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REVIEW

Elderly patients and falls: a systematic review and meta-analysis

Dilay Hacıdursunoğlu Erbaş[1] · Fadime Çınar[2] · Fatma Eti Aslan[3]

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Abstract

Objective The predetermination of the risk for falls in elderly patients, who will have or had a surgery, enables one to carry out the protective/preventive interventions on this matter. The aim of this review was to provide an up-to-date meta-analysis with regard to falls in elderly surgical patients.

Materials and methods The studies, which were carried out on elderly patients between January 2009 and November 2019 and which investigated the risk factors for falls in elderly surgical patients, were screened on the databases of Google Scholar, Pubmed, Ovid, Cinahl through various combinations of keywords, such as "geriatrics", "aged", "surgery", "accidental falls" in English or Turkish, to determine the risk factors for the falls in elderly surgical patients.

Results Meeting the study inclusion criteria, 18 studies were analyzed. Of these studies, three were retrospective, seven descriptive, two case–control, four cross-sectional, and two prospective. The kappa value of the general rate of agreement was found as 0.84. No publication bias found in the studies included (Kendall's tau $b = 0.31$; $p = 0.07$) in the meta-analysis based on the values calculated.

Conclusion In this meta-analysis, it was determined that the falls in elderly surgical patients were quite a prevalent public health problem, that the presence of chronic diseases and previous history of falls constituted an extremely high risk for the falls in elderly patients, and that the age or the presence of a gait-inhibiting condition did not constitute any risk for the falls in elderly patients.

Keywords Accidental fall · Elderly · Surgery · Risk factors · Meta-analysis

Introduction

As our world grows older with each passing day, the life expectancy of humans is prolonged, and therefore the elderly population is exponentially increasing, in line with the reduction in the birth rates and the improvement of the standards of living. As per the data of 2015, the elderly population constitutes 8.5% of the world population [1]. Aging is an ongoing process from birth to death and has a universal characteristic. Biological changes accompanying the aging process increase the predisposition to falling directly or in the presence of other factors [2].

When the causes of death in the elderly are analyzed, accidents rank fifth while falls are reported to constitute 2/3 of these accidents [3]. The publication titled "Global Report on Falls Prevention in Older Age", released by the World Health Organization (WHO) in 2011, states that individuals at the age of 65 and above fall at least once every year at the rate of 35%, while the frequency of falls in elderly at the age of 70 or above rises by approximately 42%. *Falling* is defined as coming down from upstairs by leaving one's location where one stands, is present at or holds onto, or by losing one's support or balance (Turkish Language Society—TDK https://sozluk.gov.tr/ Date of access: 02.01.2020).

The risk of falling increases with advanced age or based on the presence of multiple factors. The studies report that factors, such as environmental factors, the age being > 65, a history of falling, the fear of falling, being a woman, the presence of lower extremity prosthetics, use of assisting devices (walking stick, "walker", etc.), wearing sandals,

✉ Dilay Hacıdursunoğlu Erbaş
dhacidursunoglu@gmail.com

[1] İstanbul Sancaktepe Şehit Prof. Dr. İlhan Varank Training and Research Hospital, İstanbul, Turkey

[2] Faculty of Health Sciences/Department of Health Management, İstanbul Sabahattin Zaim University, İstanbul, Turkey

[3] Faculty of Health Sciences, Bahçeşehir University, İstanbul, Turkey

medical problems (stroke, Parkinson's disease, cognitive disorders, incontinence, acute diseases, vestibular disorders, arthritis, foot problems, dizziness, syncope, orthostatic hypotension, vitamin D deficiency, depression, diarrhea, chronic pain, lack of sleep, vascular diseases, chronic diseases), changes in blood sugar, cognitive disorders, executive dysfunctions, drugs (antihypertensives, benzodiazepines, psychoactive drugs, non-steroidal anti-inflammatory drugs/NSAIDs), polypharmacy (use of more than four drugs), sarcopenia, fragility, weakness in the lower extremity, gait disorders, balance disorders, vestibular dysfunctions, limitations in everyday activities, constitute a risk in terms of falling [4, 5].

Fall-induced injuries in the elderly prolong the duration of care while increasing the need for medical care and treatment as well as the cost of healthcare [1]. Dunne et al. [6] determined that 43.7% of the patients suffered as a consequence of falls, while Wong et al. [7] determined that the period of hospitalization prolonged by 6.3 days on average. In a study conducted in our country, the additional hospital expenses caused by fall-induced serious injuries were calculated as USD 3302.60 [8].

The changes that occur in the body as a consequence of the use of anesthetic agents in surgical patients during the operation, the use of analgesics and sedatives in the postoperation management of pain, as well as the effects of the surgical intervention, start to differ by age and constitute a higher risk for the falls [9].

Determining the risk factors, evaluating the risks, and preventive care practices are of the essence in the prevention of falls in elderly surgical patients. In this meta-analysis, it was aimed to provide an up-to-date meta-analysis with regard to the falls in elderly surgical patients.

Research questions

- Is age a risk factor for falls?
- Are chronic diseases a risk factor for falls?
- Is a history of previous falls a risk factor for the falls?
- Is the presence of a gait-inhibiting condition a risk factor for the falls?

Methods

Type, place, and duration of the study

This research was conducted using the meta-analysis method, which is one of the quantitative research methods between January 2009 and November 2019.

Application steps of the study

The application steps of the study were classified on the basis of Preferred Reporting Items for Systematic Reviews and Meta-Analyzes statement (PRISMA) and Meta-analysis of Observational Studies in Epidemiology (MOOSE) criteria in the articles to be included in the meta-analysis.

Articles that meet these criteria were determined and presented in Table 1.

Research strategy

The relevant published research articles, which were conducted over elderly surgical patients and investigated the risk factor for falls, were included in the scope of the evaluation. In the study, keywords were determined in Turkey Science Terms and Medical Subject Headings (MeSH Browser). The determined keywords were scanned in Prospero (International prospective register of systematic reviews), and it was checked whether the determined research topic had been researched before then registered to Prospero. The keywords "geriatrics", "aged", "surgery", "accidental falls" determined for article searches were searched in the designated databases in English or Turkish. Articles published between January 2009 and November 2019 in Google Scholar, Pubmed, Ovid and Cinahl databases were included in the evaluation.

In the first step, 2807 publications were reached in the search performed in four databases with the determined search strategy. After removing the repetitive, that does not fit the title and summary, the remaining articles were evaluated, and the articles to be included in the full-text reading were determined. Articles found unrelated to the subject were classified and excluded from the study. Eighteen studies that met the inclusion criteria were included in the study. The article search and screening diagram for the inclusion flow of the articles is presented in Fig. 1 [26].

