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Review

Risk factors for falls in hospitalized patients with cancer: A systematic review and meta-analysis

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ABSTRACT

A primary cancer diagnosis has been confirmed as an important risk factor for falls, and the incidence of falls has been shown to be higher in patients who have undergone cancer treatment than in those who have not undergone cancer treatment. Falls during hospitalization increase the medical costs of additional treatment and falls-related mortality. Many falls are preventable and a good understanding of the predictors of falls in this population is needed. However, the risk factors for falls have not yet been identified. The purpose of this review was to identify the risk factors for falls in hospitalized patients with cancer. Eleven English and Chinese electronic databases were searched from their inception to April 2022 and the methodological quality of the included studies was assessed using the Newcastle-Ottawa Quality Assessment Scale. Five studies involving 1237 patients with cancer were included. The meta-analysis identifies eleven risk factors for falls in hospitalized patients with cancer, including age, history of falls, opiates, benzodiazepines, steroids, antipsychotics, sedatives, radiation therapy, chemotherapy, the use of an assistive device and length of hospitalization. Based on the evidence presented in this article, healthcare workers have the capacity to help reduce fall risk through the development of preventive support strategies in this population. Multicenter, prospective studies of patients with cancer should be conducted to further identify and validate their risk factors for falls.

Introduction

Accidental falls and their associated injuries are a major public health problem.[1] A primary cancer diagnosis has been confirmed as an important risk factor for falls, and the incidence of falls has been shown to be higher in patients who have undergone cancer treatment than in those who have not undergone cancer treatment.[2,3] Some studies have reported fall occurrence to be as high as 33%–50% in patients with cancer.[3,4] Falls during hospitalization prolong the hospital stay and increase the medical costs of additional treatment and falls-related mortality.[5,6] In addition, falls are one of the most common indicators for evaluating the quality of a nursing service.

Many falls are preventable. It is important to identify the factors contributing to falls, so interventions can be implemented to prevent them happening rather than waiting for a fall to happen and reacting.[7] A good understanding of the predictors of falls in this population is needed to prevent falls. Numerous studies have been conducted on falls in people with cancer. One study showed that risk factors for falls for those with cancer were poor physical condition, poor cognitive function, impaired balance, and the use of multiple medications.[8] However, most participants were older, community dwelling adults. Another study found that prescribed drugs (such as opioids, benzodiazepines, corticoids, etc.) were not risk factors for falls in patients with cancer unless they were neuroleptics.[9] Although old age is a risk factor for falls in the general population, the occurrence of falls in clinical practice is not limited to the elderly.[8] In addition, most characteristics of outpatients differ from those in in-patients for both treatment therapy and circumstance.

It is important to note that in 2018, the US Preventive Services Task Force also stated that there is currently no single tool/approach which is sufficiently reliable to help identify individuals who are at risk for falls.[10] Factors that contribute to an increased risk of falls may vary depending

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on the clinical setting and target population. The risk factors for falls in this population have not yet been identified. Thus, this systematic review focused on papers using case–control and cohort study designs to analyze relevant risk factors for falls in hospitalized patients with cancer and provide suggestions for establishing effective fall prevention strategies in these patients.

Methods

This study was designed and reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines.[11]

Search strategy

A systematic literature search of the databases PubMed, EMBASE, Web of science, Medline, the Cochrane Library, Cumulative Index for Nursing and Allied Health (CINAHL), PsycINFO, China National Knowledge Infrastructure, Wan Fang Data (Chinese), Technology Journal Database (VIP) databases, and Chinese biomedical literature service system (SinoMed) were conducted from inception to April 2022 and restricted to English and Chinese language papers. Grey literature was also searched in Google Scholar using a similar search strategy. The search was performed by two independent reviewers using the keywords ('neoplas*' OR 'tumo*' OR 'cancer' OR 'carcinoma*' OR 'oncolog*' OR 'malignanc*') AND ('accidental fall*' OR 'fall*' OR 'slip*') AND ('risk factor*' OR 'dangerous factor*' OR 'influence factor*' OR 'predict*' OR 'associate factor*' OR 'hazard factor*' OR 'relevant factor*'). Relevant publications from the reference lists of identified papers were also extensively screened to avoid missing any potential publications during the database search. Search strategies were determined in consultation with hospital librarians and through group discussions. The hospital librarian, Ms. Zhengjinjin, was invited to review and guide the reformulated search strategy. Add Medline, PsychINFO, Google Scholar databases, add "oncolog*", "malignanc*", "relevant factor*" search terms, and change "or" to "OR". Appendix S1 See Appendix S1 for the detailed search strategy, with modified sections marked in red. All confirmed works were entered into EndNoteX7 for management.

