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Systems-level Interventions for Fall Risk Assessment, Fall Prevention, and Fall Injury Prevention in Long-term Care Facilities: A Scoping Review

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Abstract

Objectives: Older adults living in long-term care facilities (LTCFs) are at high risk for falls. Interventions to prevent falls and fall-related injury in this population may be individual-level or system-focused interventions. However, relatively little attention has been given to research on systems-focused interventions. This scoping review seeks to synthesize previous studies on the effects of system-focused interventions for fall prevention in LTCFs.

Methods: We searched Ovid-Medline, CINAHL, and Embase databases from 2007 to 2024 following the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) extension for Scoping Reviews. We conducted a narrative synthesis to summarize findings from the included studies.

Results: In the initial search, 403 studies were identified and underwent title and abstract screening resulting in 116 articles retrieved for full-text review. Twenty studies were included in the final data extraction. Systems-level fall prevention interventions evaluated in LTCFs include: (1) multicomponent and multidisciplinary programs, (2) environmental adaptations, (3)

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technological adaptations, and (4) staff education and training programs. Eleven out of seventeen included quantitative studies reported significant effects of system-focused interventions to reduce falls in LTCFs.

Conclusions: This scoping review reveals the effectiveness of system-level fall prevention strategies in LTCFs. Enhancing training, customizing tools, and fostering a supportive leadership culture are vital for improving fall prevention practices in LTCFs.

Keywords

Fall; Interventions; Older People; Residential Institution

Introduction

Compared to their counterparts living in the community, older adults residing in long-term care facilities (LTCFs) have a higher risk for falls (1,2). About half of residents at the LTCFs fall at least once a year (1), resulting in physical injuries as well as psychosocial consequences (e.g., fear of falling, and reduction in social activities)(3,4). Fall prevention interventions can be divided into two groups depending on the target of risk factors: (1) person-focused interventions and (2) system-level interventions. This is the second of two scoping reviews focused on fall prevention within LTCFs and focuses on system-level fall prevention programs.

System-level fall prevention interventions in long-term care facilities refer to comprehensive strategies designed to minimize fall risks by enhancing the entire care environment and organizational practices, rather than focusing on individual residents. These interventions can be applied broadly to all residents in the facility and are implemented through facility-wide modifications, technological integrations, policy enhancements, comprehensive monitoring, and management practices. While person-level programs include interventions delivered directly to individual residents, system-level programs focus on broader strategies such as staff education, environmental alterations and audits, safety maintenance of patient equipment, implementation of multidisciplinary fall prevention teams, and the review of policies or processes regarding fall prevention (2).

Although falls in LTCFs constitute a substantial public health issue, research predominantly focuses on person-level interventions, often overlooking the critical role of system-level strategies. Part 1 of our series detailed these person-level interventions and their impacts. Now, Part 2 shifts focus to these system-level interventions, to synthesize evidence on system-level approaches. Prior reviews by Francis-Coad et al.(2) and Gulka et al.(5) provide synthesis of quantitative evidence demonstrating that multifaceted interventions, including additional staffing and expert resources, have been shown to reduce fall rates in LTCFs. Nevertheless, these analyses generally neglect the qualitative dimensions that are pivotal for comprehending the contextual and experiential factors integral to the efficacy and sustainability of fall prevention initiatives. To address this gap, our scoping review includes both quantitative with qualitative evidence, thereby synthesizing a more comprehensive perspective on system-level fall prevention strategies within LTCFs. This integrative approach aims to deepen our understanding of the aspects that contribute to successful

fall prevention, ensuring that proposed strategies are not only statistically effective but also practically feasible and adaptable within the intricate environments of LTCFs.

Thus, the aims of this scoping review were to: (1) synthesize the evidence for the fall prevention interventions focusing on system-level approaches in the LTCFs, and (2) identify clinical and research implications derived from review. The results will assist facility administrators and policy makers to identify effective system-level fall prevention and implementation strategies to decrease adverse outcomes of falls among older adults living in the LTCFs.

Methods

We conducted a scoping review using the Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) guidelines (6).