Searching articles and inclusion criteria in meta-analysis

The titles and abstracts of the identified studies were examined to exclude studies that failed to meet the inclusion criteria. The full texts of the selected studies were analyzed and evaluated. The inclusion criteria in all studies to determine the research were as follows:

- The articles analyzing the falls in elderly surgical patients were published between January 2009 and November 2019.

Table 1 Characteristics of included studies

Name of the study	Authors and year of the study	Type of study	Sample size	Average age	Chronic illness questioning status	Previous fall history questioning status	Questioning the existence of the situation that would prevent walking	Quality,evaluation score (A:9–12) (B:5–8) (C:1–4)
The determination of patients' falling risk and taken preventive measures in neurology and neurosurgery clinics	Savcı et al. [10]	Descriptive	110	75	✗	✓	✓	A
Postoperative patient ffalls on an orthopedic inpatient unit	Ackerman et al. [11]	Retrospective	6912	65	✗	✗	✗	C
Falling risk score in patients undergone to neurosurgery	Berke and Aslan [12]	Descriptive	127	65	✗	✓	✓	A
Evaluatıon of practıes related to fallıng prevention and determinatıon of falling risk of elderly patients who are treated ın surgıcal clınıcs	Çeçen and Özbayır [9]	Descriptive	121	65	✓	✓	✓	A
Determination of fall risk according to hendrich II and morse fall scale: a pilot study	Özden et al. [13]	Descriptive and cross-sectional	130	78	✓	✓	✓	A
Relationship between asking an older adult about falls and surgical outcomes	Jones et al. [14]	Prospective cohort	235	74	✓	✗	✗	B
Evaluating fall risk	Tanıl et al. [15]	Descriptive	1625	65	✗	✗	✗	C
Risks of falling in surgical patients	Özlü et al. [16]	Cross-sectional	288	65	✓	✓	✓	A
The cost of serious patient fall-related injuries at hospitals in Turkey: a matched case–control study	Barış et al. [8]	Case–control	78	67	✗	✗	✗	C
The determination of falling risk of patients and precautions taken in neurosurgery clinic	Çelik and Zıngal [17]	Descriptive	70	65	✗	✗	✗	C

Table 1 (continued)

Name of the study	Authors and year of the study	Type of study	Sample size	Average age	Chronic illness questioning status	Previous fall history questioning status	Questioning the existence of the situation that would prevent walking	Quality,evaluation score (A:9–12) (B:5–8) (C:1–4)
Exploring risk factors of patient falls: a retrospective hospital record study in japan	Ishikuro et al. [18]	Retrospective	1362	75	✗	✓	✓	A
Incidence and characteristics of accidental falls in Hospitalizations	Kobayashi et al. [19]	Prospective	826	65	✗	✓	✗	B
Factors associated with the risk of fall in adults in the postoperative period: a cross-sectional study	Mata et al. [20]	Cross-sectional	257	65	✓	✗	✗	B
Falls ın surgıcal patıents: subsıdıes for safe nursıng care	Victor et al. [21]	Retrospective descriptive	70	65	✓	✗	✗	B
Determination of risk factors in patient falls	Yaşar and Türk [22]	Descriptive	132	65	✓	✓	✓	A
Risk factors for fall occurrence in hospitalized adult patients: a case–control study	Severo et al. [23]	Case–control	358	75	✗	✓	✓	A
Risk factors for falls in hospital ın-patients: a prospective nested case–control study	Najafpour et al. [24]	Prospective case control	1326	60	✓	✓	✓	A
Determination of falling risks of patients over 65 years old in the surgical clinics	Özşaker et al. [25]	Descriptive	120	71	✓	✓	✓	A

