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Original Research Report

The Association Between Anxiety and Falls: A Meta-Analysis

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Abstract

Objectives: Falls occur frequently among older adults and can lead to a range of adverse and debilitating outcomes. Although symptoms of clinical anxiety have been implicated as risk factors for falls, there is no current consensus on the empirical association between anxiety and falls. The current study aimed to address this gap in the literature by conducting a quantitative, meta-analytic review of findings from previous studies.

Method: A systematic literature search of bibliographic databases was conducted, yielding 18 studies that fit the criteria for inclusion in the meta-analysis.

Results: A random-effects model of all 18 studies showed a significant overall odds ratio of 1.53 (95% CI 1.28–1.83, $p < .001$), indicating that elevated levels of anxiety were associated with a 53% increased likelihood of falls. A high amount of variance among effect sizes was observed. Only age was identified as a moderator of this relationship in a subgroup of the samples.

Conclusions: Clinical anxiety is associated with falls, however, further research is required to elucidate the factors that might moderate or mediate this relationship, the casual pathways through which they are related, and the associations between different types of anxiety and falls.

Keywords: Anxiety—Epidemiology—Falls and mobility problems—Falls risk—Meta-analysis—Review

Falls are highly prevalent among older adults. Approximately 30%–40% of community-dwelling older adults will experience a fall each year, a significant proportion of these resulting in a major injury or hospitalization (Rubenstein, 2006). In addition, falls can lead to a range of other adverse outcomes, such as withdrawal from social and physical activities (Tinetti & Williams, 1998), reduced quality of life (Hartholt et al., 2011), and subsequent lower life satisfaction (Maher & Conroy, 2015; Stenhagen, Ekström, Nordell, & Elmståhl, 2014). The impact of falls on health and social services (Scuffham, Chaplin, & Legood, 2003), and economic burden (Stevens, Corso, Finkelstein, & Miller, 2006), is substantial.

Numerous physical and environmental factors have been identified that can contribute to increased risk of falls (Ambrose, Paul, & Hausdorff, 2013). Recently, psychological well-being and psychopathology have also been implicated in their etiology (Finkelstein, Prabhu, & Chen, 2007). Poorer mental health has been shown to be associated with functional impairment in a range of domains, such as physical health and activity (McKnight & Kashdan, 2009) and cognitive functioning (Bauermeister & Bunce, 2015), and can interact with other known risk factors, thereby increasing the chance that individuals will fall. For example, depressive symptoms are an independent risk factor for falls (Kvelde et al., 2013). This is likely due to various sequelae of depression such as impaired neuropsychological functioning (e.g., attention, concentration, and planning–organization; Manning et al., 2014) that may impact on variables such as reaction time, which is associated with

stability and falls (Graveson, Bauermeister, McKeown, & Bunce, 2015), and psychomotor slowing leading to postural abnormalities (Turcu et al., 2004).

Anxiety represents another possible risk factor and outcome of falls. Anxiety disorders (Baxter, Scott, Vos, & Whiteford, 2013) and subthreshold, clinically significant levels of anxiety symptoms (Bryant, Jackson, & Ames, 2008) are common in adults. This is particularly so in older adults (Wolitzky-Taylor, Castriotta, Lenze, Stanley, & Craske, 2010), who are more likely to fall (Rubenstein, 2006). To date, research concerned with the association between anxiety and falls has focused predominantly on the constructs of fear of falling, fall-related self-efficacy, and the avoidance of activities due to these concerns (Jørstad, Hauer, Becker, & Lamb, 2005). These constructs are typically regarded as a consequence of prior falls, which then increase subsequent falls risk. They are intrinsically associated with falls, however, only modestly correlated with symptoms of clinical anxiety (e.g., Painter et al., 2012; Ribeiro & Santos, 2015; Smith, Zalewski, Motl, van Hart, & Malzahn, 2010). Clinical anxiety, which is experienced in a more pervasive manner and can involve somatic, behavioral, and cognitive symptoms, may also lead to an increased risk of falling. The causal mechanisms linking clinical anxiety symptoms with falls have not been studied in great detail, however, there are a number of plausible pathways through which the symptoms of clinical anxiety may increase the risk of falls. For example, increased dizziness (Eckhardt-Henn, Breuer, Thomalske, Hoffmann, & Hopf, 2003), gait stiffness caused by increased muscle tension (Pluess, Conrad, & Wilhelm, 2009), hypertension (Player & Peterson, 2011), deconditioning due to avoidance or restriction of activity, dysfunctional visual control (Staab, 2014), and hypervigilance leading to maladaptive attentional biases (Richards, Benson, Donnelly, & Hadwin, 2014).