Selection and exclusion criteria

The inclusion criteria were as follows: (1) the study design was either original case–control or cohort trial study; (2) the study investigated the risk factors of fallen patients with cancer (diagnosed via histopathological examination); (3) the fall occurred during hospitalization; (4) the study included fall and non-fall group; (5) the study population were adults (age $\geq$ 18 years).

The studies that fulfilled the following criteria were excluded: (1) review articles, letters, comments, or meeting abstracts; (2) duplicate publications or studies with identical data; (3) studies in which sufficient data for the calculation of odds ratios (*OR*) and 95% confidence intervals (*CI*) were not provided.

Risk factors of concern

The risk factors for falls in this article were determined through analysis of the included studies, supported by the experience of senior clinical care managers. Risk factors were selected based on general patient characteristics, physical condition, and type of treatment. The choice of variables was determined via consultation and mutual agreement between the authors (two nurses with master's degrees and one nurse manager experienced in managing quality improvement).

Drug use was categorized according to medication classes prescribed per patient during their hospital stay: antidepressants, antipsychotics, benzodiazepines, opiates, diuretics, sedatives, and steroids. The treatment methods most commonly used in patients with cancer during their hospital stay were surgery, chemotherapy, and radiotherapy.

Data on history of falls in the previous 12 months were collected. The presence or absence of cancer metastasis was determined at the time of admission. The diagnoses of cancer were divided into two categories: oncology (neoplasm or solid tumor) and hematologic malignancies (leukemias, lymphomas, and multiple myeloma). Patient use of an assistive device (walkers, walking aids, wheel chairs, etc.) during hospitalization was examined.

Data extraction

Data were independently obtained from each eligible study by two reviewers (WGZ and YSM). Disagreements were resolved by discussion between the two reviewers and, if necessary, a third reviewer (CL) was consulted to reach a consensus. The summary table records the following characteristics for included studies: first author, country, publication year, research design, features of the study population, sample size, age, gender, and the risk factors for falls.

Quality assessment

Newcastle–Ottawa Scale (NOS) ratings are used to assess the quality of observational studies.[12] The NOS comprises eight items in three domains: selection of the study groups, ascertainment of exposure and outcome, and comparability of groups. The ratings are based on a star system with a maximum rating of nine. A study with a score of 0–4 is considered low quality, and 5–9 is considered high-quality.[13] This meta-analysis only included high-quality studies. In terms of comparability, after group discussion, we chose age as the most important control factor, which was controlled by matching. Controlling for other potential confounders can get an additional point. The assessments were performed by two authors (WGZ and YSM), and any disagreements were resolved by discussion with a third author (CL).

Data analysis

Statistical analyses were performed using Review Manager 5.3 (Cochrane Collaboration, UK) and Stata version 11.0 (Stata Corporation LP, TX, USA). *OR* and mean difference (*MD*) with 95% *CI* were used to pool the outcome data. The I^2 test was used to test for statistical heterogeneity. For outcomes with low heterogeneity ($I^2 < 50\%$ and $P > 0.1$), a fixed-effects model (the Mantel-Haenszel method) was used for secondary analysis; otherwise ($I^2 \geq 50\%$ or $P \leq 0.1$), a random-effects model (the DerSimonian and Laird method) was used.[14] Sensitivity analysis was carried out by omitting one study after another and exchanging effect models. Publication bias was conducted using *Egger's tests*.[15] All statistical tests were conducted as two-sided, and a P value < 0.05 was considered statistically significant.

Results

Study selection and description

A total of 15,509 studies were obtained through electronic database searches, of which 5661 were excluded due to duplication. 57 full-text articles were retained after reviewing the title and abstract information. Of these, 52 were excluded (Fig. 1). Eventually, five studies[4,9,16–18] fulfilled the inclusion criteria and were included in the meta-analysis. Four studies[4,9,16,17] were case–control studies and one study[18] was a cohort study. A total of 1237 patients with cancer were enrolled in the included trials; of these, 450 patients had a fall (Table 1).

