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The risk of falls and fractures in geriatric benzodiazepine users: a review

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ABSTRACT

Benzodiazepines continue to be frequently prescribed, despite recommendations to avoid their use in older adults due to associated harms. This review summarizes studies published between January 2005 and September 2025 examining the association between benzodiazepine use and the risk of falls and fractures in older adults. A total of 21 studies were included, involving hospitalized patients, nursing home residents, and community-dwelling older adults. Most studies found that benzodiazepine use in older adults is linked to a higher risk of falls or related injuries. The risk was greatest at the start of treatment, with higher doses, with long-acting drugs, and when benzodiazepines were used together with other medications. Although some hospital-based studies did not find significant differences between users and non-users, the overall findings suggest that benzodiazepines play an important role in fall- and fracture-related harm in older adults. Stopping these drugs was linked to fewer falls, showing that using them less can make patients safer. Avoiding or limiting benzodiazepines, especially when starting treatment and in frail older adults or those with multiple illnesses, should be a priority to prevent injuries and improve care.

keywords: benzodiazepines, falls, fractures, geriatric population, older adults, osteoporosis

1. INTRODUCTION

Benzodiazepines are among the most frequently prescribed psychotropic medications in developed countries, and their growing worldwide use has raised considerable concern. Benzodiazepines continue to be the core of treatment plans for many neurological and psychiatric disorders due to their quick onset and relatively rapid symptom relief, as their depressant action on the central nervous system (CNS) is known to be extensive (Picton et al., 2018). Typically, benzodiazepines are divided into three categories according to their elimination half-life: long-acting (examples: diazepam, chlordiazepoxide, flurazepam, clorazepate), intermediate-acting (examples: alprazolam, clonazepam, lorazepam, oxazepam), and short-acting (examples: midazolam, triazolam) (Sarangi et al., 2021).

1.1. Mechanism of action of benzodiazepines

Benzodiazepines enhance the action of the γ-aminobutyric acid (GABA), a neurotransmitter that reduces neuronal activity in the CNS. This results in sedation,

anxiolysis, improved sleep, and anticonvulsant effects. They act at the GABA-A receptor, a protein complex that functions as a chloride ion channel in neurons (Pallanti et al., 2024). Each $GABA_A$ receptor has two α subunits, two β subunits, and one γ subunit, with several possible subtypes. Different combinations of these subunits create unique configurations of the $GABA_A$ receptor. However, most benzodiazepines can bind to most receptor isoforms non-selectively. Benzodiazepines attach to a modulatory site situated between the $\alpha 1$, $\alpha 2$, $\alpha 3$, or $\alpha 5$ subunits and the γ subunit of the $GABA_A$ receptor and act as allosteric enhancers, which increase the frequency of opening of the GABA-gated chloride channel. The subsequent entry of chloride ions into the neuron leads to hyperpolarization of the cellular membrane, suppresses action potential generation, and ultimately induces depressive effects in the CNS (Hood et al., 2014).

1.2. The prevalence of benzodiazepine use

The American Geriatrics Society (AGS) recommends avoiding benzodiazepine use in individuals aged 65 years and older. Nevertheless, despite these guidelines and the well-documented adverse effects, benzodiazepines continue to rank among the most frequently prescribed psychotropic medications and medications in general, particularly in primary care. Studies show that in the United States, benzodiazepine use is highest among adults aged 65 and older, approaching 9% (Hood et al., 2014; Markota et al., 2016). Nevertheless, some experts suggest an even higher use. According to the National Survey on Drug Use and Health (NSDUH) and its 2015 and 2016 cross-sectional analysis, nearly 13% of adults aged 65 and over indicated benzodiazepine use within the past year (Gupta et al., 2021). Benzodiazepines are more often prescribed to women than men. Surprisingly, the 12-month prevalence of diagnosed sedative, hypnotic, or anxiolytic use disorder in adults aged 65 and older remains remarkably low, at just 0.04% (Markota et al., 2016).