Although some studies have reported associations between anxiety symptoms and falls, this has typically not been the focus of research. Further, the methodology and findings of these studies have been inconsistent. Given this, no consensus exists regarding the empirical association between anxiety symptoms and falls. A clearer understanding of this association would inform the process of falls risk reduction and identify possible adverse outcomes for individuals experiencing clinical anxiety. The current study aimed to address this gap by systematically searching the extant literature on falls and synthesizing findings on their association with anxiety symptoms. Using meta-analytic statistical techniques, the review aims to clarify the association between anxiety and falls by providing a quantitative summary of available evidence. The findings of this review will be particularly relevant to the development of strategies to lower both anxiety symptoms and anxiety disorders in order to reduce the incidence of falls, which have a major impact on the lives of a high percentage of older people (Wolitzky-Taylor et al., 2010).

Method

The review was conducted in accordance with the evidence-based guidelines for systematic reviews described in the PRISMA statement (Liberati et al., 2009).

Data Sources and Search Strategy

On July 3, 2015, electronic literature searches were conducted using the following nine databases: Social Sciences Citation Index, PsychINFO, Academic OneFile, MEDLINE Complete, InfoTrac Health Reference Center Academic, ScienceDirect, Science Citation Index, CINAHL Complete, and PsycARTICLES. The search included all peer-reviewed articles written in English published up to the time the search was conducted. The word "fall" was used as a keyword appearing in the title and "anxiety" as a keyword found anywhere in the text of the article. References from the identified articles were also searched for relevant articles.

Study Selection

The following criteria were used to identify eligible articles:

1. the article presented original quantitative data;
2. falls prevalence was assessed, either historically, prospectively, or both, and participants were categorized as either fallers or nonfallers;
3. current or historical anxiety symptoms were assessed by a self- or clinician-rated symptom rating scale or some other quantitative measure, or a diagnosis of an anxiety disorder was assessed via self-report or a diagnostic interview;
4. the sample included individuals who had fallen at least once and individuals who had not fallen;
5. the sample did not consist of hospitalized individuals; and
6. sufficient information was presented so that the methodology of the study and the results could be extracted.

Data Extraction

The following information was extracted from the articles selected for full review: authors, year of publication, country where the study was conducted, characteristics of the sample used in analyses (i.e., age, percentage female, number of participants classified as fallers or nonfallers), the study design, measure of anxiety symptoms, measurement of falls, and any variables that were adjusted for in the study analyses. From each study that was included in the meta-analysis, we extracted quantitative data of the associations between anxiety and the outcome of falls or no falls.

Statistical Analyses

The outcome of interest was falls, with the association with anxiety expressed as an odds ratio (OR). Where sufficient

information was available to do so, and if not already reported as such, descriptive and test statistics showing the association between falls and anxiety were converted to OR with 95% confidence intervals (CIs). If this information was not available, authors were contacted. In total, authors from three studies were contacted, and one responded with the requested data. Where multiple effect sizes were reported, we utilized the effect size estimate that was most adjusted for potential confounding variables (e.g., demographics and other falls risk factors). All studies included a falls and nonfalls group, with the exception of one (Vetter & Ford, 1989). In this instance, three nonoverlapping groups of participants with varying frequency of falls were collapsed to compare with another group of nonfallers.

Meta-analytic calculations were performed using Review Manager 5.3 (Review Manager [RevMan] Version 5.3.5, 2011). Given that we expected there to be heterogeneity between the studies, we opted for a random-effects model to more robustly estimate the overall effect size. A random-effects model assumes that the included studies represent a random sample of studies distributed around a mean effect size for a population, rather than assuming each study conveys the true effect size. The heterogeneity of effect sizes was assessed using the Q statistic and the I^2 statistic. The Q statistic provides an estimate of whether or not differences between the effect sizes are larger than we might expect to occur by chance and is distributed as a chi-square statistic with accompanying p value. A p value less than .05 indicates that the difference between the study effect sizes is significant. The I^2 statistic indicates the magnitude of heterogeneity among the study effect sizes, with statistics of 50% or higher indicative of a large amount of variance between effect sizes (Higgins, Thompson, Deeks, & Altman, 2003).

A file drawer statistic was also calculated to account for the possibility of publication bias (i.e., the overrepresentation of positive findings over null findings). A fail-safe N was computed (Orwin, 1983), which represented the number of additional studies with an average OR point estimate of 1.0 that would be required to reduce the effect size to 1.0. In addition to this, the trim and fill method for adjusting for possible publication bias in meta-analysis was used (Duval & Tweedie, 2000). This method trims small and extreme studies from the sample and provides an adjusted effect size estimate, as well an estimate of the number of missing studies that would be required to counterbalance the influence of samples with extreme effects.

Results

Figure 1 presents a flowchart of the study selection process. The initial search returned 884 articles. The search engine removed 165 duplicates and another 23 (total 188) were found manually. This left 696 articles. Of these, 136 were identified by their abstract as potentially meeting criteria for inclusion in the study. After examining the full text of the articles, 16 studies met the criteria for inclusion. A further two eligible studies were found through crossreferencing, making a total of 18 studies included in the meta-analysis.

