Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

HHS Public Access

Author manuscript

Rehabil Nurs. Author manuscript; available in PMC 2018 October 01.

Published in final edited form as:

Rehabil Nurs. 2018 ; 43(4): 201–213. doi:10.1097/rnj.0000000000000173.

Risk factors for falls in adult cancer survivors: An integrative review

Grace Campbell, PhD, MSW, RN, CRRN,
Assistant Professor, University of Pittsburgh School of Nursing, Pittsburgh, PA

Rachel A. Wolfe, MSN, CRNA, RN-BC, CARN, CCRN, and
Nurse Anesthetist, UPMC Hamot, Erie, PA and Children's Hospital of Pittsburgh of UPMC, Pittsburgh, PA

Mary Lou Klem, PhD, MLIS
Health Sciences Librarian, Health Sciences Library System, University of Pittsburgh, Pittsburgh, PA

Abstract

Purpose—To identify risk factors for falls among cancer survivors.

Design—Systematic integrative literature review.

Methods—We searched PubMed, Embase, CINAHL, Cochrane Central Register of Controlled Trials, and PEDro for studies investigating fall risk in cancer. Reports of randomized controlled trials, descriptive studies (quantitative and qualitative), and theoretical papers meeting predetermined criteria were included. Quality ratings of included studies were done and data were extracted and compiled by two independent reviewers.

Findings—Twenty nine articles met inclusion criteria. Literature quality was moderate (median quality score 1.67 out of 3 possible points. Heterogeneity of statistics and reporting methods precluded calculation of summary effect sizes, but physical function, cognitive function, balance/gait, and certain medication types appear to increase fall risk.

Conclusions and Clinical Relevance—Modifiable risk factors such as those identified in this review represent tangible intervention targets for rehabilitation professionals for decreasing the risk of falls among cancer survivors.

Keywords

Cancer; Cancer Survivorship; Rehabilitation; Accidental falls

Correspondence: Grace Campbell, PhD, MSW, RN, CRRN, Assistant Professor, University of Pittsburgh School of Nursing, Department of Acute & Tertiary Care, 336 Victoria Building, 3500 Victoria Street, Pittsburgh, PA 15261, gbc3@pitt.edu, 412-417-8804, Fax: 412-383-7227.

Conflict of interest: The authors have no conflicts of interest to report.

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

Background

Accidental falls and their associated mobility disability are a major public health crisis, and individuals with cancer are at especially high fall risk (Wildes et al., 2015). Falls are common among cancer survivors (any person from the point of cancer diagnosis through end of life; NCI, 2014) with estimated prevalence ranging from 33% (Spoelstra 2013) to 50% or more (Capone 2012; Stone 2012). Cancer survivors' risk for falls is higher than that of community dwelling older adults (Spoelstra 2013). In medically vulnerable populations such as cancer survivors, falls can have serious consequences including fractures (Z. Chen et al., 2005; Ward, Wong, Moore, & Naeim, 2014), subdural hematomas (Reichman et al., 2012), fear of falls, activity limitation (Hornyak, Brach, Wert, Hile, & Studenski, 2013; Patil, Uusi-Rasi, Kannus, Karinkant, & Seievanen, 2014), institutionalization (Analpahan, Gibson, Anpalahan, & Gibson, 2008), and death (Dunn, Rudberg, Furner, & Cassel, 1992).

Factors predisposing adult cancer survivors to falls are not well understood. In the general older adult population, factors such as age, gender, cognitive impairment, depression, comorbidities, need for assistance with activities of daily living (ADLs), history of previous falls, and medications confer increased fall risk (Rubenstein & Josephson, 2006), yet such factors do not consistently explain fall risk in cancer survivors. For example, a systematic review of fall risk factors among older adults with cancer (Wildes et al., 2015) found that ADL dependence and prior falls were associated with falls among older adults with cancer, but age and medications were not. Furthermore, while older age is an important risk factor for falls in the general population, among various clinical populations, the occurrence of falls is not limited to older adults. Because individuals with cancer of any age are at increased risk of falls (Kuriya et al., 2014), it is necessary to identify and understand the characteristics most strongly associated with falls among all cancer survivors regardless of age, so that appropriate preventive interventions can be initiated. Thus, the purpose of this review is to identify the principal known risk factors for falls and summarize the current state of knowledge in this area.

Methods/Design

Eligibility criteria

To comprehensively assess the state of the emerging science of fall risk factors among adult cancer survivors, we systematically conducted an integrative literature review. Much of the extant literature on this topic is descriptive, exploratory work that would normally be excluded by the strict eligibility criteria for systematic reviews (Umscheid, 2013). Systematic reviews are typically limited to empirical studies, while integrative reviews represent the breadth of available scholarship, including a range of methodologies such as qualitative studies and applications of theory(Whittemore & Knafl, 2005). We used a predetermined, rigorous methodology for systematically identifying and including relevant literature, extracting data, and drawing conclusions as would be done in a systematic review (Engberg, 2008; Umscheid, 2013; Whittemore & Knafl, 2005), but we also aimed to include descriptive studies (both quantitative and qualitative) literature and explication of theory.

Our initial inclusion criteria were:

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

1. Randomized controlled trials (RCTs) of any type of intervention among adult cancer survivors at any point in the survivorship trajectory (from initial diagnosis through end of life) and in any setting (outpatient/community, hospital inpatient, hospice, or long term care facility) comparing characteristics of participants who fell with participants who did not fall or reporting associations between falls and participant characteristics.
2. Observational studies (cross-sectional and longitudinal) of balance, falls, or mobility among adults (≥ age 18) at any point in the survivorship trajectory and in any setting, if demographic and clinical factors associated with accidental falls are presented.
3. Qualitative studies in which the phenomenon of interest is mobility, balance, or falls among adult cancer survivors at any point in the survivorship trajectory and in any setting.
4. Theoretical papers in which the phenomenon of interest is falls or fall risk among adult cancer survivors at any point in the survivorship trajectory and in any setting.

We then iteratively refined the inclusion criteria (Russell, 2005), allowing preliminary search results to guide development of final eligibility criteria and search methodology (Ganong, 1987). We excluded narrative literature reviews due to the high probability of bias in selection of included literature (Umscheid, 2013), gray literature (e.g., unpublished reports, theses, dissertations), and articles concerning pediatric cancer patients. The final eligibility checklist is provided in Table 1.

Literature search

Literature searches were designed and conducted by an experienced medical librarian (M.L.K) from the health sciences library system at our large urban research university. The following databases were initially searched from date of inception to July 2014: PubMed, Embase.com, CINAHL (Ebscohost), Cochrane Central Register of Controlled Trials (Wiley) and PEDro (Physiotherapy Evidence Database). All searches were updated in 2016 and then again in May 2017. When available, a database limit of English language was applied.