Study quality

NOS ratings for these studies ranged from five to seven (maximum

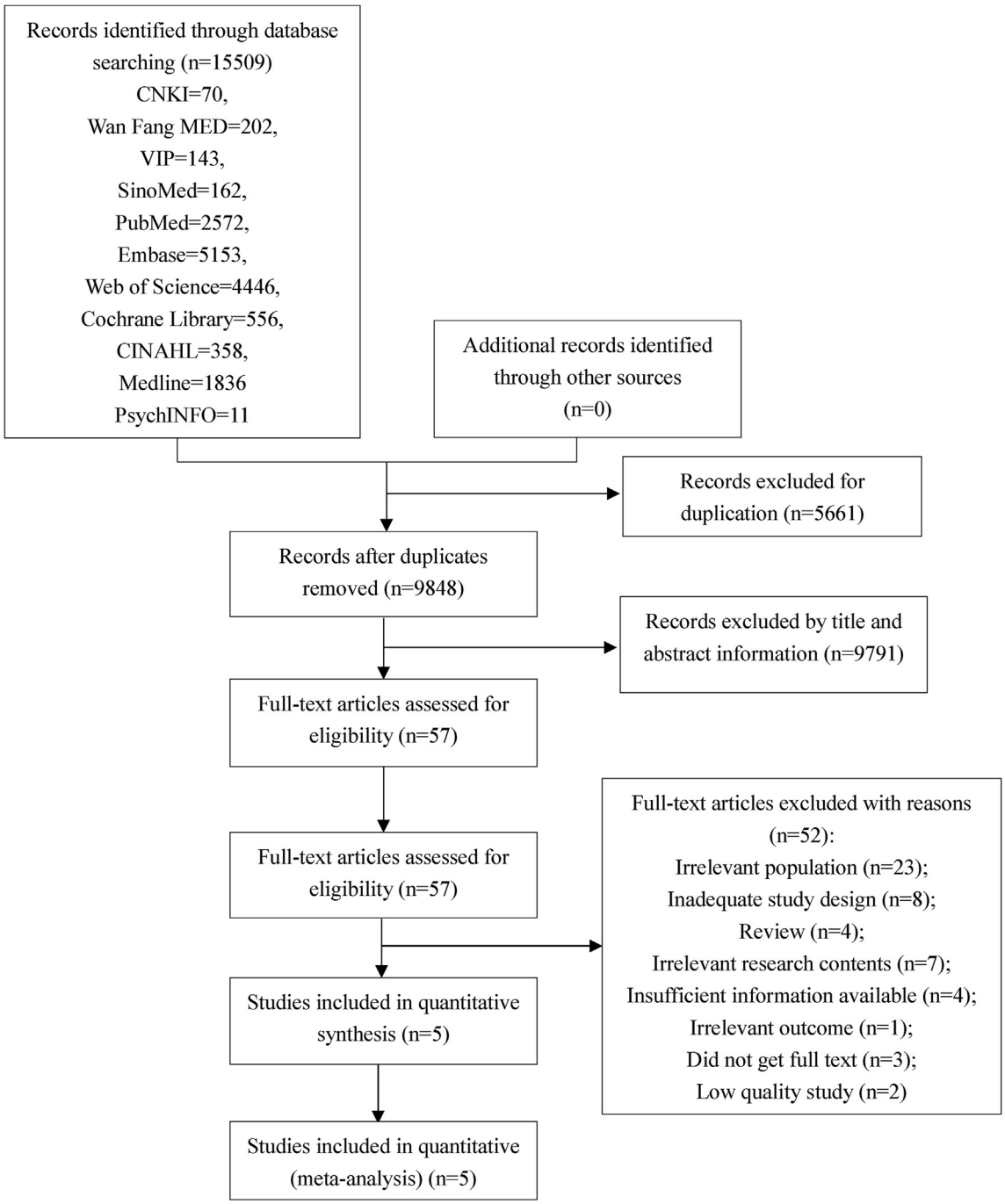

Fig. 1. Flowchart of the study selection process for inclusion in the meta-analysis.

possible star is nine). Three articles[4,9,16] scored seven stars and one articles[18] scored six stars. Only one article[17] scored five stars. The details of the quality assessment are presented in Appendix S2.

Risk factors for falls in patients with cancer

Demographic characteristics

Risk factors for demographic characteristics of falls in patients with cancer were analyzed in this study. Four studies[4,9,17,18] were mentioned age as a factor and found that patients who developed falls were significantly older (*MD* = 3.74, 95% *CI* 0.72–6.77; I^2 = 60%; *P* = 0.02) (Fig. 2). Because of the significant heterogeneity among studies, a sensitivity analysis was conducted by sequentially excluding single papers. After O′ Connell's study was excluded from the analysis, no significant heterogeneity was observed among the remaining three studies (*P* = 0.85, I^2 = 0%). Then, a fixed-effects model was used, and the pooled effects showed that age was a risk factor for falls in patients with cancer (*MD* = 2.26, 95% *CI* 0.10–4.42; *P* = 0.04) and the results robust (Appendix S3, Figs S1). All studies[4,9,16–18] reported the relationship between falls and gender and found it was not a risk factor for fall in patients with cancer (*OR* = 1.16, 95% *CI* 0.91–1.49; I^2 = 0%; *P* = 0.23) (Fig. 3).