Study Characteristics

Table 1 presents details of the 18 studies included in the meta-analysis. The majority of the included studies (n = 16) were reported in the past 15 years and were conducted in westernized countries. A total of 29,267 participants were included, with the sample size ranging from 41 to 15,405; the average percentage of women in the sample was 55.3%. The majority of participants were older adults (n = 16), with the exception of two studies where participants 12 or 20 years and older were recruited. In these two studies, the reported measures of central tendency indicated that their samples largely consisted of middle- and older-aged adults. Fifteen samples of the studies comprised community-dwelling individuals, whereas three samples were of individuals living in care facilities. The study designs used were prospective cohort (n = 8), retrospective (n = 9), and cross-sectional (n = 1). For 14 of the studies, the criterion for being classified as a "faller" was the occurrence of one or more falls over the time period of interest. The remaining studies defined being a "faller" as two or more falls (n = 2), two or more falls or one or more injurious falls (n = 1), and one or more injurious falls (n = 1). The reported occurrence of falls ranged from 4.8% to 66.8% of the sample. There was variation across studies in the measurement of anxiety that was used, with 11 using previously validated self-report measures of anxiety symptomatology, four self-reported or health professional-reported anxiety disorders, two a measure of anxiety symptoms designed for the study, and one a structured diagnostic interview for anxiety disorders.

Overall Effect Size Analysis

A weighted, random-effects meta-analysis tested the association between anxiety and falls across the 18 effect sizes included in the analysis. As indicated in Figure 2, a significant overall OR was found, with an effect size of 1.53 (95% CI = 1.28–1.83, p < .001) Schmid and colleagues (2013) was the only study to report an OR point estimate of less than 1.0, although this was not statistically significant. Their study, as distinct from other included studies, used a measure of symptoms from one specific anxiety disorder: generalized anxiety disorder.

The fail-safe N (Orwin, 1983) for the overall effect size was 18, indicating that a minimum of 305 studies with an OR point estimate of 1.0 would have to be added to the included studies before the average effect became 1.01. Given this, the current findings can be interpreted as being robust to the effect of unpublished studies or future studies with null effects. The trim and fill procedure indicated that only five studies were potentially missing from the sample (27%), and when filling for these missing data, the effect

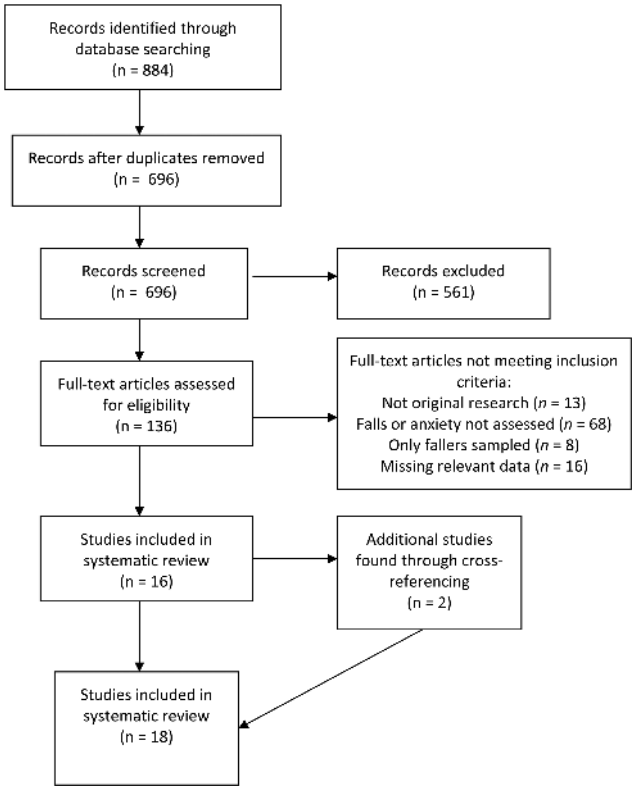

Figure 1. Flowchart of the study selection process.

size did not significantly differ (OR = 1.34, 95% CI = 1.12–1.61, $p < .001$).

The heterogeneity statistics indicated a large between-study variance, $Q = 58.6$, $I^2 = 71\%$, $p < .001$. As the effect size derived from Schmid and colleagues' (2013) study was the only one that showed an OR of less than 1.0, and therefore was an outlier, it was removed from the analysis to assess the impact on heterogeneity. This removal made little difference ($Q = 57.29$, $I^2 = 72\%$, $p < .001$). Given the large observed variance, subgroup analyses were conducted to assess for differences in effects based on possible moderating characteristics of the studies.