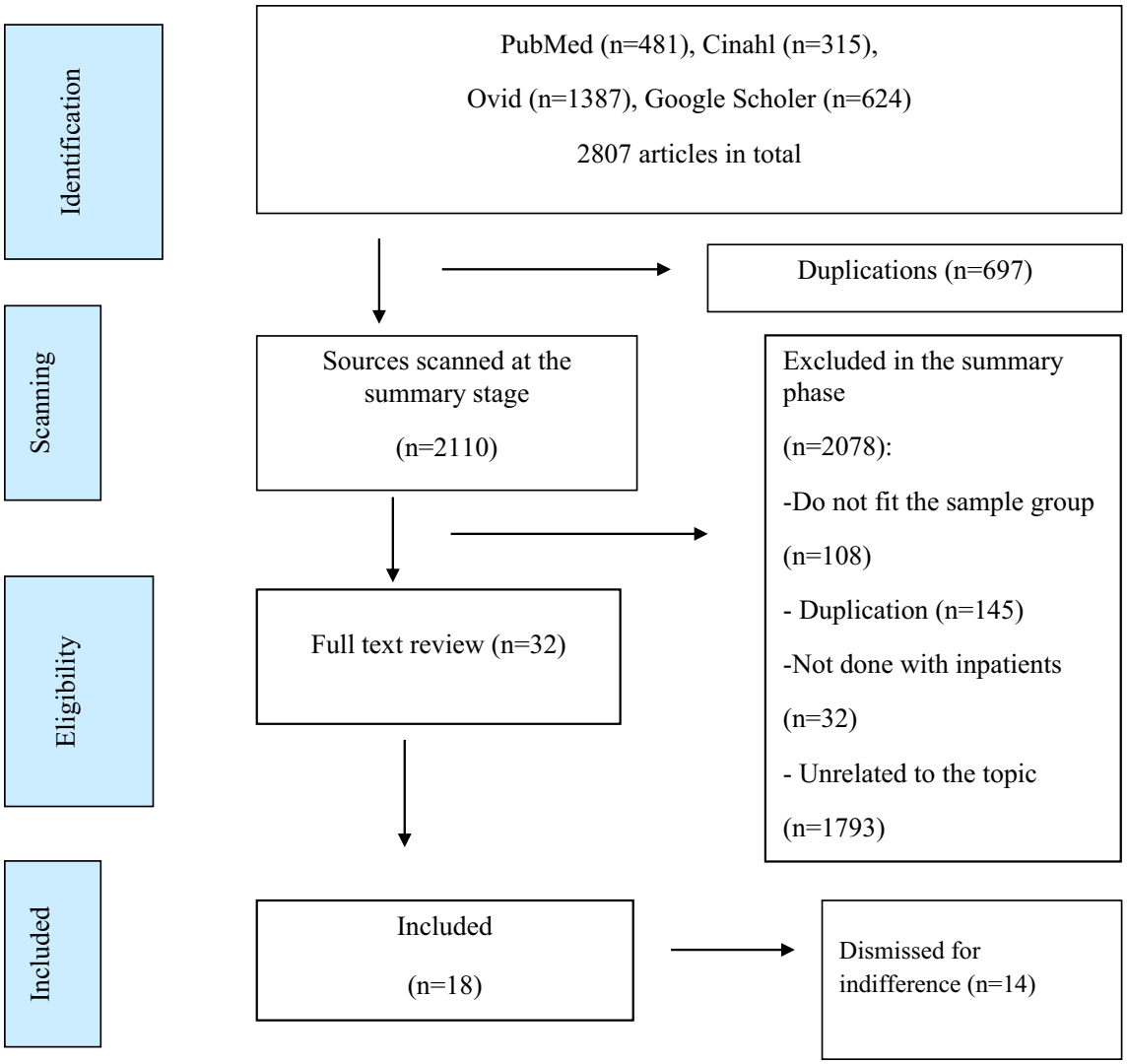

Fig. 1 PRISMA flow diagram of the study selection and identification

- English or Turkısh language should be used in all studies.
- Articles should have been published in national and international journals.
- Studies should be in full-text form.
- The studies should be original and quantitative.
- Dissertations, systematic reviews and oral or poster presentations performed in the conferences were not included in the study.

Methodological quality assessment according to the review, coding, and inclusion criteria of articles

Independent and detailed abstract and full-text readings of the articles were completed by two researchers/experts to prevent publication bias. The articles evaluated were coded according to their descriptive features. These defining features.

- Name of the study, authors, and year
- Type of study
- The sample size of the study
- Variables of average age, chronic illness questioning status, previous fall history questioning status, questioning the existence of the situation that would prevent walking
- Quality evaluation score

Twelve of the research quality evaluation criteria proposed by Polit and Beck [27] were used for the remaining eight publications after the review of the studies. These criteria allow a general evaluation based on the aims, sample characteristics, findings, and results of the studies. Each study was separately evaluated by the researchers

Model		Effect size and 95% interval			Test of null (2-Tail)		Heterogeneity				Tau-squared			
Model	Number Studies	Point estimate	Lower limit	Upper limit	Z-value	P-value	Q-value	df (Q)	P-value	I-squared	Tau Squared	Standart Error	Variance	Tau
Fixed	10	1,922	1,551	2,382	5,967	0,000	62,131	9	0,000	85,514	0,780	0,525	0,276	0,883
Random	10	1,632	0,875	3,045	1,540	0,124								

Fig. 2 Heterogeneity test results for the age variable

Model	Study name	Statistics for each study					Odds ratio and 95% CI					Residual (Random)
		Odds ratio	Lower limit	Upper limit	Z-Value	p-Value	0,01	0,10	1,00	10,00	100,00	Std Residual
	YAŞAR – 2018	1,510	0,177	12,901	0,376	0,707						-0,06
	MATA-2017	2,826	1,660	4,813	3,825	0,000						0,63
	ÖZLÜ-2015	2,076	1,116	3,863	2,307	0,021						0,27
	ÇEÇEN-2011	0,284	0,156	0,517	-4,115	0,000						-1,99
	ACKERMAN-2010	2,868	1,310	6,278	2,635	0,008						0,62
	SAVCI-2009	0,944	0,442	2,017	-0,148	0,883						-0,60
	ÖZŞAKER-2019	3,143	0,904	10,927	1,801	0,072						0,63
	TANIL-2014	3,599	2,480	5,221	6,745	0,000						0,94
	ÇELİK-2016	0,488	0,315	1,773	-1,089	0,276						-1,14
	BERKE-2010	3,160	0,996	10,031	1,953	0,051						0,65
Random		**1,632**	**0,875**	**3,045**	**1,540**	**0,124**						

Fig. 3 Overall effect size of age on fall development in elderly surgical patient

over all of the criteria, and they were given "one point" if they fully met each article, and "zero points" when they failed to meet them. The scores that the study can get according to the criteria range from 0 to 12. In the study, articles belonging to all subgroups were examined independently by two researchers, and articles scoring seven or more in the quality evaluation were evaluated as quality. Since studies evaluated with strong and medium quality will be included in the meta-analysis, a total of 18 studies met this criterion and were included in the meta-analysis.

Data analysis

In the analysis of the data, the licensed software "Comprehensive Meta-Analysis Academic (CMA)/Non-profit

Model		Effect size and 95% interval			Test of null (2-Tail)		Heterogeneity				Tau-squared			
Model	Number Studies	Point estimate	Lower limit	Upper limit	Z-value	P-value	Q-value	df (Q)	P-value	I-squared	Tau Squared	Standart Error	Variance	Tau
Fixed	10	1,925	1,448	2,560	4,503	0,000	4,444	9	0,880	0,000	0,000	0,117	0,014	0,000
Random	10	1,925	1,448	2,560	4,503	0,000								

Fig. 4 Heterogeneity test results for the chronic disease variable

Pricing (Version 3)" was used. The data of all articles meeting the inclusion criteria and decided to be included in the study were entered into the CMA software, and the heterogeneity of the articles was evaluated. In the heterogeneity test, the random-effects model in the group analyzed with $p \leq 0.05$, and the fixed-effect model in the group analyzes with $p > 0.05$, effect sizes, study weights, 95% confidence intervals, and the overall effect size was calculated all the studies. The statistical significance limit was accepted as $p \leq 0.05$ in the evaluation of the overall effect. Funnel Plot analysis was performed to test the publication bias, and the results of Classic Fail-Safe N and Tau coefficient calculations were used.

Effect size

The "Risk Ratio = Odds Ratio" was used to calculate the effect size in this study. The effect size was calculated through the "Odds ratio and Standard Deviation" values in the study. In the present study, Cochran's Q statistics were used to test the heterogeneity between the studies. In heterogeneity assessment, when the heterogeneity ratio (I^2) below 25% is considered as not heterogeneous; it is considered as low between 25 and 50%, moderate between 51 and 75%, and high above 75% [28]. The Odds ratio is equal to one means that there is no correlation between the variables. This ratio being above 1 shows the effectiveness of the risk ratio. The negative sign (–) before the effect values states that the effect of the risk factor for the falls measured in the studies has a negative direction/is in favor of the control (non- fall) group; while the positive (+) sign specifies that the effect has a positive direction/is in favor of the experiment (fall) group. If the effect size has a value of zero (0) or near zero, it can be inferred that there are no effective results in favor of or against the fall and non-fall groups [29].