Four studies[4,16–18] evaluated the effects of history of falls on hospitalized patients with cancer (Fig. 4). Of these studies, two studies[16,18] investigated the history of falls in the year before hospitalization. One study[4] reported history of falls within six months before hospitalization

Table 1
Characteristics of included studies.

Author, Year, Country	Patient recruitment	Case/ controls	How falls were assessed/ ascertained	Study design	Risk factors for falls	Study quality score (NOS)
Jun *et al.*, 2018, Korea	Hospitalized patients with cancer	178/178	Medical records	Case–control study	- history of falls - use of an assistive device - a high fall scale score on admission - a high ECOG score - pain - fatigue - abnormal vital signs on admission - surgery - radiotherapy - benzodiazepines - steroids - opiates - antipsychotic	7
Vela *et al.*, 2018, USA	Inpatients with hematological malignancy	59/109	Incident reporting system	Case–control study	- age $\geq$ 65 - leukemia - benzodiazepines - anticonvulsants - corticosteroids - antidepressants	5
Capone *et al.*, 2012, USA	Hospitalized patients with cancer	143/145	Event report system	Case–control study	- low pain level - abnormal gait - cancer type - metastasis - blood product - antidepressant - antipsychotic	7
Sophie *et al.*, 2008, Switzerland	In-patients with advanced cancer	36/162	Incident report form	Case–control study	- delirium - neuroleptics	7
O'Connell *et al.*, 2005, Australia	Hospitalized patients with cancer	34/193	Medical records	Cohort study	- age - ECOG scale - muscle strength - self-rated fatigue score	6

NOS, Newcastle–Ottawa Scale; ECOG: Eastern Cooperative Oncology Group.

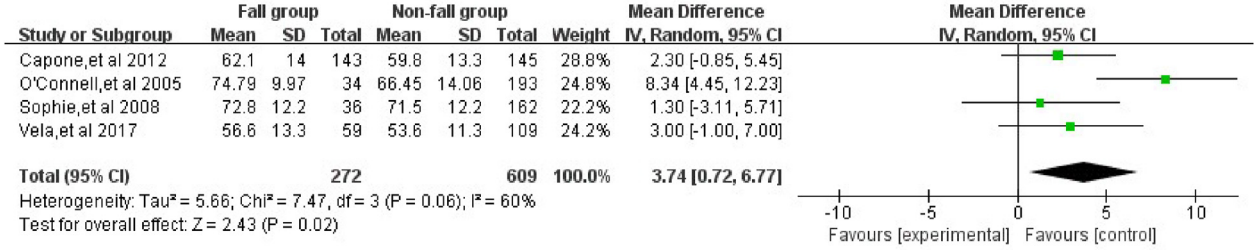

Fig. 2. Age in the falls group versus the non-falls group.

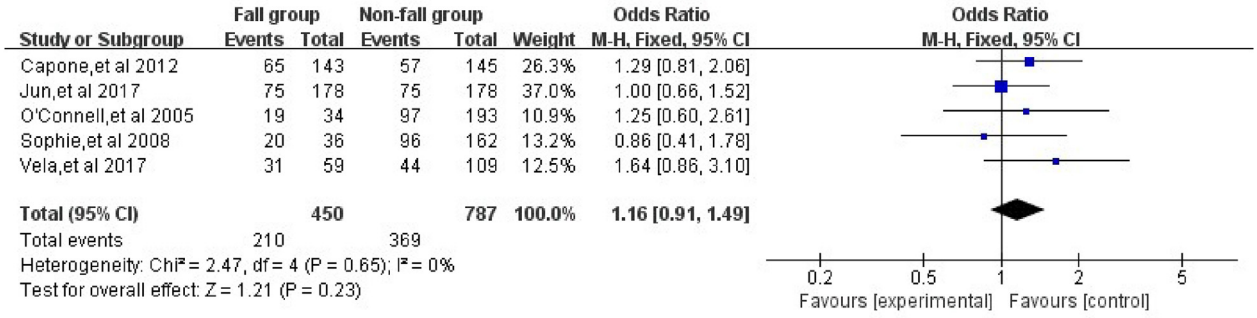

Fig. 3. Female in the falls group versus the non-falls group.