A search string was first developed for PubMed, consisting of natural language terms and controlled vocabulary (Medical Subject Headings) representing the concepts of “cancer survivor” and “falls”. This search string was then translated by the medical librarian for use in the other databases. The PubMed search appears in Appendix 1.

Study selection process

Initially, we hand screened abstracts of articles identified by search results to eliminate duplicate articles, articles conducted exclusively among patients under age 18, and those that were clearly unrelated to accidental falls or fall risk among cancer survivors. Results of the prescreened initial search were then be independently screened by two research team members and compared to the initial inclusion criteria. Articles recommended for inclusion were marked by each team member, and the lists were compared. Disagreements were

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

discussed, and the team arrived at a consensus regarding inclusion based on eligibility criteria. Based on initial search results, the team also evaluated whether eligibility criteria should be modified. The screening process was repeated when eligibility criteria were modified. Once a preliminary list of articles for inclusion was identified, two raters independently reviewed the full text of each identified article for a final inclusion decision. We documented each article excluded during the initial screening process and reasons for exclusion. Article selection is detailed in the PRISMA diagram in Figure 1 (Liberati et al., 2009).

Data items

The quality of each study meeting final eligibility criteria was rated and assigned a score using a published literature quality checklist (Rodgers & Knafl, 2000; Smith & Stullenbarger, 1991). The quality checklist appears in Appendix 2. Each of 21 criteria were rated using a zero to three score with zero indicating that the element is absent, and three indicating that the element is present and fully described. The mean of the quality scores were then calculated to obtain the article's final quality score. For items not applicable to a particular article, the denominator was adjusted accordingly when calculating the quality score; for example, statistical presentation was not included in the quality score for qualitative studies. In an effort to include all published literature on the topic, articles of low methodological quality were not excluded, but we have noted methodologic weaknesses that might influence the strength of conclusions drawn from these studies when interpreting results. Article quality scores are reported in Table 2.

Data collection process

Data from each article in the final sample were collected using a tabular data form. The data collection form was pilot tested by both data abstractors on a 10% random sample of identified literature and modified as needed to increase clarity and rater agreement regarding data to be abstracted. Once the data abstraction form was finalized, the two raters independently abstracted data on all identified articles. We recorded author, year, conceptual framework, sample size and characteristics (e.g. gender, age, diagnosis), setting, design, variables, data analysis, results (e.g. test statistic, degrees of freedom, odds ratio, confidence interval, p value), significance and interpretation of findings, limitations, and methodological weaknesses from each study.

After all raters had completed data extraction, they compared data tables, discussed discrepancies, and arrived at a resolution by consensus. We had planned to have a senior researcher with expertise in cancer survivorship issues adjudicate all discrepancies for which consensus could not be reached by the raters, but no discrepancies required adjudication. After reaching consensus on extracted data, to achieve consistent risk factor terminology across articles we categorized individual risk factor variables conceptually, to derive our final list of relevant risk factors. We examined overall effect sizes for the included studies to draw conclusions about the current state of the science.

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

Results

Study Selection—A total of 29 articles were identified for inclusion in this review. Database searches and search updates identified a total of 8,793 citations. After removing duplicates, a total of 6,838 records remained. Of these, 6,762 were discarded after failing to meet inclusion criteria. The full text articles for the remaining 76 citations were then examined in more detail to further determine eligibility; at this point, 47 were excluded. Twenty eight articles met the final inclusion criteria. One additional article, identified by examining the references of the selected articles, also met inclusion criteria and was included in the review, for a total sample of 29 articles. See flow diagram (Figure 1). The search yielded no RCTs, 28 observational studies, one qualitative study, and no explications of theory.

Included studies and article quality ratings—Table 2 summarizes the characteristics of the 29 included articles and provides the quality score for each. The median quality score for included studies was 1.67 out of a possible 3.0 points (range 1.24–2.45), suggesting that overall article quality was moderate. As noted, we did not exclude any articles, regardless of quality, in order to reflect as much of the available knowledge as possible.

Synthesis of included studies

Published evidence included in this review identified an array of non-modifiable and modifiable risk factors. Non-modifiable risk factors include items such as age, sex, cancer stage or severity, or cancer site. Because our objective was to identify the most important known risk factors, those that were unique to one study are not included in the summary. When available, we report results of multivariate analyses. Univariate analyses are only reported when multivariate analyses were not available in the article. Odds ratios for risk factors that were reverse coded by some manuscripts are reported in our analysis as inverses, for consistency of interpretation. A summary of key modifiable risk factors appears in Table 3.

We identified 15 potential risk factors that we categorized as modifiable risk factors (Table 3). Of these, physical function, cognitive function, balance/gait, and medication type were the most often represented in the 29 included studies. An overall effect size could not be calculated due to variability of statistical analysis and reporting across studies. However, based on available odds ratios (ORs) and 95% confidence intervals (CIs), physical function, cognitive function, balance/gait, and medication type appear to be associated with falls in the studies we reviewed. Conversely, body mass index/nutrition status, number of medications taken, muscle strength, and mood appear to be less strongly associated with falls among cancer survivors. Forest plots of key risk factors are presented in Figures 2–5.

Discussion

The results of this integrative review describe the state of the emerging science of factors associated with falls among adult cancer survivors. We found 29 studies meeting inclusion criteria. The quality of results reporting in the included studies was moderate. We included

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

all identified studies in order to gain a complete view of the current state of knowledge regarding fall risk among cancer survivors.

Studies identified an array of nom-modifiable and modifiable risk factors. Both types of risk factors are important from a prognostic perspective; that is, identifying patients at any given time who are likely to fall. Yet, non-modifiable factors offer limited intervention potential. For example, clinicians could institute increased vigilance toward patients with advanced age or more severe disease, but increased clinician vigilance is a compensatory strategy focusing on increasing clinician surveillance of at-risk patients, rather than on restoring abilities to decrease fall risk over time. We argue that modifiable risk factors such as physical function or balance and gait impairments should form the basis for a clinical fall risk assessment, because they point to clear intervention targets within the scope of rehabilitation practice.

Factors conferring increased fall risk may vary according to clinical setting and target population. Seven of the included studies were conducted in an inpatient setting (hospital, hospice, or palliative care). However, due to variability across studies regarding analytic techniques and results reporting, there were too few studies conducted in inpatient settings to warrant drawing conclusions unique to that setting.

