

**The Epidemiological and Clinical Characteristics of Infection-Related Falls in Older Adults: A Review of Literature**

by

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## **Abstract**

Falls are a critical public health issue among older adults, often resulting in significant morbidity and mortality. This review of literature investigates the relationship between falls and infections in older adults, aiming to elucidate the underlying mechanisms and identify strategies for management and prevention. This review reveals that COVID-19, influenza and influenza-like illnesses, coexisting systemic infections, urinary tract infections, and HIV/AIDS are infections associated among older adults who experience falls. The interaction between older adult falls and infections can lead to a multitude of adverse outcomes, including prolonged hospitalizations, functional decline, and increased healthcare costs. Recognizing the public health significance of this association, efforts to implement targeted interventions, including early detection and appropriate treatment of acute infections, medication review to mitigate polypharmacy-related risks, and multifactorial fall prevention strategies, are imperative to reduce the burden of falls and improve the quality of life for older adults. This review discusses the importance of taking a multidisciplinary approach in addressing infection-related falls in older populations and has implications in optimizing preventive measures and interventions tailored to this vulnerable demographic.

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## Preface

During my tenure as a graduate student, I have experienced significant growth not only in my academic and research abilities but also in my skills as a clinical provider. My time as a public health student has deepened my understanding of the various factors and determinants that influence health, enhancing my ability to serve both communities and patients effectively.

First and foremost, I extend my heartfelt gratitude to my program director, Dr. Linda Rose Frank, for her steadfast support and unwavering belief in my abilities throughout my academic journey. Despite encountering setbacks, Dr. Frank's encouragement and guidance provided invaluable direction, enabling me to navigate challenges and persist.

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To my wife, I extend my deepest thanks. Without you, none of this would be possible.

Lastly, I am indebted to my patients, whose experiences and stories continually motivate me to excel in my role as a clinician. They are the reason I am inspired to make a difference every single day.



## 1.0 Introduction

In the United States, more than 1 out of 4 older Americans aged 65 and above fall per the Centers for Disease Control and Prevention (CDC). This equates to approximately 36 million falls each year. The burden of this public health issue cannot be overstated, and often results in both nonfatal and fatal injuries. Moreover, the healthcare costs associated with falls are quite high, costing approximately \$50 billion on an annual basis with 75% paid by both Medicare and Medicaid. Consequently, addressing falls in the older adult population may also aid in lowering healthcare costs in the country.

Inherently, older adults are a vulnerable population that present with issues impacting their health. Although frailty presents with the normal physiological aging process, which serves as an etiology for falls, there are also other factors associated such as chronic and acute medical conditions, cognitive level, and environmental accessibility. In particular, the epidemiological and clinical characteristics regarding underlying acute or chronic infections serving as a factor in falls in this population is not well understood. There is a present lack of literature that thoroughly investigates these characteristics in a comprehensive and cohesive manner.

Thus, the aim of this review of literature is to determine what epidemiological and clinical characteristics currently exist in older adults with infections that may contribute to falls both in the hospital and community settings. Specifically, this review will seek to identify what infectious conditions are likely to be associated with falls and discuss what mitigative strategies are available to prevent and manage the complications from falls associated with an infectious condition in the target population.

As individuals advance in age, their immune systems undergo a gradual decline in function, a phenomenon commonly referred to as immunosenescence. This age-related immune dysregulation renders older adults more susceptible to infections, which can range from relatively benign urinary tract infections to life-threatening sepsis (Lee et al., 2022). Concurrently, aging is accompanied by a myriad of physiological changes, including diminished sensorimotor functions, decreased muscle strength, impaired balance, and alterations in gait dynamics, all of which predispose older adults to fall incidents (Rodrigues et al., 2022). While these age-related changes have long been acknowledged as primary risk factors for falls, the interplay between infections and falls represents a novel and complex dimension in geriatric healthcare, with implications that extend beyond the realm of traditional risk assessment and management strategies.

The elderly population are often more susceptible to infections (Häder et al., 2023). This elevated susceptibility to infections can be attributed to a multitude of factors, including age-related changes in immune function, the presence of comorbidities, polypharmacy, functional impairments, and institutionalization, among others. Moreover, older adults may present with atypical or nonspecific manifestations of infections, posing diagnostic challenges and leading to delays in appropriate intervention (Clifford et al., 2016). Consequently, infections not only pose direct threats to health but also exert indirect effects on mobility, cognition, and functional independence, thereby heightening the risk of falls in this vulnerable population.

As described above, falls in the older adult population pose a significant public health issue, and can be capable of causing serious injuries and even death. There are numerous general complications that may arise from falls, which include orthopedic injuries, head injuries, deleterious psychosocial concerns, and loss of independence. These complications are of great burden to public health and will be discussed in detail below.

## **1.1 Orthopedic Injuries**

Orthopedic injuries, particularly fractures, are among some of the most common and frequent complications resulting from falls in the older adult population. Approximately 220,000 hip and wrist fractures occur among individuals over age 65. Anatomic areas prone to fractures include the hip, pelvis, humerus, and wrist. Injuries such as joint dislocations and sprains may also be encountered (Institute of Medicine [US] Division of Health Promotion and Disease Prevention et al., 1992). Management strategies involve tailored approaches such as surgical intervention for stabilization and alignment, pain management, early mobilization, physical therapy for rehabilitation, and measures to prevent further complications. However, these fractures can lead to various additional complications both as a direct result of the fall but also its management. For example, hip fractures are associated with increased risks of thromboembolic events (e.g., deep vein thrombosis), hospital-acquired infections from procedures, and pressure ulcers (Carpintero et al., 2016).