Inclusion and exclusion criteria

The inclusion criteria were: (1) at least one fall risk assessment or fall prevention intervention activity was reported; (2) the target of intervention/activity was at the systems-level in long-term care settings; (3) the outcome was assessed by fall risk, fall, and injurious falls; (4) studies were published after 2007. We excluded studies if the setting was other than skilled nursing, long-term care, residential care, and home care.

Search Strategy

We searched published papers from January 1, 2007, to September 19, 2024. We used three online databases, including Ovid-Medline, CINAHL, and Embase. Search terms used employed MeSH or Emtree terms for fall prevention and long-term care facilities and related combinations. Our search strategy, crafted in collaboration with a health sciences librarian to ensure its comprehensiveness, is detailed in Appendix 1. The review was facilitated by use of systematic review software (Covidence, Melbourne, Australia).

Study Selection

After independently reviewing titles and abstracts, we retrieved and closely examined the full text of all studies that initially met our inclusion criteria. This full-text review involved a detailed evaluation to confirm each study's eligibility based on our predefined inclusion criteria. Any disagreements between the two primary researchers (AU and DW) regarding the eligibility of specific studies were thoroughly discussed. If a consensus could not be reached through discussion, we involved a third reviewer (HT) to make a final determination.

Data Extraction

Each included article was evaluated and organized in order based on the primary author's last name. Data were abstracted from each article in 4 different categories: general information (e.g., study ID, first author, year, title, country, type of study, and funding resources), characteristics of included studies (e.g., aim of study, study design, setting), intervention (e.g., intervention description, method of identifying/recruiting,

intervention time and intervention frequency), and results of study (e.g., baseline participants characteristics, measurement tool, primary outcomes, and secondary outcomes).

Data Synthesis

We first summarized the basic features (e.g., author, year, country, study design, setting) of the included studies. Next, a narrative synthesis of quantitative findings was presented. As study designs and study populations were diverse, we then synthesized findings into different categories depending upon the key findings. Interventions from the quantitative studies were categorized based on their effectiveness: positive, negative, and neutral. A positive effect indicated a significant reduction in falls and fall-related injuries, demonstrating the success of the intervention. A negative effect indicates a significant increase in falls and fall-related injuries, marking the intervention as ineffective or counterproductive. Lastly, a neutral effect describes interventions that neither significantly reduce nor increase fall rates. This categorization helps in evaluating the impact of various system-focused interventions and guides future strategies for fall prevention in LTCFs. A qualitative synthesis of studies was also conducted to provide a better understanding of the experiences and perceptions of staff and residents in relation to fall prevention programs.

Results

Study Selection

Using three different databases, 403 studies were identified for possible inclusion in the review. Following the title and abstract review, 276 were excluded (11 studies were duplicates, and 276 were unrelated to the topic of this review; See Figure 1) for this study's analysis. Following full text review, an additional 96 were excluded leaving a total of 20 studies meeting review criteria.

Characteristics of Studies

The final analysis included 17 quantitative and three qualitative studies. The quantitative study designs were non-randomized experimental trials (n=7), randomized control trials (n=5), prospective observation study (n=2), and retrospective observational studies (n=2). Study duration ranged from 7 weeks to 24 months. The studies included in our analysis were conducted in a variety of international settings, including Australia, Canada, Germany, Malaysia, Netherlands, Poland, Spain, the United Kingdom, and the United States. Among these, seven studies took place in long-term care facilities, fourteen were conducted in nursing homes, and one study was situated within a specialized dementia care unit. Sample sizes across the studies ranged from 28 to 45,312 participants aged 65 years or older. A majority of studies (14/20) included data related to multimorbidity in their populations (e.g., neurologic, cardiac, pulmonary, urinary, and hip fractures). Table 1 presents the general characteristics of the included studies.

Type and Effect of Fall Prevention Interventions

Our analysis divided the studies into the following four types of fall prevention programs: (1) multicomponent and multidisciplinary programs (7–16), (2) environmental adaptation

(17,18), (3) technological adaptations (19–22), and (4) staff education and training programs (23–26) (See Table 2).