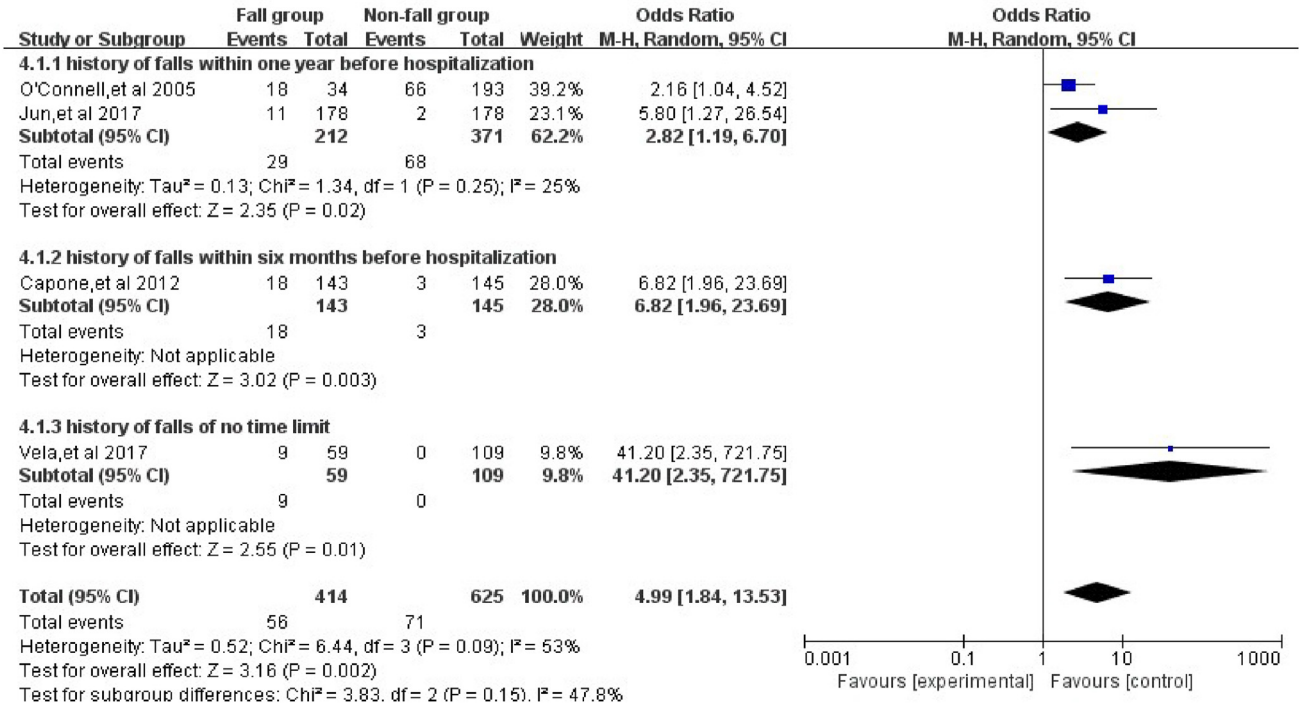

Fig. 4. History of falls in the falls group versus the non-falls group.

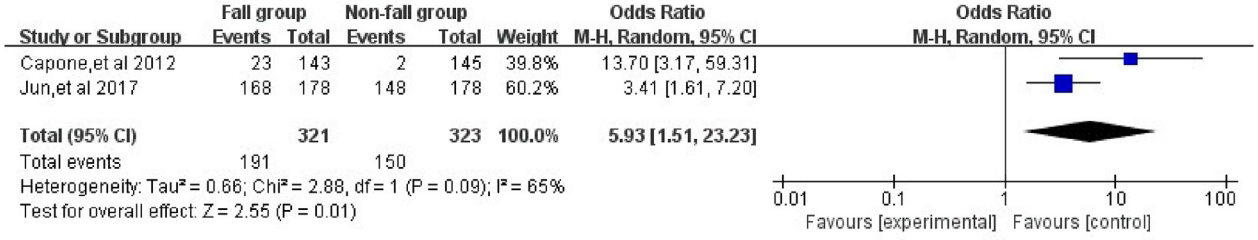

Fig. 5. The use of an assistive device in the falls group versus the non-falls group.

Table 2
Associated factors of falls in patients with cancer in meta-analysis.