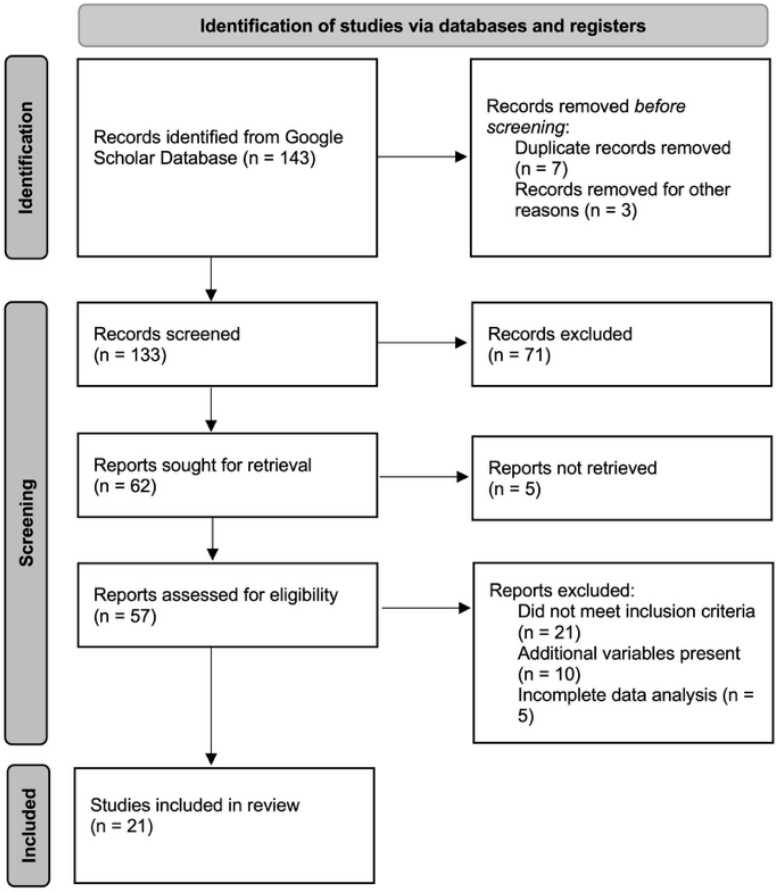

Figure 1. The PRISMA flow diagram detailing the study's methodology.

1.3. Benzodiazepine use-associated risks

It is well recognized that benzodiazepine use is linked to an increased risk of various adverse outcomes, such as dependence, cognitive impairment, falls and fractures, and overall mortality (Hertz and Barczak, 2025). The World Health Organization describes a fall as "an

event which results in a person coming to rest inadvertently on the ground or floor or other lower level". Around 28-35% of adults aged 65 and older experience a fall annually. That percentage increases to around 32-42% in individuals aged over 70. Among patients in long-term care, 30-50% fall each year, with 40% of these falls recurrent. Falls are the leading cause of injury, hospitalization, and death in the geriatric population (Vitry et al., 2010).

Use of benzodiazepines is linked to a greater risk of falls and clinically significant fractures, especially in individuals aged 65 years or older (Markota et al., 2016). Available estimates indicate that the risk of falling is 50% higher in benzodiazepine users. In addition to this, a number of studies prove a strong association between benzodiazepine use and hip fractures. That interrelationship poses a significant health risk for older adults because of the high mortality of hip fractures in that patient group, with the one-year mortality rate after suffering a hip fracture being estimated at around 21%. Some centers report even higher figures. The risk is reported to be the highest among patients who just started taking benzodiazepines (Schnell et al., 2010).

In this review, we focus on the most recent studies analyzing the risk of falls and fractures among geriatric benzodiazepine users and present an updated review on the subject.

2. REVIEW METHODS

To establish the current state of knowledge, we searched the Google Scholar database for articles published between January 2005 and September 2025 using the following search string: intitle:"benzodiazepines" OR intitle:"benzodiazepine" AND intitle:"falls" OR intitle:"falling" OR intitle:"fracture" OR intitle:"fractures", which yielded 143 results. From that list, in our analysis, we included only peer-reviewed original articles focusing on the geriatric population and written in English. After initial elimination, 133 studies were screened, and 57 of them were assessed for eligibility. Finally, 21 of the analyzed articles were considered sufficiently relevant for inclusion in this review (Figure 1).

