46	(Colagiuri et al., 2011)	1738	3002	3002	54.4	26-70	2011	Denmark	Europe	CS	Breast	Mixed	Mixed	PSQI	>5	Low
47	(Moore, Berger, & Dizona, 2011)	124	206	206	52.1 3	29-79	2011	US	North America	LG	Breast	Localized	Under/Treat	PSQI	>5	Moderate
48	(Grutsch et al., 2011)	70	84	19	62	40-94	2011	US	North America	LG	Lung	Advanced	Under/Treat	PSQI	>5	Moderate
49	(JL. Sun, Chiou, & Lin, 2011)	84	195	116	56.7		2011	Taiwan	Asia	CS	Mixed	Mixed	> 3 month After/Treat	AIS	>7	Moderate
50	(Rand et al., 2011)	239	395	395	59.3	35-85	2011	Norway	Europe	CS	Mixed	Mixed	Under/Treat	PSQI	>5	Moderate
51	(Kotronoulas, Papadopoulou, Papapetrou, & Patiraki, 2011)	114	209	124	54.9	19-85	2011	Greek	Europe	CS	Mixed	Mixed	Mixed	PSQI	≥8	Moderate
52	(Enderlin et al., 2011)	47	67	67	65.1	50-90	2011	US	North America	CS	Breast	Mixed	Mixed	PSQI	>5	Moderate
53	(Dhruva et al., 2012)	40	73	73	55		2012	US	North America	LG	Breast	Mixed	Under/Treat	GSDS	≥ 43	Moderate
54	(Phillips et al., 2012) (Phillips, Jim, Donovan, Pinder-Schenck, & Jacobsen, 2012)	165	288	187	56.7		2012	US	North America	CS	Mixed	Mixed	Mixed	PSQI	>5	Moderate
55	(Forsythe et al., 2012) (Forsythe, Helzlsouer, MacDonald, & Gallicchio, 2012)	255	1171	910	64.3		2012	US	North America	CS	Mixed	Mixed	> 3 month After/Treat	ESS	≥10	Moderate
56	(Liu, Rissling, et al., 2012)	59	97	97	50.7	34-79	2012	US	North America	LG	Breast	Localized	Under/Treat	PSQI	>5	Low
57	(Mosher & Duhamel, 2012)	63	90	90	57.9		2012	US	North America	CS	Breast	Advanced	> 3 month After/Treat	PSQI	>5	Low
58	(Liu, Mills, et al., 2012)	40	53	53	50.3	34-79	2012	US	North America	LG	Breast	Localized	Under/Treat	PSQI	>5	Moderate
59	(Clevenger et al., 2012)	103	133	133	60.4		2012	US	North America	LG	Gynaecolo gical	Mixed	Under/Treat	PSQI	>5	Moderate
60	(Van Onselen et al., 2012)	219	398	398	54.9		2012	US	North America	LG	Breast	Localized	Under/Treat	GSDS	≥43	Low
61	(Mansano-Schlosser & Ceolim, 2012)	78	140	72	69.8		2012	Brazil	South America	CS	Mixed	Mixed	Mixed	PSQI	>5	Moderate
62	(Taylor et al., 2012)	22	51	51	64	31-87	2012	US	North America	CS	Breast	Localized	> 3 month After/Treat	ISI	≥7	Moderate
63	(Tzeng, Fu, & Lin, 2012)	162	205	70	58.4		2012	Taiwan	Asia	CS	Mixed	Mixed	Mixed	PSQI	>5	Moderate
64	(Desai et al., 2013)	207	413	413	61.7	33-88	2013	US	North America	CS	Breast	Localized	Under/Treat	ISI	≥ 8	Moderate

65	(Clevenger et al., 2013)	123	173	173	59.4		2013	US	North America	LG	Gynaecolo gical	Mixed	Under/Treat	PSQI	>5	Moderate
66	(Sanford et al., 2013)	53	80	80	49.7	29-71	2013	US	North America	LG	Breast	Localized	Under/Treat	PSQI	≥5	Moderate
67	(Saini et al., 2013)	102	173	79	58.8	20-80	2013	Italy	Europe	CS	Mixed	Mixed	Under/Treat	PSQI	≥5	Moderate
68	(Caplette-Gingras, Savard, Savard, & Ivers, 2013)	47	63	63	50		2013	Canada	North America	CS	Breast	Localized	Under/Treat	ISI	≥7	Moderate
69	(Nakamura, Lipschitz, Kuhn, Kinney, & Donaldson, 2013)	30	57	43	52		2013	US	North America	LG	Mixed	Mixed	Mixed	MOS-SS	35	Moderate
70	(Hall, Mishel, & Germino, 2014)	187	313	313	43.9	24-50	2014	US	North America	CS	Breast	No Evidence of Disease	> 3 month After/Treat	ISI	≥8	Moderate
71	(Doong et al., 2015)	230	393	393	54.2		2014	US	North America	CS	Breast	Mixed	Under/Treat	GSDS	≥ 43	Moderate
72	(R. T. H. Ho & Fong, 2014)	91	197	197	49.4		2014	Hong Kong	Asia	LG	Breast	Localized	Under/Treat	PSQI	≥8	Low
73	(Ma, Chang, & Lin, 2014)	25	68	34	52.4		2014	Taiwan	Asia	CS	Mixed	Mixed	> 3 month After/Treat	PSQI	≥5	Moderate
74	(Hong, Tian, & Wu, 2014)	486	706	257	52.4		2014	China	Asia	CS	Mixed	Mixed	Under/Treat	PSQI	≥5	Moderate
75	(J. J. Mao et al., 2014)	55	67	67	59.7	41-76	2014	US	North America	LG	Breast	Localized	Under/Treat	PSQI	>5	Moderate
76	(Romito et al., 2014)	302	403	252	57	20-86	2014	Italy	Europe	CS	Mixed	Mixed	Under/Treat	PSQI	≥5	Low
77	(Vargas et al., 2014)	168	240	240	50		2014	US	North America	LG	Breast	Localized	Under/Treat	PSQI	>5	Low
78	(Courneya et al., 2014)	152	296	296	50.9		2014	Canada	North America	LG	Breast	Localized	Under/Treat	PSQI	>5	Low
79	(Kashani & Kashani, 2014)	54	57	57	43	23-63	2014	Iran	Asia	LG	Breast	Localized	Under/Treat	PSQI	>5	Moderate
80	(Valko et al., 2015)	14	65	21	57.3		2015	Switzerlan d	Europe	CS	Brain	Localized	Under/Treat	ESS	≥10	Moderate
81	(SY. Ho, Rohan, Parent, Tager, & McKinley, 2015)	101	134	134	50.7		2015	US	North America	LG	Breast	Localized	Under/Treat	PSQI	>5	Moderate
82	(Klyushnenkova, Sorkin, & Gallicchio, 2015)	138	861	861	62	33-95	2015	US	North America	CS	Breast	No Evidence of Disease	> 3 month After/Treat	ESS	≥10	Moderate
83	(Mercadante et al., 2015)	499	890	391	69.7		2015	Italy	Europe	CS	Mixed	Advanced	Mixed	AIS	≥6	Low
84	(He et al., 2015)	88	162	124	40.2		2015	China	Asia	CS	Head and Neck	Mixed	Under/Treat	PSQI	>5	Moderate
85	(Nishiura, Tamura, Nagai, & Matsushima, 2015)	28	50	15	71.8		2015	Japan	Asia	CS	Lung	Advanced	Mixed	AIS	≥6	Moderate
86	(Yu & Nho, 2015)	97	152	152	54.1	22-72	2015	Korea	Asia	CS	Gynaecolo gical	Mixed	Under/Treat	PSQI	≥5	Moderate
87	(Qin et al., 2015)	31	60	23	39.3		2015	China	Asia	CS	Head and Neck	Advanced	Under/Treat	PSQI	≥5	Moderate
88	(Morris et al., 2015)	297	500	380		20-80	2015	Australia	Australia	CS	Mixed	Mixed	Mixed	ISI	≥7	Low

89	(Tian, Chen, & Zhang, 2015)	49	76	76	48.4		2015	China	Asia	LG	Gynaecolo gical	Localized	Under/Treat	PSQI	>5	Moderate
90	(Josée Savard, Ivers, Savard, & Morin, 2015)	305	465	465	54.9		2015	Canada	North America	LG	Breast	Localized	Under/Treat	ISI	>8	Low
91	(Josée Savard et al., 2015)	96	263	0	61.7		2015	Canada	North America	LG	Prostate	Localized	Under/Treat	ISI	>8	Low
92	(Akman, Yavuzsen, Sevgen, Ellidokuz, & Yilmaz, 2015)	127	314	167	58.5	28-84	2015	Turkey	Asia	CS	Mixed	Mixed	Under/Treat	PSQI	>5	Moderate
93	(Berrett-Abebe, Cadet, Pirl, & Lennes, 2015)	35	67	41	51.8		2015	US	North America	CS	Mixed	No Evidence of Disease	> 3 month After/Treat	PSQI	>5	Moderate
94	(Roscoe et al., 2015)	88	96	84	56		2015	US	North America	LG	Mixed	No Evidence of Disease	> 3 month After/Treat	ISI	>8	Low
95	(Lafçi & Öztunç, 2015)	59	60	60	46.4	27-69	2015	Turkey	Asia	LG	Breast	Mixed	Under/Treat	PSQI	>5	Moderate
96	(CC. Li, Tsai, Chang, & Chen, 2017)	52	95	95	57.4		2016	Taiwan	Asia	CS	Gynaecolo gical	Mixed	Under/Treat	PSQI	>5	Moderate
97	(Jung et al., 2016)	40	198	198	46.3		2016	Korea	Asia	LG	Breast	Localized	Under/Treat	ISI	≥ 8	Moderate
98	(Collins et al., 2017)	172	292	105	62		2016	US	North America	CS	Mixed	Advanced	> 3 month After/Treat	PSQI	>5	Moderate
99	(Bagheri-Nesami et al., 2016)	89	100	53	44		2016	Iran	Asia	CS	Lymphom a	Mixed	Under/Treat	PSQI	>5	Moderate
100	(Fontes, Gonçalves, Pereira, & Lunet, 2017)	302	501	501			2017	Portugal	Europe	LG	Breast	Mixed	> 3 month After/Treat	PSQI	>5	Low
101	(Loth et al., 2017)	20	51	14	61.1		2017	France	Europe	CS	Head and Neck	Advanced	Under/Treat	ESS	≥10	Moderate
102	(Mercadante et al., 2017)	219	219	108	65.4	23-90	2017	Italy	Europe	CS	Mixed	Advanced	Mixed	AIS	≥6	Moderate
103	(Halle et al., 2017)	161	264	112	65.8		2017	Norway	Europe	LG	Lung	Mixed	Under/Treat	GSDS	≥43	Moderate
104	(Chung, Youn, & Choi, 2017)	119	124	77	55.1	25-84	2017	Korea	Asia	CS	Mixed	Mixed	Mixed	ISI	≥7	Moderate
105	(Ji et al., 2017)	74	170	97	56.6	32-77	2017	China	Asia	LG	Mixed	Mixed	Under/Treat	PSQI	>5	Moderate
106	(Davies, Patel, Gregory, & Lee, 2017)	123	174	100	66	35-90	2017	UK	Europe	CS	Mixed	Advanced	Mixed	PSQI	≥5	Moderate
107	(Echchikhi et al., 2017)	136	284	215	49.5	17-80	2017	Morocco	Africa	CS	Mixed	Mixed	Mixed	ISI	≥7	Moderate
108	(Rogers et al., 2017)	171	222	222	54.4		2017	US	North America	LG	Breast	No Evidence of Disease	> 3 month After/Treat	PSQI	>5	Low
109	(Cha et al., 2017)	95	208	165	50.7	19-81	2017	Korea	Asia	CS	Mixed	Mixed	> 3 month After/Treat	ISI	>15	Moderate
110	(Peoples et al., 2017)	85	95	84	56.2	26-75	2017	US	North America	LG	Mixed	No Evidence of Disease	> 3 month After/Treat	ISI	>8	Moderate
111	(Mansano-Schlosser, Ceolim, & Valerio, 2017)	90	156	156			2017	Brazil	South America	CS	Breast	Localized	Under/Treat	PSQI	>5	Moderate
112	(N. Li, Otomaru, & Taniguchi, 2017)	64	77	25	67.7	26-86	2017	Japan	Asia	CS	Head and Neck	No Evidence of Disease	> 3 month After/Treat	PSQI	>5	Moderate