## **1.2 Head Injuries**

Falls can cause head injuries ranging from minor bumps and bruises to more severe traumatic brain injuries, such as concussions or intracranial bleeding. Traumatic brain injuries can have both acute and chronic cognitive and functional consequences (Bramlett & Dietrich, 2015). The anatomical changes that occur with aging influence how head trauma manifests physiologically in elderly individuals. Compared to younger individuals, elderly individuals are more likely to experience subdural hematomas and intraparenchymal hemorrhages following head

injuries. This difference is due to the increased adherence of the dura mater to the skull in older individuals, which makes the underlying bridging veins more susceptible to injury during trauma. Consequently, bleeding from these veins within the skull results in the formation of intracranial subdural hematomas, whereas epidural hematomas are more common in younger patients. Furthermore, as individuals age, there is progressive brain atrophy, creating more space within the cranial cavity. This increased space allows for more bleeding in the case of a subdural hematoma. These factors contribute to a delayed onset of symptoms in elderly patients, leading them to seek medical care later than younger individuals, which contributes to an increased rate of morbidity and mortality. Moreover, older adults are also more likely to be on multiple prescription medications to include anticoagulants. Anticoagulants increases the rate of bleeding should traumatic injury occur and can also contribute to increased possibility of disability as well as death (Yee & Jain, 2023).

### **1.3 Deleterious Psychosocial Concerns**

Deleterious psychosocial concerns represent a significant issue encountered in older adults who experience falls. A systematic review conducted by Petersen et al. in 2020 highlighted that falls can contribute to social exclusion among older individuals. This social exclusion may, in turn, lead to diminished self-efficacy, reduced self-respect, and an increased perception of overall lack of well-being (Cheng et al., 2021). Furthermore, the mental state of older adults is often negatively impacted following a fall, encompassing elements such as fear of falling, heightened anxiety, and symptoms of depression (Cui et al., 2023). Thus, the experience of a fall can profoundly affect an older adult's sense of security and confidence in their ability to carry out activities of daily living

independently. The resulting fear of falling, in particular, can become a pervasive concern, leading individuals to curtail their activities and social engagements out of fear of further injury or embarrassment (Chandrasekaran et al., 2021). By recognizing and addressing the psychosocial impact of falls on older adults, healthcare professionals can promote successful aging and well-being in this vulnerable population.

#### **1.4 Loss of Independence**

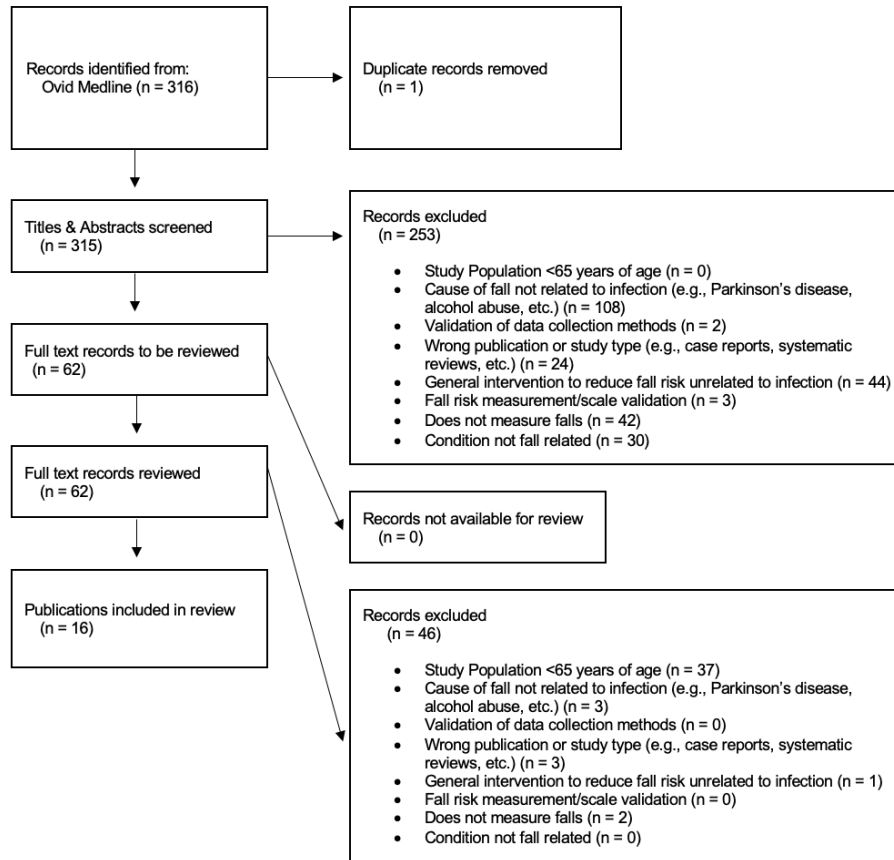
The link between falls and loss of independence in the older adult population is profound and complex. Falls often result in physical injuries that can impair mobility and limit the ability to perform activities of daily living, such as walking or getting out of bed. Moreover, as previously mentioned, the experience of falling can instill a persistent fear of falling again, leading individuals to restrict their activities and become more sedentary, which in turn contributes to functional loss. This loss of both physical capability and confidence may necessitate increased reliance on caregivers or family members for assistance with daily tasks, eroding an older adult's sense of autonomy and self-reliance and be associated with negative psychosocial outcomes (Morgan & Brazda, 2013). In severe cases, falls can precipitate changes in living arrangements, such as moving to assisted living facilities, impacting emotional well-being, and exacerbating feelings of dependence and loss of control. Addressing this link requires a multitude of holistic strategies that encompass fall prevention strategies, rehabilitation, and support services to help older adults maintain independence and quality of life despite the challenges posed by falls.

## 2.0 Methods

In conducting this literature review, a thorough search strategy was employed using a range of specific keywords and phrases to capture relevant studies pertaining to the targeted condition and population. The search terms utilized encompassed variations of terms related to falls and infections, such as "fall", "falls", "falling", "aging", "geriatric", "geriatrics", "elderly", "infected", and "infection". Ovid MEDLINE<sup>®</sup>, a bibliographic database and article index, was selected as the primary source for identifying pertinent literature. The inclusion criteria for this literature review primarily focused on articles that explored the relationship between falls and infections within the older adult population, defined as individuals aged 65 and above. The scope of infections considered in this review was comprehensive, encompassing both acute conditions (e.g., COVID-19, influenza) and chronic illnesses (e.g., HIV/AIDS). This broad approach aimed to gather a diverse range of reports and findings related to the intersection of falls and infections among older adults, contributing to a comprehensive understanding of this significant public health issue.