Risk factors	No. of studies	Cases/ controls	*OR* (95%*CI*) or *MD* (95%*CI*)	*Z*	*P*	Heterogeneity of study design			Model	*Egger*'s test
						χ^2	*P*	I^2		
Age	4	272/609	3.74 (0.72–6.77)	2.43	0.02	7.47	0.06	60	R	0.898
Female	5	450/787	1.16 (0.91–1.49)	1.21	0.23	2.47	0.65	0	F	0.783
Opiates	4	416/594	1.72 (1.28–2.33)	3.54	0.0004	1.43	0.70	0	F	0.472
Benzodiazepines	4	416/594	2.17 (1.59–2.97)	4.84	<0.000,01	4.10	0.25	27	F	0.377
Antidepressants	3	238/416	2.09 (0.94–4.64)	1.82	0.07	6.66	0.04	70	R	0.309
Steroids	4	416/594	2.89 (1.66–5.03)	3.75	0.0002	10.53	0.01	72	R	0.457
Antipsychotics	3	357/485	3.12 (2.13–4.56)	5.87	<0.000,01	2.28	0.32	12	F	0.684
Sedatives	2	179/307	2.78 (1.60–4.86)	3.60	0.0003	1.02	0.31	2	F	NA
Dementia	2	179/307	2.43 (0.10–57.79)	0.55	0.58	4.64	0.03	78	R	NA
Radiation therapy	2	321/323	2.08 (1.41–3.07)	3.67	0.0002	0.35	0.55	0	F	NA
Chemotherapy	3	357/485	1.71 (1.14–2.59)	2.57	0.01	0.49	0.78	0	F	0.998
Anemia	2	321/323	1.41 (0.96–2.06)	1.76	0.08	1.93	0.16	48	F	NA
Use of an assistive device	2	321/323	5.93 (1.51–23.23)	2.55	0.01	2.88	0.09	65	R	NA
History of falls	4	414/625	4.99 (1.84–13.53)	3.16	0.002	6.44	0.09	53	R	0.099
Main oncologic disease (solid tumor)	3	357/485	0.50 (0.15–1.70)	1.11	0.27	11.12	0.004	82	R	0.970
Metastasis	2	321/323	2.67 (0.84–8.50)	1.66	0.10	11.71	0.0006	91	R	NA
Hemoglobin level (g/L)	2	95/271	−0.50 (-4.11–3.12)	0.27	0.79	0.15	0.70	0	F	NA
Length of hospitalization (days)	3	238/416	6.85 (4.65–9.05)	6.11	<0.000,01	3.69	0.16	46	F	0.893

Model: R, random; F, fixed; NA, not available.

and one study[17] reported history of falls with no time limit. Three subgroups were divided according to time of investigation and a statistically significant association with falls was still found (*OR* = 4.99, 95% *CI* 1.84–13.53; I^2 = 53%; *P* = 0.002).

Two studies[4,16] mentioned the factor, use of an assistive device during hospitalization, which was found to have a statistically significant association with falls (*OR* = 5.93, 95% *CI* 1.51–23.23; I^2 = 65%; *P* = 0.01) (Fig. 5).

Three studies[4,9,17] compared the length of hospitalization stay (days) between falls and non-falls groups. The pooled data suggested that fall risk was higher in those with a longer hospital stay (*MD* = 6.85, 95% *CI* 4.65–9.05; I^2 = 46%; *P* < 0.000,01).

Treatment

Four studies[4,9,16,17] reported the relationship between falls and the use of opiates (*OR* = 1.72, 95% *CI* 1.28–2.33; I^2 = 0%; *P* = 0.0004) or benzodiazepines (*OR* = 2.17, 95% *CI* 1.59–2.97; I^2 = 27%; *P* < 0.000,01) and found they were associated with falls in hospitalized patients with cancer (Table 2).

Four studies[4,9,16,17] mentioned the factor, use of steroids during hospitalization, and a statistically significant association with falls was found (*OR* = 2.89, 95% *CI* 1.66–5.03; I^2 = 72%; *P* = 0.0002) (Table 2). Because of the significant heterogeneity among studies, a sensitivity analysis was conducted by sequentially excluding single papers. After Vela's study was excluded from the analysis, no significant heterogeneity was observed among the remaining three studies (*P* = 0.23, I^2 = 31%). A fixed-effects model was then used, and the pooled effects showed that using steroids was a risk factor for falls in patients with cancer (*OR* = 2.24, 95% *CI* 1.66–3.03; *P* < 0.000,01) and the results were robust (Appendix S3, Figs S2).

Three studies[4,9,16] mentioned the factor, use of antipsychotics during hospitalization and a statistically significant association with falls was found (*OR* = 3.12, 95% *CI* 2.13–4.56; I^2 = 12%; *P* < 0.000,01) (Table 2).

Two studies[4,9] were synthesized for the factor use of sedatives during hospitalization and those studies indicated a statistically significant association with falls (*OR* = 2.78, 95% *CI* 1.60–4.86; I^2 = 2%; *P* = 0.0003) (Table 2).

Two studies[4,16] reported the relationship between falls and radiation therapy during hospitalization and showed a statistically significant association with falls (*OR* = 2.08, 95% *CI* 1.41–3.07; I^2 = 0%; *P* = 0.0002) (Table 2).

Three studies[4,9,16] analyzed the association of chemotherapy during hospitalization and fall and found the statistically significant association (*OR* = 1.71, 95% *CI* 1.14–2.59; I^2 = 0%; *P* = 0.01) (Table 2).