113	(Miladinia, Baraz, Ramezani, & Malehi, 2018)	274	406	186	33.4		2018	Iran	Asia	CS	Leukaemi a	Mixed	Under/Treat	PSQI	>5	Moderate
114	(Gu et al., 2018)	92	202		61.2		2018	China	Asia	CS	Lung	Mixed	Under/Treat	PSQI	>5	Moderate
115	(Adams et al., 2018)	18	62	0	43.7	21-61	2018	Canada	North America	LG	Testicular	Localized	> 3 month After/Treat	PSQI	>5	Moderate
116	(Steel et al., 2018)	173	294	106	61.9		2018	US	North America	CS	Gastrointe stinal	Advanced	> 3 month After/Treat	PSQI	>5	Moderate
117	(Henneghan, Carter, Stuifbergan, Parmelee, & Kesler, 2018)	57	90	90	49		2018	US	North America	CS	Breast	Localized	> 3 month After/Treat	PSQI	≥6	Moderate
118	(Jim et al., 2018)	257	570	241	54.8		2018	US	North America	LG	Mixed	Mixed	> 3 month After/Treat	PSQI	≥5	Moderate
119	(Nelson et al., 2018)	35	84	60	38		2018	US	North America	CS	Mixed	Mixed	> 3 month After/Treat	ISI	≥ 8	Moderate
120	(Gonzalez et al., 2018)	46	78	0	68.5		2018	US	North America	CS	Prostate	Localized	> 3 month After/Treat	ISI	≥8	Moderate
121	(Dreher et al., 2018)	74	100	33	68.1		2018	Germany	Europe	LG	Lung	Mixed	Under/Treat	PSQI	≥5	Moderate
122	(H. Mao et al., 2018)	605	1103	1103	63.2	20-92	2018	US	North America	LG	Breast	Localized	> 3 month After/Treat	ISI	≥15	Low
123	(Johansen, Cvancarova, & Ruland, 2018)	212	281	162	57	18-86	2018	Norway	Europe	CS	Mixed	Mixed	Under/Treat	GSDS	≥ 43	Moderate
124	(Lowery-Allison et al., 2018)	76	200	200	57		2018	US	North America	CS	Breast	No Evidence of Disease	> 3 month After/Treat	PSQI	>8	Moderate
125	(Overcash, Tan, Patel, & Noonan, 2018)	20	60	60	77.6	69-93	2018	US	North America	CS	Breast	Mixed	Under/Treat	PSQI	>5	Moderate
126	(O. Palesh et al., 2018)	36	71	71	52.5		2018	US	North America	LG	Mixed	Localized	Under/Treat	ISI	>8	Moderate
127	(Saberzadeh-Ardestani, Khosravi, Zebardast, & Sadighi, 2019)	16	74	42	68.9		2019	Iran	Asia	LG	Breast	Mixed	> 3 month After/Treat	ESS	≥10	Moderate
128	(Berger, Kupzyk, Djalilova, & Cowan, 2019)	690	1302	1302	60.1	21-90	2019	US	North America	CS	Breast	Localized	> 3 month After/Treat	PSQI	>5	Low
129	(W. Li et al., 2019)	137	180	180	53	22-74	2019	China	Asia	LG	Breast	Localized	Under/Treat	PSQI	>5	Moderate
130	(Tejada et al., 2019)	998	1331	1037	57.1		2019	US	North America	LG	Mixed	Mixed	Under/Treat	GSDS	≥ 43	Low
131	(GW. Sun et al., 2020)	166	434	180	62.6	25-89	2019	China	Asia	CS	Gastrointe stinal	Mixed	Under/Treat	AIS	≥6	Moderate
132	(Papadopoulos, Kiagia, Charpidou, Gkiozos, & Syrigos, 2019)	70	119	34	64		2019	Greek	Europe	CS	Lung	Mixed	> 3 month After/Treat	PSQI	>5	Moderate
133	(Zubair, Mumtaz, & Taj, 2019)	112	170	60	52.1		2019	Pakistan	Asia	CS	Head and Neck	Mixed	> 3 month After/Treat	PSQI	>5	Moderate
134	(Imanian, Imanian, & Karimyar, 2019)	114	115	115	47	25-69	2019	Iran	Asia	CS	Breast	Localized	Under/Treat	PSQI	>5	Moderate

135	(Schieber et al., 2019)	260	405	227	58.6	20-90	2019	Germany	Europe	LG	Mixed	Mixed	Under/Treat	ISI	≥7	Moderate
136	(Liou et al., 2019)	556	1072	1072	62.1		2019	US	North America	CS	Breast	Localized	> 3 month After/Treat	ISI	≥8	Low
137	(Fleming et al., 2019)	97	173	173	58		2019	UK	Europe	LG	Breast	Localized	Under/Treat	ISI	≥7	Low
138	(Fong & Ho, 2020)	71	127	74	68		2019	Hong Kong	Asia	LG	Gastrointe stinal	Localized	Under/Treat	PSQI	≥ 8	Moderate
139	(Garland et al., 2019)	157	160	91	61.5		2019	US	North America	LG	Mixed	No Evidence of Disease	> 3 month After/Treat	ISI	>8	Moderate
140	(Strollo, Fallon, Gapstur, & Smith, 2020)	968	1903	1193	64.5		2020	US	North America	CS	Mixed	Localized	> 3 month After/Treat	PSQI	>5	Moderate
141	(Yoshikawa et al., 2020)	70	139	42	64	35-89	2020	Japan	Asia	CS	Gastrointe stinal	Mixed	Under/Treat	PSQI	>5	Moderate
142	(Saesen, van der Veen, Buyse, & Nuyts, 2021)	20	50	17	64.2	32-88	2020	Belgium	Europe	LG	Head and Neck	Mixed	Under/Treat	ESS	≥10	Moderate
143	(İzci et al., 2020)	23	56	56	53		2020	Turkey	Asia	CS	Breast	Localized	> 3 month After/Treat	PSQI	>5	Moderate
144	(Şanlier, Şahin, Demirkazik, Özkan, & Şenler, 2020)	144	264	132	57.3	19-88	2020	Turkey	Asia	CS	Breast	Localized	Under/Treat	PSQI	>5	Moderate
145	(Al Maqbali et al., 2020)	288	369	245		20-75	2020	Oman	Asia	CS	Mixed	Mixed	> 3 month After/Treat	PSQI	>5	Moderate
146	(Fekih-Romdhane et al., 2020)	33	50	50	52	34-65	2020	Tunis	Africa	CS	Breast	Mixed	Under/Treat	PSQI	>5	Moderate
147	(Pai, Sivanandh, & Udupa, 2020)	53	92	67	53	18-79	2020	India	Asia	CS	Mixed	Mixed	Under/Treat	PSQI	>5	Moderate
148	(Hoang, Molassiotis, Chan, Nguyen, & Liep Nguyen, 2020)	91	213	129	53.1		2020	Vietnam	Asia	CS	Mixed	Mixed	Under/Treat	ISI	≥7	Moderate
149	(Chan, Jheng, & Wang, 2020)	60	98	98	51.4		2020	Taiwan	Asia	CS	Breast	No Evidence of Disease	> 3 month After/Treat	PSQI	>5	Moderate
150	(Lin, Cheng, Nejati, et al., 2020)	438	573	247	61.3		2020	Iran	Asia	LG	Mixed	advanced	Mixed	ISI	>8	Moderate
151	(Lin, Cheng, Imani, et al., 2020)	773	859	348	67.4		2020	Iran	Asia	LG	Mixed	advanced	> 3 month After/Treat	PSQI	>5	Low
152	(Martin et al., 2020)	37	64	64	57.8	22-75	2020	US	North America	CS	Breast	No Evidence of Disease	> 3 month After/Treat	ISI	>8	Moderate
153	(Gonzalez et al., 2021)	451	632	632	55		2021	US	North America	LG	Breast	Mixed	> 3 month After/Treat	PSQI	≥5	Moderate
154	(Santoso et al., 2021)	246	560	142	63		2021	Netherlan d	Europe	CS	Head and Neck	Mixed	Under/Treat	PSQI	>5	Moderate
155	(Al Maqbali, 2021)	98	133	133		20-75	2021	Oman	Asia	CS	Mixed	Mixed	> 3 month After/Treat	PSQI	>5	Moderate
156	(Kreutz, Müller, Schmidt, & Steindorf, 2021)	28	54	54	49		2021	Germany	Europe	CS	Mixed	Mixed	> 3 month After/Treat	PSQI	>5	Moderate
157	(Ratcliff et al., 2021)	200	375	375	49.8 2		2021	US	North America	LG	Breast	Localized	Under/Treat	PSQI	>5	Moderate
158	(Daldoul et al., 2021)	28	70	70	43		2021	Tunis	Africa	CS	Breast	Mixed	Under/Treat	ISI	>8	Moderate

159	(Nguyen et al., 2021)	61	80	80	62	2021	Australia	Australia	LG	Breast	No Evidence of Disease	> 3 month After/Treat	PSQI	>5	Moderate
160	(Jeon et al., 2021)	43	81	31	51.1	2021	Australia	Australia	CS	Brain	Mixed	Mixed	PSQI	>5	Moderate

CS= Cross Sectional; LG= Longitudinal; Athens Insomnia Scale (AIS); Epworth Sleepiness Scale (ESS); General Sleep Disturbance Scale (GSDS); Hamilton Depression Inventory (HDI); Insomnia Severity Index (ISI); Medical Outcomes Study-Sleep Scale (MOS-SS); Pittsburgh Sleep Quality Index (PSQI); Sleep Disturbance Adult Scale (SDAS); Sleep Impairment Index (SII); Sleep Questionnaire (SQ); Women's Health Initiative- -Sleep Disturbance Scale (WHI-SDS). **Supplementary Table 2:** Quality assessment result of observational Studies using the Newcastle-Ottawa Scale.