### **3.0 Results**

The initial search using Ovid MEDLINE<sup>®</sup> retrieved a total of 316 records, from which 1 duplicate was identified. After applying inclusion and exclusion criteria during the title and abstract screening processes, 253 records were excluded. Following full-text review, an additional 46 records were excluded based on the predefined criteria. Ultimately, 16 publications met the inclusion criteria and were included in this literature review. Figure 1 provides a comprehensive flow diagram illustrating the search and screening processes, including details of the specific criteria used for inclusion and exclusion at each stage.



**Figure 1: Flow Diagram**

Of the 16 publications included, the distribution was as follows: 1 prospective cohort study, 1 prospective observational study, 3 retrospective observational studies, 4 cross-sectional studies, and 7 retrospective cohort studies. These studies were conducted across multiple countries, with representation from Vietnam (1 study), Saudi Arabia (1 study), Brazil (1 study), Poland (1 study), Sweden (1 study), Denmark (1 study), France (2 studies), England (2 studies), and the United States (6 studies). Among the studies focusing on infection-related falls in older adults, 10 investigated COVID-19, 2 explored influenza and influenza-like illnesses (ILI), 2 examined coexisting systemic infections (CSI), 1 addressed urinary tract infections (UTI), and 1 explored HIV/AIDS. Therefore, 15 studies explored the association between acute infections and falls in



older adults, while 1 study investigated the link between a chronic infection and falls in this population.

The primary findings across the studies related to COVID-19 were consistent, with all 10 studies concluding that COVID-19 infection can be associated with falls among older adults. Specifically, 7 studies (Knopp et al., 2020; Blain et al., 2020; Sacco et al., 2020; Nabors et al., 2021; Karlsson et al., 2021; Hunt et al., 2021; Nguyen et al., 2022) highlighted falls as an atypical symptom suggestive of COVID-19 infection in this population. 3 other studies described several factors and situations related to falls in older adults with COVID-19, such as arrhythmias (Mikos et al., 2022), functional impact (Nascimento et al., 2023), and recommendation for mitigative strategy (Alshehri, 2024). Similarly, the 2 studies focusing on influenza and ILI reported similar findings, emphasizing associations between influenza and falls or fall-related injuries in older adults (McConeghy et al., 2018; Axelsson et al., 2022). Additionally, 2 studies examined falls in older adults with CSIs and highlighted falls as a potential symptom (Blair & Manian, 2017; Manian et al., 2020). A study on UTIs concluded that routine urinalysis for older patients presenting with falls could help identify infections present on admission (Shu et al., 2018). Lastly, a study explored the relationship between falls and older adults with HIV, highlighting polypharmacy as a potential intermediary factor. This study found that a significant proportion (81%) of older individuals within the study with HIV were taking medications with a high potential for adverse effects, as defined by the Beers Criteria (Kosana et al., 2023).

## **4.0 Discussion**

### **4.1 COVID-19**

In December of 2019, Coronavirus Disease 2019 (COVID-19), began in Wuhan, China, and spread across the world, causing a significant pandemic spanning more than three years. The causative infectious agent of this disease is the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) virus. This strain of the coronavirus group of viruses is a positive-sense single-stranded RNA virus and is capable of infecting both humans and nonhumans. COVID-19 is highly transmissible and can cause mild to severe forms of disease, with the latter predominantly affecting older adults and those with underlying comorbidities such as obesity, diabetes, cancer, and prior organ transplantation, among others (Cascella et al., 2023).

The clinical manifestations of COVID-19 typically include fever or chills, cough, shortness of breath, fatigue, myalgia, headache, new loss of taste or smell, congestion, rhinorrhea, sore throat, nausea, vomiting, and diarrhea (CDC, 2024). However, older adults can have atypical presentations of disease, and this is true for infections as well. Any change in baseline should be registered as a cause for concern in this population (Vonnes & El-Rady, 2021).

The relationship between COVID-19 and falls in the older adult population is a critical area of investigation given the profound impact of the COVID-19 pandemic on older individuals worldwide. The studies reviewed in this analysis consistently point toward an association between COVID-19 infection and falls among older adults, highlighting the complexity of both diagnosing and managing COVID-19 in this vulnerable population.

One notable finding across multiple studies is the identification of falls as an atypical symptom suggestive of COVID-19 infection in older adults (Knopp et al., 2020; Blain et al., 2020; Sacco et al., 2020; Nabors et al., 2021; Karlsson et al., 2021; Hunt et al., 2021; Nguyen et al., 2022). This unconventional presentation underscores the challenge of diagnosing COVID-19 in older individuals, particularly when typical respiratory symptoms such as cough and shortness of breath may not manifest prominently. Instead, single, or repetitive falls may serve as important indicators of underlying COVID-19 infection, necessitating a high index of suspicion among healthcare providers. Depending on the institution and practice, a clinical decision-making tool or algorithm may help standardize this finding for healthcare providers, potentially reducing delays in diagnosis and treatment.

The observed association between COVID-19 and falls could be multifactorial. One potential explanation is the direct impact of COVID-19 on the central nervous system, leading to neurologic symptoms such as dizziness, imbalance, or altered mental status, which can increase the risk of falls (Nabors et al., 2021). Additionally, the systemic inflammatory response triggered by COVID-19 could contribute to muscle weakness and fatigue (Pescaru et al., 2022), further predisposing older adults to falls. Nguyen et al.'s study (2022) further defined an association between COVID-19 infection and lower-limb weakness, which serves as a factor that may cause older adults to fall. COVID-19's effects on the cardiovascular system may also be a factor that cause older adults to fall. In 2022, Mikos et al. reported that COVID-19 infection could be linked to arrhythmia due to a combination of direct cardiomyocyte injury and systemic inflammation. The authors suggest that during the hyperinflammatory state of COVID-19 disease, rhythm disturbances and endotheliopathy may work together to promote thromboembolic complications, which could impair cerebral blood flow and contribute to falls. These insights not only propose

potential mechanisms underlying falls in COVID-19 patients but also emphasize the critical role of long-term anticoagulation therapy in cases with a high risk of arrhythmia and thromboembolism.