Heterogeneity

In this study, to test the inter-study heterogeneity, Cochran's Q test was used; $p < 0.05$ was considered statistically significant, and the study results were interpreted accordingly. To determine if there were any publication biases in the studies subjected to meta-analysis, initially, the scatters in the funnel plot were analyzed, which was followed by an Egger's linear regression test and the Begg and Mazumdar rank correlation statistics.

Results

Descriptive findings

As a consequence of the screening, 2807 studies were found. Of those meeting the study inclusion criteria, 18 studies were analyzed. The studies included in the meta-analysis are three retrospectives, seven descriptive, two case–control, four cross-sectional and two prospective.

Characteristics of the sampling group in the studies considered

The sample size in the studies included in the meta-analysis was determined to be between 70 and 6912.

Evaluation of methodological quality

In this meta-analysis, it was found that the agreement between coders was 84% according to the quality assessment score. In the reliability analysis, Cohen's kappa is 0.84 95% confidence interval [Confidence Interval (CI) (CI 0.812–0.885)]. Kappa value < 0 worse fit than chance fit; 0.01–0.20 insignificant compliance; 0.21–0.40 poor compliance; 0.41–0.60 moderate compliance; 0.61–0.80

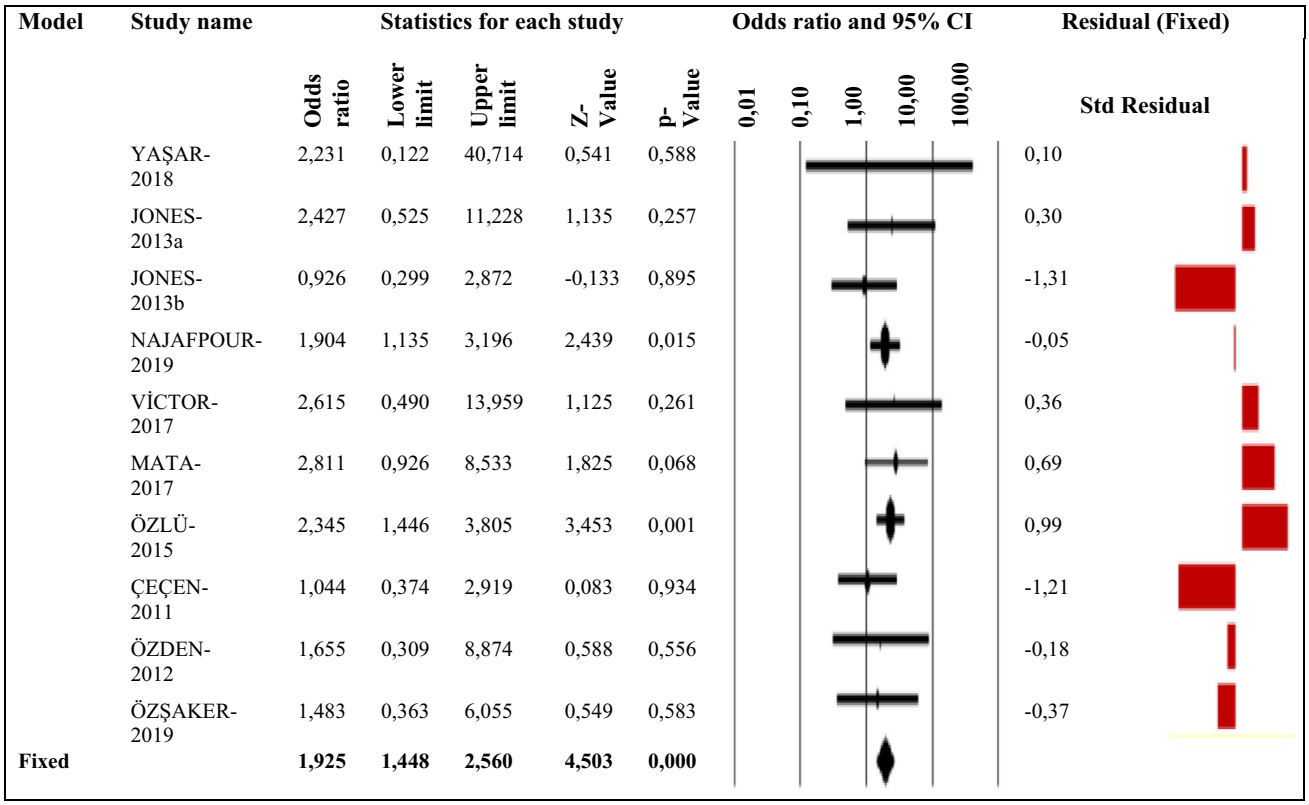

Fig. 5 Overall effect size of chronic disease presence on fall development in elderly surgical patient

Model		Effect size and 95% interval			Test of null (2-Tail)		Heterogeneity				Tau-squared			
Model	Number Studies	Point estimate	Lower limit	Upper limit	Z-value	P-value	Q-value	df (Q)	P-value	I-squared	Tau Squared	Standart Error	Variance	Tau
Fixed	9	1,713	1,368	2,144	4,694	0,000	13,125	8	0,108	39,050	0,086	0,117	0,014	0,293
Random	9	1,691	1,220	2,344	3,156	0,002								

Fig. 6 Heterogeneity test results for the previous fall history variable

good fit and 0.81–1.00 very good fit, or 0.75 and above excellent, 0.40–0.75 medium-good and below 0.40 is considered to be a poor fit. The kappa value (0.84) in this study shows that there is a very good level of agreement between encoders.

Analytical findings

In the study, a heterogeneity test was implemented for the variables, such as age, chronic diseases, previous history of falls and presence of any gait-inhibiting condition, which were evaluated as the risk factors for falls in elderly patients. As a result of the heterogeneity test, the *p* value was found to be lower than 0.05 and the *Q* (44.0) value was found to be higher than the value corresponding to the *df* value.