Publication bias

The publication bias of the studies included in this meta-analysis was evaluated using *Egger's test*. The results are shown in Table 2. The results of this meta-analysis showed no publication bias for all risk factors (*P* > 0.05). No test for funnel plot was performed due to insufficient number of studies (*n* < 10).

Discussion

According to the inclusion and exclusion criteria, a total of five studies were included, encompassing 1237 patients. All studies were rated high-quality using the NOS scale. The meta-analysis identifies eleven risk factors for falls in hospitalized patients with cancer, including age, history of falls, opiates, benzodiazepines, steroids, antipsychotics, sedatives, radiation therapy, chemotherapy, the use of an assistive device, and length of hospitalization.

Similar to previous reports, this meta-analysis revealed that age was a risk factor for falls in patients with cancer.[8,19] Elderly people are more prone to falls as they age, especially patients over 65 years old. Physiological changes as part of the normal aging process can change one's ability to tolerate anti-tumor treatments and put the patient at risk of toxicity, which may lead to falls.[20] Thus, older patients may require more frequent monitoring. However, increasing age was found not to be associated with falls in two studies of patients with cancer.[21,22] Explanations for this phenomenon may be that clinicians could be using chronological age as a proxy for other factors when making recommendations on cancer treatment for older patients, meaning some patients receive less intensive treatment and are thus less likely to fall.[23] The interaction of age at cancer diagnosis and cancer treatment with relation to falls needs to be investigated further.

The present study did not reveal gender as a significant risk factor for falls in patients with cancer, similar to the finding of a previous study.[3] However, some authors believe that gender may predict falls.[24,25] One study found that the only significant difference between patients who fell once and patients who fell repeatedly was gender. Men were more likely than women to experience more falls during the study period.[26] A possible explanation could be that men did not use the call light for the reasons of dignity or pride or because they believed they did not need assistance, compared to women, who may be more inclined to ask for help. However, studies have also shown that women have a higher rate of fall injuries than men. This may be related to reasons such as osteoporosis or a decrease in estrogen in women.[27,28] How gender specifically affects falls in patients with cancer is also worth exploring further in future studies.

Patients with cancer usually take multiple medications together, especially patients with cancer and with co-morbidities. Thus, adverse drug reactions may occur, leading to increased morbidity and mortality. Several types of drugs are associated with a significant risk of falls, the so-called 'fall risk increasing drugs'. Similar to a previous study, the present study revealed a significant association between falls and the use of benzodiazepines, leading to a two-fold increase in fall risk in patients with cancer.[1] Benzodiazepines are often used in middle-aged or older adults to treat anxiety or sleeping disorders during hospitalization. However, the effect of benzodiazepines in the treatment of sleep disorders is often temporary. In addition, it can lead to psychological dependence and thus difficulties in stopping the drug.[29] It also increases the risk of falls in hospitalized patients with cancer.

The use of antipsychotics was also demonstrated as a risk factor for falls in patients with cancer. Stone *et al.* suggest that antipsychotics themselves are associated with an increased risk of falling.[30] A cohort study reported that the difference in fall incidence rate between taking central nervous system (CNS) drugs and non-CNS drugs was statistically significant.[31] Further analysis of CNS drugs, indicated that taking hypnotics, sedatives, opioids, and antipsychotics was associated with a higher risk of falls. Another study evaluated the dose–response relationship between psychotropic drugs and falls in nursing home residents with dementia.[32] The authors found that the risk of falling increases with the dose of antipsychotic drugs and showed that, even at low doses, psychotropic drugs increase the risk of falling. Similarly, in a systematic review investigating the relationship between medications and falls, it was clearly shown that the use of antipsychotic drugs or neuroleptics increases the likelihood of falls.[33]

Steroids are another risk factor of fall, potentially playing a role via muscle weakness in patients with cancer.[34,35] Glucocorticoids have a direct catabolic effect on muscle, reducing protein synthesis, and increasing protein catabolism rate, leading to muscle atrophy.[36] Therefore, fall risk for these patients may be increased.

Opioids are a class of drugs often used to treat pain in hospitalized patients with cancer . Currently, opioids that cause sedation and dizziness are often used in patients with cancer, increasing the fall risk.[37] This study demonstrated that opiates increased fall risk for patients with cancer. Many different types of drugs can cause side effects, which increase the risk of falls; however, the role of medications and falls in patients with cancer has not been conclusively determined. Thus, more studies for falls in patients with cancer taking different medications are required.