	Study	Representativeness of the sample (One Point)	Sample Size (One Point)	Non-Respondents (One Point)	Ascertainment of the exposure (One Point)	Study controls for other variable (Two Point)	Assessment of Outcome (One Point)	Statistical Test (One Point)	Adequate Follow up time (One Point)	Score	
1	(Carpenter & Andrykowski, 1998)	0	0	1	1	1	1	1	0	5	Moderate
2	(J. Savard et al., 2001)	0	0	1	1	1	1	1	0	5	Moderate
3	(Fortner et al., 2002)	0	0	1	1	1	1	1	0	5	Moderate
4	(Beck et al., 2004)	0	0	1	1	2	1	1	0	6	Moderate
5	(MH. Savard et al., 2005)	0	0	1	1	2	1	1	0	6	Moderate
6	(Josée Savard et al., 2005)	0	0	1	1	1	1	1	1	6	Moderate
7	(Sela et al., 2005)	0	0	0	1	2	1	1	0	5	Moderate
8	(Carlson & Garland, 2005)	0	0	1	1	2	1	1	0	6	Moderate
9	(Ancoli-Israel et al., 2006)	0	0	1	1	2	1	1	0	6	Moderate
10	(Gooneratne et al., 2007)	0	0	1	1	1	1	0	1	5	Moderate
11	(Berger et al., 2007)	0	0	1	1	2	1	1	1	7	Low
12	(Fox et al., 2007)	0	0	1	1	1	1	1	1	6	Moderate
13	(Oxana Gronskaya Palesh et al., 2007)	0	0	1	1	2	1	1	0	6	Moderate
14	(Akechi et al., 2007)	0	0	1	1	2	1	1	1	7	Low
15	(Kyriaki Mystakidou et al., 2007)	0	0	1	1	2	1	1	0	5	Moderate
16	(Shahidi et al., 2007)	0	0	0	1	1	1	1	1	5	Moderate
17	(Bardwell et al., 2008)	0	1	1	1	1	1	1	1	7	Low
18	(O. Palesh et al., 2008)	1	1	1	1	2	1	1	0	8	Low
19	(Rogers et al., 2008)	0	0	1	1	1	1	1	1	6	Moderate
20	(Chen et al., 2008)	0	0	0	1	2	1	1	1	6	Moderate
21	(Dirksen, Belyea, et al., 2009)	0	0	1	1	1	1	1	0	5	Moderate
22	(Tremblay et al., 2009)	0	0	1	1	1	1	1	1	6	Moderate
23	(Liu et al., 2009)	0	1	1	1	2	1	1	0	7	Low
24	(Dirksen, Epstein, et al., 2009)	0	1	1	1	1	1	1	0	6	Moderate
25	(Gibbins et al., 2009)	0	0	1	1	1	1	1	0	5	Moderate
26	(K. Mystakidou et al., 2009)	0	1	1	1	1	1	1	0	6	Moderate
27	(Aouizerat et al., 2009)	0	0	1	1	2	1	1	1	7	Low
28	(Price et al., 2009)	0	0	1	1	2	1	1	1	7	Low
29	(Josée Savard et al., 2009)	1	1	1	1	2	1	1	0	8	Low
30	(Berger et al., 2009)	0	0	1	1	1	1	1	1	6	Moderate
31	(Van Ongeler et al., 2010)	0	0	1	1	2	1	1	0	6	Moderate
32	(Vargas et al. 2010)	1	1	1	1	1	1	1	0	6	Moderate
33	(Vargas et al., 2010)	0	1	1	1	1	1	1	0	0	Moderate
34	(Dodd et al, 2010)	0	0	1	1	2	1	1	0	6	Moderata
35	(Barsavick et al., 2010)	0	0	1	1	1	1	1	1	6	Moderate
37	(Beck et al. 2010)	0	0	1	1	1	1	1	1	6	Moderate
38	(Beek et al., 2010) (Park et al., 2010)	0	0	1	1	1	1	1	1	6	Moderate
39	(Garrett et al., 2011)	0	0	1	1	2	1	1	0	5	Moderate
40	(Miaskowski, Paul. et al. 2011)	0	0	1	1	2	1	1	1	7	Low
41	(Miaskowski, Lee, et al., 2011)	1	0	1	1	1	1	1	0	6	Moderate
42	(Sandadi et al., 2011)	0	0	1	1	1	1	1	0	5	Moderate
43	(Delgado-Guay et al., 2011)	0	0	1	1	1	1	1	1	6	Moderate
44	(Bower et al., 2011)	0	0	1	1	1	1	1	1	6	Moderate
45	(Hanisch et al., 2011)	0	1	1	1	1	1	1	0	6	Moderate
46	(Colagiuri et al., 2011)	0	1	1	1	2	1	1	1	8	Low

47	(Moore et al., 2011)	0	1	1	1	1	1	1	0	6	Moderate
48	(Grutsch et al., 2011)	0	0	1	1	2	1	1	0	6	Moderate
49	(JL. Sun et al., 2011)	0	0	1	1	1	1	1	1	6	Moderate
50	(Rand et al., 2011)	0	0	0	1	1	1	1	1	5	Moderate
51	(Kotronoulas et al., 2011)	0	0	1	1	1	1	1	1	6	Moderate
52	(Enderlin et al., 2011)	0	0	0	1	1	1	1	1	5	Moderate
53	(Dhruva et al., 2012)	0	1	1	1	1	1	1	0	6	Moderate
54	(Phillips et al., 2012)	0	0	1	1	1	1	1	0	5	Moderate
55	(Forsythe et al., 2012)	0	0	1	1	1	1	1	1	6	Moderate
56	(Liu, Rissling, et al., 2012)	0	0	1	1	2	1	1	1	7	Low
57	(Mosher & Duhamel, 2012)	0	1	1	1	2	1	1	0	7	Low
58	(Liu, Mills, et al., 2012)	0	1	1	1	1	1	1	0	6	Moderate
59	(Clevenger et al., 2012)	0	0	1	1	2	1	1	0	6	Moderate
60	(Van Onselen et al., 2012)	0	1	1	1	2	1	1	0	7	Low
61	(Mansano-Schlosser & Ceolim, 2012)	0	0	0	1	1	1	1	1	5	Moderate
62	(Taylor et al., 2012)	0	0	0	1	1	1	1	1	5	Moderate
63	(Tzeng et al., 2012)	0	0	1	1	1	1	1	1	6	Moderate
64	(Desai et al., 2013)	0	0	1	1	1	1	1	0	5	Moderate
65	(Clevenger et al., 2013)	0	0	1	1	2	1	1	0	6	Moderate
66	(Sanford et al., 2013)	0	0	1	1	1	1	1	1	6	Moderate
67	(Saini et al., 2013)	0	0	0	1	2	1	1	0	5	Moderate
68	(Caplette-Gingras et al., 2013)	0	0	0	1	1	1	1	1	5	Moderate
69	(Nakamura et al., 2013)	0	0	1	1	1	1	1	1	6	Moderate
70	(Hall et al., 2014)	0	0	1	1	1	0	1	1	5	Moderate
71	(R. T. H. Ho & Fong, 2014)	0	0	1	1	2	1	1	1	7	Low
72	(Ma et al., 2014)	0	0	1	1	2	1	1	0	6	Moderate
73	(Hong et al., 2014)	0	0	0	1	2	1	1	0	5	Moderate
74	(J. J. Mao et al., 2014)	0	0	1	1	2	1	1	0	6	Moderate
75	(Romito et al., 2014)	0	1	1	1	2	1	1	0	7	Low
76	(Vargas et al., 2014)	1	1	1	1	2	1	1	0	8	Low
77	(Courneya et al., 2014)	0	1	1	1	2	1	1	0	7	Low
78	(Kashani & Kashani, 2014)	0	0	1	1	1	1	1	1	6	Moderate
79	(Valko et al., 2015)	1	0	1	1	1	1	1	0	6	Moderate
80	(SY. Ho et al., 2015)	0	0	1	1	2	1	1	0	6	Moderate
81	(Klyushnenkova et al., 2015)	0	0	1	1	1	1	1	0	5	Moderate
82	(Mercadante et al., 2015)	0	1	1	1	1	1	1	1	7	Low
83	(He et al., 2015)	0	0	1	1		1	1	0	5	Moderate
84	(Nishiura et al., 2015)	0	1	1	1	1	1	1	0	6	Moderate
85	(No. 6 NHz 2015)	0	0	1	1	1	1	1	1	6	Moderate
80 97	(Yu & Nho, 2015)	0	0	0	1	2	1	1	0	5	Moderate
0/	(Morris et al. 2015)	0	1	1	1	2	1	1	0	5	Low
00 80	(Mons et al., 2015)	0	1	1	1	2	1	1	0	6	Moderate
00	(Iosée Savard et al. 2015)	0	1	1	1	2	1	1	0	7	Low
91	(Josée Savard et al. 2015)	0	1	1	1	2	1	1	0	7	Low
92	(Akman et al. 2015)	0	0	1	1	1	1	1	1	6	Moderate
93	(Berrett-Abebe et al. 2015)	0	0	0	1	1	1	1	1	5	Moderate
94	(Boscoe et al. 2015)	0	1	1	1	2	1	1	0	7	Low
95	(Lafci & Öztunc. 2015)	0	0	0	1	1	1	1	1	5	Moderate
96	(Jung et al. 2016)	0	0	1	1	1	1	1	0	5	Moderate
97	(Bagheri-Nesami et al., 2016)	0	0	1	1	1	1	1	0	5	Moderate
98	(CC. Li et al., 2017)	0	0	1	1	1	0	1	1	5	Moderate
99	(Collins et al., 2017)	1	0	1	1	1	1	1	0	6	Moderate
100	(Fontes et al., 2017)	0	0	1	1	2	1	1	1	7	Low
101	(Loth et al., 2017)	0	0	1	1	1	1	1	0	5	Moderate
102	(Mercadante et al., 2017)	0	0	1	1	1	1	1	1	6	Moderate
	• · · · · · · · · · · · · · · · · · · ·		i					i			