The heterogeneity of studies analyzed in this review highlights the nascence of this field of inquiry. Included studies investigated a wide variety of potential risk factors, and within each risk factor variable, there is considerable heterogeneity of measures and operational definitions. For example, some studies measure physical function using the objective Short Physical Performance Battery, while others use self report scales or clinician ratings of patient function such as the Eastern Cooperative Oncology Group (ECOG) Performance Status Scale (Oken et al., 1982) or Karnovsky Performance Status Scale (Schag, Heinrich, & Ganz, 1984). Such heterogeneity also necessitated some judgment by the research team when categorizing risk factors. For example, the VR-12 Mental Component Summary used in one study (Pandya et al., 2016) includes aspects of mood, mental health, and social role functioning and is included in our Mood category. Other research teams could conceivably place this scale within a different risk factor category, such as Instrumental Activities of Daily Living. Some studies did not provide any operational definitions or measures for key variables and concepts. Furthermore, variations in the quality of design descriptions and heterogeneity of statistical methods and reporting across studies precluded calculation of pooled effect sizes. Variations in reporting of confidence intervals and p values further impedes the ability to evaluate the statistical and clinical importance of the body of evidence around any given risk factor.

All of the empirical studies included in our review are observational studies representing associations rather pieces of a causal chain, highlighting the need for further research. For example, associations between falls occurrence and use of assistive devices are strong, but competing explanations for this result make drawing clear conclusions difficult. It is possible that the devices themselves cause falls, due to improper use, catching on environmental hazards, etc. However, it is also possible that assistive device use is merely an artifact of

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

weakness, imbalance, advanced disease, or other factors that are the actual source of fall risk.

Wide confidence intervals noted in the data from a number of studies suggest that these studies may be underpowered. Drawing conclusions from such underpowered results must be undertaken with caution, and highlights the need for additional, appropriately powered studies examining risk factors for falls.

Limitations—Several limitations of our study must be considered. First, we attempted to ensure independence of the sample, such that results from any given analysis were included in effect size calculations only once. However, we found several articles that reported similar analyses, using the same research questions and the same data sets, but in different years and different journals. In these cases, we included only the most recently published paper in our analysis. Despite the care that we used to ensure that each data source was only included once, at times it was difficult to discern when analyses were duplicates. We may have inadvertently included some data more than once in our analysis, which could lead to overestimation of the effect size for some risk factors. Second, we did not include gray literature such as dissertations and other unpublished works, so our results may reflect a publication bias. Third, we rated the quality of all included articles, but we did not exclude those of poor quality in order to provide a synthesis of as much published literature as possible. Our conclusions may therefore be less robust than would be expected if all included articles were of uniformly high quality. Fourth, some studies included multifactorial scales as risk prognosticators; for example, the Revised International Prognostic Index (Sehn et al., 2015) or multidimensional geriatric assessment scales such as the Vulnerable Elders Survey (Saliba et al., 2001). We included data from multifactorial scales in our presentation of results when statistics for individual items were provided in source articles. However, when only a total score for the multifactorial scale was provided, we excluded these data because a total scale score precludes determining which component(s) of the scale drive the association with fall risk. Finally, our ability to calculate a pooled effect size for each risk factor across studies was limited due to lack of uniform reporting of summary statistics, sample sizes, and p values. Despite these limitations, our analysis represents an important contribution to the literature on modifiable fall risk factors for cancer survivors.

Conclusion—The rapid increase in the number of published reports of fall risk factors among cancer survivors since our initial search demonstrates the clinical importance of falls among cancer survivors (Holley 2002; others), yet it remains unclear which patients are most likely to fall during their survivorship trajectory. Clinicians are thus ill equipped to initiate preventive interventions and target those interventions appropriately. The results from this integrative review suggest that poor physical function, poor cognitive function, and impairment of balance or gait are factors that confer risk to fall and that present reasonable intervention targets for rehabilitation professionals seeking to decrease the risk of falls and injuries among cancer survivors. Clinical trials are needed to determine whether targeting these impairments leads to decrease in falls. This review has also identified ongoing gaps in knowledge, including the role of pain and other symptom severity in fall risk in our target

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

population, and the relative lack of knowledge around risk factors that are particularly important in the inpatient setting.

Acknowledgments

The authors wish to acknowledge the assistance of Himani Bhatt, DPT, for her assistance with data screening and extraction.

Source funding: Dr. Campbell's effort on this manuscript was partially funded by NINR T32 NR011972.

References

Analpahan M, Gibson SJ, Anpalahan M, Gibson SJ. Geriatric syndromes as predictors of adverse outcomes of hospitalization. Internal Medicine Journal. 2008; 38(1):16–23. DOI: 10.1111/j.1445-5994.2007.01398.x [PubMed: 17542997]

Bao T, Basal C, Seluzicki C, Li SQ, Seidman AD, Mao JJ. Long-term chemotherapy-induced peripheral neuropathy among breast cancer survivors: prevalence, risk factors, and fall risk. Breast Cancer Research and Treatment. 2016; 159(2):327–333. DOI: 10.1007/s10549-016-3939-0 [PubMed: 27510185]

Bylow K, Dale W, Mustian K, Stadler WM, Rodin M, Hall W, … Mohile SG. Falls and Physical Performance Deficits in Older Patients With Prostate Cancer Undergoing Androgen Deprivation Therapy. Urology. 2008; 72(2):422–427. DOI: 10.1016/j.urology.2008.03.032 [PubMed: 18561991]

Capone LJ, Albert NM, Bena JF, Tang AS. Predictors of a Fall Event in Hospitalized Patients With Cancer. Oncology Nursing Forum. 2012; 39(5):E407–E415. DOI: 10.1188/12.ONF.E407-E415 [PubMed: 22940520]

Chen TY, Janke MC. Predictors of falls among community-dwelling older adults with cancer: results from the health and retirement study. Supportive Care in Cancer: Official Journal of the Multinational Association of Supportive Care in Cancer. 2013; 22(2):479–85. DOI: 10.1007/s00520-013-2000-7

Chen Z, Maricic M, Bassford T, Pettinger M, Ritenbaugh C, Lobez AM, … LeBoff MS. Fracture risk among breast cancer survivors. Archives of Internal Medicine. 2005; 165:552–558. [PubMed: 15767532]

Choksi P, William ME, Kidwel KM, Stella J, Soyster M, Hanauer D, van Poznak C. Adjuvant Aromatase Inhibitors in Early Breast Cancer May Not Increase the Risk of Falls. J Bone Rep Recomm. 2017; 2(2) https://doi.org/10.4172/2469-6684.100023. http://doi.org/10.4172/2469-6684.100023.Adjuvant.

Dunn JE, Rudberg MA, Furner SE, Cassel CK. Mortality, disability, and falls in older persons: The role of underlying disease and disability. American Journal of Public Health. 1992; 82(3):395–400. DOI: 10.2105/AJPH.82.3.395 [PubMed: 1531583]

Engberg S. From the Center for Clinical Investigation. 2008 Jun.35:258–265.

Ganong LH. Integrative reviews of nursing research. Research in Nursing & Health. 1987; 10(1):1–11. [PubMed: 3644366]

Gewandter, JS., Dworkin, RH., Turk, DC., Farrar, JT., Fillingim, RB., Gilron, I., … Walco, Ga. Research design considerations for chronic pain prevention clinical trials: IMMPACT recommendations. Pain. 2015.