Moderator Analysis

Subgroup analyses were conducted to assess whether the heterogeneity in the association between anxiety and falls observed across the studies might be accounted for by particular characteristics of the studies. Again, random-effects models were used. The Q and I^2 statistic were used to assess whether there were differences in the effects between the subgroups, and therefore whether that subgroup variable moderated effect sizes. Heterogeneity was also assessed within each subgroup. The studies were grouped based on the following variables: the design of the study, anxiety measurement (measured as the presence or absence of an anxiety disorder, or as elevated symptoms), the setting (a care facility or community-dwelling), whether the sample was one of individuals with identified health care needs (i.e., living in a residential home, obstructive pulmonary disease, stroke, cancer, cognitive impairment, or presenting to an emergency department) or not, the recruitment method (a random probability sample, a whole population being sampled, or nonrandom recruitment with identified populations), and whether the study reported univariate statistics for the association between anxiety and falls or reported multivariate statistics adjusted for possible confounding variables. A Bonferroni correction was used among the subgroup analyses to account for possible type 1 errors ($\alpha = 0.05/6 = .008$). Differences in effect sizes between the subgroups were assessed by inspection of the CIs around the OR point estimate, with a lack of overlap also indicating statistically significant differences.

To assess whether gender or age was a moderator, meta-regressions were conducted using random-effects models in Comprehensive Meta-Analysis (Version 3.3.070). The proportion of women in each group was treated as a continuous variable. For age, only nine studies reported the requisite statistics for inclusion in a meta-regression.

As shown in Table 2, no significant differences between subgroups were found. Post hoc power analyses were conducted to assess whether the tests had adequate statistical power to detect significant differences using G*Power 3.1.9.2 (Faul, Erdfelder, Lang, & Buchner, 2007). The results showed that the moderator tests were powered to detect very small effects, ranging between OR = .87–1.13 (for recruitment setting) to OR = .93–1.07 (whether confounds were controlled for or not), if they were present. The OR showing the association between anxiety and falls was found to be significant within all subgroups. The effect sizes were comparable with the overall effect for studies, with overlapping CIs. Within the subgroups, studies that were retrospective/cross-sectional, assessed for anxiety disorder, sampled individuals in care facilities, had a larger age range of participants, used random sample or a whole population, and those that adjusted for confounds had nonsignificant tests for heterogeneity and low-to-moderate variance in effect sizes. This indicates that effect sizes in these subgroups were relatively homogenous. Heterogeneity was significant and high among studies that were prospective, used measures of anxiety symptomatology, sampled community-dwelling individuals, had identified health care needs, recruited older adults or identified populations, and did not account for potential confound variables.

The results of the meta-regressions indicated that gender was not a significant moderator, unstandardized regression coefficient = .01 (95% CI = –.01 to .02), $SE = .01$, $p = .38$. However, older age was marginally significant as a predictor of a stronger association between anxiety and falls, unstandardized regression coefficient = .04 (95% CI = –.00 to .09), $SE = .02$, $p = .05$. Consistent with the total sample of studies, this subset of nine studies was highly heterogeneous

Table 1. Details of Studies Included in the Systematic Review

Author (year)	Sample characteristics	*N*	% Female	Age	Design	Country	Anxiety measurement	Falls measurement and classification	% Fallers	Adjustment for confounds
Chen, Hwang, Chen, Chen, and Lan (2008)	Residents in a veteran care home	585	0	*M* years = 80.9 (*SD* = 5.4)	Retrospective survey (6 months)	Taiwan	Anxiety disorder recorded in medical history	Self-report of ≥ one fall in the last 6 months	8	/
Chen, Mo, Yi, Morrison, and Mao (2013)	Stratified, random community health survey	15,405	54	12+ years of age 14.9%: 12–24 28.2%: 25–44 33.3%: 45–64 23.6%: 65+	Retrospective survey (12 months)	Canada	Self-reported anxiety disorder	Self-report of ≥ one injurious fall in the last 12 months	5.8	Age, sex, education, income, smoking status, body mass index, physical activity, and alcohol use
Damián, Pastor-Barriuso, Valderrama-Gama, and de Pedro-Cuesta (2013)	Residents in aged-care institutions selected through stratified, clustered random sampling	733	76	65+ years 12.5%: 65–74 42.5%: 75–84 45%: 85+	Retrospective survey (1 month)	Spain	Treating physician-reported anxiety disorder	≥ one treating physician-reported fall in the last month	12	Age, sex, cognitive status, functional dependence, number of modifiable diseases, and number of medications
Delbaere et al. (2010)	Random recruitment from community-dwelling adults	500	54	*M* years = 77.9, *SD* = 4.6	Prospective cohort study (12 months)	Australia	Goldberg Anxiety Scale (cutoff ≥ 5)	Monthly falls diaries and follow-up telephone calls as required. Faller if > one fall, or ≥ one fall if injurious over the 12 months	33.2	/
Gassmann, Rupprecht, and Freiberger (2009)	Representative, random sample of community-dwelling adults	622	48	65+ years 32.5%: 65–69 50.7%: 70–79 14.8%: 80–89 2%: 90+	Retrospective survey (6 months)	Germany	Likert scale of self-reported anxiety (1–6), with cutoff = 3	Self-report of ≥ one fall in the last 6 months	16.2	/
Hellström, Vahlberg, Urell, and Emtner (2009)	Patients with a diagnosis of obstructive pulmonary disease visiting a lung clinic	80	64	*M* years = 65	Retrospective survey (12 months)	Sweden	Hospital Anxiety and Depression Scale (used as a continuous variable)	Self-report of having a fall in the last 12 months	25	/