103	(Halle et al., 2017)	0	0	1	1	2	1	0	1	6	Moderate
104	(Chung et al., 2017)	0	0	0	1	1	1	1	1	5	Moderate
105	(Ji et al., 2017)	0	0	0	1	1	1	1	1	5	Moderate
106	(Davies et al., 2017)	0	0	1	1	1	1	1	1	6	Moderate
107	(Echchikhi et al., 2017)	0	0	0	1	1	1	1	1	5	Moderate
108	(Rogers et al., 2017)	0	1	1	1	2	1	1	0	7	Low
109	(Cha et al., 2017)	0	0	0	1	1	1	1	1	5	Moderate
110	(Peoples et al., 2017)	0	0	0	1	2	1	1	0	5	Moderate
111	(Mansano-Schlosser et al., 2017)	0	0	1	1	1	1	1	1	6	Moderate
112	(N. Li et al., 2017)	0	0	1	1	1	1	1	1	6	Moderate
113	(Miladinia et al., 2018)	0	0	1	1	1	1	1	1	6	Moderate
114	(Gu et al., 2018)	0	0	1	1	1	1	1	0	5	Moderate
115	(Adams et al., 2018)	0	0	1	1	2	1	1	0	6	Moderate
116	(Steel et al., 2018)	1	0	1	1	1	1	1	0	6	Moderate
117	(Henneghan et al., 2018)	0	0	1	1	1	1	1	0	5	Moderate
118	(Jim et al., 2018)	0	0	1	1	2	1	1	0	6	Moderate
119	(Nelson et al., 2018)	0	0	1	1	1	1	1	0	5	Moderate
120	(Gonzalez et al., 2018)	0	0	1	1	1	1	1	1	6	Moderate
121	(Dreher et al., 2018)	0	0	1	1	1	1	1	0	5	Moderate
122	(H. Mao et al., 2018)	1	1	1	1	2	1	1	0	8	Low
123	(Johansen et al., 2018)	0	0	1	1	1	1	1	1	6	Moderate
124	(Lowery-Allison et al., 2018)	0	0	0	1	1	1	1	1	5	Moderate
125	(Overcash et al., 2018)	0	0	0	1	1	1	1	1	5	Moderate
126	(O. Palesh et al., 2018)	0	0	1	1	1	1	1	1	6	Moderate
127	(Saberzadeh-Ardestani et al., 2019)	0	0	1	1	2	1	0	0	5	Moderate
128	(Berger et al., 2019)	0	1	1	1	2	1	1	0	7	Low
129	(W. Li et al., 2019)	0	0	1	1	1	1	1	0	5	Moderate
130	(Tejada et al., 2019)	0	1	1	1	2	1	1	0	7	Low
131	(Papadopoulos et al., 2019)	0	0	1	1	1	1	1	0	5	Moderate
132	(Zubair et al., 2019)	0	0	1	1	1	1	1	0	5	Moderate
133	(Imanian et al., 2019)	0	0	1	1	1	1	1	0	5	Moderate
134	(Schieber et al., 2019)	0	0	0	1	1	1	1	1	5	Moderate
135	(Liou et al., 2019)	0	0	1	1	2	1	1	1	7	Low
136	(Fleming et al., 2019)	0	1	1	1	2	1	1	0	7	Low
137	(Garland et al., 2019)	0	0	1	1	1	1	1	1	6	Moderate
138	(GW. Sun et al., 2020)	0	0	1	1	1	1	1	1	6	Moderate
139	(Strollo et al., 2020)	0	0	1	1	1	1	1	0	5	Moderate
140	(Yoshikawa et al., 2020)	0	0	1	1	1	1	1	0	5	Moderate
141	(İzci et al., 2020)	0	0	1	1	1	1	1	0	5	Moderate
142	(Şanlier et al., 2020)	1	0	1	1	1	1	1	0	6	Moderate
143	(Al Maqbali et al., 2020)	0	0	1	1	2	1	1	0	6	Moderate
144	(Fekih-Romdhane et al., 2020)	0	0	0	1	1	1	1	1	5	Moderate
145	(Pai et al., 2020)	0	0	1	1	1	1	1	0	5	Moderate
146	(Fong & Ho, 2020)	0	0	1	1	2	1	1	0	6	Moderate
147	(Hoang et al., 2020)	0	0	0	1	1	1	1	1	5	Moderate
148	(Chan et al., 2020)	0	0	0	1	1	1	1	1	5	Moderate
149	(Lin, Cheng, Nejati, et al., 2020)	0	0	1	1	2	1	1	0	6	Moderate
150	(Lin, Cheng, Imani, et al., 2020)	1	1	1	1	2	1	1	0	8	Low
151	(Martin et al., 2020)	0	0	1	1	1	1	1	1	6	Moderate
152	(Saesen et al., 2021)	0	0	0	1	2	1	1	0	5	Moderate
153	(Gonzalez et al., 2021)	0	0	1	1	2	1	1	0	6	Moderate
154	(Santoso et al., 2021)	0	0	1	1	2	1	1	0	6	Moderate
155	(Al Maqbali, 2021)	0	0	1	1	1	1	1	0	5	Moderate
156	(Kreutz et al., 2021)	0	0	0	1	2	1	1	1	6	Moderate
157	(Ratcliff et al., 2021)	0	0	1	1	2	1	1	0	6	Moderate
158	(Daldoul et al., 2021)	0	0	0	1	1	1	1	1	5	Moderate

159	(Nguyen et al., 2021)	0	0	1	1	1	1	1	1	6	Moderate
160	(Jeon et al., 2021)	0	0	1	1	1	1	1	0	5	Moderate

Ratings: Low Risk of Bias 7-9: Moderate Risk of Bias: 5-6: High Risk of Bias: 1-4.

References

- Adams, S. C., DeLorey, D. S., Davenport, M. H., Fairey, A. S., North, S., & Courneya, K. S. (2018). Effects of high-intensity interval training on fatigue and quality of life in testicular cancer survivors. *British Journal of Cancer*, *118*(10), 1313–1321. https://doi.org/10.1038/s41416-018-0044-7
- Akechi, T., Okuyama, T., Akizuki, N., Shimizu, K., Inagaki, M., Fujimori, M., ... Uchitomi, Y. (2007). Associated and predictive factors of sleep disturbance in advanced cancer patients. *Psycho-Oncology*, 16(10), 888–894.
- Akman, T., Yavuzsen, T., Sevgen, Z., Ellidokuz, H., & Yilmaz, A. U. (2015). Evaluation of sleep disorders in cancer patients based on Pittsburgh Sleep Quality Index. *European Journal of Cancer Care*, 24(4), 553–559.
- Al Maqbali, M. (2021). Sleep Disturbance Among Arabic Breast Cancer Survivors. *Supportive Care in Cancer*. https://doi.org/10.1007/s00520-021-06088-x
- Al Maqbali, M., Hughes, C., Rankin, J., Dunwoody, L., Hacker, E. D., & Gracey, J. (2020). Fatigue and Sleep Disturbance in Arabic Cancer Patients After Completion of Therapy: Prevalence, Correlates, and Association With Quality of Life. *Cancer Nursing*, 0. https://doi.org/doi: 10.1097/NCC.00000000000825
- Ancoli-Israel, S., Liu, L., Marler, M. R., Parker, B. A., Jones, V., Sadler, G. R., ... Fiorentino, L. (2006). Fatigue, sleep, and circadian rhythms prior to chemotherapy for breast cancer. *Supportive Care in Cancer*, 14(3), 201–209. https://doi.org/10.1007/s00520-005-0861-0
- Aouizerat, B. E., Dodd, M., Lee, K., West, C., Paul, S. M., Cooper, B. A., ... Miaskowski, C. (2009). Preliminary evidence of a genetic association between tumor necrosis factor alpha and the severity of sleep disturbance and morning fatigue. *Biological Research for Nursing*, 11(1), 27– 41. https://doi.org/10.1177/1099800409333871
- Bagheri-Nesami, M., Goudarzian, A. H., Jan Babaei, G., Badiee, M., Mousavi, M., & Sadegh Sharifi, M. (2016). Sleep Quality and Associated Risk Factors in Leukemia Patients Undergoing Chemotherapy in Iran. Asian Pacific Journal of Cancer Prevention: APJCP, 17(S3), 107–111. https://doi.org/10.7314/apjcp.2016.17.s3.107
- Bardwell, W. A., Profant, J., Casden, D. R., Dimsdale, J. E., Ancoli-Israel, S., Natarajan, L., ... Pierce, J. P. (2008). The relative importance of specific risk factors for insomnia in women treated for early-stage breast cancer. *Psycho-Oncology*, 17(1), 9–18. https://doi.org/10.1002/pon.1192
- Barsevick, A., Beck, S. L., Dudley, W. N., Wong, B., Berger, A. M., Whitmer, K., ... Stewart, K. (2010). Efficacy of an intervention for fatigue and sleep disturbance during cancer chemotherapy. *Journal of Pain and Symptom Management*, 40(2), 200–216. https://doi.org/10.1016/j.jpainsymman.2009.12.020

- Beck, S. L., Berger, A. M., Barsevick, A. M., Wong, B., Stewart, K. A., & Dudley, W. N. (2010). Sleep quality after initial chemotherapy for breast cancer. *Supportive Care in Cancer*, 18(6), 679–689. https://doi.org/10.1007/s00520-009-0662-y
- Beck, S. L., Schwartz, A. L., Towsley, G., Dudley, W., & Barsevick, A. (2004). Psychometric evaluation of the Pittsburgh sleep quality index in cancer patients. *Journal of Pain and Symptom Management*, 27(2), 140–148. https://doi.org/10.1016/j.jpainsymman.2003.12.002
- Berger, A. M., Farr, L. A., Kuhn, B. R., Fischer, P., & Agrawal, S. (2007). Values of sleep/wake, activity/rest, circadian rhythms, and fatigue prior to adjuvant breast cancer chemotherapy. *Journal of Pain and Symptom Management*, 33(4), 398–409. https://doi.org/10.1016/j.jpainsymman.2006.09.022
- Berger, A. M., Kuhn, B. R., Farr, L. A., Von Essen, S. G., Chamberlain, J., Lynch, J. C., & Agrawal, S. (2009). One-year outcomes of a behavioral therapy intervention trial on sleep quality and cancer-related fatigue. *Journal of Clinical Oncology*, 27(35), 6033–6040. https://doi.org/10.1200/JCO.2008.20.8306
- Berger, A. M., Kupzyk, K. A., Djalilova, D. M., & Cowan, K. H. (2019). Breast Cancer Collaborative Registry Informs Understanding Of Factors Predicting Sleep Quality. *Supportive Care in Cancer*, 27(4), 1365–1373. https://doi.org/10.1007/s00520-018-4417-5
- Berrett-Abebe, J., Cadet, T., Pirl, W., & Lennes, I. (2015). Exploring the relationship between fear of cancer recurrence and sleep quality in cancer survivors. *Journal of Psychosocial Oncology*, *33*(3), 297–309. https://doi.org/10.1080/07347332.2015.1020586
- Bower, J. E., Ganz, P. A., Irwin, M. R., Kwan, L., Breen, E. C., & Cole, S. W. (2011). Inflammation and Behavioral Symptoms After Breast Cancer Treatment: Do Fatigue, Depression, and Sleep Disturbance Share a Common Underlying Mechanism? *Journal of Clinical Oncology*, 29(26), 3517–3522. https://doi.org/10.1200/JCO.2011.36.1154
- Caplette-Gingras, A., Savard, J., Savard, M.-H., & Ivers, H. (2013). Is insomnia associated with cognitive impairments in breast cancer patients? *Behavioral Sleep Medicine*, *11*(4), 239–257. https://doi.org/10.1080/15402002.2012.672940
- Carlson, L. E., & Garland, S. N. (2005). Impact of mindfulness-based stress reduction (MBSR) on sleep, mood, stress and fatigue symptoms in cancer outpatients. *International Journal of Behavioral Medicine*, *12*(4), 278–285. https://doi.org/10.1207/s15327558ijbm1204_9
- Carpenter, J. S., & Andrykowski, M. A. (1998). Psychometric evaluation of the Pittsburgh sleep quality index. *Journal of Psychosomatic Research*, 45(1), 5–13.
- Cha, K. M., Chung, Y. K., Lim, K. Y., Noh, J. S., Chun, M., Hyun, S. Y., ... Kim, N. H. (2017). Depression and insomnia as mediators of the relationship between distress and quality of life in cancer patients. *Journal of Affective Disorders*, 217, 260–265. https://doi.org/10.1016/j.jad.2017.04.020
- Chan, Y.-N., Jheng, Y.-W., & Wang, Y.-J. (2020). Chemotherapy-Induced Peripheral Neurotoxicity as A Risk Factor for Poor Sleep Quality in Breast Cancer Survivors Treated with Docetaxel. *Asia-Pacific Journal of Oncology Nursing*, 8(1), 68–73. https://doi.org/10.4103/apjon.apjon_51_20
- Chen, M.-L., Yu, C.-T., & Yang, C.-H. (2008). Sleep disturbances and quality of life in lung cancer patients undergoing chemotherapy. *Lung Cancer*, 62(3), 391–400. https://doi.org/10.1016/j.lungcan.2008.03.016