Furthermore, the indirect consequences of COVID-19, such as prolonged hospitalization or isolation, can lead to deconditioning and functional decline in older adults, increasing their susceptibility to falls. This was aptly demonstrated by Nascimento et al.'s study conducted in Brazil in 2023 where a high prevalence of falls was observed in older adults with COVID-19 during a period of mandatory confinement. The psychological impact of the pandemic, including fear of infection and reduced access to healthcare services, may also play a role in compromising physical function and increasing fall risk among elderly individuals (MacLeod et al., 2021).

The findings from these studies underscore the importance of considering COVID-19 infection in the differential diagnosis of falls among older adults, especially in cases where typical respiratory symptoms are absent. Clinicians must maintain a vigilant approach to assessing older patients presenting with falls, ensuring timely testing for COVID-19 and appropriate management to mitigate the spread of the virus and optimize clinical outcomes. The literature reviewed supports a clear association between COVID-19 infection and falls in the older adult population. Further research is needed to elucidate the underlying mechanisms and risk factors contributing to this association, as well as to develop targeted interventions aimed at preventing falls and optimizing care for older adults during the ongoing COVID-19 pandemic and beyond. For example, integration of balance exercises for older adults with COVID-19 may aid in improving proprioception and mitigate fall events (Alshehri, 2024). Older adults hospitalized with COVID-19 could also benefit from telemetry monitoring to identify arrhythmias, which, as discussed earlier, may be linked to falls. Hospital systems with established telemetry guidelines may find it

advantageous to integrate these findings into their guidelines, given their demonstrated effectiveness as a clinical tool (Dhillon et al., 2012). Ultimately, enhanced awareness, proactive measures, and preventive practices such as vaccine awareness are essential to address the unique challenges posed by COVID-19 in the context of falls among elderly individuals and to promote optimal health and well-being in this vulnerable population.

## **4.2 Influenza and Influenza-like Illness**

Influenza and influenza-like illness (ILI) are contagious respiratory infections caused by influenza viruses, primarily influenza A and B. The viruses primarily target the respiratory system, causing a range of symptoms that can vary in severity. Pathologically, influenza viruses infect respiratory epithelial cells, leading to inflammation and damage to the respiratory mucosa. Common clinical signs and symptoms of influenza and ILI include fever or chills, cough, sore throat, runny or stuffy nose, muscle or body aches, headache, fatigue, and occasionally gastrointestinal symptoms like nausea, vomiting, or diarrhea. In severe cases, influenza can lead to complications such as pneumonia, exacerbation of underlying chronic conditions, and even death, particularly in vulnerable populations such as older adults, young children, pregnant women, and individuals with compromised immune systems. The hallmark feature of influenza is its seasonal pattern, with outbreaks typically occurring during colder months.

The relationship between influenza and ILI and falls in the older adult population represents a critical area of investigation with substantial implications for healthcare practice and public health interventions. Infections caused by influenza and ILI present a spectrum of

respiratory symptoms that can range from mild to severe, particularly affecting older adults aged 65 and older due to age-related changes in immune function and prevalent comorbidities.

Several studies have elucidated the association between influenza or ILI and falls among older adults. For instance, McConeghy et al. (2018) conducted a study focused on nursing home residents and identified a 13% increased risk of hip fracture hospitalizations associated with influenza illness. Similarly, Axelsson et al. (2022) conducted study in Sweden and reported that older adults admitted with an influenza diagnosis had an elevated risk of fracture or fall injury during the first-year post-discharge.

The linkage between influenza or ILI and falls in older adults can be multifactorial. An animal study conducted by Bartley et al. (2016) revealed that influenza can induce muscle inflammation, atrophy, and functional impairment, which may persist longer in older individuals. This implies a molecular connection between influenza infection and disability in older adults, potentially contributing to falls. Additionally, influenza-related symptoms such as dizziness, fatigue, and unsteady gait can contribute to functional decline and decreased mobility, predisposing older adults to falls (Axelsson et al., 2022).

Furthermore, the impact of influenza on overall health and functional status underscores the critical role of preventive measures such as influenza vaccination. Vaccination against seasonal influenza has demonstrated effectiveness in reducing the risk of influenza-related complications and hospitalizations among older adults, consequently mitigating the risk of falls and fall-related injuries associated with influenza (Axelsson et al., 2022). A systematic review by Moa et al. (2023) corroborated these assertions and found that influenza vaccination for older adults in aged care facilities may serve a protective function against infection in conjunction with masking and social distancing practices, thereby providing an avenue for mitigating fall risk.

Influenza and ILI exert substantial effects on falls in the older adult population, necessitating vigilant assessment and management by healthcare providers. More investigation is warranted to delineate specific mechanisms linking influenza to falls and to develop targeted interventions aimed at reducing falls related to this condition. Implementing comprehensive vaccination strategies and multifaceted approaches plays a significant role in reducing the burden of falls and fall-related injuries associated with influenza in older adults.

### **4.3 Coexisting Systemic Infection**

Coexisting systemic infections (CSI) represent a significant but often overlooked factor contributing to falls among older adults, presenting a complex intersection between infection and mobility in this population. Blair and Manian (2017) highlighted that falls may manifest as an atypical symptom of underlying systemic infections such as bacteremia, which may not be initially suspected by healthcare providers. This underscores the importance of considering infectious etiologies in older adults presenting with falls, particularly those exhibiting signs of systemic inflammatory response syndrome or other indicators of infection. A delay in diagnosis for a condition such as sepsis can result in increased morbidity and mortality (Kassyap et al., 2018).

Moreover, Manian et al. (2020) demonstrated a high prevalence of CSIs among older patients hospitalized due to falls, with rates reaching 26.1% in those aged 75 years and older. Urinary tract infections and bacteremia emerged as common culprits, emphasizing the need for thorough diagnostic evaluation in this population. The presence of CSIs not only increases the risk of falls but also complicates clinical management, as these infections may lead to altered mental status and weakness, further exacerbating mobility issues.