3. RESULTS & DISCUSSION

3.1. Benzodiazepine use and falls and fractures in general geriatric population

According to a cross-sectional analysis of data from wave 1 of The Irish Longitudinal Study on Ageing published by Marron et al., (2020), which included 8,175 individuals aged 50 or older, 302 (3.69%) of whom reported taking benzodiazepines, benzodiazepine use was associated with falls, controlling for confounders; odds ratio (OR) = 1.40; 95% confidence interval (CI) = 1.08-1.82; p= 0.012. Additionally, the researchers found no significant association between benzodiazepines and unexplained falls, controlling for confounders; OR = 1.41; 95% CI 0.95-2.10; p= 0.09.

Rossat et al., (2011) studied the association between benzodiazepines and recurrent falls. Their cross-sectional study included 7,643 community-dwelling volunteers aged 65 and older. The researchers aimed to look into whether benzodiazepine use is linked to recurrent falls while considering other factors. They also examined whether benzodiazepine use interacts with balance problems, influencing the risk of falls in older adults. The collected data included Mini-Mental State Examination (MMSE) scores, Clock Drawing Test (CDT) results, one-leg balance (OLB) performance, five-times sit-to-stand (FTSS) test results, and fall history. The study participants were grouped according to the number of falls: 0, 1, 2, or 3 or more. Among the 1,456 fallers (19.2%), 994 (13.0%) had a single fall, while 462 (6.1%) were recurrent fallers (more than 2 falls). The number of falls increased significantly with age (Incident Rate Ratio (IRR) = 1.04, $p < 0.001$), female gender (IRR = 2.24, $p < 0.001$), and benzodiazepine use (IRR = 1.65, $p < 0.001$). After adjustment, only older age (IRR = 1.02, $p < 0.001$), female gender (IRR = 2.15, $p < 0.001$), use of clobazam (IRR = 2.54, $p = 0.04$) or prazepam (IRR = 1.63, $p = 0.03$), and poorer OLB performance (IRR = 1.55, $p < 0.001$) remained significantly associated with the number of falls.

Na et al., (2022) conducted a nationwide population-based case-crossover study to examine the risk of falls associated with long-acting benzodiazepines or tricyclic antidepressants (TCAs) use in community-dwelling older adults. 6,370,275 fall or fall fracture cases from the national health insurance data warehouse in South Korea were screened. Data were extracted for elderly patients who presented to the hospital as a result of a fall and were either diagnosed with their first fall or a fracture that was fall-related after being prescribed benzodiazepines (n=1805). To examine these associations, the study used conditional logistic regression, stratified by age and gender, to control for potential confounders. The results showed that long-acting benzodiazepine use more than doubled the risk of falls or fall-related fractures (OR = 2.16; 95% CI 1.85–2.52). In addition, longer prescription durations (≥49 days) were associated with an even higher risk of falls and fractures.

Carrier et al., (2020) researched the long-term risk of the most common fall-related fractures in older occasional users of benzodiazepines. In a representative cohort from the French National Health Insurance Fund comprising individuals aged 50 years and

older (n = 106,437), benzodiazepine dispensing patterns and hip and forearm fractures were monitored over an 8-year period. Joint latent class models were applied to concurrently identify BZD dispensing trajectories and fracture risk across the entire cohort and among participants aged 75 years and older. A survival model was then used to estimate adjusted hazard ratios (aHRs) for the association between these trajectories and fracture risk. The researchers identified 5 trajectories. Compared with individuals who did not use benzodiazepines, the risk of fractures did not increase among occasional users (aHR = 0.99, 95% CI 0.99-1.00) or decreasing users (aHR = 0.90, 95% CI 0.74-1.08). However, it was considerably elevated among early increasing users (aHR = 1.86, 95% CI 1.62-2.14) and late increasing users (aHR = 1.39, 95% CI 1.15-1.60). Similar usage patterns and corresponding risk levels were observed among individuals aged 75 years or older.

Van Der Hooft et al., (2008) investigated the association between inappropriate use of benzodiazepines and risk of fracture, as well as the clinical value of the Beers criteria for benzodiazepine use. A nested case-control study was conducted within the Rotterdam Study, a population-based cohort of 7,983 older adults. The proportion of 'inappropriate' benzodiazepine use, according to the Beers criteria definition, was compared between fracture cases and controls. Fracture risk was similar in users of "inappropriate" and "appropriate" benzodiazepines (OR = 1.07, 95% CI 0.72-1.60). In contrast, people using high doses or taking benzodiazepines for a longer period (14-90 days) had a much higher risk of fractures, regardless of the benzodiazepine type (OR = 3.45, 95% CI 1.38-8.59). These results show that inappropriate benzodiazepine use, as defined by the Beers criteria, is not independently associated with fracture risk. However, higher doses and longer use (> 14 days) are linked to an increased risk, no matter which benzodiazepine is prescribed.