Multicomponent and Multidisciplinary programs: The multicomponent and multidisciplinary programs explored by Burland et al. (8), Capezuti et al. (9), Logan et al. (10), Rask et al. (11), Szczerbińska et al. (12), Becker et al. (14), Colon-Emeric et al. (13), Gulpers et al. (15), and Kopke et al. (16) demonstrated the effectiveness of interdisciplinary efforts and systemic changes in fall prevention. Several interventions combining staff education, environmental modifications, and risk assessments have demonstrated significant reductions in both falls and fall-related injuries, highlighting the effectiveness of comprehensive, multifactorial approaches in nursing homes. Logan et al. (10) implemented a multifactorial approach to fall prevention, involving various strategies such as exercise programs, medication reviews, and environmental modifications such as improved lighting. The program led to a significant 43% reduction in fall rates compared to usual care group. Becker et al. (14) introduced a multifactorial fall and fracture prevention program across nursing homes in Bavaria, focusing on staff education, exercise programs, and environmental modifications (e.g., proper bed heights, grab bars, and proper lighting). The program showed an 8.3% reduction in falls and 18% reduction in femoral fractures. Burland et al. (8) evaluated a comprehensive fall management program aimed at reducing falls by conducting environmental audits (e.g., hazardous environments) within nursing homes, incorporating risk assessments, and implementing educational strategies for staff and families to foster safer and more mobile environments for residents. The program resulted in a significant reduction in falls leading to hospitalization, decreasing from 0.036 per person-year before the intervention to 0.020 per person-year afterward.

Several interventions have highlighted the importance of multidisciplinary collaboration and staff involvement in effective fall prevention strategies. Szczerbińska et al. (12) evaluated the implementation of multifactorial interventions in nursing homes, which involved comprehensive assessments and tailored interventions for residents. These interventions included engaging the entire nursing staff in fall risk assessments and implementing dedicated professional evaluations. The study showed significant reductions in falls when the entire nursing staff was involved in the fall prevention strategy, compared to a nursing home where only a single physiotherapist led the assessments. Colón-Emeric et al. (13) examined the CONNECT + FALLS program, which combined staff communication training with a standard fall prevention program in nursing homes. This program achieved a 50% reduction in restraint use without increasing falls. Andrews et al. (2012) applied an action research approach to reduce staff isolation and foster evidence-informed practices. The study established a Falls Action Research Group, engaging a mix of nursing and non-nursing staff across two facilities to improve their fall prevention efforts through collaborative action, which resulted in enhanced teamwork and communication, breaking down occupational silos. This collaborative environment supported sustained improvement in fall prevention activities.

Several studies examined the impact of combining staff training and interventions to reduce restraint use on falls and fall-related injuries. Capezuti et al. (9) included staff education and multidisciplinary care as part of their program to reduce restrictive side rail use. The

intervention resulted in a significant reduction in falls for residents who reduced side rail use, with a decrease in the fall rate from 0.12 to 0.06. Köpke et al. (16) applied a guideline-based intervention to reduce physical restraint use in nursing homes, involving staff education and structured consultations. This program resulted in a 6.5% reduction in physical restraint use with no significant increase in falls. Rask et al. (11) used a quasi-experimental design to test a falls management program that included staff training, policy changes, and individualized care plans. The program kept fall rates stable in intervention facilities while restraint use decreased significantly, whereas fall rates increased in non-intervention facilities. Gulpers et al. (15) implemented the EXBELT program to reduce belt restraint use in psychogeriatric nursing homes, emphasizing staff education and alternative interventions, achieving a 50% reduction in restraint use without increasing falls.

Environmental Adaptations: Environmental adaptations to space and lighting have been evaluated in several studies. Detweiler et al.(17) investigated the introduction of a dementia wander garden, a therapeutic landscape designed to enhance resident safety and well-being, and found that in a 38.7% reduction in falls and a significant decrease in antipsychotic medication use among high garden users. Grant et al. (18) evaluated the impact of upgraded dynamic lighting systems in care homes. The study reported a significant 43% reduction in falls in the experimental sites compared to control sites, where the fall rate was 4.82 falls per 1000 resident-days in the experimental group versus 8.44 falls per 1000 resident-days in the control group.