- Chung, S., Youn, S., & Choi, B. (2017). Assessment of Cancer-Related Dysfunctional Beliefs about Sleep for Evaluating Sleep Disturbance in Cancer Patients. *Sleep Medicine Research*, 8(2), 98– 101. https://doi.org/10.17241/smr.2017.00073
- Clevenger, L., Schrepf, A., Christensen, D., DeGeest, K., Bender, D., Ahmed, A., ... Lutgendorf, S. K. (2012). Sleep disturbance, cytokines, and fatigue in women with ovarian cancer. *Brain, Behavior, and Immunity*, 26(7), 1037–1044. https://doi.org/10.1016/j.bbi.2012.04.003
- Clevenger, L., Schrepf, A., Degeest, K., Bender, D., Goodheart, M., Ahmed, A., ... Lutgendorf, S. K. (2013). Sleep disturbance, distress, and quality of life in ovarian cancer patients during the first year after diagnosis. *Cancer*, 119(17), 3234–3241. https://doi.org/10.1002/cncr.28188
- Colagiuri, B., Christensen, S., Jensen, A. B., Price, M. A., Butow, P. N., & Zachariae, R. (2011).
 Prevalence and Predictors of Sleep Difficulty in a National Cohort of Women With Primary
 Breast Cancer Three to Four Months Postsurgery. *Journal of Pain and Symptom Management*, 42(5), 710–720. https://doi.org/10.1016/j.jpainsymman.2011.02.012
- Collins, K. P., Geller, D. A., Antoni, M., Donnell, D. M. S., Tsung, A., Marsh, J. W., ... Steel, Jennifer. L. (2017). Sleep duration is associated with survival in advanced cancer patients. *Sleep Medicine*, 32, 208–212. https://doi.org/10.1016/j.sleep.2016.06.041
- Courneya, K. S., Segal, R. J., Mackey, J. R., Gelmon, K., Friedenreich, C. M., Yasui, Y., ... McKenzie, D. C. (2014). Effects of exercise dose and type on sleep quality in breast cancer patients receiving chemotherapy: A multicenter randomized trial. *Breast Cancer Research and Treatment*, 144(2), 361–369. https://doi.org/10.1007/s10549-014-2883-0
- Daldoul, A., Ammar, N., Krir, M. W., Khechine, W., Hajji, A., Bergaoui, H., ... Zoukar, O. (2021). Insomnia in breast cancer: Prevalence and associated factors. *BMJ Supportive & Palliative Care*. https://doi.org/10.1136/bmjspcare-2020-002718
- Davies, A. N., Patel, S. D., Gregory, A., & Lee, B. (2017). Observational study of sleep disturbances in advanced cancer. *BMJ Supportive & Palliative Care*, 7(4), 435–440. https://doi.org/10.1136/bmjspcare-2017-001363
- Delgado-Guay, M., Yennurajalingam, S., Parsons, H., Palmer, J. L., & Bruera, E. (2011). Association between self-reported sleep disturbance and other symptoms in patients with advanced cancer. *Journal of Pain and Symptom Management*, 41(5), 819–827. https://doi.org/10.1016/j.jpainsymman.2010.07.015
- Desai, K., Mao, J. J., Su, I., Demichele, A., Li, Q., Xie, S. X., & Gehrman, P. R. (2013). Prevalence and risk factors for insomnia among breast cancer patients on aromatase inhibitors. *Support Care Cancer*, 21(1), 43–51. https://doi.org/10.1007/s00520-012-1490-z
- Dhruva, A., Paul, S. M., Cooper, B. A., Lee, K., West, C., Aouizerat, B. E., ... Miaskowski, C. (2012). A longitudinal study of measures of objective and subjective sleep disturbance in patients with breast cancer before, during, and after radiation therapy. *Journal of Pain and Symptom Management*, 44(2), 215–228.
- Dirksen, S. R., Belyea, M. J., & Epstein, D. R. (2009). Fatigue-based subgroups of breast cancer survivors with insomnia. *Cancer Nursing*, 32(5), 404–411. https://doi.org/10.1097/NCC.0b013e3181a5d05e

- Dirksen, S. R., Epstein, D. R., & Hoyt, M. A. (2009). Insomnia, depression, and distress among outpatients with prostate cancer. *Applied Nursing Research: ANR*, 22(3), 154–158. https://doi.org/10.1016/j.apnr.2007.09.001
- Dodd, M. J., Cho, M. H., Cooper, B. A., & Miaskowski, C. (2010). The effect of symptom clusters on functional status and quality of life in women with breast cancer. *European Journal of Oncology Nursing*, 14(2), 101–110. https://doi.org/10.1016/j.ejon.2009.09.005
- Doong, S.-H., Dhruva, A., Dunn, L. B., West, C., Paul, S. M., Cooper, B. A., ... Miaskowski, C. (2015). Associations Between Cytokine Genes and a Symptom Cluster of Pain, Fatigue, Sleep Disturbance, and Depression in Patients Prior to Breast Cancer Surgery. *Biological Research for Nursing*, 17(3), 237–247. https://doi.org/10.1177/1099800414550394
- Dreher, M., Krüger, S., Schulze-Olden, S., Keszei, A., Storre, J. H., Woehrle, H., ... Müller, T. (2018). Sleep-disordered breathing in patients with newly diagnosed lung cancer. *BMC Pulmonary Medicine*, *18*(1), 72. https://doi.org/10.1186/s12890-018-0645-1
- Echchikhi, Y., El-Abbassi, S., Touil, A., Kacemi, H., El-Majjaoui, S., Kebdani, T., & Benjafaar, N. (2017). Sleep disorders and sleep quality in Moroccan adult patients with cancer during treatment. *Journal of Cancer Science and Therapy*, 9, 637–643.
- Enderlin, C. A., Coleman, E. A., Cole, C., Richards, K. C., Kennedy, R. L., Goodwin, J. A., ... Mack, K. (2011). Subjective sleep quality, objective sleep characteristics, insomnia symptom severity, and daytime sleepiness in women aged 50 and older with nonmetastatic breast cancer. *Oncology Nursing Forum*, 38(4), E314-325. https://doi.org/10.1188/11.ONF.E314-E325
- Fekih-Romdhane, F., Achouri, L., Hakiri, A., Jaidane, O., Rahal, K., & Cheour, M. (2020). Hopelessness is associated with poor sleep quality after breast cancer surgery among Tunisian women. *Current Problems in Cancer*, 44(1), 100504. https://doi.org/10.1016/j.currproblcancer.2019.100504
- Fleming, L., Randell, K., Stewart, E., Espie, C. A., Morrison, D. S., Lawless, C., & Paul, J. (2019). Insomnia in breast cancer: A prospective observational study. *Sleep*, 42(3). https://doi.org/10.1093/sleep/zsy245
- Fong, T. C. T., & Ho, R. T. H. (2020). Mindfulness facets predict quality of life and sleep disturbance via physical and emotional distresses in Chinese cancer patients: A moderated mediation analysis. *Psycho-Oncology*, 29(5), 894–901. https://doi.org/10.1002/pon.5363
- Fontes, F., Gonçalves, M., Pereira, S., & Lunet, N. (2017). Neuropathic pain after breast cancer treatment and its impact on sleep quality one year after cancer diagnosis. *The Breast*, *33*, 125–131. https://doi.org/10.1016/j.breast.2017.03.013
- Forsythe, L. P., Helzlsouer, K. J., MacDonald, R., & Gallicchio, L. (2012). Daytime sleepiness and sleep duration in long-term cancer survivors and non-cancer controls: Results from a registrybased survey study. *Supportive Care in Cancer*, 20(10), 2425–2432. https://doi.org/10.1007/s00520-011-1358-7
- Fortner, B. V., Stepanski, E. J., Wang, S. C., Kasprowicz, S., & Durrence, H. H. (2002). Sleep and quality of life in breast cancer patients. *Journal of Pain and Symptom Management*, 24(5), 471–480. https://doi.org/10.1016/s0885-3924(02)00500-6

- Fox, S. W., Lyon, D., & Farace, E. (2007). Symptom Clusters in Patients With High-Grade Glioma. *Journal of Nursing Scholarship*, 39(1), 61–67. https://doi.org/10.1111/j.1547-5069.2007.00144.x
- Garland, S. N., Xie, S. X., DuHamel, K., Bao, T., Li, Q., Barg, F. K., ... Mao, J. J. (2019). Acupuncture Versus Cognitive Behavioral Therapy for Insomnia in Cancer Survivors: A Randomized Clinical Trial. *Journal of the National Cancer Institute*, 111(12), 1323–1331. https://doi.org/10.1093/jnci/djz050
- Garrett, K., Dhruva, A., Koetters, T., West, C., Paul, S. M., Dunn, L. B., ... Miaskowski, C. (2011). Differences in Sleep Disturbance and Fatigue Between Patients with Breast and Prostate Cancer at the Initiation of Radiation Therapy. *Journal of Pain and Symptom Management*, 42(2), 239–250. https://doi.org/10.1016/j.jpainsymman.2010.11.010
- Gibbins, J., McCoubrie, R., Kendrick, A. H., Senior-Smith, G., Davies, A. N., & Hanks, G. W. (2009). Sleep-wake disturbances in patients with advanced cancer and their family carers. *Journal of Pain and Symptom Management*, 38(6), 860–870. https://doi.org/10.1016/j.jpainsymman.2009.04.025
- Gonzalez, B. D., Eisel, S. L., Qin, B., Llanos, A. A. M., Savard, J., Hoogland, A. I., ... Bandera, E. V. (2021). Prevalence, risk factors, and trajectories of sleep disturbance in a cohort of African-American breast cancer survivors. *Supportive Care in Cancer*, 29(5), 2761–2770. https://doi.org/10.1007/s00520-020-05786-2
- Gonzalez, B. D., Small, B. J., Cases, M. G., Williams, N. L., Fishman, M. N., Jacobsen, P. B., & Jim, H. S. L. (2018). Sleep disturbance in men receiving androgen deprivation therapy for prostate cancer: The role of hot flashes and nocturia. *Cancer*, 124(3), 499–506. https://doi.org/10.1002/cncr.31024
- Gooneratne, N. S., Dean, G. E., Rogers, A. E., Nkwuo, J. E., Coyne, J. C., & Kaiser, L. R. (2007). Sleep and quality of life in long-term lung cancer survivors. *Lung Cancer*, 58(3), 403–410. https://doi.org/10.1016/j.lungcan.2007.07.011
- Grutsch, J. F., Wood, P. A., Du-Quiton, J., Reynolds, J. L., Lis, C. G., Levin, R. D., … Hrushesky, W. J. (2011). Validation of actigraphy to assess circadian organization and sleep quality in patients with advanced lung cancer. *Journal of Circadian Rhythms*, 9, 4. https://doi.org/10.1186/1740-3391-9-4
- Gu, F., Li, X.-F., Xu, J.-F., Gao, G.-H., Wu, Y.-F., & Zhou, C.-C. (2018). Effect of nicotine dependence on quality of life and sleep quality in patients with lung cancer who continue to smoke after diagnosis. *Journal of Thoracic Disease*, 10(5), 2583–2589. https://doi.org/10.21037/jtd.2018.05.12
- Hall, D. L., Mishel, M. H., & Germino, B. B. (2014). Living with cancer-related uncertainty: Associations with fatigue, insomnia, and affect in younger breast cancer survivors. Supportive Care in Cancer: Official Journal of the Multinational Association of Supportive Care in Cancer, 22(9), 2489–2495. https://doi.org/10.1007/s00520-014-2243-y
- Halle, I. H., Westgaard, T. K., Wahba, A., Oksholm, T., Rustøen, T., & Gjeilo, K. H. (2017). Trajectory of sleep disturbances in patients undergoing lung cancer surgery: A prospective study. *Interactive CardioVascular and Thoracic Surgery*, 25(2), 285–291. https://doi.org/10.1093/icvts/ivx076