Gewandter JS, Fan L, Magnuson A, Mustian K, Peppone L, Heckler C, … Mohile SG. Falls and functional impairments in cancer survivors with chemotherapy-induced peripheral neuropathy (CIPN): A University of Rochester CCOP study. Supportive Care in Cancer. 2013; 21:2059–2066. [PubMed: 23446880]

Hornyak V, Brach JS, Wert DM, Hile E, Studenski S. What is the relations between fear of falling and physical activity in older adults? Archives of Physical Medicine and Rehabilitation. 2013; 94:2529–2534. [PubMed: 23816923]

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

Huang MH, Lytle T, Miller Ka, Smith K, Fredrickson K. History of falls, balance performance, and quality of life in older cancer survivors. Gait and Posture. 2014; 40(3):451–456. DOI: 10.1016/j.gaitpost.2014.05.015 [PubMed: 24931110]

Huang MH, Shilling T, Miller KA, Smith K, LaVictoire K. History of falls, gait, balance, and fall risks in older cancer survivors living in the community. Clinical Interventions in Aging. 2015; 10:1497–1503. DOI: 10.2147/CIA.S89067 [PubMed: 26425079]

Institute, NC. Dictionary of Terms. 2014. Retrieved August 3, 2016, from http://cancercontrol.cancer.gov/ocs/statistics/definitions.html

Jun, MD., Lee, KM., Park, SA. Risk factors of falls among inpatients with cancer; International Nursing Review. 2017. p. 1-8.

Kolb NA, Smith AG, Singleton JR, Beck SL, Stoddard GJ, Brown S, Mooney K. The association of chemotherapy-induced peripheral neuropathy symptoms and the risk of falling. JAMA Neurology. 2016; 73(7):860–866. DOI: 10.1001/jamaneurol.2016.0383 [PubMed: 27183099]

Kong Q, Wang Y, Song C, Liu Y, Qin H. European Journal of Oncology Nursing Prospective analysis of the risk factors for falls in lymphoma patients. European Journal of Oncology Nursing. 2014; 18(5):540–544. DOI: 10.1016/j.ejon.2014.03.016 [PubMed: 24954769]

Kuriya, M., Yennurajalingam, S., de la Cruz, MG., Wei, W., Palla, S., Bruera, E. Frequency and factors associated with falls in patients with advanced cancer presenting to an outpatient supportive care clinic; Palliative and Supportive Care. 2014. p. 1-5.

Liberati A, Altman DG, Tetzlaff J, Mulrow C, Gøtzsche PC, Ioannidis JPA, … Moher D. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: Explanation and elaboration. PLoS Medicine. 2009; 6(7)doi: 10.1371/journal.pmed.1000100

O'Connell B, Cockayne M, Wellman D, Baker L. Fall risk factors and the nature of falls in inpatient oncology and palliative care settings. Contemporary Nurse: A Journal for the Australian Nursing Profession. 2005; 18(3):247–257. DOI: 10.5172/conu.18.3.247

Oken MM, Creech RH, Tormey DC, Horton J, Davis TE, McFadden ET, Carbone PP. Toxicity and response criteria of the Eastern Cooperative Oncology Group. American Journal of Clinical Oncology. 1982; 5:649–655. [PubMed: 7165009]

Overcash JA, Rivera HR, Van Schaick J. An Analysis of Falls Experienced by Older Adult Patients Diagnosed With Cancer. Oncology Nursing Forum. 2010; 37(5):573–580. DOI: 10.1188/10.ONF.573-580 [PubMed: 20797949]

Overcash J, Beckstead J. Predicting falls in older patients using components of a comprehensive geriatric assessment. Clinical Journal of Oncology Nursing. 2008; 12(6):941–949. DOI: 10.1188/08.CJON.941-949 [PubMed: 19064388]

Pandya C, Magnuson A, Dale W, Lowenstein L, Fung C, Mohile SG. Association of falls with health-related quality of life (HRQOL) in older cancer survivors: A population based study. Journal of Geriatric Oncology. 2016; 7(3):201–210. DOI: 10.1016/j.jgo.2016.01.007 [PubMed: 26907564]

Patil R, Uusi-Rasi K, Kannus P, Karinkant S, Seievanen H. Concern about falling in older women with a history of falls: Associations with Health, Functional Ability, Physical Activity and Quality of Life. Gerontology. 2014; 60:22–30. [PubMed: 24107382]

Pautex S, Herrmann FR, Zulian GB. Factors associated with falls in patients with cancer hospitalized for palliative care. Journal of Palliative Medicine. 2008; 11(6):878–884. DOI: 10.1089/jpm.2007.0241 [PubMed: 18715180]

Pearse H, Nicholson L, Bennett M. Falls in hospices: a cancer network observational study of fall rates and risk factors. Palliative Medicine. 2004; 18(5):478–481. DOI: 10.1191/0269216304pm903oa [PubMed: 15332426]

Puts MTE, Monette J, Girre V, Wolfson C, Monette M, Batist G, Bergman H. The fall rate of older community-dwelling cancer patients. Supportive Care in Cancer. 2013; 21(3):775–783. DOI: 10.1007/s00520-012-1579-4 [PubMed: 22941117]

Reichman J, Singer S, Navi B, Reiner A, Panageas K, Gutin PH, DeAngelis LM. Subdural hematoma in patients with cancer. Neurosurgery. 2012; 71:74–79. [PubMed: 22705720]

Rodgers, BL., Knafl, KA. Concept Development in Nursing. Philadelphia: W.B. Saunders; 2000.

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

Rubenstein LZ, Josephson KR. Falls and their prevention in elderly people: what does the evidence show? The Medical Clinics of North America. 2006; 90:807–824. http://doi.org/doi:10.1016/j.mcna.2006.05.013. [PubMed: 16962843]

Russell CL. An overview of the integrative research review. Progress in Transplantation. 2005; 15(1)

Saliba D, Elliott M, Rubenstein LZ, Solomon DH, Young RT, Camberg CJ, … Wenger NS. The Vulnerable Elders Survey: A Tool for Identifying Vulnerable Older People in the Community. Journal of the American Geriatric Society. 2001; 49:1691–1699.