Table 1. *Continued*

Author (year)	Sample characteristics	*N*	% Female	Age	Design	Country	Anxiety measurement	Falls measurement and classification	% Fallers	Adjustment for confounds
Hyndman, Ashburn, and Stack (2002)	Community-dwelling adults with stroke identified and recruited through general practices	41	37	*M* years = 69.7, *SD* = 11.6	Retrospective survey (12 months)	English	Hospital Anxiety and Depression Scale (used as a continuous variable)	Self-report of ≥ one fall in the last 12 months	51.2	/
Iinattiniemi et al. (2009)	Whole population sample of community-dwelling older adults	494	86	*M* years = 88, *SD* = 2.5	Prospective cohort study (11 months)	Finland	Dichotomous item asking whether they had "feelings of anxiety, nervousness of fear"	Falls occurrence monitored via bimonthly telephone calls. Faller if ≥ one fall over the 11 months	35	Recurrent faller, poor self-rated health, poor mental agility, urination problems, vision difficulty, body mass index, depressive symptoms, and number of medications, antipsychotic, hypnotic, or antidepressant medications
Menant et al. (2013)	Randomly selected community-dwelling adults	516	51.2	*M* years = 79.9, *SD* = 4.4	Prospective cohort study (12 months)	Australia	Goldberg Anxiety Scale (cutoff ≥ 5)	Monthly falls diaries and follow-up telephone calls as required. Faller if ≥ two falls over the 12 months	34.4	Dizziness, neck and back pain, and physiological profile assessment score
Morsch et al. (2015)	Random sample of 39 cities, multicluster sampling of neighborhoods, systematic sampling of households within the cluster of the neighborhood, and a random selection of an older individual within the household	7,184	51.7	60+ years 52.6%: 50–69 34.6%: 70–79 12.8%: 80+	Retrospective survey (12 months)	Brazil	Self-reported anxiety disorder	Self-report of ≥ one fall in the last 12 months	9.8	Age, gender, activity level, depression diagnosis, and medication for depression

Table 1. *Continued*

Author (year)	Sample characteristics	*N*	% Female	Age	Design	Country	Anxiety measurement	Falls measurement and classification	% Fallers	Adjustment for confounds
Naughton et al. (2012)	Older adults presenting to an emergency department	306	50.6	Falls group: *M* years = 79, *SD* = 8 Nonfalls group: *M* years = 76, *SD* = 6.6	Cross-sectional survey	Ireland	Hospital Anxiety and Depression Scale (cutoff > 7)	Presenting at either with a fall- or nonfall-related injury	16.7	/
Puts et al. (2013)	Patients referred to a cancer center after a diagnosis of cancer	112	69.6	*M* years = 74.1, *SD* = 6	Prospective cohort study (6 months)	Canada	Hospital Anxiety and Depression Scale (cutoff > 10)	Fall assessed at 3 and 6 months. Faller if ≥ one fall over the 6 months	15.2	/
Schmid et al. (2013)	Patients at a veterans health med center with history of stroke or transient ischemic heart attack and diagnosis of hypertension or high blood pressure	160	3	*M* years = 67.7, *SD* = 9.7	Prospective cohort study (12 months)	United States	Generalized Anxiety Disorder 7-item Scale	Bimonthy contact (calls or in-person) to ask about falls events. Faller if ≥ one falls over the last 12 months	66.8	/
Taylor et al. (2014)	Adults recruited from health service settings who were community dwelling and had a mild–moderate cognitive impairment	177	56	*M* years = 82.2, range 62–98	Prospective cohort study (12 months)	Australia	Goldberg Anxiety Scale (used as a continuous variable)	Monthly falls calendars with reply-paid envelopes were given to the participants and/or carers. Phone calls in event of nonreturn of calendar. Faller if ≥ one fall over the 12 months	62.7	Age and education
Tinetti and Williams (1998)	Probability sample of community-dwelling adults	957	72	> 71 years of age	Prospective cohort study (12 months)	United States	Spielberger State-Trait Anxiety Inventory (cutoff ≥ 32)	Face-to-face interview at baseline then at 12-month follow-up. Faller if ≥ one fall over the 12 months	28	/
Vetter and Ford (1989)	Whole population sample of community-dwelling adults aged ≥ 70 years of age in a small town	674	58.8	70+ years 41.5%: 70–74 30.3%: 75–79 16.9%: 80–84 11.3%: 85–100	Retrospective survey (12 months)	Wales	Symptom-based interview to identify "caseness" and likelihood of psychiatric diagnosis of anxiety (cutoff ≥ 4)	Self-report of ≥ one fall in the last 12 months. Collateral information also collected	26.5	/