- Hanisch, L. J., Gooneratne, N. S., Soin, K., Gehrman, P. R., Vaughn, D. J., & Coyne, J. C. (2011). Sleep and daily functioning during androgen deprivation therapy for prostate cancer. *European Journal of Cancer Care*, 20(4), 549–554. https://doi.org/10.1111/j.1365-2354.2010.01226.x
- He, Y., Meng, Z., Jia, Q., Hu, F., He, X., Tan, J., ... Liu, Y. (2015). Sleep Quality of Patients with Differentiated Thyroid Cancer. *PLOS ONE*, *10*(6), e0130634. https://doi.org/10.1371/journal.pone.0130634
- Henneghan, A. M., Carter, P., Stuifbergan, A., Parmelee, B., & Kesler, S. (2018). Relationships between self-reported sleep quality components and cognitive functioning in breast cancer survivors up to 10 years following chemotherapy. *Psycho-Oncology*, 27(8), 1937–1943. https://doi.org/10.1002/pon.4745
- Ho, R. T. H., & Fong, T. C. T. (2014). Factor structure of the Chinese version of the Pittsburgh Sleep Quality Index in breast cancer patients. *Sleep Medicine*, 15(5), 565–569. https://doi.org/10.1016/j.sleep.2013.10.019
- Ho, S.-Y., Rohan, K. J., Parent, J., Tager, F. A., & McKinley, P. S. (2015). A Longitudinal Study of Depression, Fatigue, and Sleep Disturbances as a Symptom Cluster in Women with Breast Cancer. *Journal of Pain and Symptom Management*, 49(4), 707–715. https://doi.org/10.1016/j.jpainsymman.2014.09.009
- Hoang, H. T. X., Molassiotis, A., Chan, C. W., Nguyen, T. H., & Liep Nguyen, V. (2020). New-onset insomnia among cancer patients undergoing chemotherapy: Prevalence, risk factors, and its correlation with other symptoms. *Sleep & Breathing = Schlaf & Atmung*, *24*(1), 241–251. https://doi.org/10.1007/s11325-019-01839-x
- Hong, J. S., Tian, J., & Wu, L. H. (2014). The influence of chemotherapy-induced neurotoxicity on psychological distress and sleep disturbance in cancer patients. *Current Oncology*, 21(4), 174– 180. https://doi.org/10.3747/co.21.1984
- Imanian, M., Imanian, M., & Karimyar, M. (2019). Sleep Quality and Fatigue among Breast Cancer Patients Undergoing Chemotherapy. *International Journal of Hematology-Oncology and Stem Cell Research*, 13(4), 196–200.
- İzci, F., Özdem, G., İlgün, A. S., Ağaçayak, F., Duymaz, T., Erdoğan, Z., ... Özmen, V. (2020). Pre-Treatment and Post-Treatment Anxiety, Depression, Sleep and Sexual Function Levels in Patients with Breast Cancer. *European Journal of Breast Health*, 16(3), 219–225. https://doi.org/10.5152/ejbh.2020.5259
- Jeon, M. S., Dhillon, H. M., Koh, E.-S., Nowak, A. K., Hovey, E., Descallar, J., ... Agar, M. R. (2021). Exploring sleep disturbance among adults with primary or secondary malignant brain tumors and their caregivers. *Neuro-Oncology Practice*, 8(1), 48–59. https://doi.org/10.1093/nop/npaa057
- Ji, Y.-B., Bo, C.-L., Xue, X.-J., Weng, E.-M., Gao, G.-C., Dai, B.-B., ... Xu, C.-P. (2017). Association of Inflammatory Cytokines With the Symptom Cluster of Pain, Fatigue, Depression, and Sleep Disturbance in Chinese Patients With Cancer. *Journal of Pain and Symptom Management*, 54(6), 843–852. https://doi.org/10.1016/j.jpainsymman.2017.05.003
- Jim, H. S. L., Sutton, S., Majhail, N. S., Wood, W. A., Jacobsen, P. B., Wingard, J. R., ... Lee, S. J. (2018). Severity, course, and predictors of sleep disruption following hematopoietic cell transplantation: A secondary data analysis from the BMT CTN 0902 trial. *Bone Marrow Transplantation*, 53(8), 1038–1043. https://doi.org/10.1038/s41409-018-0138-0

- Johansen, S., Cvancarova, M., & Ruland, C. (2018). The Effect of Cancer Patients' and Their Family Caregivers' Physical and Emotional Symptoms on Caregiver Burden. *Cancer Nursing*, 41(2), 91–99. https://doi.org/10.1097/NCC.00000000000493
- Jung, D., Lee, K.-M., Kim, W.-H., Lee, J.-Y., Kim, T.-Y., Im, S.-A., ... Hahm, B.-J. (2016). Longitudinal Association of Poor Sleep Quality With Chemotherapy-Induced Nausea and Vomiting in Patients With Breast Cancer. *Psychosomatic Medicine*, 78(8), 959. https://doi.org/10.1097/PSY.00000000000372
- Kashani, F., & Kashani, P. (2014). The effect of massage therapy on the quality of sleep in breast cancer patients. *Iranian Journal of Nursing and Midwifery Research*, *19*(2), 113–118.
- Klyushnenkova, E. N., Sorkin, J. D., & Gallicchio, L. (2015). Association of obesity and sleep problems among breast cancer survivors: Results from a registry-based survey study. *Supportive Care in Cancer*, 23(12), 3437–3445. https://doi.org/10.1007/s00520-015-2692-y
- Kotronoulas, G. C., Papadopoulou, C. N., Papapetrou, A., & Patiraki, E. (2011). Psychometric evaluation and feasibility of the Greek Pittsburgh Sleep Quality Index (GR-PSQI) in patients with cancer receiving chemotherapy. *Supportive Care in Cancer*, 19(11), 1831–1840. https://doi.org/10.1007/s00520-010-1025-4
- Kreutz, C., Müller, J., Schmidt, M. E., & Steindorf, K. (2021). Comparison of subjectively and objectively assessed sleep problems in breast cancer patients starting neoadjuvant chemotherapy. *Supportive Care in Cancer*, 29(2), 1015–1023. https://doi.org/10.1007/s00520-020-05580-0
- Lafçi, D., & Öztunç, G. (2015). The effect of music on the sleep quality of breast cancer patients. *International Journal of Caring Sciences*, 8(3), 633.
- Li, C.-C., Tsai, Y.-F., Chang, T.-C., & Chen, L. (2017). Associations among menopausal symptoms, sleep and fatigue in Taiwanese women with endometrial cancer. *European Journal of Cancer Care*, 26(5). https://doi.org/10.1111/ecc.12559
- Li, N., Otomaru, T., & Taniguchi, H. (2017). Sleep quality in long-term survivors of head and neck cancer: Preliminary findings. *Supportive Care in Cancer*, 25(12), 3741–3748. https://doi.org/10.1007/s00520-017-3804-7
- Li, W., Kwok, C. C.-H., Chan, D. C.-W., Ho, A. W.-Y., Ho, C.-S., Zhang, J., ... Tse, L. A. (2019). Disruption of sleep, sleep-wake activity rhythm, and nocturnal melatonin production in breast cancer patients undergoing adjuvant chemotherapy: Prospective cohort study. *Sleep Medicine*, 55, 14–21. https://doi.org/10.1016/j.sleep.2018.11.022
- Lin, C.-Y., Cheng, A. S. K., Imani, V., Saffari, M., Ohayon, M. M., & Pakpour, A. H. (2020). Advanced psychometric testing on a clinical screening tool to evaluate insomnia: Sleep condition indicator in patients with advanced cancer. *Sleep and Biological Rhythms*, 18(4), 343–349. https://doi.org/10.1007/s41105-020-00279-5
- Lin, C.-Y., Cheng, A. S. K., Nejati, B., Imani, V., Ulander, M., Browall, M., ... Pakpour, A. H. (2020). A thorough psychometric comparison between Athens Insomnia Scale and Insomnia Severity Index among patients with advanced cancer. *Journal of Sleep Research*, 29(1), e12891. https://doi.org/10.1111/jsr.12891

- Liou, K. T., Ahles, T. A., Garland, S. N., Li, Q. S., Bao, T., Li, Y., ... Mao, J. J. (2019). The Relationship Between Insomnia and Cognitive Impairment in Breast Cancer Survivors. JNCI Cancer Spectrum, 3(3), pkz041. https://doi.org/10.1093/jncics/pkz041
- Liu, L., Fiorentino, L., Natarajan, L., Parker, B. A., Mills, P. J., Sadler, G. R., ... Ancoli-Israel, S. (2009). Pre-treatment symptom cluster in breast cancer patients is associated with worse sleep, fatigue and depression during chemotherapy. *Psycho-Oncology*, 18(2), 187–194. https://doi.org/10.1002/pon.1412
- Liu, L., Mills, P. J., Rissling, M., Fiorentino, L., Natarajan, L., Dimsdale, J. E., ... Ancoli-Israel, S. (2012). Fatigue and Sleep Quality are Associated with Changes in Inflammatory Markers in Breast Cancer Patients Undergoing Chemotherapy. *Brain, Behavior, and Immunity*, 26(5), 706–713. https://doi.org/10.1016/j.bbi.2012.02.001
- Liu, L., Rissling, M., Natarajan, L., Fiorentino, L., Mills, P. J., Dimsdale, J. E., ... Ancoli-Israel, S. (2012). The longitudinal relationship between fatigue and sleep in breast cancer patients undergoing chemotherapy. *Sleep*, *35*(2), 237–245. https://doi.org/10.5665/sleep.1630
- Loth, A., Michel, J., Giorgi, R., Santini, L., Rey, M., Elbaum, J.-M., ... Fakhry, N. (2017). Prevalence of obstructive sleep apnoea syndrome following oropharyngeal cancer treatment: A prospective cohort study. *Clinical Otolaryngology*, 42(6), 1281–1288. https://doi.org/10.1111/coa.12869
- Lowery-Allison, A. E., Passik, S. D., Cribbet, M. R., Reinsel, R. A., O'Sullivan, B., Norton, L., ... Kavey, N. B. (2018). Sleep problems in breast cancer survivors 1–10 years posttreatment. *Palliative and Supportive Care*, 16(03), 325–334. https://doi.org/10.1017/S1478951517000311
- Ma, C.-L., Chang, W.-P., & Lin, C.-C. (2014). Rest/activity rhythm is related to the coexistence of pain and sleep disturbance among advanced cancer patients with pain. *Supportive Care in Cancer*, 22(1), 87–94. https://doi.org/10.1007/s00520-013-1918-0
- Mansano-Schlosser, T. C., & Ceolim, M. F. (2012). Factors associated with sleep quality in the elderly receiving chemotherapy. *Revista Latino-Americana De Enfermagem*, 20(6), 1100–1108. https://doi.org/10.1590/s0104-11692012000600012
- Mansano-Schlosser, T. C., Ceolim, M. F., & Valerio, T. D. (2017). Poor sleep quality, depression and hope before breast cancer surgery. *Applied Nursing Research: ANR*, 34, 7–11. https://doi.org/10.1016/j.apnr.2016.11.010
- Mao, H., Bao, T., Shen, X., Li, Q., Seluzicki, C., Im, E.-O., & Mao, J. J. (2018). Prevalence and risk factors for fatigue among breast cancer survivors on aromatase inhibitors. *European Journal of Cancer*, *101*, 47–54. https://doi.org/10.1016/j.ejca.2018.06.009
- Mao, J. J., Farrar, J. T., Bruner, D., Zee, J., Bowman, M., Seluzicki, C., ... Xie, S. X. (2014). Electroacupuncture for fatigue, sleep, and psychological distress in breast cancer patients with aromatase inhibitor-related arthralgia: A randomized trial. *Cancer*, 120(23), 3744–3751. https://doi.org/10.1002/cncr.28917
- Martin, C. M., Greene, D., Harrell, J. P., Mwendwa, D. T., Williams, C. D., Horton, S., ... Taylor, T. R. (2020). The impact of social constraints on insomnia among African-American breast cancer survivors: The mediating role of fear of recurrence. *Psycho-Oncology*, 29(8), 1296–1302. https://doi.org/10.1002/pon.5435