Zint et al., (2010) assessed how the concurrent use of potentially interacting medications, as well as drug dosage and treatment duration, influences the risk of hip fracture associated with benzodiazepines and related drugs (BZDRs) use in older adults. A nested case-control study was conducted among Medicare beneficiaries aged 65 years and older enrolled in the Pennsylvania Pharmaceutical Assistance Contract for the Elderly (PACE) program between 1994 and 2005. The study included 17,198 patients hospitalized for hip fractures and 85,990 matched controls based on hospitalization date (index date). Use of benzodiazepinesand interacting medications within the two weeks preceding the index date was identified using data on dispensing dates, days supplied, quantities, and drug strengths. The adjusted relative risk (aRR) of hip fracture associated with overall benzodiazepine use was 1.2 (95% CI 1.1-1.2). However, the risk was notably higher for the concomitant use of alprazolam, lorazepam, and zolpidem with their interacting drugs – 1.5 (95% CI 1.3-1.7), 1.9 (95% CI 1.7-2.2), and 1.7 (95% CI 1.4-2.0), respectively – and for benzodiazepine use initiated within 14 days before the index date (RR 2.1, 95% CI 1.5-2.8). The relative risk also increased with higher benzodiazepine doses, reaching its peak for defined daily doses greater than 1 (RR 1.3, 95% CI 1.2-1.5).

Van Strien et al., (2013) aimed to investigate the relationship between the use of various classes of psychotropic medications, particularly short-acting benzodiazepines, and the incidence of falls in older adults. This retrospective cohort study was conducted among patients attending the day clinic of the Department of Geriatric Medicine at the University Medical Center Utrecht in the Netherlands. Data were collected on how often falls occurred in the past year and on medication use. Logistic regression was used to analyze the link between fall frequency and the use of psychotropic medications. A total of 404 patients were included, and 238 (58.9%) had experienced at least one fall in the previous year. After multivariate adjustment, frequent falls remained significantly associated with the use of psychotropic medications (OR = 1.96; 95% CI 1.17-3.28), including short-acting benzodiazepines or Z-drugs (OR = 1.94; 95% CI 1.10-3.42).

The correlation between the risk of hip fractures resulting from falls and the use of benzodiazepines and opioids in the population of older adults was examined by Machado-Duque et al. in a case-control study (Machado-Duque et al., 2018). The researchers identified drugs dispensed in the 30 days preceding the hip fracture diagnosis. The study included 287 patients with hip fractures and 574 controls, 4.2% of whom were prescribed benzodiazepines in the previous month. Adjusted multivariate analysis revealed that the use of benzodiazepines (OR = 3.73; 95% CI 1.60-8.70) within the month preceding the event was significantly associated with an increased likelihood of experiencing a fall resulting in hip fracture.

Pariente et al., (2008) investigated the association between benzodiazepine use and injurious falls in community-dwelling elders. The researchers carried out a nested case–control study using 10 years of follow-up data from the French community-based Personnes Âgées QUID (PAQUID) cohort. The main outcome was the occurrence of an injurious fall, which is defined as a fall resulting in hospitalization, fracture, head injury, or death. Controls were chosen at a 3-to-1 ratio and matched to cases based on frequency. Benzodiazepine exposure was defined as reported use within the two weeks before the follow-up visit that took place before the fall. Use of benzodiazepines was linked to a higher risk of injury after a fall, with the effect being much stronger in older age. The adjusted

odds ratio for injurious falls was 2.2 (95% CI 1.4, 3.4) in people aged 80 years and older. In contrast, it was 1.3 (95% CI 0.9, 1.9) in those under 80 years old. Among benzodiazepine users aged 80 years and older, the population attributable risk for injurious falls was 28.1% (95% CI 16.7, 43.2). The incidence of injurious falls in benzodiazepine users was 2.8 per 100 person-years. More than 9% of these falls resulted in death.