Technological Adaptations: Several technological interventions aimed at fall prevention in LTCFs have explored various approaches to managing fall risks, focusing on medication management and environmental monitoring through video analysis. Colón-Emeric et al. (19) piloted computerized order entry algorithms to enhance fall prevention efforts, leveraging health information technology to manage fall risk, though the program showed no statistically significant reduction in falls. Lapane et al.(20) implemented a pharmacist-led intervention, using technology to monitor and optimize medication regimens that affect fall risk, resulting in fewer falls and a reduction in delirium. Woolrych et al. (21) and Yang et al. (22) used video analysis in long-term care facilities to observe environmental conditions and identify factors contributing to falls, providing insights into the circumstances leading to falls, though they did not report direct reductions in fall rates.

Staff Education and Training Programs: Several studies, including Bonner et al.(23), Nelson et al.(24), Muñoz et al. (26), and Teresi et al. (25), evaluated the effectiveness of staff education and training programs in reducing falls and resident outcomes in LTCFs. Bonner et al. (23) implemented a student-led fall prevention program in a long-term care facility that included interdisciplinary environmental rounds, staff training, and the designation of fall prevention champions, resulting in a significant reduction in falls from 16.1% to 9% over 60 days. Nelson et al. (24) examined the link between safe patient handling and resident outcomes in long-term care through a patient care ergonomics program, which included lifting equipment and staff training, leading to improved physical function and a reduction in falls among residents. Muñoz et al. (26) applied the CHROME (Chemical Restraints Avoidance Methodology) criteria to optimize psychotropic medication prescriptions and

eliminate chemical restraints in dementia patients, leading to a reduction in overall falls, though falls with complications (excluding hip fractures) increased slightly. Teresi et al. (25) evaluated a Resident-to-Resident Mistreatment (R-REM) intervention aimed at nursing staff, focusing on improving staff awareness and management of mistreatment and environmental factors contributing to falls, with the program resulting in a 5% reduction in falls, though the reduction was not statistically significant.

Effect of the Interventions: Out of the 17 quantitative studies, 11 found a positive effect on their outcome (Table 2). For multicomponent and multidisciplinary programs, six studies reported positive effects on facility fall rates (8–10,12–14), while three studies showed neutral effects (11,15,16). Environmental adaptations had positive effects on the facility's fall rate or number of falls (17,18), while technological adaptations using electronic health record showed neutral effects (19,20). Staff education and training programs had positive effects on the facility's fall rate or number of falls in three studies (23,24,26), while one study showed a neutral effect (25).

Among the qualitative studies, Andrews et al.(7) extended the scope of multicomponent fall prevention programs by using an action research approach to engage staff across different roles in residential aged care facilities. Their strategy included collaborative educational initiatives and practical interventions, targeting improved footwear for residents. This study highlighted the importance of interdisciplinary collaboration and staff empowerment as essential elements of effective fall prevention, echoing the need for comprehensive and adaptive models in long-term care settings. Two studies, Woolrych et al.(21) and Yang et al., (22) utilized video analysis to observe and analyze the environmental conditions in LTCFs, contributing to an understanding of the circumstances leading to falls and identifying potential interventions.

Discussion

This scoping review underscored the importance of comprehensive interventions that necessitate active participation and collaboration from the full spectrum of nursing staff and residents in LTCFs. Such inclusive strategies may lead to more efficacious outcomes in fall prevention efforts. Broader engagement across all levels of staff not only diminishes staff isolation but also enhances the quality and sustainability of preventive measures (27,28). Inclusive approaches ensure that interventions are tailored to the diverse needs and perspectives within the LTCF community. This review also found that staff educational programs, when specifically targeted, were effective in reducing fall rates. These programs equip staff with crucial knowledge and skills to proactively manage fall risks, thereby reducing fall rates significantly. Additionally, involving residents in the development and execution of fall prevention programs is essential as it brings diverse perspectives that can refine and optimize the effectiveness of these initiatives.

Several multicomponent and multidisciplinary interventions demonstrated positive effects on fall prevention, and key factors contributed to their success. Successful interventions often incorporated a combination of staff education, individualized risk assessments, and environmental modifications. These components worked synergistically to address both