Schag CC, Heinrich RL, Ganz PA. Karnofsky performance status revisited: Reliability, validity, and guidelines. Journal of Clinical Oncology. 1984; 2(3):187–193. DOI: 10.1200/JCO.1984.2.3.187 [PubMed: 6699671]

Sehn LH, Berry B, Chhanabhai M, Fitzgerald C, Gill K, Hoskins P, … Connors JM. The revised International Prognostic Index (R-IPI) is a better predictor of outcome than the standard IPI for patients with diffuse large B-cell lymphoma treated with R-CHOP. Blood. 2015; 109(5):1857–1862. DOI: 10.1182/blood-2006-08-038257.The

Smith MC, Stullenbarger E. A prototype for integrative review and meta analysis of nursing research. Journal of Advanced Nursing. 1991; 16(11):1272–1283. [PubMed: 1836474]

Spoelstra S, Given BA, Schutte DL, Sikorskii A, You M, Given CW. Do older adults with cancer fall more often? A comparative analysis of falls in those with and without cancer. Oncology Nursing Forum. 2013; 40:E69–E78. [PubMed: 23448747]

Stone CA, Lawlor PG, Savva GM, Bennett K, Kenny RA. Prospective study of falls and risk factors for falls in adults with advanced cancer. Journal of Clinical Oncology. 2012; 30(2128–2133): 2128–2133. DOI: 10.1200/JCO.2011.40.7791 [PubMed: 22585687]

Tofthagen C, Overcash J, Kip K. Falls in persons with chemotherapy-induced peripheral neuropathy. Supportive Care in Cancer. 2012; 20:583–589. http://doi.org/doi:10.1007/s00520-011-1127-7. [PubMed: 21380613]

Umscheid CA. A Primer on Performing Systematic Reviews and Meta-analyses. Clinical Infectious Diseases: An Official Publication of the Infectious Diseases Society of America. 2013; 57(5):725–34. DOI: 10.1093/cid/cit333 [PubMed: 23697745]

Vande Walle N, Kenis C, Heeren P, Van Puyvelde K, Decoster L, Beyer I, … Milisen K. Fall predictors in older cancer patients: a multicenter prospective study. 2014; 14(1):1–10. DOI: 10.1186/1471-2318-14-135

Ward PR, Wong MD, Moore R, Naeim A. Fall-related injuries in elderly cancer patients treated with neurotoxic chemotherapy: A retrospective cohort study. Journal of Geriatric Oncology. 2014; 5(1): 57–64. DOI: 10.1016/j.jgo.2013.10.002 [PubMed: 24484719]

Whittemore R, Knafl K. The integrative review: updated methodology. Journal of Advanced Nursing. 2005; 52(5):546–553. [PubMed: 16268861]

Wildes TM, Dua P, Fowler SA, Miller JP, Carpenter CR, Avidan MS, Stark S. Systematic review of falls in older adults with cancer. Journal of Geriatric Oncology. 2015; 6(1):70–83. DOI: 10.1016/j.jgo.2014.10.003 [PubMed: 25454770]

Williams GR, Deal AM, Nyrop KA. Geriatric assessment as an aide to understanding falls in older adults with cancer. Support Care Cancer. 2015; 23(8):2273–80. DOI: 10.1007/s00520-014-2598-0 [PubMed: 25576434]

Winters-Stone KM, Horak F, Jacobs PG, Trubowitz P, Dieckmann NF, Stoyles S, Faithfull S. Falls, Functioning, and Disability Among Women With Persistent Symptoms of Chemotherapy-Induced Peripheral Neuropathy. Journal of Clinical Oncology: Official Journal of the American Society of Clinical Oncology. 2017; 35(23):2604–2612. DOI: 10.1200/JCO.2016.71.3552 [PubMed: 28586243]

Winters-Stone KM, Moe E, Graff JN, Dieckmann NF, Stoyles S, Borsch C, … Beer TM. Falls and Frailty in Prostate Cancer Survivors: Current, Past, and Never Users of Androgen Deprivation Therapy. Journal of the American Geriatrics Society. 2017; 65(7):1414–1419. DOI: 10.1111/jgs.14795 [PubMed: 28263373]

Winters-Stone KM, Torgrimson B, Horak F, Eisner A, Nail L, Leo MC, … Luoh SW. Identifying factors associated with falls in postmenopausal breast cancer survivors: A multi-disciplinary

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

approach. Archives of Physical Medicine and Rehabilitation. 2011; 92(4):646–652. DOI: 10.1016/j.apmr.2010.10.039 [PubMed: 21367394]

Wu FJ, Sheu SY, Lin HC, Chung SD. Increased Fall Risk in Patients Receiving Androgen Deprivation Therapy for Prostate Cancer. Urology. 2016; 95:145–150. DOI: 10.1016/j.urology.2016.05.058 [PubMed: 27318262]

Appendix 1. Literature search strategy

PubMed, Embase, CINAHL, CENTRAL [Cochrane register of controlled trials] and PEDro [Physiotherapy evidence database] were searched using the following key words: cancer, neoplasms, carcinoma, malignancy, tumor, oncology, leukemia, sarcoma, lymphoma, melanoma, blastoma, radiotherapy, chemotherapy, antineoplastic, adjuvant chemotherapy, consolidation chemotherapy, induction chemotherapy, maintenance chemotherapy, antineoplastic protocols, chemoradiotherapy, AND accidents, accident prevention, accidental falls, accidents (home), accident proneness, falls, fallers, fall related, near fall, falls efficacy. The PubMed search string was:

((((((((((((((((((cancer*[Title/Abstract]) OR neoplas*[Title/Abstract]) OR carcinoma*[Title/Abstract]) OR malignan*[Title/Abstract]) OR tumour*[Title/Abstract]) OR tumor*[Title/Abstract]) OR oncolog*[Title/Abstract]) OR leukemia*[Title/Abstract]) OR sarcoma*[Title/Abstract]) OR lymphoma*[Title/Abstract]) OR melanoma*[Title/Abstract]) OR blastoma*[Title/Abstract]) OR radiotherapy[Title/Abstract]) OR chemotherapy[Title/Abstract]) OR antineoplastic[Title/Abstract]) OR anti neoplastic[Title/Abstract])) OR ((((((((“Neoplasms”[Mesh]) OR “Radiotherapy”[Mesh]) OR “Chemotherapy, Adjuvant”[Mesh]) OR “Consolidation Chemotherapy”[Mesh]) OR “Induction Chemotherapy”[Mesh]) OR “Maintenance Chemotherapy”[Mesh]) OR “Antineoplastic Protocols”[Mesh]) OR “Chemoradiotherapy”[Mesh])))) AND (((((((“Accidents”[Mesh:noexp]) OR “Accident Prevention”[Mesh:noexp]) OR “Accidental Falls”[Mesh]) OR “Accidents, Home”[Mesh]) OR “Accident Proneness”[Mesh])) OR ((((((falls[Title/Abstract]) OR faller[Title/Abstract]) OR fallers[Title/Abstract]) OR fall related[Title/Abstract]) OR near fall*[Title/Abstract]) OR falls efficacy[Title/Abstract]))