Softic et al., (2013) carried out a retrospective-prospective controlled study to evaluate the incidence of falls and related complications, and to identify and analyze risk factors for falls among elderly patients (≥65 years) under the care of family medicine teams in Tuzla Canton. A total of 400 medical records of patients aged 65 and older were reviewed, from which a subgroup of patients with documented fall incidents was analyzed. 123 of 376 (34%) respondents experienced falls. The intake of benzodiazepines was associated with an increased risk of falls. The time span of the intake varied, with the longest lasting up to 17 years. A significant positive correlation was identified between the frequency of falls and the duration of the continuous sedative use of the drug (Spearman correlation coefficient = 0.220, p = 0.001), as well as between the frequency and duration of benzodiazepine use (Spearman correlation coefficient = 0.197, p = 0.009). Additionally, a significant positive correlation was discovered between the frequency of falls and the number of daily doses of sedatives prescribed (Spearman correlation coefficient = 0.207, p = 0.001).

Interestingly, different results were obtained by Ballokova et al., (2014). A prospective cohort study of patients aged 70years or older admitted to 11 acute care hospitals in Australia was conducted. Falls were documented both prospectively during hospitalization and retrospectively for the 90 days preceding admission. Among 1,412 patients, 146 (10.3%) were using benzodiazepines at admission and 155 (11.3%) at discharge. The rate of in-hospital falls did not differ significantly between benzodiazepine users and non-users (incidence rate ratio 1.03, 95% CI 0.58–1.82). Benzodiazepine use at admission was not clearly linked to having fallen in the previous 90 days when compared with non-users. In contrast, patients taking diazepam reported falls much more often than those using other benzodiazepines (70.8% vs. 36.1%; p = 0.002), especially when compared with patients using oxazepam (70.8% vs. 25.0%; p < 0.001). After adjusting for confounders, diazepam use at admission remained positively associated with a history of falls relative to other benzodiazepines (odds ratio 3.0; 95% CI 1.1-8.5; p = 0.036).

Van de Ven et al., (2018) investigated the relationship between the use of antidepressants or benzodiazepines and the likelihood of experiencing a subsequent major osteoporotic fracture. Using data from the Dutch PHARMO Database Network, the researchers carried out a cohort study. Between 2002 and 2011, 4,854 individuals over 65 suffered their first major osteoporotic fracture (MOF), including 1,766 hip fractures. The researchers determined incidence rates and adjusted hazard ratios using Cox proportional hazards models. 31% (95% CI 30.1, 32.8) of patients received a benzodiazepine prescription within 1 year after a MOF. Interestingly, according to the study, current use of benzodiazepines was not linked to a higher risk of fractures either within 1 year after a MOF (adjusted HR = 1.18; 95% CI 0.76-1.81) or throughout the entire follow-up period (adjusted HR = 1.18; 95% CI 0.90–1.55).

Saarelainen et al., (2017) aimed to examine the relationship between the use of BZDRs and the risk of hip fractures, post-fracture mortality, and length of hospital stay among community-dwelling individuals with and without Alzheimer's disease (AD). A retrospective cohort study, which included all community-dwelling persons diagnosed with AD in Finland during 2005-2011 (n=70,718) and their matched comparison persons without AD was conducted. Use of BZDRs was linked to an increased risk of hip fracture in individuals both with and without AD (aHR 1.4, 95% CI 1.2-1.7 and 1.6, 95% CI 1.3-1.9], respectively). Among patients with Alzheimer's disease, BZDR use during a hip fracture episode was associated with a hospital stay exceeding four months (adjusted odds ratio (aOR) 1.9, 95% CI 1.3-2.8), whereas no such association was found in individuals without AD. One-year post-fracture mortality was not related to BZDR use.

3.2. Prescribing benzodiazepines in hospitals and nursing homes

Ackroyd-Stolarz et al., (2009) studied the correlation between inappropriate prescribing of benzodiazepines for older adults and risk of falls during a hospital stay. In this 1-year retrospective cross-sectional study, the researchers analyzed discharges from a tertiary care hospital in Halifax, Nova Scotia, and used pharmacy data to identify benzodiazepine prescriptions associated with an increased risk of falls, according to the updated Beers criteria. The collected data were subsequently matched with records of in-hospital falls obtained from incident report forms. 5,831 patients who received a prescription for at least one benzodiazepine during the hospital stay were identified. A total of 574 falls were documented among 374 patients, with 226 incidents (39.4%) resulting in injury. Based on the Beers criteria, 936 discharges (9.3%) included a prescription for at least one potentially inappropriate benzodiazepine. There were no statistically significant differences in fall rates (4.5% vs. 3.8%, p = 0.30) or fall-related injuries (2.6% vs. 1.8%, p = 0.08) between patients

given potentially inappropriate benzodiazepines and those given appropriate or no benzodiazepines. These results suggest that relying exclusively on the Beers criteria for benzodiazepines may not effectively identify patients at risk of falls or related injuries.