Table 1. *Continued*

Author (year)	Sample characteristics	N	% Female	Age	Design	Country	Anxiety measurement	Falls measurement and classification	% Fallers	Adjustment for confounds
Whitney, Close, Jackson, and Lord (2012)	Adults living in aged-care institutions with cognitive impairments, not bedbound or recently hospitalized	109	63%	*M* years = 84.5, *SD* = 8.3	Prospective cohort study (6 months)	England	Goldberg Anxiety Scale (cutoff ≥ 5)	Fortnightly visits to assess for falls through accident reports, care plans, and clinical notes. Faller if ≥ one fall over the 6 months	48.6	Antidepressant medication, sway score, and attention and orientation
Williams et al. (2015)	Age-stratified, random sample of women	1,062	100	20–93 years of age. Median age = 50, Interquartile range = 33.5–65.0	Retrospective survey (12 months)	Australia	12-month prevalence of any anxiety disorders as assessed by the Structured Clinical Interview for DSM Disorders	Self-report of ≥ two falls in the last 12 months	4.8	/

($Q = 24.37$, $I^2 = 71\%$, $p < .001$), with age as a moderator explaining 26% of the variance between the effect sizes.

Discussion

This study aimed to clarify the association between anxiety and the occurrence of falls by systematically reviewing the literature for studies that have examined these variables and employing meta-analytic statistical techniques. The meta-analytic findings from 18 studies indicated that there was a significant positive association between anxiety symptoms and falls. Individuals who reported elevated levels of anxiety were 1.53 times more likely to have a fall than those who did not. Although significant variance was observed among the study effect sizes, all of the studies, with one exception, indicated that elevated anxiety symptoms were associated with falls. The fail-safe *N* also indicated that the finding was robust against future studies that indicated no association and together with results from the trim and fill procedure provided good evidence refuting the likelihood of publication bias.

Only age was identified as moderating the relationship between anxiety and falls, explaining approximately a quarter of the between-study variance in effect sizes. Although this finding is indicative that older age is predictive of a stronger association between reporting clinical anxiety and experiencing a fall, only half of the studies were included in the analysis, and cautious interpretation is needed. In general, a high level of heterogeneity in the overall meta-analysis hinders the interpretation of the findings. This is congruent with previous meta-analyses of depressive symptoms as a risk factor for falls (Kvelde et al., 2013) and is possibly due to variation between studies on a range of methodological variables. Aside from age, the remaining subgroup analyses did not provide clear evidence as to which factors might moderate differences in effect sizes across the studies. They did reveal, however, relatively homogenous variance between effect sizes for studies grouped by retrospective/cross-sectional design, the assessment of anxiety as an anxiety disorder, samples of individuals in care facilities, random probability or whole population methods of sample, and statistical adjustment for confounding variables. Significant, positive associations were found between anxiety and falls for all these groups, with the homogeneity in variance providing some confidence in the validity of these effects.

No difference in the association between anxiety and falls was observed between samples of community-dwelling individuals and those with identified health care needs. Although the finding that health care needs do not have a moderating effect on this relationship is consistent with finding on depressive symptoms and falls (Kvelde et al., 2013), this is still somewhat surprising given the numerous ways in which poorer health is related to clinical anxiety (El-Gabalawy, Mackenzie, Shooshtari, & Sareen, 2011) and the risk of a falls event (Ambrose et al., 2013). Again,