immediate fall risks and longer-term prevention strategies. However, in some studies, such as those by Colón-Emeric et al. (13) and Rask et al. (11), challenges related to staff engagement, leadership buy-in, and inconsistent application across facilities hindered the full potential of these interventions. In the included studies, several implementation challenges were identified, including staff engagement (7,11), unclear specific staff roles and responsibilities (7), and integration into daily routines (11). Additionally, staff turnover and limited financial resources made it difficult to maintain consistent application of fall prevention strategies, reducing their effectiveness in the long term (11). Organizational culture hindering implementation and poor interdisciplinary collaboration also posed significant challenges (12). These challenges were consistent with those found in previous review studies (27,29). These studies highlight that successful implementation requires not only comprehensive interventions but also organizational support and leadership commitment to ensure that strategies are consistently applied. Furthermore, interventions that focused primarily on reducing physical restraints (15,16) did not address other critical components, such as staff training on broader fall prevention strategies or environmental modifications. Simply focusing on reducing restraints was not enough to significantly prevent falls, as more comprehensive approaches are needed to address the multifactorial nature of fall risks.

Research suggests that thoughtfully designed natural spaces and other environmental modifications may contribute to fall prevention in long-term care facilities. These environmental adaptations, as indicated in three studies (8,17,18), address potential physical hazards and promote a therapeutic environment that supports the well-being and mobility, and safety of residents. For example, Grant et al. (18) found that dynamic lighting systems significantly reduced falls by improving visual acuity, cognition, and sleep patterns. Future research should examine a range of environmental adaptations, from simple to extensive, to inform best practices for safer living environments.

Electronic health records and computerized order entry tools showed promise in fall prevention, though their adoption was limited due to challenges like staff turnover, resistance to workflow changes, and inadequate training (19,20). Future efforts should focus on providing ongoing staff training, customizing user-friendly tools that fit seamlessly into clinical workflows, and generating robust evidence to demonstrate the effectiveness of these technologies (30). Leadership commitment to fostering a supportive culture for technology use, alongside mechanisms for interdisciplinary communication and regular feedback, could enhance electronic health record adoption and optimize patient care outcomes in LTCFs (31).

The integration of video footage in LTCFs serves as an invaluable tool for enhancing the accuracy of fall incident reports and identifying environmental risk factors. Studies by Yang et al.(22) and Woolrych et al.(21) have demonstrated that video analysis can reveal discrepancies in fall reports and uncover unique resident behaviors that contribute to falls, such as interactions with furniture or nocturnal activities. By providing objective evidence, video footage has proven critical in refining our understanding of fall dynamics and improving intervention strategies (32). Despite the clear benefits, the implementation of video technology in LTCFs must navigate challenges such as ensuring resident privacy

and managing costs, with studies showing that thoughtful placement of cameras in common areas and anonymization techniques can effectively address privacy concerns.

Staff education and training programs are crucial to effective fall prevention strategies in LTCFs. Studies in this review, including Bonner et al. (23), Burland et al. (8), Muñiz et al. (26), and Teresi et al. (25), highlighted the importance of equipping staff with practical tools and knowledge to manage fall risks. These programs typically focused on enhancing awareness of environmental hazards, improving staff skills in the proper use of assistive devices, implementing safe resident handling techniques, and ensuring effective communication and collaboration among staff. While Bonner et al. (23) and Burland et al. (8) emphasized continuous training to maintain long-term effectiveness, Muñiz et al. (26) and Teresi et al. (25) pointed to the need for organizational support and role clarity to ensure consistent application of fall prevention strategies. Although Teresi et al. (25) did not find statistically significant results, the intervention's reduction in fall rates was considered clinically meaningful, demonstrating the value of improving staff awareness of behavioral and environmental risk factors.

The reviewed studies highlighted several methodological challenges, including inconsistent definitions of falls, varied data collection methods, and a lack of standardized outcome measures (33–35). Many studies relied on quasi-experimental designs and small sample sizes, limiting generalizability, while randomized controlled trials were rare but necessary to establish causality. Short follow-up periods also made it difficult to assess long-term effectiveness.

There is a notable lack of studies focused specifically on system-level fall prevention interventions in LTCFs, with most research reviewing person-level and system-level interventions together. Discriminating between these intervention types is critical, as it highlights the importance of institutional commitment, such as changing organizational culture, addressing staff shortage, and implementing comprehensive technology-based fall prevention strategies. In response to this gap, various innovative technological approaches have emerged to enhance fall prevention strategies. These range from traditional emergency call systems to more advanced technologies like AI-based fall detection sensors (36), radar-based systems (37), and ambient sensor-based technologies such as acoustic sensory floors (38), microphone-based systems (39), and smart carpets (40,41), which have demonstrated high accuracy in controlled settings. Recent studies have shown promising results with novel interventions combining sensors and machine learning algorithms, achieving high sensitivity and specificity in fall prediction and detection (42,43). Future research should focus on evaluating the effectiveness of these technologies, using standardized definitions and rigorous designs to better understand their impact on fall rates.