Berry et al., (2016) studied the correlation between an increased risk of falling and a change to a benzodiazepine drug prescription in a nursing home setting. The researchers gathered data on 594 long-term nursing home residents who had experienced at least one fall and applied a case-crossover design to compare the frequency of benzodiazepine medication changes in the days preceding a fall with those occurring during more remote periods. It was discovered that the risk of falls was higher in the 24 hours following benzodiazepine initiation compared with other times (OR = 3.79, 95% CI 1.10-13.00). In addition to this, a cessation of benzodiazepine was associated with a significantly reduced risk of falling (OR = 0.26, 95% CI 0.08-0.91)

The correlation between insomnia, benzodiazepine use, and falls was also studied by Jiang et al., (2019). They studied 605 residents from 25 long-term care facilities in central Shanghai. A baseline survey assessed sleep quality and benzodiazepine use, followed by a one-year follow-up to record falls and injurious falls. Logistic regression was used for both univariate and multivariate analyses. After adjusting for potential confounders, benzodiazepine use was associated with a significantly higher risk of injurious falls (RR = 3.128, 95% CI 1.541–6.350).

Briesacher et al., (2010) aimed to assess whether programs aimed to help cover the prescription drugs' cost, but exclude benzodiazepine medications from coverage, such as Medicare Part D, decrease the risk of fractures in elderly individuals in nursing homes. This quasi-experimental study employed interrupted time-series analysis and extended Cox proportional-hazards models to compare changes in outcomes before and after the implementation of Medicare Part D in the United States. The study followed 1,068,104 residents, including a subgroup of 50,874 from a pharmacy database with fracture data. Monthly prescribing rates for benzodiazepines and potential alternatives were tracked. The researchers calculated hazard ratios for new hip fractures and falls, adjusted for age, sex, and ethnicity. After the introduction of Medicare Part D, states without supplemental coverage showed an immediate and significant 10-percentage-point drop in benzodiazepine use (from 27.0% to 17.0%; 95% CI −0.11 to −0.09; $p < 0.001$). Interestingly, the HR for incident hip fracture after Medicare Part D implementation was 1.60 (95% CI 1.05-2.45; $p = 0.03$) in the no-supplemental-coverage state and 1.17 (95% CI, 0.93-1.46; $p = .18$) in the partial-supplemental-coverage states, compared with states offering complete supplemental coverage. Despite the fact that such policies influence medication use among nursing home residents, they may not lead to a reduction in fracture risk.

Izza et al., (2020) aimed to explore the link between polypharmacy, psychotropic medications, and falls risk in a cohort of UK care home residents. This prospective cohort study included residents from 84 care homes across the United Kingdom. Data were obtained from residents' care documentation and medication administration records. Among the 1,655 participants, 519 (31%) experienced a fall within three months. Both the total number of regularly prescribed medications and the use of at least one regular psychotropic drug were identified as independent risk factors for falls (aOR = 1.06; 95% CI 1.03–1.09; $p<0.01$ and aOR = 1.39; 95% CI 1.10–1.76; $p<0.01$, respectively). The likelihood of falling was significantly higher among individuals taking antidepressants ($p<0.01$) or benzodiazepines ($p<0.01$), whereas no significant association was found for antipsychotic use ($p>0.05$).

3.3. Falls and fractures in the emergency department

Martinez-Cengotitabengoa et al., (2018) conducted a record linkage study among older adults aged 65 years and above who consecutively presented to the emergency department of Araba University Hospital in Vitoria, Spain, due to a fall. The researchers reviewed records of 654 adults aged 65 years and older, of whom 285 (43.6%) had been prescribed a benzodiazepine or a Z-drug within two weeks prior to their hospital visit for a fall, more frequently women. 78.4% of prescriptions were for BZD/Z-drugs with a short half-life. Most patients, 83.5%, received just one BZD/Z-drug, while 16.5% were prescribed more than one. There was no clear difference between men and women. More than half of the patients, 58%, received doses higher than what is recommended for older adults. This occurred more often in men than in women, with rates of 70.0% compared to 53.1%.