Age

As a result of the heterogeneity test, the *p* value was found to be lower than 0.05 and the *Q* (62,131) value was found to be

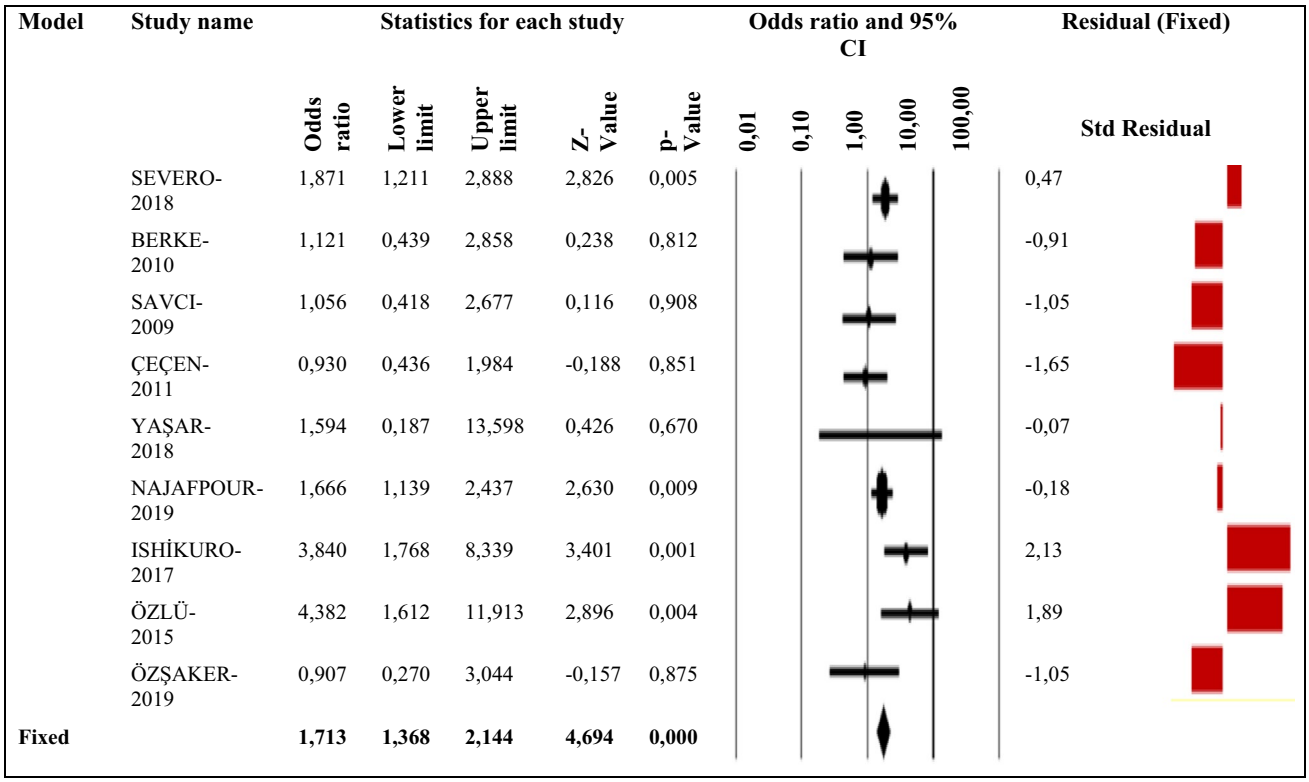

Fig. 7 Overall effect size of previous fall history on the development of falls in the elderly surgical patient

Model	Number Studies	Point estimate	Lower limit	Upper limit	Z-value	P-value	Q-value	df (Q)	P-value	I-squared	Tau Squared	Standart Error	Variance	Tau
Fixed	8	1,199	0,935	1,538	1,433	0,152	92,707	7	0,000	92,449	1,741	1,252	1,568	1,319
Random	8	1,164	0,436	3,108	0,304	0,761								

Fig. 8 Heterogeneity test results for the state variable that will prevent walking

higher than the value corresponding to the *df* value; as a consequence of the individual research included in the analysis, the studies, which were analyzed based on the age variable evaluated as a risk factor for the falls in elderly patients, were found to be of a heterogeneous structure in the meta-analysis. The I^2 statistical value was calculated as 85.51. As a result of the calculations, the effect size distribution was evaluated according to the random effects model (Fig. 2). Through an analysis carried out based on the random-effects model, it was determined that the general effect size of the age over the occurrence of the falls in the elderly surgical patient was at high levels and had a positive direction with a value of 1.63 (CI 0.87–3.04; $p > 0.05$) and that the effect of the age over the occurrence of the falls in elderly surgical patients was found to be meaningful in itself, although it was not statistically significant when analyzed collectively (Fig. 3).

Chronic disease

As a result of the heterogeneity test, the *p* value was found to be higher than 0.05 and the *Q* (444) value was found to

be lower than the value corresponding to the *df* value; as a consequence of the individual research included in the analysis, the studies, which were analyzed based on the chronic disease variable evaluated as a risk factor for the falls in the elderly patient, were found to be of a homogeneous structure in the meta-analysis. The I^2 statistical value was calculated as 0.00. As a result of the calculations, the effect size distribution was evaluated according to the fixed effects model (Fig. 4). Through an analysis made with the fixed effects model, it was determined that the general effect size of the presence of chronic diseases over the occurrence of the falls in elderly surgical patients was at high levels and had a positive direction with a value of 1.92 (CI 1.44–2.56; $p < 0.05$), and that it was statistically significant (Fig. 5).

Previous history of falls

As a result of the heterogeneity test, the *p* value was found to be higher than 0.05 and the *Q* (13,12) value was found to be lower than the value corresponding to the *df* value; as a consequence of the individual research included in the analysis, the studies, which were analyzed based on the variable of previous history of falls evaluated as a risk factor for the falls in elderly patient, were found to be of a homogeneous structure in the meta-analysis. The I^2 statistical value was calculated as 39.05. As a result of the calculations, the effect size distribution was evaluated according to the fixed effects model (Fig. 6). Through an analysis made with the fixed effects model, it was determined that the general effect size of the presence of previous history of falls over the occurrence of the falls in elderly surgical patients was at high levels and had a positive direction with a value of 1.71 (CI 1.36–2.14; $p < 0.05$), and that it was statistically significant (Fig. 7).

Gait-inhibiting condition

As a result of the heterogeneity test, the p-value was found to be lower than 0.05 and the Q (92,70) value was found to be higher than the value corresponding to the *df* value; as a consequence of the individual research included in the analysis, the studies, which were analyzed based on the gait-inhibiting condition variable evaluated as a risk factor for the falls in the elderly patient, were found to be of a heterogeneous structure in the meta-analysis. The I^2 statistical value was calculated as 92.44. As a result of the calculations, the effect size distribution was evaluated according to the random effects model (Fig. 8). Through an analysis carried out based on the random-effects model, it was determined that the general effect size of the presence of a gait-inhibiting condition over the occurrence of the falls in the elderly surgical patient was at high levels and had a positive direction with a value of 1.16 (CI 0.43–3.10; $p > 0.05$), and that the effect of the presence of a gait-inhibiting condition over the