Strengths and Limitations

A strength of this scoping review is that it provides a comprehensive overview of the current literature on systems-level fall prevention programs in LTCFs. Additionally, the inclusion criteria were broad, allowing for a diverse range of interventions and study designs to be analyzed. The synthesis of qualitative evidence provided valuable insights into the reasons for the fall and the importance of communication and collaboration among LTCF staff.

This study should be considered in terms of the limitations. First, the limited number of studies within certain categories may restrict the ability to fully assess the effectiveness of interventions across different LTCF contexts. Additionally, heterogeneity of interventions and study designs included in the review may make it challenging to draw firm conclusions about the effectiveness of systems-level fall prevention programs in LTCFs. Lastly, the exclusion of non-English language studies may have resulted in important evidence being missed.

Conclusions

LTCFs residents are a high fall risk population. This scoping review emphasizes the significance of collaborative, system-level fall prevention strategies in LTCFs, highlighting multicomponent fall programs, targeted educational programs and environmental modifications as effective measures. These interventions are shown to enhance fall prevention outcomes when they involve both staff and residents in their development and implementation. However, the adoption of technologies like electronic health records, despite their potential, faces challenges such as resistance to change and integration difficulties. Moving forward, efforts should concentrate on improving technology adoption through ongoing training, tailored tool customization, and robust leadership support to foster a technology-positive culture. Addressing these challenges and continuing to refine interventions will be crucial for advancing fall prevention practices in LTCFs.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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What is already known on this topic:

Falls in long-term care facilities (LTCFs) are common. Various interventions, such as staff training and environmental changes, have been utilized to try and reduce fall rates.

What this study adds:

This study broadens the understanding of system-level fall prevention interventions in LTCFs by highlighting the effectiveness of multifaceted strategies and the challenges in implementing technology solutions, providing a comprehensive view that is less explored in existing research.

How this study might affect research, practice or policy:

The findings encourage deeper investigation into the long-term effectiveness and adaptability of system-level interventions, promoting more targeted and longitudinal studies in this area. The insights can guide LTCFs in refining fall prevention programs and influence policy makers to support the adoption of effective strategies through enhanced training, resource allocation, and tailored technology integration.