Appendix 2. Assessment of Study Quality Instrument

Elements	1—Low	2—Med	3—High	0—Absent	N/A
Introduction					
• Justification for study					
• Conceptual framework					
• Statement of problem/purpose					
• Critical review of issues					
• Hypothesis or study questions stated					
• Operational definitions					
Methodology					
• Design described					
• Control of validity threats					

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

Elements	1—Low	2—Med	3—High	0—Absent	N/A
• Sufficient sample size					
• Representative sample					
• Data collection procedures described					
• Instrument validity described					
• Instrument reliability described					
Data Analysis and Results					
• Statistical treatment					
• Data presentation					
• Results related to problem/hypothesis					
• Findings substantiated by methods used					
Conclusions/Recommendations					
• Discussion related to background/significance					
• Conclusions logically derived from findings/results					
• Recommendations consistent with findings					
• Alternate explanations advanced					
N = 21 elements					
Sum =					
Mean score (sum / 21) =					

Adapted from Smith MC & Stullenbarger E. (1991). A prototype for integrative review and meta-analysis of nursing research. *Journal of Advanced Nursing*

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

Key Practice Points

1. Cancer survivors are at especially high risk of falls and resultant injuries.
2. Falls can have serious consequences among cancer survivors, including fractures, hematomas, fear of additional falls, activity limitation, institutionalization, and death.
3. Non-modifiable risk factors for falls may include advanced age and advanced cancer stage.
4. Modifiable risk factors such as poor physical function, poor cognitive function, impaired balance and gait, and use of certain types of medications offer opportunities for rehabilitation professionals to intervene to decrease the risk of falls.

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

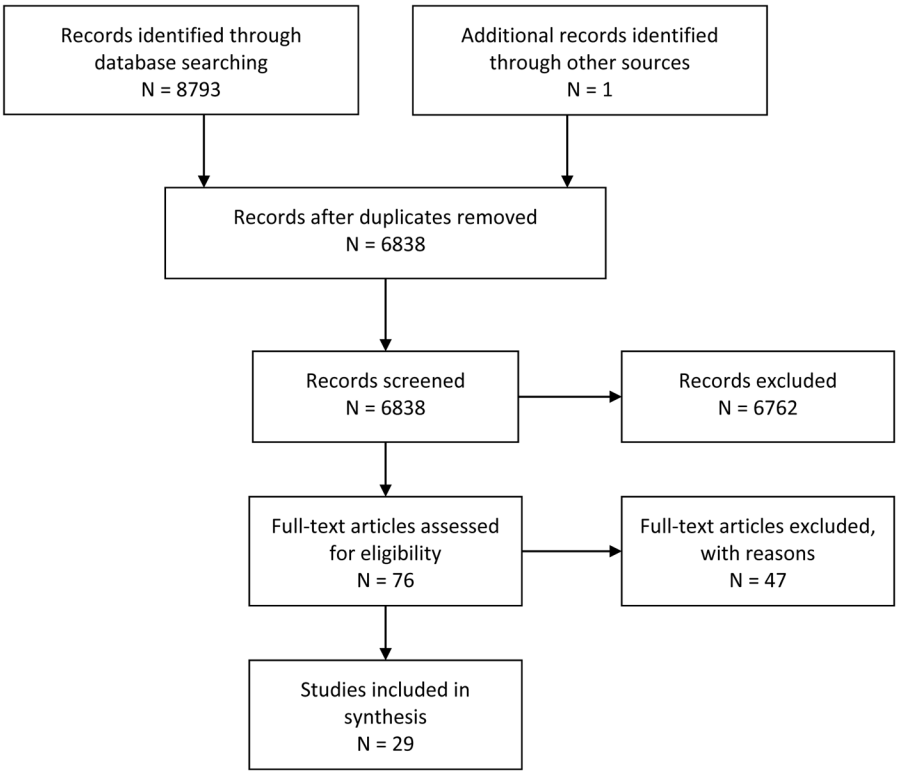

Figure 1.
PRISMA flow diagram

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

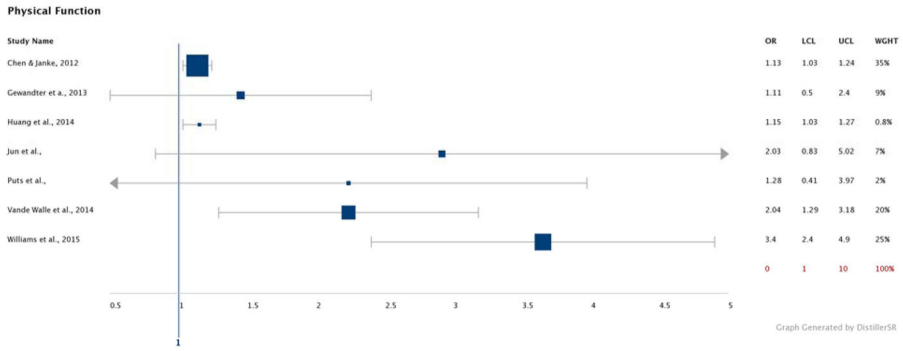

Figure 2.
Physical function.

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

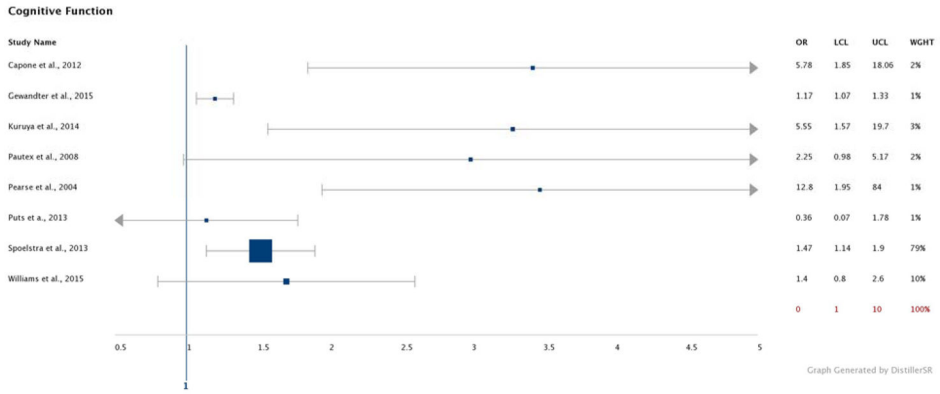

Figure 3.
Cognitive function.