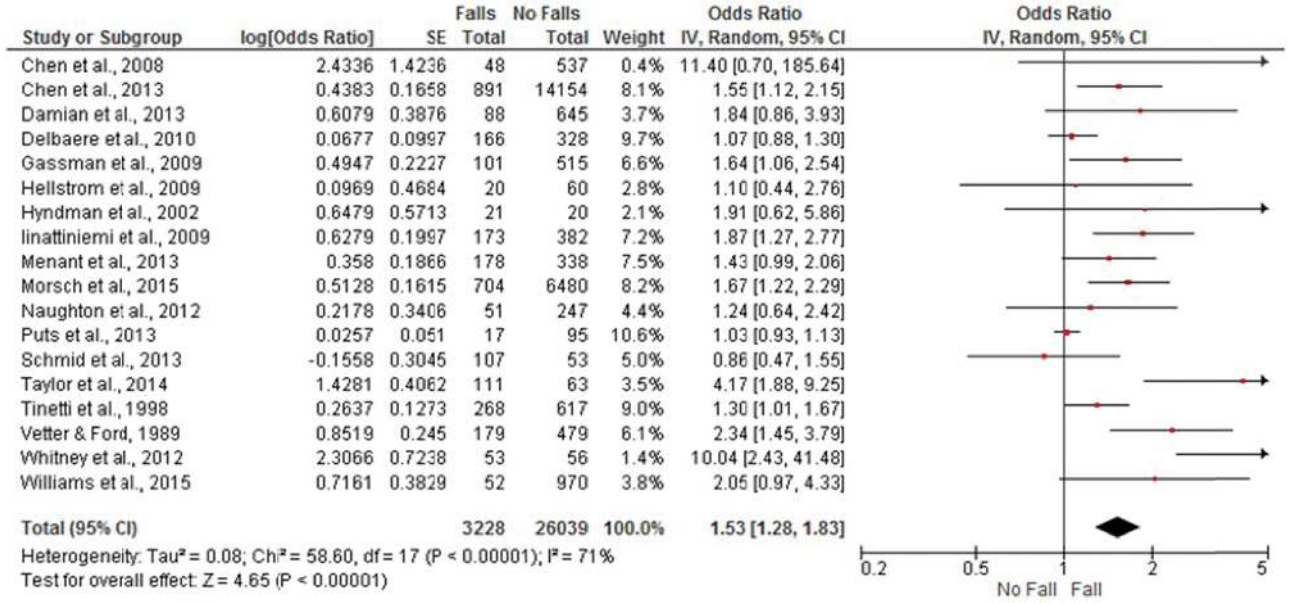

Figure 2. Forest plot of the association between anxiety and falls.

Table 2. Moderator Analyses of the Association between Anxiety and Falls

Variable	*k*	No. of fallers	No. of nonfallers	OR	*p* Values	95% CI	*Q*	I^2 (%)
Design							1.7	40
Prospective	8	1,073	1,932	1.39	.01	1.09, 1.77	33.4***	79
Retrospective/cross-sectional	10	2,155	24,107	1.69	<.001	1.43, 1.99	5.9	0
Anxiety assessment							0.8	0
Anxiety disorder	5	1,783	22,786	1.67	<.001	1.36, 2.06	2.4	0
Elevated symptoms	13	1,445	3,253	1.47	<.001	1.19, 1.81	45.6***	74
Setting							2.6	62
Care facility	3	189	1,238	4.54	.03	1.15, 17.91	5.3	62
Community-dwelling	15	3,039	24,801	1.46	<.001	1.23, 1.73	46.3***	70
Health care needs							0.2	0
Yes	9	516	1,776	1.69	.02	1.09, 2.62	27.9***	71
No	9	2,712	24,263	1.52	<.001	1.28, 1.80	17.2*	54
Recruitment							4.9	59
Random sample	8	2,448	24,047	1.40	<.001	1.21, 1.63	10.6	34
Whole population	2	352	861	2.05	<.001	1.51, 2.78	0.5	0
Identified population	8	428	1,131	1.70	.03	1.04, 2.76	26.0*	71
Adjusted for confounds							5.1	81
Yes	7	2,198	22,118	1.87	<.001	1.44, 2.42	12.3	51
No	11	1,030	3,921	1.29	.01	1.07, 1.55	23.4**	57

Notes: CI = confidence interval; OR = odds ratio.
*p < .05. **p < .01. ***p < .001.

the heterogeneity between these studies may explain, in part, this lack of effect.

It is noteworthy that the group of studies that controlled for confounding variables was more homogenous in their effect size relative to those that did not. The association between anxiety and falls in this group was at least as strong as those that were not adjusted. This supports the notion of anxiety as an independent predictor of falls. Furthermore, two studies that controlled for the presence of depressive symptoms or a diagnosis of depression (Iinattiniemi, Jokelainen, & Luukinen, 2009; Morsch, Shenk, & Bos, 2015) found that anxiety remained an independent predictor of falls. This is suggestive that anxiety symptoms may increase falls risk independently from this other established psychological risk factor for falls.

The causal relationship between anxiety symptoms and falls cannot be ascertained from the current findings. The observed association in retrospective and cross-sectional studies may reflect anxiety operating as a causal factor in falls, or alternatively as an outcome of having experienced a fall (Bloch et al., 2014). The prospective studies in this review do provide relatively stronger evidence that elevated anxiety symptoms are predictive of falls at a later point in time. More broadly, however, it is probable that anxiety is both a causal factor and an outcome of falls. Recent research is supportive of the notion of anxiety symptoms and falls creating a positive feedback loop (Friedman, Munoz, West, Rubin, & Fried, 2002), whereby anxiety increases falls risk, and subsequent falls events increase anxiety symptoms.