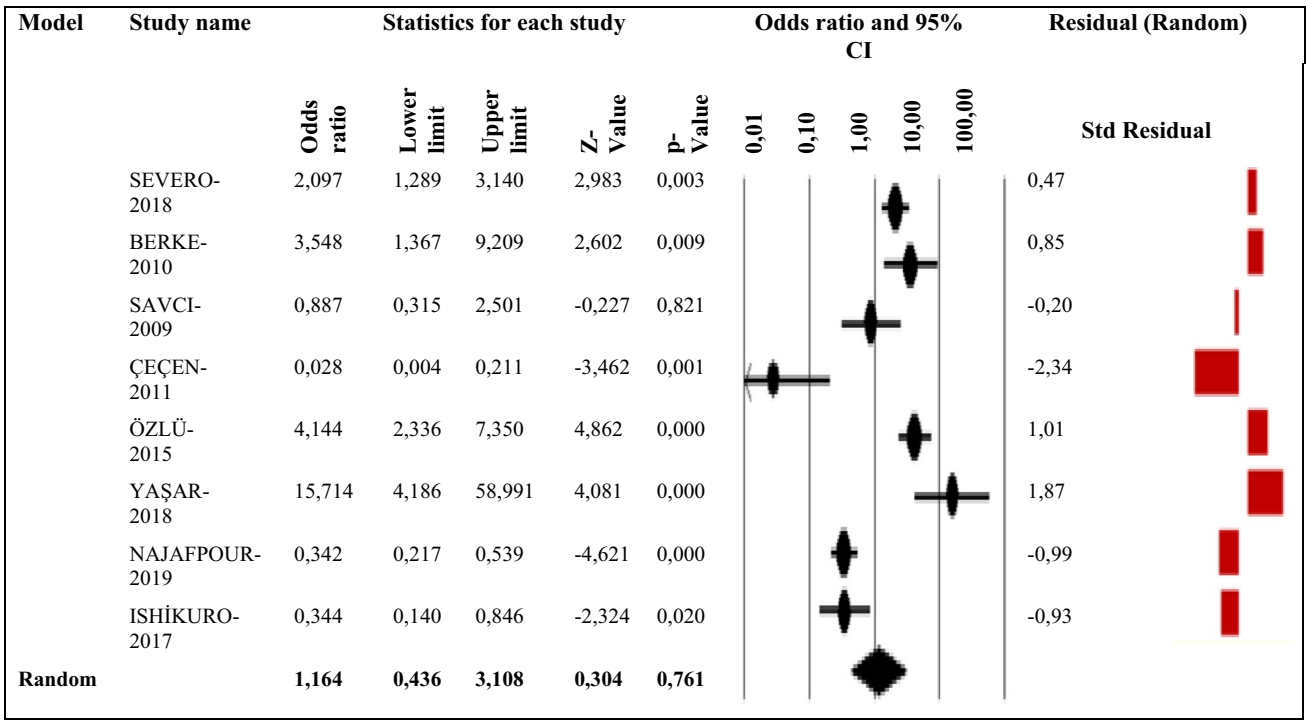

Fig. 9 Overall effect size of the presence of a condition that prevents walking, the development of falls in the elderly surgical patient

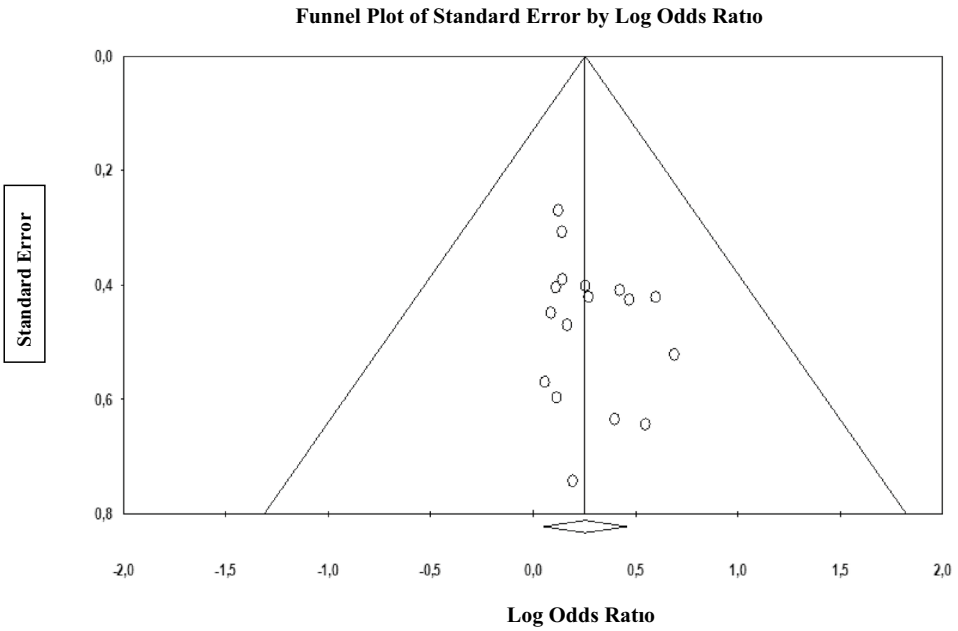

Fig. 10 The results of the funnel scatter plot

occurrence of the falls in elderly surgical patients was found to be meaningful in itself, although it was not statistically significant when analyzed collectively (Fig. 9).

Publication bias

The results of the funnel scatter plot that is evaluated as a visual summary of the meta-analysis set and that demonstrates the possibility of any publication bias was shown in Fig. 10. As seen in Fig. 10, a great majority of 18 studies included in the research are positioned in quite a close proximity to the combined effect size. The calculation of Kendall's tau b coefficient is another way to determine the publication bias in meta-analysis studies. In the absence of a publication bias, this coefficient is expected to be close to 1, while the two-tailed p value, namely p value, is expected to be higher than 0.05, meaning it does not constitute any significant difference [29]. No publication bias could be found in the studies included (Kendall's tau $b = 0.31$; $p = 0.07$) in the meta-analysis based on the values calculated in this statistic.

Discussion

Falls and fall-induced injuries are quite common and serious problems for hospitalized and elderly patients. Falling is an important problem that prolongs the period of hospitalization of the elderly patient, causes secondary traumas and increases the cost of care [5]. In a study carried out over the elderly, Pirrie et al. [30] determined that 14 (22.6%) of 62 elderly adults at risk of falling were between the ages of 65–74, 19 (30.6%) were between the ages of 75–84, and 16 (25.8%) were 85 age and over, 50 (80.6%) had a fear of falling, 38 (61.3%) had fallen in the previous year.

As important risk factors for falls in the literature; variables, such as age, gender, past history of falling, physical and cognitive impairments, multiple drug use are reported [31, 32]. In the study conducted by Kim et al. [33] on the elderly, it was determined that the elderly groups were at higher risk of falling. It is observed that the risk of falling increases particularly with the history of surgical intervention that is combined with being an elderly patient.