The findings underscore the importance of vigilance for coexisting infections in older adults presenting with falls, as prompt recognition and treatment of underlying CSIs can potentially prevent further falls and improve outcomes. Healthcare providers should maintain a high index of suspicion for CSIs as a cause of falls, especially in the absence of obvious trauma or mechanical factors. Enhanced infection control measures and targeted interventions aimed at preventing and managing CSIs could play a crucial role in reducing fall-related morbidity and mortality in this susceptible population. Examples of this could include system-wide implementation of algorithm-based guidelines and standardized screening tools as well as implementation of sepsis bundling protocols that have been shown to improve patient outcomes (Schinkel et al., 2022).

#### **4.4 Urinary Tract Infection**

Urinary tract infections (UTI) are common bacterial infections affecting the urinary system, including the kidneys, ureters, bladder, and urethra. These infections are more prevalent in older adults due to age-related changes in the urinary tract, such as decreased bladder emptying and weakened immune responses (Akhtar et al., 2019). UTIs represent a common yet underrecognized risk factor for falls among older adults, warranting a closer examination of their interplay with mobility and fall risk in this population. A study by Shu et al. (2018) have highlighted the association between UTIs and falls in older adults, with UTIs often presenting with atypical symptoms that include falls.

The presence of a UTI can lead to nonspecific symptoms in older adults, including altered mental status, generalized weakness, and functional decline, which may not immediately raise



suspicion of an underlying infection. This atypical presentation underscores the importance of comprehensive assessment and diagnostic vigilance in older adults presenting with falls, especially those with predisposing factors such as urinary incontinence or indwelling catheters. Other atypical symptoms of UTIs that healthcare providers should be aware of that may manifest in conjunction with falls include hypotension, tachycardia, urinary incontinence, poor appetite, drowsiness, and delirium (Dutta et al., 2022).

Furthermore, the study by Shu et al. (2018) advocates for routine urinalysis in older adults presenting with falls to promptly identify and treat UTIs that may otherwise go undetected. Delayed diagnosis and treatment of UTIs can result in adverse outcomes. Complicated UTIs are reported as the most frequent cause of sepsis in adults over 65 years of age (Hsiao et al., 2023), a risk that may be compounded by delays in administering appropriate antimicrobial treatment (Kmietowicz, 2019), further escalating the likelihood of sepsis in this population. Currently, the 2021 Surviving Sepsis Campaign guidelines set forth by the Society of Critical Care Medicine does not include urinalysis as a component of the “Hour-1 Bundle” for adults with suspected sepsis or septic shock. Therefore, implementing routine urinalysis or integration of the practice into an existing institutional bundling protocol could be beneficial for prompt UTI detection in older adults who present with a fall but lack other clinical signs or symptoms of infection. This enables antibiotic treatment to be started promptly, when necessary, without delay.

#### **4.5 HIV/AIDS**

Human Immunodeficiency Virus (HIV) infection and the resulting Acquired Immunodeficiency Syndrome (AIDS) pose a significant global public health challenge,

particularly impacting older adults who are increasingly represented within the HIV/AIDS population. HIV is a retrovirus that attacks the body's immune system, specifically targeting CD4 cells, weakening the immune response and making individuals vulnerable to opportunistic infections and certain cancers.

The relationship between HIV/AIDS and falls in the older adult population represents a multifaceted intersection of aging, chronic disease, and complex physiological changes. As individuals with HIV/AIDS are living longer due to advancements in antiretroviral therapy, they are increasingly encountering age-related health challenges, including an elevated risk of falls. Older adults with HIV/AIDS experience unique health issues that can directly contribute to falls, such as peripheral neuropathy (Schütz & Robinson-Papp, 2015), which can impair sensation and balance, and HIV-associated neurocognitive disorders, which may affect brain and cognitive function (Cotto et al., 2019). Moreover, the chronic inflammatory state associated with HIV infection and its treatment can lead to muscle wasting and bone demineralization, further predisposing individuals to falls and fractures (Kruger & Nell, 2017).

In addition to these direct effects of HIV/AIDS, older adults with this condition often contend with a higher burden of comorbidities, including cardiovascular disease, diabetes, and osteoarthritis, all of which can independently increase the risk of falls (Appeadu, 2023). Polypharmacy is prevalent in this population, introducing medication-related side effects that increase the risk of falls. Kosana et al. (2023) highlighted a significant proportion of their study participants (aged  $\geq 65$  years) taking medications with a high potential for adverse effects according to the Beers Criteria, which could result in or exacerbate falls, especially with advancing age (AlHarkan et al., 2023).

Preventive strategies tailored to older adults with HIV/AIDS should incorporate comprehensive geriatric assessment, including evaluation of gait and balance, strength and mobility testing, and cognitive screening. Interventions to mitigate fall risk may include physical therapy to improve strength and balance, modification of the home environment to reduce hazards, and optimization of medication regimens to minimize side effects. Furthermore, healthcare providers should be vigilant in assessing and addressing fall risk factors in this population, aiming to preserve functional independence and quality of life.

As those with HIV/AIDS are now living longer due to advancements in therapy, future research efforts should focus on elucidating the specific mechanisms underlying the increased risk of falls in older adults with HIV/AIDS, including the interplay between chronic inflammation, neurocognitive impairment, musculoskeletal changes, and polypharmacy. Developing evidence-based guidelines and interventions such as medication reconciliation and regular medication review with appropriate de-prescribing if needed, is essential (Back & Marzolini, 2020). Tailoring these interventions to the growing population of older adults with HIV/AIDS will optimize care and reduce the burden of falls and fall-related injuries.

#### **4.6 Public Health Implications and Recommendations for Further Research**

The findings from this comprehensive review of literature carry substantial public health implications, emphasizing the pressing need for targeted interventions and holistic strategies to address the intricate relationship between infections and falls among older adults. First and foremost, public health efforts should prioritize enhanced surveillance systems to closely monitor infections, particularly during outbreaks like COVID-19 and influenza seasons. Timely detection

of infections in older adults can enable prompt interventions to prevent falls and mitigate associated adverse outcomes. Additionally, a multidisciplinary approach involving healthcare providers such as physicians, nurses, pharmacists, and public health professionals is crucial. Integrated care models need to be developed to facilitate seamless communication and coordination, ensuring prompt management of infections and implementation of fall prevention strategies. Specific strategies for this may include the provision of both synchronous and asynchronous continuing education content for healthcare providers. As an example, brief educational sessions addressing the connection between infections and falls in older adults could be integrated into healthcare systems and online platforms like the TRAIN national learning network. This network, which serves over 2 million public health professionals, offers a multitude of quality training opportunities (Public Health Foundation, n.d.).