Clinical anxiety is among the most prevalent of all mental health problems (Baxter et al., 2013; Kessler et al., 2005) and may represent an additional risk factor for falls. These findings pertain primarily to older adults, given the vast majority of participants in this study were in this demographic, for whom falls are already highly prevalent (Rubenstein, 2006). In other terms, falls, and the functional impairment and disability that they can lead to (Gill, Murphy, Gahbauer, & Allore, 2013), may be another adverse outcome for those suffering from anxiety. Given this, further research into anxiety reduction as a means of reducing falls risk may be warranted. As distinct from interventions that more narrowly target fear of falling or related constructs, treatment aimed at clinical anxiety in general may have a more pervasive effect in reducing falls risk. This may occur through mechanisms such as those referred to previously, for example, reduced gait stiffness (Pluess et al., 2009) and dizziness (Eckhardt-Henn et al., 2003), and more adaptive cognitive functioning (Richards et al., 2014). Evidence indicates that psychotropic medications used to treat anxiety, such as antidepressants and anxiolytics, are themselves independent risk factors for falls due to the numerous physiological and cognitive side effects they can produce (Huang et al., 2012; Payne, Abel, Simpson, & Maxwell, 2013; van Strien, Koek, van Marum, & Emmelot-Vonk, 2013). Therefore, in the context of other risk factors for falling, clinical anxiety might be more safely treated with psychological treatments, or the judicious use of medications, balancing their benefits with possible iatrogenic falls risk.

Limitations and Future Directions

As discussed earlier, methodological differences between studies, such as study design, the population of interest, and measurement of anxiety, likely contribute to heterogeneity and hinder the interpretation of these findings. Some variation was also found in the classification of participants as fallers or nonfallers. Although most studies determined individuals to be "fallers" if sustaining one or more fall, some used other classifications, which may have added to the variance across studies. However, these findings were not able to be subgrouped and compared, as two studies used different classification systems.

We did not include studies that reported continuous associations between the number of falls and severity of anxiety symptoms in our review. This was because studies that we found in our search that reported these correlations only examined groups of fallers, and therefore anxiety could not be assessed as a variable that discriminated between fallers and nonfallers. Future meta-analyses might focus on these studies to investigate any exposure–response relationship between anxiety and number of falls. Given our search terms, it is possible that studies examining falls as a correlate of anxiety, rather than falls as the primary variable of interest, may have been missed. However, our experience has shown that few studies have focused primarily on anxiety and assessed falls as a secondary interest. Further, including the term "anxiety" as a keyword in the title when performing our database search returns 50,000+ hits. This would likely make replications of this systematic review considerably less reliable. Given the findings for the fail-safe *N* test and trim and fill procedure, it was thought that the effect on results of any missing studies would also be minimal.

We have shown that the OR associating anxiety with falls is comparable with that found for depression, yet anxiety has received considerably less research attention (Kvelde et al., 2013). Future research should use robust methodology, such as random sampling, and more consistent use of validated methods of measuring anxiety symptoms and disorders. To examine whether anxiety is independently associated with falls, controlling for potentially confounding variables, including depression, is also indicated. Future research might seek to elucidate the casual pathways between anxiety and falls. These may include unique variance through casual pathways shared with depression, for example, reduced attention or muscle strength (Kvelde, Pijnappels, Delbaere, Close, & Lord, 2010), or independent causal pathways, for example, an increased startle response (Ray et al., 2009) or dizziness (Eckhardt-Henn et al., 2003). Current theory and empirical findings on perceptual-motor performance suggest that anxiety produces misinterpretations of stimuli as threatening, as well as a bias toward attending to threat-related stimuli (Nieuwenhuys & Oudejans, 2012). This leaves leaving less attention for task-relevant information needed for behaviors such as moving in a stable and safe manner. Further, the increased arousal experienced in anxiety may lead to less efficient, "stiffening" strategies in movement that influence balance performance and falls risk (Young & Mark Williams, 2015). Theories such as these might be further empirically tested in the context of falls.

The question of whether anxiety symptoms, different anxiety disorders, and disorders associated with heightened anxiety have differential effects on falls and falls risk has not yet been investigated. For example, obsessive–compulsive disorder might lead to an increase in compulsive behaviors such as cleaning or checking, which may increase the risk of falls in the home. Alternatively, specific phobias that relate to stimuli that are less rarely encountered (e.g.,

needles or snakes) may be less likely to cause pervasive clinical anxiety and affect falls risk.

Conclusion

In this meta-analysis, anxiety was found to be significantly associated with the occurrence of falls. In the context of high statistical and methodological variation among studies, only age was found to be a moderator of this association. Further research is needed to establish the causal mechanisms through which anxiety might operate as a risk factor for falls, and therefore whether treatment of clinical anxiety might also reduce falls risk.

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Conflict of Interest

There were no identified conflicts of interest.

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