- Mercadante, S., Adile, C., Ferrera, P., Masedu, F., Valenti, M., & Aielli, F. (2017). Sleep disturbances in advanced cancer patients admitted to a supportive/palliative care unit. *Supportive Care in Cancer*, *25*(4), 1301–1306. https://doi.org/10.1007/s00520-016-3524-4
- Mercadante, S., Aielli, F., Adile, C., Ferrera, P., Valle, A., Cartoni, C., ... Porzio, G. (2015). Sleep Disturbances in Patients With Advanced Cancer in Different Palliative Care Settings. *Journal* of Pain and Symptom Management, 50(6), 786–792. https://doi.org/10.1016/j.jpainsymman.2015.06.018
- Miaskowski, C., Lee, K., Dunn, L., Dodd, M., Aouizerat, B. E., West, C., ... Swift, P. (2011). Sleep-Wake Circadian Activity Rhythm Parameters and Fatigue in Oncology Patients Prior to the Initiation of Radiation Therapy. *Cancer Nursing*, 34(4), 255–268. https://doi.org/10.1097/NCC.0b013e3181f65d9b
- Miaskowski, C., Paul, S. M., Cooper, B. A., Lee, K., Dodd, M., West, C., ... Wara, W. (2011). Predictors of the trajectories of self-reported sleep disturbance in men with prostate cancer during and following radiation therapy. *Sleep*, *34*(2), 171–179. https://doi.org/10.1093/sleep/34.2.171
- Miladinia, M., Baraz, S., Ramezani, M., & Malehi, A. S. (2018). The relationship between pain, fatigue, sleep disorders and quality of life in adult patients with acute leukaemia: During the first year after diagnosis. *European Journal of Cancer Care*, 27(1), e12762. https://doi.org/10.1111/ecc.12762
- Moore, T. A., Berger, A. M., & Dizona, P. (2011). Sleep aid use during and following breast cancer adjuvant chemotherapy. *Psycho-Oncology*, 20(3), 321–325. https://doi.org/10.1002/pon.1756
- Morris, B. A., Thorndike, F. P., Ritterband, L. M., Glozier, N., Dunn, J., & Chambers, S. K. (2015). Sleep disturbance in cancer patients and caregivers who contact telephone-based help services. *Supportive Care in Cancer*, 23(4), 1113–1120. https://doi.org/10.1007/s00520-014-2458-y
- Mosher, C. E., & Duhamel, K. N. (2012). An examination of distress, sleep, and fatigue in metastatic breast cancer patients. *Psycho-Oncology*, *21*(1), 100–107. https://doi.org/10.1002/pon.1873
- Mystakidou, K., Parpa, E., Tsilika, E., Gennatas, C., Galanos, A., & Vlahos, L. (2009). How is sleep quality affected by the psychological and symptom distress of advanced cancer patients? *Palliative Medicine*, *23*(1), 46–53. https://doi.org/10.1177/0269216308098088
- Mystakidou, Kyriaki, Parpa, E., Tsilika, E., Pathiaki, M., Patiraki, E., Galanos, A., & Vlahos, L. (2007). Sleep quality in advanced cancer patients. *Journal of Psychosomatic Research*, 62(5), 527–533. https://doi.org/10.1016/j.jpsychores.2006.11.008
- Nakamura, Y., Lipschitz, D. L., Kuhn, R., Kinney, A. Y., & Donaldson, G. W. (2013). Investigating efficacy of two brief mind-body intervention programs for managing sleep disturbance in cancer survivors: A pilot randomized controlled trial. *Journal of Cancer Survivorship: Research and Practice*, 7(2), 165–182. https://doi.org/10.1007/s11764-012-0252-8
- Nelson, A. M., Jim, H. S. L., Small, B. J., Nishihori, T., Gonzalez, B. D., Cessna, J. M., ... Jacobsen, P. B. (2018). Sleep Disruption Among Cancer Patients Following Autologous Hematopoietic Cell Transplantation. *Bone Marrow Transplantation*, 53(3), 307–314. https://doi.org/10.1038/s41409-017-0022-3
- Nguyen, N. H., Vallance, J. K., Buman, M. P., Moore, M. M., Reeves, M. M., Rosenberg, D. E., ... Lynch, B. M. (2021). Effects of a wearable technology-based physical activity intervention on

sleep quality in breast cancer survivors: The ACTIVATE Trial. *Journal of Cancer Survivorship*, *15*(2), 273–280. https://doi.org/10.1007/s11764-020-00930-7

- Nishiura, M., Tamura, A., Nagai, H., & Matsushima, E. (2015). Assessment of sleep disturbance in lung cancer patients: Relationship between sleep disturbance and pain, fatigue, quality of life, and psychological distress. *Palliative & Supportive Care*, 13(3), 575–581. https://doi.org/10.1017/S1478951513001119
- Otte, J. L., Carpenter, J. S., Russell, K. M., Bigatti, S., & Champion, V. L. (2010). Prevalence, Severity, and Correlates of Sleep-Wake Disturbances in Long-Term Breast Cancer Survivors. *Journal of Pain and Symptom Management*, 39(3), 535–547. https://doi.org/10.1016/j.jpainsymman.2009.07.004
- Overcash, J., Tan, A., Patel, K., & Noonan, A. M. (2018). Factors Associated With Poor Sleep in Older Women Diagnosed With Breast Cancer. *Oncology Nursing Forum*, 45(3), 359–371. https://doi.org/10.1188/18.ONF.359-371
- Pai, A., Sivanandh, B., & Udupa, K. (2020). Quality of Sleep in Patients with Cancer: A Crosssectional Observational Study. *Indian Journal of Palliative Care*, 26(1), 9–12. https://doi.org/10.4103/IJPC.IJPC_164_19
- Palesh, O., Scheiber, C., Kesler, S., Janelsins, M. C., Guido, J. J., Heckler, C., ... Mustian, K. M. (2018). Feasibility and acceptability of brief behavioral therapy for cancer-related insomnia: Effects on insomnia and circadian rhythm during chemotherapy: a phase II randomised multicentre controlled trial. *British Journal of Cancer*, 119(3), 274–281. https://doi.org/10.1038/s41416-018-0154-2
- Palesh, O., Zeitzer, J. M., Conrad, A., Giese-Davis, J., Mustian, K. M., Popek, V., ... Spiegel, D. (2008). Vagal Regulation, Cortisol, and Sleep Disruption in Women with Metastatic Breast Cancer. *Journal of Clinical Sleep Medicine*, 4(5), 441–449.
- Palesh, Oxana G., Roscoe, J. A., Mustian, K. M., Roth, T., Savard, J., Ancoli-Israel, S., ... Morrow, G. R. (2010). Prevalence, demographics, and psychological associations of sleep disruption in patients with cancer: University of Rochester Cancer Center-Community Clinical Oncology Program. *Journal of Clinical Oncology*, 28(2), 292–298. https://doi.org/10.1200/JCO.2009.22.5011
- Palesh, Oxana Gronskaya, Collie, K., Batiuchok, D., Tilston, J., Koopman, C., Perlis, M. L., ... Spiegel, D. (2007). A Longitudinal Study of Depression, Pain, and Stress as Predictors of Sleep Disturbance among Women with Metastatic Breast Cancer. *Biological Psychology*, 75(1), 37–44. https://doi.org/10.1016/j.biopsycho.2006.11.002
- Papadopoulos, D., Kiagia, M., Charpidou, A., Gkiozos, I., & Syrigos, K. (2019). Psychological correlates of sleep quality in lung cancer patients under chemotherapy: A single-center crosssectional study. *Psycho-Oncology*, 28(9), 1879–1886. https://doi.org/10.1002/pon.5167
- Park, J. H., Lee, S. J., Gwak, J. I., Shim, J. Y., & Lee, J. K. (2010). Sleep Quality of Breast Cancer Patients Receiving Chemotherapy in the Outpatients Setting. *Korean Journal of Family Medicine*, 31(10), 778–785.
- Peoples, A. R., Garland, S. N., Perlis, M. L., Savard, J., Heckler, C. E., Kamen, C. S., ... Roscoe, J. A. (2017). Effects of cognitive behavioral therapy for insomnia and armodafinil on quality of life in cancer survivors: A randomized placebo-controlled trial. *Journal of Cancer Survivorship*, *11*(3), 401–409. https://doi.org/10.1007/s11764-017-0597-0

- Phillips, K. M., Jim, H. S., Donovan, K. A., Pinder-Schenck, M. C., & Jacobsen, P. B. (2012). Characteristics and correlates of sleep disturbances in cancer patients. *Supportive Care in Cancer*, 20(2), 357–365. https://doi.org/10.1007/s00520-011-1106-z
- Price, M. A., Zachariae, R., Butow, P. N., deFazio, A., Chauhan, D., Espie, C. A., ... Webb, P. M. (2009). Prevalence and predictors of insomnia in women with invasive ovarian cancer: Anxiety a major factor. *European Journal of Cancer*, 45(18), 3262–3270. https://doi.org/10.1016/j.ejca.2009.05.030
- Qin, L., Mo, Y.-L., Li, L., Wei, Z.-J., Zhu, X.-D., Yin, X., & Wei, Q. (2015). Sleep characteristics and psychological symptoms in patients with locally advanced nasopharyngeal carcinoma before and after intensity-modulated radiotherapy and concurrent chemotherapy. *Psychology, Health & Medicine*, 20(6), 662–669. https://doi.org/10.1080/13548506.2014.967703
- Rand, K. L., Otte, J. L., Flockhart, D., Hayes, D., Storniolo, A. M., Stearns, V., ... Carpenter, J. S. (2011). Modeling hot flushes and quality of life in breast cancer survivors. *Climacteric*, 13(6), 171–180. https://doi.org/10.3109/13697131003717070
- Ratcliff, C. G., Zepeda, S. G., Hall, M. H., Tullos, E. A., Fowler, S., Chaoul, A., ... Cohen, L. (2021). Patient characteristics associated with sleep disturbance in breast cancer survivors. *Supportive Care in Cancer*, 29(5), 2601–2611. https://doi.org/10.1007/s00520-020-05777-3
- Rogers, L. Q., Courneya, K. S., Oster, R. A., Anton, P. M., Robbs, R. S., Forero, A., & McAuley, E. (2017). Physical Activity and Sleep Quality in Breast Cancer Survivors: A Randomized Trial. *Medicine and Science in Sports and Exercise*, 49(10), 2009–2015. https://doi.org/10.1249/MSS.00000000001327
- Rogers, L. Q., Courneya, K. S., Robbins, K. T., Rao, K., Malone, J., Seiz, A., ... Burra, V. (2008). Factors associated with fatigue, sleep, and cognitive function among patients with head and neck cancer. *Head & Neck*, 30(10), 1310–1317. https://doi.org/10.1002/hed.20873
- Romito, F., Cormio, C., De Padova, S., Lorusso, V., Berio, M. A., Fimiani, F., ... Mattioli, V. (2014). Patients attitudes towards sleep disturbances during chemotherapy. *European Journal of Cancer Care*, 23(3), 385–393. https://doi.org/10.1111/ecc.12106
- Roscoe, J. A., Garland, S. N., Heckler, C. E., Perlis, M. L., Peoples, A. R., Shayne, M., ... Morrow, G. R. (2015). Randomized placebo-controlled trial of cognitive behavioral therapy and armodafinil for insomnia after cancer treatment. *Journal of Clinical Oncology*, *33*(2), 165–171. https://doi.org/10.1200/JCO.2014.57.6769
- Saberzadeh-Ardestani, B., Khosravi, B., Zebardast, J., & Sadighi, S. (2019). Chemotherapy effect on daytime sleepiness and contributing factors in older adults with cancer. *Journal of Geriatric Oncology*, *10*(4), 632–636. https://doi.org/10.1016/j.jgo.2018.10.003
- Saesen, K., van der Veen, J., Buyse, B., & Nuyts, S. (2021). Obstructive sleep apnea in head and neck cancer survivors. *Supportive Care in Cancer*, *29*(1), 279–287. https://doi.org/10.1007/s00520-020-05428-7
- Saini, A., Berruti, A., Ferini-Strambi, L., Castronovo, V., Rametti, E., Giuliano, P. L., ... Ostacoli, L. (2013). Restless Legs Syndrome as a Cause of Sleep Disturbances in Cancer Patients Receiving Chemotherapy. *Journal of Pain and Symptom Management*, 46(1), 56–64. https://doi.org/10.1016/j.jpainsymman.2012.06.018