Babu et al., (2024) studied benzodiazepines and other sedatives in adults aged 65 and older who were treated for serious injuries from falls. In our analysis, we focused on older adults who were seen after a fall (n = 1,365). From this group, we randomly selected 300 patients. We ensured balance by age, sex, and trauma-center quotas from individuals evaluated by trauma teams at selected Level 1 trauma centers in the United States. We analyzed blood samples to estimate, among other things, the prevalence of benzodiazepines. Benzodiazepines were found in 9.3% (95% CI 6.0-12.6%).

Nurmi-Lüthje et al., (2006) aimed to evaluate the use of benzodiazepines and benzodiazepine-related drugs among patients admitted to two hospitals in Finland due to an acute hip fracture. The researchers studied the use of benzodiazepines based on asking

the patient or the patient's relatives, medical history, or blood or serum analysis. The study included 223 patients, 30% of whom reported the use of hypnotics; serum or urine analysis was positive for benzodiazepines in 37% of cases. When both laboratory findings and medical drug records were considered, 113 patients (51%) were found to be using benzodiazepines or benzodiazepine-related medications. The concordance between medical records and laboratory results, expressed as the overlap area, was 32% in men and 59% in women; 38% among community-dwelling patients; 63% among those living in residential homes; and 68% among institutionalized patients. Half of the patients presenting with an acute hip fracture were using benzodiazepines or benzodiazepine-related medications. The summary of the analyzed literature included in the review is presented in Table 1.

Table 1. Analyzed literature and a brief summary.

Reference	Studied population	Key findings (relevant for this review)
Marron et al., (2020)	8,175 participants of The Irish Longitudinal Study on Ageing.	Benzodiazepine use is linked to an increased risk of falls among community-dwelling older adults, with a stronger association observed in those reporting poor sleep quality.
Rossat et al., (2011)	7,643 community-dwelling volunteers aged ≥ 65 years from 3 health centers in North-East of France.	The use of benzodiazepines (clobazam or prazepam) are related to the recurrence of falls.
Na et al., (2022)	6,370,275 fall or fall fracture cases among community-dwelling elderly patients from the database of the South Korean national health insurance data warehouse.	Use of long-acting benzodiazepines more than doubles the risk of falls or fall-related fractures, and this risk increases further with longer duration of use.
Carrier et al., (2020)	A representative cohort of the French National Health Insurance Fund of 106,437 individuals aged ≥ 50 years	Fracture risk was not increased in either occasional users or in decreasing users. It was significantly higher in early increasing users and in late increasing users in people older than 50 or 75 years.
Van Der Hooft et al., (2008)	A population-based cohort of 7,983 elderly (the Rotterdam Study, individuals aged ≥ 55 years).	Fracture risk did not significantly differ between 'inappropriate' and 'appropriate' benzodiazepine users as defined by the Beers criteria. However, patients taking high doses or using benzodiazepines for 14-90 days faced a notably higher fracture risk, regardless of the specific benzodiazepine type.
Zint et al., (2010)	17,198 patients hospitalized for hip fractures and 85,990 matched controls (Medicare beneficiaries aged ≥ 65 years enrolled in the PACE program).	The risk of hip fracture associated with benzodiazepine use increases with the concurrent use of interacting medications and higher doses, reaching its peak during the initiation phase of therapy.
Van Strien et al., (2013)	404 patients in the day clinic of the department of geriatric medicine of the University Medical Center Utrecht in the Netherlands.	Short-acting benzodiazepines, strongly increase the frequency of falls in elderly patients.