There are studies showing that the age factor is and is not effective over the falls. In a study carried out over surgical patients, Fındık et al. [34] determined that the risk of falling increased with the increasing mean age of the patients included in the study. Similarly, in a study determining the risk for falls in the patients, Özden et al. [13] reported that 53.8% of the patients included in the group of 65-year-old and above were under the risk of falling. In a study conducted by Rashid et al. [35], it was determined that 47 of 235 patients had a high risk of falling and 34 of these patients were 70 years old and over. The study results show that the risk of falling is higher in elderly surgical patients. Of the patients included in the study conducted by Özşaker et al. [25], 71.6% were found to be in the age range of 65–74, with a mean age of 71.34 ± 6.04, while no statistically significant correlation could be found between the age group and risk of falling. In a study carried out to determine the risk of falling for the inpatients in neurology and neurosurgery clinics, Savcı et al. [10] did not find

any significant difference with regard to the age groups. In the studies included in the scope of the study, it was determined that being elderly singlehandedly constituted a risk factor for falling, although no significant difference could be found between being elderly and falling when the studies were analyzed collectively ($p = 0.124$). The research studies examined, it was determined that showed similar characteristics between the Turkish-based and the non-Turkish-based studies, the relationship between the fall with being old.

The presence of chronic diseases is a risk factor for falling. In a study carried out to analyze the reasons for the falls in elderly patients who fell, Victor et al. [21] determined that 97.1% of the falling patients had chronic diseases. In another study conducted to analyze the status of falling in elderly patients who had a major elective surgical operation, Jones et al. [14] spotted hypertension in 19 out of 29 patients who had a colorectal surgery and fell (66%), and in 44 out of 49 patients who had cardiac surgery and fell (90%). A significant correlation was found between the presence of chronic diseases and falling in this meta-analysis ($p = 0.000$), and the study results are in parallel with the literature. The research studies examined, it was determined that showed similar characteristics between the Turkish-based and the non-Turkish-based studies, the relationship between the fall with having chronic disease.

In a study conducted by Berke and Aslan [12], it is reported that 52.7% of the patients with a history of falls in the past three weeks, and 25.9% of the patients with no history of falls had the risk of falling. In a study conducted by Schwendimann et al. [36] to analyze the risk factors for falls in inpatients, it was found that 50.1% of the falling patients had a previous history of falls. In a study conducted by Najafpour et al. [24], it was reported that ($n = 185$) 22.7% of the patients who fell had a previous history of falls. In the study to evaluate the prevalence of falls among older adults conducted by Sharif et al. [37], it was determined that 188 (50.8%) elderly people experienced falls in the last two years. A significant correlation was found between the variable of history of falls and falling in this meta-analysis ($p = 0.000$), and the study results are in parallel with the literature. The research studies examined, it was determined that showed different characteristics between the Turkish-based and the non-Turkish-based studies, the relationship between the fall with previous history of falls.

The use of assisted walking devices (e.g. walking sticks, crutches, walkers) as a result of gait disorders or balance disorders, remission in muscle strength and coordination disorders, which are included in the causes of falls, is considered to be a risk factor for the falls [4]. In the study conducted by Savcı et al. [10], no significant difference could be determined between the high risk of falling and the use of assisted walking devices ($p > 0.05$). In the study conducted by Çeçen and Özbayır [9], it was determined that the risk of falling increased in the patients who were at advanced ages and had difficulties in hearing and walking, and they were found to be significantly correlated when the factors affecting the falls in elderly patients, such as age, gender, vision, hearing, presence of gait problems, were compared to the points they scored on Hendrich's fall risk scale ($p < 0.05$). In the study carried out by Severo et al. [23], it was reported that ($n = 179$) 81% of the patients with gait limitations fell. Based on the results obtained from this study, while it was found that there was a significant difference between the presence of a gait-inhibiting condition and the falls when the studies included in the analysis were evaluated one by one, no significant difference could be found between them when evaluated collectively ($p = 0.761$). The research studies examined, it was determined that showed similar characteristics between the Turkish-based and the non-Turkish-based studies, the relationship between the fall with use of assisted walking devices.

Conclusion

Falls are a risk factor for patients of all ages. The risk of falling increases due to an increase in the factors, such as the changes that occur in the body with advanced age, the increase in the number of chronic diseases, the medicines are taken, the assisting devices used for gait and hearing, previous history of falls, and the fear of falling. Furthermore, it is also known that the post-operation drugs used in surgical patients and the changes in the body that are caused by stress due to the operation-related anxiety, are among the factors that lead to falling. Fall risk can be predetermined and actions can be taken to reduce the occurrence and severity of falls. Predetermination of the risk for falls in elderly patients, who will have or had surgery, enables one to carry out the protective/preventive interventions on this matter. In this meta-analysis, the presence of chronic disease and previous history of falls is particularly emphasized as the important factors although there are many factors that are effective in the occurrence of a fall in elderly patients. The fact that no significant correlation was found between the age factor and falling is believed to have been caused by the fact that the population of patients above the age of 65 was higher in numbers compared to the population of patients of other age groups in the studies included in the meta-analysis. It is believed that this meta-analysis carried out to determine the risk factors effective in falls in elderly surgical patients, which is a universal public health problem both in the world and in our country, will function as a guideline for any prospective studies. Within this scope, in addition to the determination of the risk factors, it was set forth that experimental studies, which may be of evidential quality, are required with regard to the methods that can be used to prevent falls.

Limitations

This meta-analysis was limited to 18 studies due to the low number of international and national studies aimed at determining the risk factors that are effective in the falls in elderly surgical patients. Furthermore, the fact that only the past 10 years were taken into consideration in the studies included in the evaluation, was another limitation, in addition to the investigation of the fall-related risk factors.

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Data availability The data sets generated and analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Conflict of interest The authors declare that they have no conflict of interest.

Statement of human and animal rights This article does not contain any studies with human or animal subjects performed by any of the authors.

Ethical approval This is a meta-analysis study.

İnform consent For this type of study, formal consent is not required.