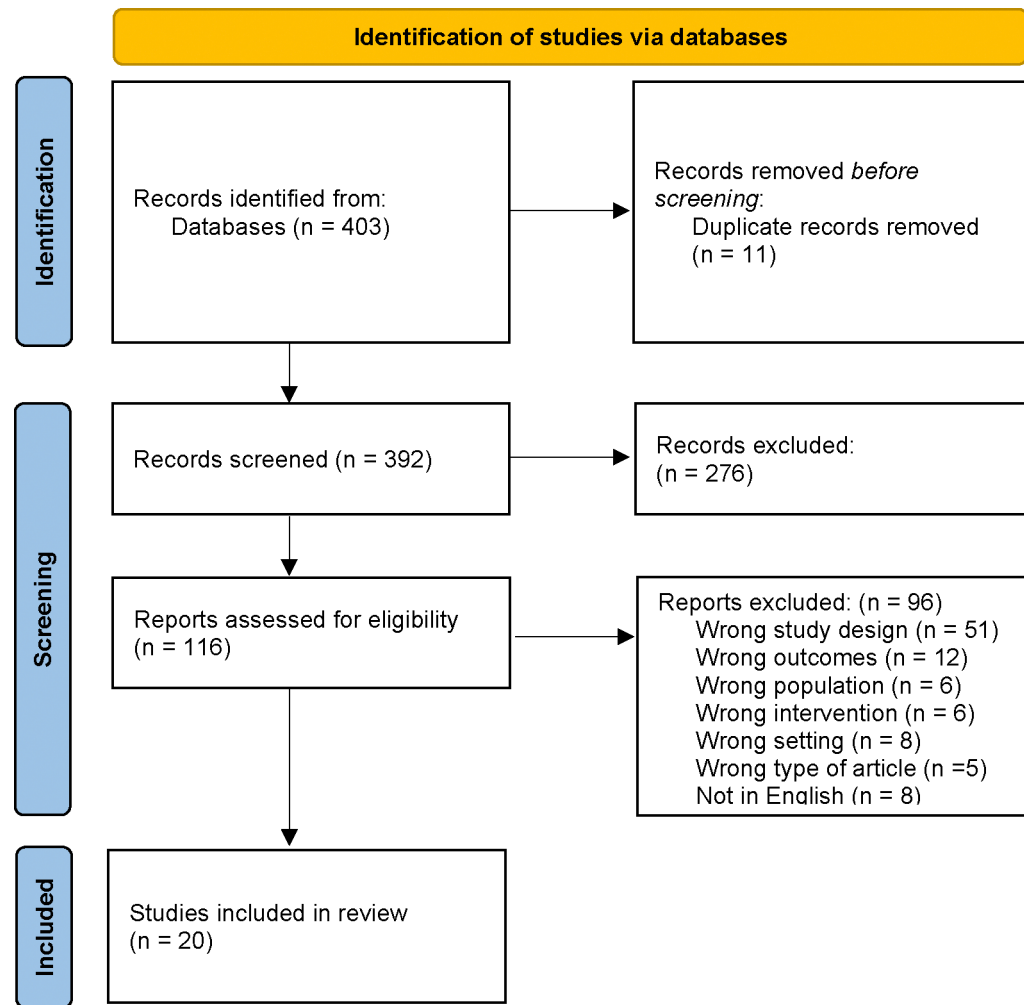


Figure 1.
PRISMA flowchart for identification, screening, and eligibility.

Table 1.

Summary of included studies.

Author (year)	Study design	Setting	Number of participants	Age (Years)	Gender (Female)
Andrews et al. (2012)	Qualitative	Long-term care facilities	NA	NA	NA
Becker et al. (2011)	Translational intervention study	Nursing home	Intervention: 13653 Control: 31688	Intervention: 84.3 Control: 84.2	Intervention: 78.8% Control: 78.4%
Bonner et al. (2007)	Non-randomized experimental design	Long-term care facilities	NA	NA	NA
Burland et al. (2013b)	Non-randomized experimental design	Nursing home	Intervention: 310 Control: 317	Intervention: <80: 84 (27.1%) 80-86: 82 (26.5%) 87-91: 87 (28.1%) 92+: 57 (18.4%) Control: <80: 78 (24.61%) 80-86: 98 (30.9%) 87-91: 89 (28.1%) 92+: 52 (16.4%)	Intervention: 63.9% Control: 62.8%
Capezuti et al. (2007)	Non-randomized experimental design	Nursing home	Discontinued restrictive side rail use: 130 Continued restrictive side rail use: 121	Discontinued restrictive side rail use: 83.6 Continued restrictive side rail use: 84.0	Discontinued restrictive side rail use: 77% Continued restrictive side rail use: 72.7%
Colon-Emeric et al. (2009)	Non-randomized experimental design	Nursing home	Nursing home A: 20 Nursing home B: 20	72.2	4.1%
Colon-Emeric et al. (2013)	Randomized controlled trial	Nursing home	Intervention: 358 Control: 293	Intervention: 79.0 Control: 77.4	30%
Derweiler et al. (2009)	Retrospective observational design	Dementia Unit	Low use group: 14 High use group: 14	80.5	0%
Grant et al. (2022)	Prospective observational	Long-term care facilities	Pre-intervention: 515 (Intervention: 291, Control : 224) Post-intervention: 235 (Intervention: 235, Control : 203)	Pre-intervention Intervention: 82.1 Control: 83.5 Post-intervention Intervention: 80.6 Control: 80.4	Pre-intervention Intervention: 60.8 % Control: 53.1% Post-intervention Intervention: 62.6% Control: 58.6%
Gulpers et al. (2011)	Non-randomized experimental	Nursing home	Intervention: 250 Control: 155	Intervention: 82.1 Control: 84.4	Intervention : 70% Control: 77%
Köpke et al. (2012)	Randomized controlled trial	Nursing home	Intervention: 2283 Control: 2166	Intervention: 83 Control: 85	Intervention: 73% Control: 77%
Lapane et al. (2011)	Randomized controlled trial	Nursing home	Intervention: 1,711 Control: 1,492	Intervention: 65-74: 16.3% 75-84: 36.9% 85: 39.7%	Intervention: 72.3% Control: 68.2%