Moreover, initiatives focusing on medication optimization are imperative, given the link between polypharmacy and falls in older adults (particularly in those with chronic infections such as HIV/AIDS). Pharmacist-driven public health interventions should promote deprescribing practices and educate healthcare providers and older adults about the potential risks associated with certain medications. Community-based fall prevention programs tailored specifically to older adults should also be prioritized. These programs should incorporate evidence-based interventions like exercise programs, home safety assessments, and educational sessions on fall prevention strategies.

Furthermore, widespread public awareness campaigns targeting older adults, caregivers, and the public are essential. These campaigns should raise awareness about the heightened risk of falls during infections and promote proactive measures such as maintaining good hygiene practices and seeking timely medical attention for infections. Policymakers must play a crucial role in

developing and implementing policies aimed at improving infection prevention and control measures in healthcare and community settings frequented by older adults, ensuring access to vaccinations, infection screening, and adequate healthcare resources.

Lastly, continuous research and quality improvement initiatives are imperative to deepen the understanding of the underlying mechanisms linking infections and falls among older adults. Public health agencies should support innovative research initiatives aimed at developing novel interventions and technologies to prevent and manage infections and reduce the risk of falls in this vulnerable population. In addition, it may be beneficial to conduct qualitative studies that investigate and assess the perceptions of falling among older adults with infections. By implementing these multifaceted public health strategies, the burden of infection-related falls among older adults may be effectively alleviated, leading to enhanced overall health outcomes and a significant improvement in the quality of life for this growing demographic. Collaboration among public health agencies, policymakers, healthcare providers, and communities is essential to address this critical public health issue and prioritize the well-being of older adults.

#### **4.7 Limitations**

It is important to recognize several limitations associated with this review of literature. First, many studies included in this review and subsequent analysis were observational in nature, which limits the ability to establish causation between infections and falls in older adults. Additionally, variations in study methodologies, including differences in sample sizes, study populations, and definitions of infections and falls, may introduce heterogeneity into the findings and affect the generalizability of results. For instance, certain studies included samples with

participants aged over 65 years, whereas others focused on samples with participants over 70 years of age. A significant portion of studies, particularly those surrounding HIV/AIDS, were also eliminated from final inclusion during the screening stages due to the study population being less than 65 years of age. During the screening phase, it was observed that studies focusing on falls and HIV infection often involved middle-aged participants, typically ranging in age from around 40 to 60 years. This could be attributed to the fact that individuals with HIV are believed to display accelerated aging characteristics, and those within this age bracket might already be experiencing advanced age-related complications as a result of their condition (Erlandson et al., 2012).

Moreover, the retrospective nature of some studies could lead to potential biases, such as recall bias or incomplete data collection. Furthermore, the reliance on healthcare records for data extraction in some studies may introduce selection bias and limit the accuracy of the findings. Lastly, the complex interplay between multiple comorbidities and medications in older adults can confound the association between infections and falls, highlighting the need for more comprehensive studies that account for these factors. Overall, while the existing literature provides valuable insights, future research should address these limitations to further elucidate the complex relationship between infections and falls in the older adult population as well as define effective mitigative strategies.

## 5.0 Conclusion

In conclusion, this review of literature underscores the critical relationship between infections and falls among older adults, highlighting the substantial impact on morbidity, mortality, and healthcare utilization. The association with various infections, including COVID-19, influenza and ILI, CSI, UTI, and HIV/AIDS, emphasizes the complexity of this issue and highlights the need for comprehensive strategies. Efforts should focus on early detection and management of infections, medication optimization, and multifactorial fall prevention interventions. These elements are paramount in mitigating the adverse consequences of infection-related falls. Furthermore, adopting a multidisciplinary approach that integrates medical, nursing, and public health perspectives is essential for developing effective preventive measures and interventions tailored to the unique needs of older adults. By prioritizing these strategies, there is the possibility to significantly reduce the burden of falls and enhance the overall well-being and quality of life of this vulnerable population.

## Appendix A

### Appendix A.1 Tables

**Table 1: Summary of Literature Database(s) Searched**

Table	Vendor/Interface	Database	Date Searched	Database Update	Searcher(s)
2	Ovid	MEDLINE®	March 20, 2024	1946 to March 19, 2024	Helena M. VonVille; Tom Wen-Han Su

**Table 2: Ovid MEDLINE® Search Strategy**

Provider/Interface	Ovid
Database	Medline® ALL
Date searched	March 20, 2024
Database update	1946 to March 19, 2024
Search developer(s)	Helena M. VonVille; Tom Wen-Han Su
Limit to English	Yes
Date Range	2014-2024
Publication Types	Excluded: Case reports & Study guides; Protocols excluded
Search filter source	No search filter used

1	Accidental Falls/
2	(fall or falling or falls).ti,kf.
3	((frequency or frequent*) adj (fall or falls or falling)).ti,ab,kf.



4	1 or 2 or 3
5	aged/ or "aged, 80 and over"/ or centenarians/ or nonagenarians/ or octogenarians/ or frail elderly/
6	(aging or geriatric or geriatrics or elderly or (older adj3 (adult or adults or men or people or participant or participants or person or persons or women))).ti,ab,kf.
7	5 or 6
8	4 and 7
9	exp Infections/
10	(coronavirus or covid or covid19 or (sars adj2 cov) or hiv* or infected or infection* or (urinary adj tract) or UTI or UTIs).ti,ab,kf.
11	9 or 10
12	8 and 11
13	limit 12 to (english language and yr="2014 - 2024")
14	13 not ((case reports or study guide).pt. or protocol.ti.)