- Sandadi, S., Frasure, H. E., Broderick, M. J., Waggoner, S. E., Miller, J. A., & von Gruenigen, V. E. (2011). The effect of sleep disturbance on quality of life in women with ovarian cancer. *Gynecologic Oncology*, 123(2), 351–355. https://doi.org/10.1016/j.ygyno.2011.07.028
- Sanford, S. D., Wagner, L. I., Beaumont, J. L., Butt, Z., Sweet, J. J., & Cella, D. (2013). Longitudinal prospective assessment of sleep quality: Before, during, and after adjuvant chemotherapy for breast cancer. Supportive Care in Cancer: Official Journal of the Multinational Association of Supportive Care in Cancer, 21(4), 959–967. https://doi.org/10.1007/s00520-012-1612-7
- Şanlier, N. T., Şahin, M. A., Demirkazik, A., Özkan, A., & Şenler, F. Ç. (2020). Sleep Quality of Cancer Patients Receiving Systemic Treatment: A Cross-Sectional Study. *Journal of Oncological Sciences*, 6(1), 15–22. https://doi.org/10.37047/jos.2019-71898
- Santoso, A. M. M., Jansen, F., Lissenberg-Witte, B. I., Baatenburg de Jong, R. J., Langendijk, J. A., Leemans, C. R., ... NET-QUBIC consortium. (2021). Poor sleep quality among newly diagnosed head and neck cancer patients: Prevalence and associated factors. *Supportive Care in Cancer*, 29(2), 1035–1045. https://doi.org/10.1007/s00520-020-05577-9
- Savard, J., Simard, S., Blanchet, J., Ivers, H., & Morin, C. M. (2001). Prevalence, clinical characteristics, and risk factors for insomnia in the context of breast cancer. *Sleep*, 24(5), 583– 590. https://doi.org/10.1093/sleep/24.5.583
- Savard, Josée, Ivers, H., Savard, M.-H., & Morin, C. M. (2015). Cancer treatments and their side effects are associated with aggravation of insomnia: Results of a longitudinal study. *Cancer*, *121*(10), 1703–1711. https://doi.org/10.1002/cncr.29244
- Savard, Josée, Simard, S., Hervouet, S., Ivers, H., Lacombe, L., & Fradet, Y. (2005). Insomnia in men treated with radical prostatectomy for prostate cancer. *Psycho-Oncology*, *14*(2), 147–156. https://doi.org/10.1002/pon.830
- Savard, Josée, Villa, J., Ivers, H., Simard, S., & Morin, C. M. (2009). Prevalence, natural course, and risk factors of insomnia comorbid with cancer over a 2-month period. *Journal of Clinical Oncology: Official Journal of the American Society of Clinical Oncology*, 27(31), 5233–5239. https://doi.org/10.1200/JCO.2008.21.6333
- Savard, M.-H., Savard, J., Simard, S., & Ivers, H. (2005). Empirical validation of the Insomnia Severity Index in cancer patients. *Psycho-Oncology*, 14(6), 429–441. https://doi.org/10.1002/pon.860
- Schieber, K., Niecke, A., Geiser, F., Erim, Y., Bergelt, C., Büttner-Teleaga, A., ... Weis, J. (2019). The course of cancer-related insomnia: Don't expect it to disappear after cancer treatment. *Sleep Medicine*, 58, 107–113. https://doi.org/10.1016/j.sleep.2019.02.018
- Sela, R. A., Watanabe, S., & Nekolaichuk, C. L. (2005). Sleep disturbances in palliative cancer patients attending a pain and symptom control clinic. *Palliative & Supportive Care*, 3(1), 23– 31. https://doi.org/10.1017/s1478951505050042
- Shahidi, J., Khodabakhshi, R., Yahyazadeh, S. H., Amini, M. G., & Nosrati, H. (2007). Quality of sleep in cancer patients: Evidence from Persian translation of Pittsburg Sleep Quality Index. *Austral Asian J Cancer*, *6*, 165–168.
- Steel, J. L., Terhorst, L., Collins, K. P., Geller, D. A., Vodovotz, Y., Kim, J., ... Tsung, A. (2018). Prospective Analyses of Cytokine Mediation of Sleep and Survival in the Context of Advanced

Cancer. *Psychosomatic Medicine*, 80(5), 483–491. https://doi.org/10.1097/PSY.00000000000579

- Strollo, S. E., Fallon, E. A., Gapstur, S. M., & Smith, T. G. (2020). Cancer-related problems, sleep quality, and sleep disturbance among long-term cancer survivors at 9-years post diagnosis. *Sleep Medicine*, 65, 177–185. https://doi.org/10.1016/j.sleep.2019.10.008
- Sun, G.-W., Yang, Y.-L., Yang, X.-B., Wang, Y.-Y., Cui, X.-J., Liu, Y., & Xing, C.-Z. (2020). Preoperative insomnia and its association with psychological factors, pain and anxiety in Chinese colorectal cancer patients. *Supportive Care in Cancer*, 28(6), 2911–2919. https://doi.org/10.1007/s00520-019-05151-y
- Sun, J.-L., Chiou, J.-F., & Lin, C.-C. (2011). Validation of the Taiwanese version of the Athens Insomnia Scale and assessment of insomnia in Taiwanese cancer patients. *Journal of Pain and Symptom Management*, 41(5), 904–914. https://doi.org/10.1016/j.jpainsymman.2010.07.021
- Taylor, T. R., Huntley, E. D., Makambi, K., Sween, J., Adams-Campbell, L. L., Frederick, W., & Mellman, T. A. (2012). Understanding sleep disturbances in African-American breast cancer survivors: A pilot study. *Psycho-Oncology*, 21(8), 896–902. https://doi.org/10.1002/pon.2000
- Tejada, M., Viele, C., Kober, K. M., Cooper, B. A., Paul, S. M., Dunn, L. B., ... Miaskowski, C. (2019). Identification of subgroups of chemotherapy patients with distinct sleep disturbance profiles and associated co-occurring symptoms. *Sleep*, 42(10). https://doi.org/10.1093/sleep/zsz151
- Tian, J., Chen, G. L., & Zhang, H. R. (2015). Sleep status of cervical cancer patients and predictors of poor sleep quality during adjuvant therapy. *Supportive Care in Cancer*, 23(5), 1401–1408. https://doi.org/10.1007/s00520-014-2493-8
- Tremblay, V., Savard, J., & Ivers, H. (2009). Predictors of the effect of cognitive behavioral therapy for chronic insomnia comorbid with breast cancer. *Journal of Consulting and Clinical Psychology*, 77(4), 742–750. https://doi.org/10.1037/a0015492
- Tzeng, J. I., Fu, Y.-W., & Lin, C.-C. (2012). Validity and reliability of the Taiwanese version of the Pittsburgh Sleep Quality Index in cancer patients. *International Journal of Nursing Studies*, 49(1), 102–108. https://doi.org/10.1016/j.ijnurstu.2011.08.004
- Valko, P. O., Siddique, A., Linsenmeier, C., Zaugg, K., Held, U., & Hofer, S. (2015). Prevalence and predictors of fatigue in glioblastoma: A prospective study. *Neuro-Oncology*, 17(2), 274–281. https://doi.org/10.1093/neuonc/nou127
- Van Onselen, C., Cooper, B. A., Lee, K., Dunn, L., Aouizerat, B. E., West, C., ... Miaskowski, C. (2012). Identification of distinct subgroups of breast cancer patients based on self-reported changes in sleep disturbance. *Supportive Care in Cancer*, 20(10), 2611–2619. https://doi.org/10.1007/s00520-012-1381-3
- Van Onselen, C., Dunn, L. B., Lee, K., Dodd, M., Koetters, T., West, C., ... Miaskowski, C. (2010). Relationship between mood disturbance and sleep quality in oncology outpatients at the initiation of radiation therapy. *European Journal of Oncology Nursing*, 14(5), 373–379. https://doi.org/10.1016/j.ejon.2009.12.002
- Vargas, S., Antoni, M. H., Carver, C. S., Lechner, S. C., Wohlgemuth, W., Llabre, M., ... DerHagopian, R. P. (2014). Sleep quality and fatigue after a stress management intervention

for women with early-stage breast cancer in southern Florida. *International Journal of Behavioral Medicine*, 21(6), 971–981. https://doi.org/10.1007/s12529-013-9374-2

- Vargas, S., Wohlgemuth, W. K., Antoni, M. H., Lechner, S. C., Holley, H. A., & Carver, C. S. (2010). Brief Report: Sleep Dysfunction and Psychosocial Adaptation Among Women Undergoing Treatment for Non-Metastatic Breast Cancer. *Psycho-Oncology*, *19*(6), 669–673. https://doi.org/10.1002/pon.1603
- Yoshikawa, K., Higashijima, J., Okitsu, H., Miyake, H., Yagi, T., Miura, M., ... Shimada, M. (2020). Effects of chemotherapy on quality of life and night-time sleep of colon cancer patients. *The Journal of Medical Investigation: JMI*, 67(3.4), 338–342. https://doi.org/10.2152/jmi.67.338
- Yu, S.-Y., & Nho, J.-H. (2015). Influence of Sleep Disturbance and Depression on Quality of Life in Ovarian Cancer Patients during Chemotherapy. Asian Oncology Nursing, 15(4), 203–210. https://doi.org/10.5388/aon.2015.15.4.203
- Zubair, U. B., Mumtaz, H., & Taj, R. (2019). Relationship between the Quality of Sleep and Psychiatric Morbidity among the Patients of Head and Neck Tumours. *Journal of the College* of Physicians and Surgeons--Pakistan: JCPSP, 29(6), 541–544. https://doi.org/10.29271/jcpsp.2019.06.541