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

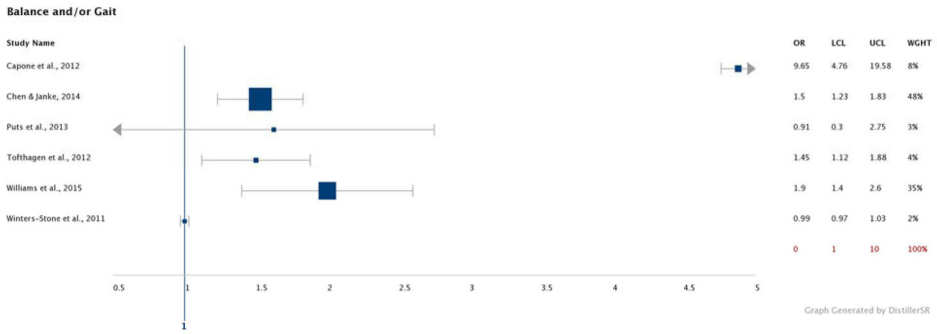

Figure 4.
Balance and gait

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

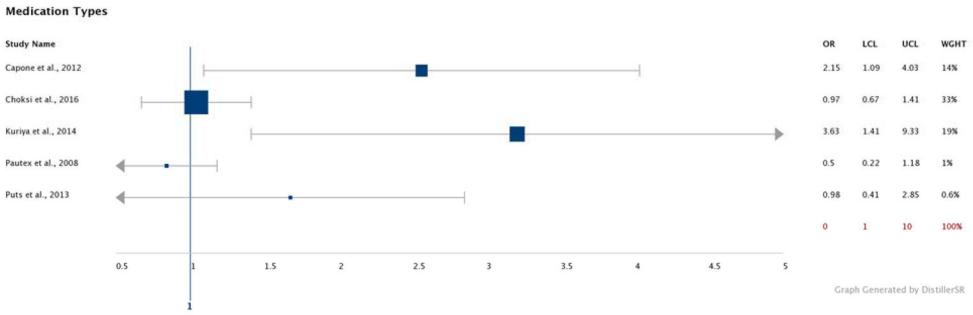

Figure 5.
Medication types.

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

Table 1

Eligibility criteria.

Level 1 Screening	
• Narrative or other non-systematic literature review • Unpublished report, thesis, or dissertation • Falls are an independent variable rather than a dependent variable (e.g. a symptom that lead to a subsequent cancer diagnosis) but lacks analysis of factors associated with the fall • Includes patients age ≤ 18	• If YES to any item, EXCLUDE article
Level 2 Screening	
• Article is a randomized controlled trial; a systematic or integrative review; or an observational quantitative or qualitative study • Article is a published abstract or letter to the editor that includes data related to factors associated with falls occurrence • Article is a theoretical piece related to falls • Actual number of falls (rather than fall “risk”) is a dependent or outcome variable • Article includes analysis of associations between potential risk factors and occurrence of falls • If sample included individuals without cancer, a subgroup analysis of factors associated with falls in the cancer group only was included	• If YES to any item, INCLUDE article

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

Table 2

Characteristics of included studies.

Citation	Design	Participants; Setting	AGE (years)	Cancer Type/Site	Cancer Treatment	Potential Risk Factors	Result Statistic	Quality Score
Bao et al., 2016	Cross sectional with retrospective falls recall	N = 296 community dwelling postmenopausal women from outpatient cancer clinics	Mean 62.0 (SD 9.0)	Breast cancer	Any taxane-based chemotherapy	Age, BMI, CIPN severity	OR	1.81
Bylow et al., 2008	Cross sectional	N = 50 community dwelling men at an outpatient cancer center	Median 78 (Range 70–92)	Prostate cancer	ADT	Age, ADLs, IADLs, comorbidities, physical function, cognitive function, social support, comorbidities, medications, nutritional assessment, fatigue	OR	1.48
Capone, Albert, Bena, & Tang, 2012	Retrospective	N = 288 hospital inpatients (143 fallers, 145 non fallers)	Mean 60.9 (SD 13.7)	Any type	Any treatment	Age, length of stay, comorbidities, cancer type/site, presence of metastasis, anemia, cancer treatment type, physical function, urinary urgency, sepsis, intracerebral bleeding, pain, pain treatment, location, patient equipment, vital signs, medications, lab results	OR	2.05
Chen & Janke, 2013	Prospective cohort	N = 1630 community dwelling older adults (age 65+)	Mean 75.4 (SD 7.05)	Any cancer except skin	N/A	Age, education, sex, race, comorbidities, physical function, pain intensity, grip strength, perceived balance	OR	1.62
Choksi et al., 2017	Retrospective case control	N = 664 (332 matched pairs of postmenopausal women: patients; non-cancer controls)	Median 67 (Range 34–95)	HR+ breast cancer	Adjuvant aromatase inhibitors	Exposure to aromatase inhibitors, bone mineral density, age at first fall, medications	OR	1.50
Gewandter et al., 2013	Secondary analysis from prospective trial; retrospective fall recall	N = 421 community dwellers from community oncology sites	Mean 60 (SD 10.3)	Any type	Any treatment	Age, sex, race, marital status, education, cancer treatment, cancer type, CIPN severity, functional impairment	OR	2.10
Gewandter et al., 2015	Cross sectional	N = 174 community dwelling older adults from a geriatric oncology clinic	Median 80 (IQR 76–85)	Any type/site	Any treatment	Age, sex, cancer stage, treatment type, muscle strength, physical function, Lawton IADL, cognitive function, depression, medications	OR	1.81
Huang, Lytle, Miller, Smith, & Fredrickson, 2014	Cross sectional with retrospective fall recall	N = 41 community dwelling older adults	Mean 67.9 (SD 8.8)	Any nonmeta-static cancer except nervous system, skin, musculoskeletal	Any treatment	Age, sex, time since diagnosis, treatment, BMI, comorbidities, gait speed, sensation, balance, self-reported balance, quality of life (physical), quality of life (mental)	OR; t test	1.90
Huang, Shilling, Miller, Smith, & LaVictoire, 2015	Cross sectional with retrospective fall recall	N = 44 community dwelling older adults	Non Fallers: Mean 67.4 (SD 8.46) ; Fallers: Mean 68.8 (SD 9.71)	Any nonmeta-static cancer except nervous system, skin, musculoskeletal	Any treatment	Age, sex, BMI, comorbidities, number of medications, cancer treatment, sensation, gait speed, balance; balance confidence/fear of falling	OR	1.86
Jun, Lee, & Park, 2017	Retrospective case control	N = 356 (178 each of fallers and non-fallers) South Korean cancer hospital inpatients	No mean provided; 54% were age 60–79	Mixed	Not specified	Age, sex, type of cancer; presence of metastasis, assistive device use, communication, orientation, physical function, sensory deficits, numbness/	OR	1.59