**Table 3: Study Characteristics**

Author(s)	Year of Publication	Country	Title	Study Type	Pertinent Primary Finding(s)	Citation
COVID-19						
Knopp et al.	2020	England	Presenting features of COVID-19 in older people: relationships with frailty, inflammation and mortality	Prospective cohort	"Some individuals were admitted without any of these cardinal COVID-19 symptoms (n= 25, 12%), instead presenting with one or more frailty syndrome (reduced mobility, falls or delirium)."	Knopp, P., Miles, A., Webb, T. E., McLoughlin, B. C., Mannan, I., Raja, N., Wan, B., & Davis, D. (2020). Presenting features of COVID-19 in older people: relationships with frailty, inflammation and mortality. <i>European geriatric medicine, 11</i> (6), 1089–1094. <a href="https://doi.org/10.1007/s41999-020-00373-4">https://doi.org/10.1007/s41999-020-00373-4</a>
Blain et al.	2020	France	Atypical clinical presentation of COVID-19 infection in residents of a long-term care facility	Prospective observational	"Another interesting feature is the relatively common fall rate as the first symptom. Since COVID-19 induces severe fatigue, it can be expected that falls can be common in residents with little or no risk of fall. This symptom needs to be considered as a possible prodromal symptom of COVID-19 during the epidemic in LTCF residents."	Blain, H., Rolland, Y., Benetos, A., Giacosa, N., Albrand, M., Miot, S., & Bousquet, J. (2020). Atypical clinical presentation of COVID-19 infection in residents of a long-term care facility. <i>European geriatric medicine, 11</i> (6), 1085–1088. <a href="https://doi.org/10.1007/s41999-020-00352-9">https://doi.org/10.1007/s41999-020-00352-9</a>
Sacco et al.	2020	France	COVID-19 in seniors: Findings and lessons	Retrospective cohort	"In conclusion, the pauci-symptomatic expression of COVID-	Sacco, G., Foucault, G., Briere, O., & Annweiler, C. (2020). COVID-19 in seniors: Findings and lessons from mass screening in

			from mass screening in a nursing home		19 in older residents, together with the high prevalence of asymptomatic forms in caregivers, justifies conducting mass screening in nursing homes, possibly prioritizing residents with suggestive combinations of clinical signs including dyspnea, falls, anorexia and/or altered consciousness."	a nursing home. <i>Maturitas</i> , 141, 46–52. <a href="https://doi.org/10.1016/j.maturitas.2020.06.023">https://doi.org/10.1016/j.maturitas.2020.06.023</a>
Nabors et al.	2021	United States	Characteristics and Outcomes of Patients 80 Years and Older Hospitalized With Coronavirus Disease 2019 (COVID-19)	Retrospective cohort	"Altered sensorium and generalized weakness led to indirect complications like falls, fractures, and intracranial hemorrhages at the time of presentation."	Nabors, C., Sridhar, A., Hooda, U., Lobo, S. A., Levine, A., Frishman, W. H., & Dhand, A. (2021). Characteristics and Outcomes of Patients 80 Years and Older Hospitalized With Coronavirus Disease 2019 (COVID-19). <i>Cardiology in review</i> , 29(1), 39–42. <a href="https://doi.org/10.1097/CRD.0000000000000368">https://doi.org/10.1097/CRD.0000000000000368</a>
Karlsson et al.	2021	Denmark	Clinical presentation and mortality in hospitalized patients aged 80+ years with COVID-19—A retrospective cohort study	Retrospective cohort	"Older patients with SARS-CoV-2 display classical symptoms of COVID-19 such as fever, cough, respiratory distress, and fatigue upon hospital admission. However, unspecific symptoms including confusion, difficulty walking, and falls are also frequent."	Karlsson, L. K., Jakobsen, L. H., Hollensberg, L., Ryg, J., Midttun, M., Frederiksen, H., Glenthoj, A., Kodahl, A. R., Secher-Johnsen, J., Nielsen, L. K., Bofill, N. G., Knudtzen, F. C., & Lund, C. M. (2021). Clinical presentation and mortality in hospitalized patients aged 80+ years with COVID-19—A retrospective cohort study. <i>Archives of gerontology and geriatrics</i> , 94, 104335. <a href="https://doi.org/10.1016/j.archger.2020.104335">https://doi.org/10.1016/j.archger.2020.104335</a>
Hunt et al.	2021	England	Failing the frail: The need to broaden the COVID-19 case definition for geriatric patients	Retrospective observational	"Clinical suspicion for COVID-19 infection is needed in patients presenting with falls and confusion, even if clinical observations are normal."	Hunt, C., Olcott, F., Williams, G., & Chan, T. (2021). Failing the frail: The need to broaden the COVID-19 case definition for geriatric patients. <i>Clinical medicine (London, England)</i> , 21(6), e604–e607. <a href="https://doi.org/10.7861/clinmed.2021-0308">https://doi.org/10.7861/clinmed.2021-0308</a>
Mikos et al.	2022	Poland	Factors Associated with Falls During Hospitalization for Coronavirus Disease 2019 (COVID-19)	Retrospective observational	"Arrhythmias may be an important predisposing factor for falls in COVID-19 disease patients and fall prevention programs should prioritize interventions directed at this vulnerable patient population."	Mikos, M., Szydio, B., Szeryguk, I., Oliveira, M. H. S., Kuboń, M., Juszczyk, G., & Henry, B. M. (2022). Factors Associated with Falls During Hospitalization for Coronavirus Disease 2019 (COVID-19). <i>Medical science monitor : international medical journal of experimental and clinical research</i> , 28, e936547. <a href="https://doi.org/10.12659/MSM.936547">https://doi.org/10.12659/MSM.936547</a>
Nguyen et al.	2022	Vietnam	Falls Among Older Adults During the COVID-19 Pandemic: A Multicenter Cross-Sectional Study in Vietnam	Cross-sectional	"To our knowledge, this is the first study to demonstrate that post-COVID-19 falls were associated with post-COVID-19 lower limb weakness. A decrease in muscle strength was reported as an initial and common symptom in COVID-19 infected individuals."	Nguyen, H. T., Nguyen, C. C., & Le Hoang, T. (2022). Falls Among Older Adults During the COVID-19 Pandemic: A Multicenter Cross-Sectional Study in Vietnam. <i>Clinical interventions in aging</i> , 17, 1393–1404. <a href="https://doi.org/10.2147/CIA.S382649">https://doi.org/10.2147/CIA.S382649</a>
Nascimento et al.	2023	Brazil	A Comparison of Cognitive Performance, Depressive Symptoms, and Incidence of Falls in Brazilian Older Women with and without a Confirmed History of COVID-19	Cross-sectional	"The findings showed a prevalence of falls of 57.1% for members of the COVID-19 group during the period of mandatory confinement. Moreover, it was found that the higher the age group, the higher the prevalence of falls."	Nascimento, M. M., Barros, N. S., Coelho, J. M. R., Silva, A. B. D. S., Ribeiro, A. S., Santos, S. T. G. D. R., Rodriguez, A. B., & Ihle, A. (2023). A Comparison of Cognitive Performance, Depressive Symptoms, and Incidence of Falls in Brazilian Older Women with and without a Confirmed History of COVID-19. <i>International journal of environmental research and public health</i> , 20(18), 6760. <a href="https://doi.org/10.3390/ijerph20186760">https://doi.org/10.3390/ijerph20186760</a>
Alshehri	2024	Saudi Arabia	The effect of COVID-19 on the risk of falling in old age adult patients: a cross-sectional study	Cross-sectional	"COVID-19 has an impact on the risk of falls in older people above 65 years. So, the introduction of balance exercises to these subjects is of high importance to improve their balance and proprioception skills and decrease the fall risk."	Alshehri F. H. (2024). The effect of COVID-19 on the risk of falling in old age adult patients: a cross-sectional study. <i>European review for medical and pharmacological sciences</i> , 28(2), 829–835. <a href="https://doi.org/10.26355/eurev_202401_35084">https://doi.org/10.26355/eurev_202401_35084</a>
Influenza and Influenza-like Illness						
McConeghy et al.	2018	United States	Influenza Illness and Hip Fracture Hospitalizations in Nursing Home Residents: Are They Related?	Retrospective cohort	"ILI hospitalizations are associated with a 13% average increase in hip fracture hospitalization risk."	McConeghy, K. W., Lee, Y., Zullo, A. R., Banerjee, G., Daiello, L., Dosa, D., Kiel, D. P., Mor, V. M., & Berry, S. D. (2018). Influenza Illness and Hip Fracture Hospitalizations in Nursing Home Residents: Are They Related?. <i>The journals of gerontology. Series A, Biological sciences and medical sciences</i> , 73(12), 1638–1642. <a href="https://doi.org/10.1093/gerona/glx200">https://doi.org/10.1093/gerona/glx200</a>