References

1. Turkish Statistical Institute (2013) Seniors with statistics. Ankara Number: 16057. Turkish Statistical Institute
2. Karadakovan A (2017) Elderly and geriatric nursing. In: Karadakovan A, Aslan FE (eds) Care in internal and surgical diseases. Akademisyen Bookstore, Ankara, p 105
3. T.C. Ministry of Health General Directorate of Primary Health Care Services (2011) Elderly health module: a training guide for educators. Anıl Printing, İstanbul
4. Karan MA (2018) Evaluation of fall, its importance and risk factors in the elderly. Aegean J Med Sci 4:129–132
5. NICE clinical guideline 161 (2013) Falls: assessment and prevention of falls in older people. National Institute for Health and Care Excellence
6. Dunne TJ, Gaboury I, Ashe MC (2014) Falls in hospital increase length of stay regardless of degree of harm. J Eval Clin Pract 20:396–400
7. Wong CA, Recktenwald AJ, Jones ML et al (2011) The cost of serious fall-related injuries at three Midwestern hospitals. Jt Comm J Qual Patient Saf 37:81–87
8. Barıs VK, Intepeler SS, Yeginboy EY (2016) The cost of serious patient fall-related injuries at hospitals in Turkey: a matched case-control study. Clin Nurs Res 27:162–179. https://doi.org/10.1177/1054773816671521
9. Çeçen D, Özbayır T (2011) Evaluation of practice's related to falling prevention and determination of falling risk of elderly patients who are treated in surgical clinics. Ege Üniversitesi Hemşirelik Yüksek Okulu Dergisi 27:11–23
10. Savcı C, Kaya H, Acaroğlu R et al (2009) The determinatıon of patients falling risk and taken preventive measures in neurology and neurosurgery clinics. Maltepe Univ J Nurs Sci 2:19–25
11. Ackerman DB, Trousdale RT, Bieber P et al (2010) Postoperative patient falls on an orthopedic inpatient unit. J Arthroplasty 25:10–14
12. Berke D, Aslan FE (2010) Falling risk score in patients undergone to neurosurgery. Turk Klin J Neur 5:147–154
13. Özden D, Karagözoğlu Ş, Kurukız S (2012) Determining patients fall risk by two scale and this sensitivity of scales in determining falling: pilot operation. Anatolian J Nurs Health Sci 15:1
14. Jones TS, Dunn CL, Wu DS et al (2013) Relationship between asking an older adult about falls and surgical outcomes. JAMA Surg 148:1132
15. Tanıl V, Çetinkaya Y, Sayer V et al (2014) Evaluating fall risk. J Health Scholars 1:21–26
16. Özlü ZK, Yayla A, Özer N et al (2015) Risk of falling in surgical patients. Kafkas J Med Sci 5:94–99. https://doi.org/10.5505/kjms.2015.19870
17. Çelik GO, Zıngal H (2016) The determination of falling risk of patients and precautions taken in neurosurgery clinic. Izmir Kâtip Çelebi Univ J Health Sci Faculty 1:7–11
18. Ishikuro M, Ubeda SRG, Obara T et al (2017) Exploring risk factors of patient falls: a retrospective hospital record study in Japan. Tohoku J Exp Med 243:195–203
19. Kobayashi K, Imagama S, Inagaki Y et al (2017) Incidence and characteristics of accidental falls in hospitalizations. Nagoya J Med Sci 79:291–298. https://doi.org/10.18999/nagjms.79.3.291
20. Mata LRF, Azevedo C, Policapro AG et al (2017) Factors associated with the risk of fall in adults in the postoperative period: a cross-sectional study. Rev Latino-Am Enfermagem 25:e2904. https://doi.org/10.1590/1518-8345.1775.2904
21. Victor MAG, Luzia MF, Severo IM et al (2017) Falls ın surgıcal patıents: subsıdıes for safe nursıng care. J Nurs UFPE Online 11:4027–4035. https://doi.org/10.5205/reuol.10712-95194-3-SM.1110sup201704
22. Yaşar G, Türk G (2018) Determination of risk factors in patients falls. J Nurs Sci 1:15–20
23. Severo IM, Kuchenbecker RS, Vieira DFVB et al (2018) Risk factors for fall occurrence in hospitalized adult patients: a case-control study. Rev Latino-Am Enfermagem 26:e3016. https://doi.org/10.1590/1518-8345.2460.3016
24. Najafpour Z, Godarzi Z, Arab M et al (2019) Risk factors for falls in hospital in-patients: a prospective nested case control study. Int J Health Policy Manage 8:300–306. https://doi.org/10.15171/ijhpm.2019.11
25. Özşaker E, Yapsu F, Yılmaz GD (2019) Determination of falling risks of patients over 65 years old in the surgical clinics. J Harran Univ Med Faculty 16:245–249. https://doi.org/10.35440/hutfd.486797
26. Moher D, Liberati A, Tetzlaff J et al (2009) Preferred reporting ıtems for systematic reviews and meta-analyses: the PRISMA statement. Ann Intern Med 151:264–269
27. Polit DF, Beck CT (2009) Literature reviews: finding and reviewing research evidence. In: Polit DF, Tatano BC (eds) Essentails of nursing research: appraising evidence for nursing practice, 7th edn. Lippincott Williams & Wilkins, Philadelphia, pp 169–193
28. Higgins JP, Thompson SG, Deeks JJ et al (2003) Measuring inconsistency in meta-analyses. Br Med J 327:557–560
29. Dinçer S (2014) Applied meta-analysis in educational sciences. Pagem Publishing, Ankara
30. Pirrie M, Saini G, Angeles R et al (2020) Risk of falls and fear of falling in older adults residing in public housing in Ontario, Canada: findings from a multisite observational study. BMC Geriatr. https://doi.org/10.1186/s12877-019-1399-1

31. Ambrose AF, Paul G, Hausdorff JM (2013) Risk factors for falls among older adults: a review of the literature. Maturitas 75:51–61. https://doi.org/10.1016/j.maturitas.2013.02.009
32. Tinetti ME, Kumar C (2010) The patient who falls "it's always a trade-off." JAMA 303:258–266. https://doi.org/10.1001/jama.2009.2024
33. Kim T, Choi SD, Xiong S (2020) Epidemiology of fall and its socioeconomic risk factors in community-dwelling Korean elderly. PLoS ONE 15:e0234787. https://doi.org/10.1371/journal.pone.0234787
34. Fındık YÜ, Yeşilyurt SD, Işıklı GA (2019) Evaluatıng fall rısk ın surgıcal patıents. Namık Kemal Med J 7:90–95
35. Rashid I, Tiwari P, Singh Lehl S (2019) Prevalence and determinants of fall risk among elderly inpatients at a tertiary care public teaching hospital. J Gerontol Gerıatrıcs 67:96–102
36. Schwendimann R, Bühler H, Geest SD et al (2008) Characteristics of hospital inpatient falls across clinical departments. Gerontology 54:342–348
37. Sharif SI, Al-Harbi AB, Al-Shihabi AM et al (2018) Falls in the elderly: assessment of prevalence and risk factors. Pharmacy Practice 16:1206. https://doi.org/10.18549/PharmPract.2018.03.1206

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