Citation	Design	Participants; Setting	AGE (years)	Cancer Type/Site	Cancer Treatment	Potential Risk Factors	Result Statistic	Quality Score
						tingling, nutritional status, pain anemia, fatigue, urinary system disorders, vital signs, type of cancer treatment, medications		
Kolb et al., 2016	Secondary analysis of prospective trial	N = 116 community dwelling adults	Mean 55.5 (SD 11.9)	Breast, ovarian, lung	Taxane or platinum chemotherapy	Age, sex, cancer type, cancer stage, cancer treatment, CIPN severity	HR, Chi square	2.09
Kong, Wang, Song, Liu, & Qin, 2014	Prospective	N = 203 Chinese newly diagnosed inpatients and outpatients	Median = 46 (Range 13–71)	Lymphoma	Chemotherapy	Age, sex, cancer stage, disease prognosis (R-IPI), cognitive function, treatment, physical function	OR	1.38
Kuriya et al., 2014	Cross-sectional with retrospective fall recall	N = 384 patients with advanced cancer at outpatient supportive care clinic	Mean = 57.9 (SD 13.3)	Any type/site	Any treatment	Age, sex, cancer type/site, medications, substance abuse history, symptom severity, cognitive function, functional status, assistive device use, presence and site of metastases, cancer treatment	OR	1.48
O'Connell, Cockayne, Wellman, & Baker, 2005	Prospective	N = 227 inpatient oncology or palliative care	Mean 67.7 (SD 13.3)	Any type/site	Not specified	Age, sex, physical function, cognitive function, muscle strength, fatigue, history of falls	t-test	1.43
Overcash, Rivera, & Van Schaick, 2010	Exploratory qualitative	N = 20 older adult outpatients	Mean 76.4 (range 70–94)	Any type/site	Any treatment	Participants' perceptions of fall causes	Not applicable	1.50
Overcash & Beckstead, 2008	Cross sectional	N = 352 older adult outpatients	Mean for Treatment group 77.8; No Treatment group 76.9; Non-cancer group 80.1	Any type/site except skin	Any treatment	Age, sex, cancer treatment, ADLs, depression, cognitive function, comorbidities	OR	1.86
Pandya et al., 2016	Cross sectional with longitudinal component	Community dwelling older adults. Cross-sectional component: N = 17,958; Longitudinal component: N = 6,313	Means/medians not provided.	Any type/site	None specified	Health-related quality of life	t-test	1.43
Pautex, Herrmann, & Zulian, 2008	Cross sectional	N = 198 inpatient palliative care patients	Mean 71 (SD 12.1)	Advanced cancer, any type/site	N/A	Age, sex, cognitive function, depression, anxiety, comorbidities, physical function	OR, chi square, t-test	1.52
Pearse, Nicholson, & Bennett, 2004	Prospective	N = 102 Inpatient Hospice	Mean 67 (Range 31–94)	N/A	N/A	Age, sex, cognitive function, physical function, postural hypotension, vision impairment, hearing impairment, medications, fall history	OR	1.52
Puts et al., 2013	Secondary data analysis from prospective study	N = 112 older adult outpatients	Mean 74.2 (SD 6)	Any type/site	Any treatment	Age, sex, living arrangements, marital status, income, education level, alcohol use, smoking status, country of origin; gait speed (slower than 1m/sec = frailty marker), cognitive function, anxiety, depression, fatigue, strength, nutritional status, BMI, physical activity	OR (unadjusted univariate regressions)	1.24
Spoelstra et al., 2013	Retrospective case control	N = 9481 community dwelling older adults (864 with cancer; 8617 without	Mean 77	Any type/site except skin	N/A	Sex, race, marital status, living status, comorbidities, depression, pain, incontinence, cognitive function, vision	OR	1.95

Citation	Design	Participants; Setting	AGE (years)	Cancer Type/Site	Cancer Treatment	Potential Risk Factors	Result Statistic	Quality Score
		cancer, matched 1:10 cases vs. controls				impairment, recent weight loss, medications, ADLs		
Stone, Lawlor, Savva, Bennett, & Kenny, 2012	Prospectivecohort	N = 185 patients with advanced cancer from community and inpatient palliative care	Mean 68 (SD 12.6)	Any type/site	N/A	Age, sex, cancer type/site, medications, physical function, pain, symptom severity, insomnia severity, cognitive function, incontinence, strength, vision impairments, sensation	HR	2.0
Tofthagen, Overcash, & Kip, 2012	Cross sectional	N = 130 community dwellers	Mean 58.4 (SD 11.8)	Any type/site	Platinum- or taxane-based chemotherapy	Age, sex, race/ethnicity, education, marital status, income, years of education, employment status, type of cancer, type of chemotherapy, number of chemotherapy cycles, cumulative dose of neurotoxic agent, severity and frequency of neuropathy symptoms (hand and foot numbness, sensitivity to cold, nerve pain, muscle/joint aches, muscle weakness, loss of balance), neuropathy interference with ADLs and life activities	OR	1.67
Vande Walle et al., 2014	Prospective	N = 937 community dwelling older adults	Median 76 (range 70–95)	Any type/site	Any treatment	Age, sex, living situation, cognitive function, depression, nutrition assessment, ADLs, IADLs, comorbidities, fatigue, pain, physical function, tumor type and stage; treatment type, number of medications inclusion).	OR	1.67
Williams, Deal, & Nyrop, 2015	Cross sectional	N = 1172 community dwelling older adults	Mean 73 (range 65–79)	Any type/site	N/A	Age, sex, race, education, marital status, cancer type, treatment phase, physical function, ADLs, IADLs, cognitive function, vision impairment, hearing impairment, mental health, comorbidities, medications, nutritional status, clinic type (academic vs. community)	OR	1.62
Winters-Stone et al., 2011	Case control (un-matched) with prospective fall follow up	N = 59 community dwelling postmenopausal women < age 70	Mean 58.5 (SD 9.7)	Nonmeta-static breast cancer	Chemotherapy (completed) or surgery with 2 years	Age, BMI, cancer stage, treatment type, time since treatment, balance, gait speed, strength, muscle mass, vision impairment	t-test, chi square (retrospecttive fall history); OR (prospective fall predicttion)	1.90
Winters-Stone et al., 2017	Cross sectional	N = 280 community dwelling males	Mean 72 (SD 8)	Prostate cancer	Any treatment	Age, race, BMI, time since diagnosis, disease severity (metatasis), treatment type, frailty criteria (fatigue, resistance, ambulation, illness, weight loss)	OR	2.45
Winters-Stone, Horak, et al., 2017	Secondary analysis of prospective intervention trial	N = 512 community dwelling women age 50 or older	Mean 62 (SD 6)	Any type/site	Any treatment	Age, neuropathy symptoms, cancer type, cancer stage, time since diagnosis, strength, balance, gait speed, comorbidities, BMI	OR	2.14
Wu, Sheu, Lin, & Chung, 2016	Cross sectional	N = 1748 (886 ADT use, 862 no ADT use) at Taiwanese ambulatory care centers or hospitals	Mean 74.2 (SD 8.4) fallers; 70.5 (SD 10.8) nonfallers	Prostate cancer	ADT	ADT exposure, age, geographic region of Taiwan, monthly income, urbanization level, comorbidities	HR	2.15