Axelsson et al.	2022	Sweden	Fractures and fall injuries after hospitalization for seasonal influenza—a national retrospective cohort study	Retrospective cohort	“Older adults admitted with influenza diagnosis have an increased risk of fracture or fall injury during the first year after discharge.”	Axelsson, K. F., Litsne, H., & Lorentzon, M. (2022). Fractures and fall injuries after hospitalization for seasonal influenza—a national retrospective cohort study. <i>Osteoporosis international : a journal established as result of cooperation between the European Foundation for Osteoporosis and the National Osteoporosis Foundation of the USA</i> , 33(1), 47–56. <a href="https://doi.org/10.1007/s00198-021-06068-1">https://doi.org/10.1007/s00198-021-06068-1</a>
Coexisting Systemic Infections						
Blair & Manian	2017	United States	Coexisting Systemic Infections in Patients Who Present With a Fall	Retrospective cohort	“In conclusion, the results of our study suggest that falls may be associated with potentially serious systemic infections, including bacteremia. Inclusion of systemic infections in the differential diagnosis of conditions that may contribute or coexist with a fall should lead to their more timely diagnosis and management.”	Blair, A., & Manian, F. A. (2017). Coexisting Systemic Infections in Patients Who Present With a Fall. <i>The American journal of the medical sciences</i> , 353(1), 22–26. <a href="https://doi.org/10.1016/j.amjms.2016.11.010">https://doi.org/10.1016/j.amjms.2016.11.010</a>
Manian et al.	2020	United States	Coexisting Systemic Infections in Patients Hospitalized Because of a Fall: Prevalence and Risk Factors	Retrospective cohort	“We found that overall 20.8% or 1 of 5 patients hospitalized for a fall or its complications is diagnosed with CSI. Older patients are particularly likely to be diagnosed with CSIs, with rates reaching 26.1% or 1 of 4 patients in the aged ≥ 75 years group.”	Manian, F. A., Hsu, F., Huang, D., Blair, A., Mosarla, R., Mulugeta, W., & Lipartia, M. (2020). Coexisting Systemic Infections in Patients Hospitalized Because of a Fall: Prevalence and Risk Factors. <i>The Journal of emergency medicine</i> , 58(5), 733–740. <a href="https://doi.org/10.1016/j.jemermed.2020.01.018">https://doi.org/10.1016/j.jemermed.2020.01.018</a>
Urinary Tract Infections						
Shu et al.	2018	United States	Elderly Fall Patients Need a Urinalysis	Retrospective observational	“Our study suggests that screening elderly fall patients with a UA will facilitate early acute treatment, identify an infection that is present on admission, and help identify strategies to prevent repeated falls.”	Shu, A., Paulasir, S., Batool, F., Corpron, C. A., Purtill, M. A., Wahl, W. L., & Brandt, M. M. (2018). Elderly Fall Patients Need a Urinalysis. <i>The American surgeon</i> , 84(8), e299–e301.
HIV/AIDS						
Kosana, et al.	2023	United States	Polypharmacy is associated with slow gait speed and recurrent falls in older people with HIV	Cross-sectional	“81% of PWH aged ≥65 years were taking a medication with high potential for adverse effects”	Kosana, P., Wu, K., Tassiopoulos, K., Letendre, S., Ma, Q., Paul, R., Ellis, R., Erlandson, K. M., & Farhadian, S. F. (2023). Polypharmacy is associated with slow gait speed and recurrent falls in older people with HIV. <i>Clinical infectious diseases : an official publication of the Infectious Diseases Society of America</i> , ciad782. Advance online publication. <a href="https://doi.org/10.1093/cid/ciad782">https://doi.org/10.1093/cid/ciad782</a>

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