Machado-Duque et al., (2018)	287 patients with hip fractures and 574 controls, patients aged ≥ 65 years in Colombia.	Using benzodiazepines in the month prior to hip fracture was significantly associated with a greater probability of suffering a fall with hip fracture.
Pariente et al., (2008)	French PAQUID community-based cohort (3,777 individuals aged ≥ 65 years)	Benzodiazepine use was significantly correlated with the incidence of injurious falls, showing a notable interaction effect with age.
Softic et al., (2013)	400 elderly individuals (≥ 65 years) receiving care from family medicine teams in Tuzla Canton.	There here is a significant correlation between the length and frequencyof benzodiazepines use and falls. Benzodiazepines increase therisk of falls. There is a positive correlation between the signature (intake) benzodiazepines and frequency of falls.
Ballokova et al., (2014)	1,412 patients aged over 70 years consecutively admitted to 11 acute care hospitals in Australia.	The incidence rates of in-hospital falls did not significantly differ between benzodiazepine users and non-users. No significant association was found between benzodiazepine use at admission and a history of falls in the last 90 days.
van de Ven et al., (2018)	4,854 patients from the Dutch PHARMO Database Network, who suffered from a first major osteoporotic fracture after the age of 65 years.	Current use of benzodiazepines was not linked to a higher risk of fractures either within 1 year after a major osteoporotic fracture or throughout the entire follow-up period.
Saarelainen et al., (2017)	70,718 community-dwelling persons diagnosed with AD in Finland	Use of BZDRs was linked to an increased risk of hip fracture in individuals with and without. Among patients with Alzheimer's disease, BZDR use during a hip fracture was associated with a hospital stay exceeding four months, but not in individuals without AD. One-year post-fracture mortality was not related to BZDR use.
Ackroyd-Stolarz et al., (2009)	10,044 discharges from a tertiary care hospital in Halifax, Nova Scotia.	No statistically significant differences were noted between patients prescribed potentially inappropriate benzodiazepines and those given appropriate or no benzodiazepines (according to the Beers criteria) in terms of fall incidence or fall-related injuries.
Berry et al., (2016)	594 long-stay nursing home residents from 2 nursing facilities in Boston, MA	The risk of falls was higher in the 24 hours following benzodiazepine initiation. Discontinuing benzodiazepine use was linked to a significant reduction in fall risk.
Jiang et al., (2019)	605 residents from 25 long-term care facilities in central Shanghai	The use of benzodiazepines significantly increased the risk of injurious falls.
Briesacher et al., (2010)	1,068,104 residents and a subsample of 50 874 residents with fracture data	Following the implementation of Medicare Part D, states without supplemental coverage experienced an immediate and significant decline in

	from 1 pharmacy, a nationwide sample of residents of nursing homes in 48 US states.	benzodiazepine use. Despite the fact, that such policies influence medication use among nursing home residents, they may not lead to a reduction in fracture risk.
Izza et al., (2020)	1,655 residents of 84 UK care homes	Number of medications and psychotropic medications (particularly antidepressants and benzodiazepines) predicted falls.
Martinez-Cengotitabengoa et al., (2018)	654 adults aged ≥ 65 years who presented for emergency care after a fall.	More than 40% of older adults seeking emergency care after a fall had a prior prescription for benzodiazepines or Z-drugs.
Babu et al., (2024)	1,356 adults aged ≥ 65 years evaluated after a fall.	Benzodiazepines were detected in 9.3% of patients.
Nurmi-Lüthje et al., (2006)	223 patients were admitted to two Finnish hospitals as a result of an acute hip fracture.	Half of the patients presenting with an acute hip fracture were using benzodiazepines or benzodiazepine-related medications.

Abbreviations: BZDRs – benzodiazepines and related drugs, AD – Alzheimer's disease.

4. CONCLUSION

The studies reviewed show a clear connection between benzodiazepine use and an increased risk of falls in older adults. The level of risk depends on the type of drug, the dose, the length of treatment, and the use of other medications. Long-acting drugs, higher doses, and starting or increasing therapy are related to more falls and fractures. Several studies also indicate a dose-response effect, with stronger links in patients who have cognitive issues or poor sleep. While a few studies found no significant connection, the overall evidence supports reducing or stopping benzodiazepines in older adults when possible. Careful prescribing and stopping these medications, especially at the beginning of treatment and in frail or multiple-illness patients, are crucial to prevent harms such as falls and hip fractures.

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Author's Contribution:

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Informed consent

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Ethical approval

Not applicable. This article does not contain any studies with human participants or animals performed by any of the authors.

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Conflict of interest

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Data and materials availability

All data associated with this study will be available based on reasonable request to the Corresponding Author.

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