Our study demonstrated that radiation therapy was a risk factor for falls in patients with cancer. Patients with cancer receive unique forms of treatment, such as radiation therapy, chemotherapy, or biologic response modifiers, which all have fatigue as their most common side effect. Fatigue may contribute to falls in hospitalized patients with cancer.[20] Ekfors *et al.* found that 93% of patients receiving radiation therapy for lung cancer reported experiencing general fatigue during treatment in a qualitative study.[38] However, no studies have directly linked falls and radiation therapy. The side effects of radiation therapy may affect the risk of falls, especially when combined with the other risk factors listed. Thus, additional studies on radiation therapy as a risk factor for patients with cancer are needed.

Chemotherapy is also a risk factor for falls in patients with cancer. The risk of falling in patients with cancer increases with the cumulative dose of chemotherapy and the use of neurotoxic drugs.[39] Other studies have shown that the sensory and motor symptoms of chemotherapy associated peripheral neuropathy are closely related to the risk of falls in patients with cancer.[40,41] Future studies should pay more attention to the relationship between the magnitude of peripheral neurotoxicity induced by different chemotherapy regimens and falls in patients with cancer.

History of falls was also found to be a key predictor in falls for hospitalized patients with cancer, leading to a five-fold increase in fall risk for patients with cancer. This is consistent with previous research results.[42,43] Collecting a falls history for the previous 12 months is the essential first step in fall risk screening recommended by the American Geriatrics Society/British Geriatrics Society.[44] Therefore, oncology clinical nurses need to ask for a history of falls and consider other fall risk factors specific to different types of cancers and their treatments.

This study conveyed that there is a strong correlation between the occurrence of falls and the use of assistive devices. It is difficult to draw a clear conclusion from this contradictory explanation. One study have found that lack of consultation with medical professionals, poor maintenance, and improper gait initiation are common problems in the use of assistive devices in older adults, which are more likely to lead to falls.[45] Cruz *et al.* reported that although most of older adults thought it was safety and confidence to using assistive devices, they had a higher rate of falls in the past six months than those who did not use assistive devices.[46] These assistive devices themselves may cause falls due to improper use by the patient or failure to grasp firmly in an unsafe environment. However, the use of assistive devices is likely to be a marker of impaired balance and may also simply be an artifact of weakness, advanced disease, or other factors that are the actual source of fall risk.[8] The use of assistive devices may only be a superficial phenomenon. Regardless of the explanation, greater observation of such patients is needed by healthcare workers.

Limitations

Several limitations of this study must be considered. First, because the tools for assessing patients' awareness, state of sensory perception, and physical performance varied, we were unable to perform a statistical analysis for this study. In addition, the included studies investigated various potential risk factors, resulting in few factors that can be combined and analyzed. The wide *CI* noted in this study suggest that the included studies may be underpowered. Drawing conclusions from such underpowered results should be undertaken with caution and future high-quality research of risk factors for falls in hospitalized patients with cancer is essential.

Implications

Falls prevention in hospitals requires accurate and timely information about patients' fall risk, understanding and timely communication of intervention strategies and resources, and team work to implement strategies to address the risks.[47] Robust fall predictors can inform anticipatory care planning and interventions to mitigate falls and their potentially devastating effects.[43] Oncology nurses and allied health professionals, including (but not limited to) physical therapists and occupational therapists, play a crucial role in finding risk factors for fall in hospitalized patients with cancer. From the findings of this article, we recommend that, in clinical practice, the focus should be on elderly oncology patients who use an assistive device and have a history of falls with a long hospital stay. Furthermore, patients with cancer who use opioids, benzodiazepines, antipsychotics, sedatives, steroids and receive radiotherapy or chemotherapy during hospitalization are at increased risk of falls. The results of this meta-analysis may serve as a guide to future researchers and will facilitate the development of appropriate preventive strategies.

Conclusions

Based on what is known to date about falls in hospitalized patients with cancer, this study determined eleven risk factors for fall in patients with cancer, including age, history of falls, use of opiates, benzodiazepines, steroids, antipsychotics, sedatives, radiation therapy, chemotherapy, using of an assistive device and length of hospitalization. Through the use of evidence-based information, such as that presented in this publication, healthcare workers have the capacity to help reduce fall risk for cancer patients during and after treatment by developing preventive support strategies. Multicenter, prospective studies of patients with cancer should be conducted to further identify and validate their risk factors for falls.

Authors' contributions

JZ: Study design, study supervision and manuscript revision. GZW: Study design, literature review, manuscript writing and manuscript revision. LC: Literature search, critical appraisal of included papers, extraction of data, data analysis. GZW: Critical appraisal of included papers, extraction of data and manuscript preparation. SMY: Critical appraisal of included papers, extraction of data, and data analysis. WLL: Literature review and search.

Declaration of competing interest

None declared.

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Appendix A Supplementary data

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