Author (year)	Study design	Setting	Number of participants	Age (Years)	Gender (Female)
				Control: 65–74: 15.8% 75–84: 35.3% 85: 36.4%	
Logan et al. (2021)	Randomized controlled trial	Long-term care facilities	Intervention: 775 Usual care: 882 Total: 1657 across 84 Long-term care facilities	Intervention: 86 Usual care: 84.2 Total: 85.0	Intervention: 70.2% Usual care: 65.9%
Muniz et al. (2020)	Prospective observational	Nursing home	107	81.6	63.5%
Nelson et al. (2008)	Retrospective observational	Nursing home	111	70	4%
Rask et al. (2007)	Non-randomized experimental	Nursing home	Intervention: 19 Control: 23	Intervention: <65=9.9% 65–84=47.9% >84=42.2% Control: <65: 10.1% 65–84: 49.9% >84: 40%	Intervention: 72.7% Control: 74.1%
Szczerbinska et al. (2010)	Factorial design	Nursing home	Nursing home A: 94 Nursing home B: 88 Nursing home C: 40	Nursing home A: 74.8 Nursing home B: 75.4 Nursing home C: 80.4	Nursing home A: 54.2% Nursing home B: 87.5% Nursing home C: 75%
Teresi et al. (2018)	Randomized controlled trial	Nursing home	Intervention: 601 Control: 600	Intervention: 85.2 Control: 85.7	Intervention: 73.3% Control: 74.0%
Woolrych et al. (2015)	Qualitative	Long-term care facilities	NA	NA	NA
Yang et al. (2015)	Diagnostic test accuracy study	Long-term care facilities	309	80.3–83.1	60.6%–69.7%

Note. NA = not applicable.

Table 2.

Summary of results/key findings in quantitative articles.

Intervention type	Author (year)	Contents of the intervention	Effect	Rate of falls		Number of falls
Multicomponent and multidisciplinary programs	Logan et al. (2021)	GtACH: Awareness-raising, staff training, screening for fall risks, decision support, implementation support, and environmental modifications	Positive	Intervention (falls per 1,000 resident days)	6.0	NA
				Usual care (falls per 1,000 resident days)	10.4	
	Becker et al. (2011)	The Bavarian fracture prevention: Education for staff, exercise program, environmental audit and modifications, hip protectors	Positive	Intervention (per 1,000 person years)	33.6	NA
				Control (per 1,000 person years)	41.0	
	Burland et al. (2013b)	Fall management program: Education for staff, residents, families; risk reduction strategies; regular fall risk assessments; environmental audits; and a post-fall protocol	Positive	Total falls (falls per person-year)	Intervention Pre: 1.95 Post: 2.24 Control Pre: 1.54 Post: 2.24	Intervention Pre: 708 Post: 1451 Control Pre: 550 Post: 1393
				Injurious falls (falls per person-year)	Intervention Pre: 0.599 Post: 0.596 Control Pre: 0.590 Post: 0.746	Intervention Pre: 208 Post: 361 Control Pre: 209 Post: 447
				Hospitalization falls (falls per person-year)	Intervention Pre: 0.04 Post: 0.02 Control Pre: 0.03 Post: 0.04	Intervention Pre: 10 Post: 12 Control Pre: 12 Post: 26
				Intervention (falls per bed per year)	Pre: 2.34 Post: 2.06	NA
	Colon_Emeric et al. (2013)	CONNECT+FALL: Education for staff, structured mentoring, self-monitoring of communication patterns, teleconferences	Positive	Control (falls per bed per year)	Pre: 2.61 Post: 2.64	
				Nursing home A (entire nursing staff was involved)	Pre: 5.05 Post: 2.52 Follow-up: 0.50	NA
	Szczerbinska et al. (2010)	EUNESE project: Registration of falls, staff training, supervised implementation of fall prevention	Positive	Nursing home B (entire nursing staff was involved)	Pre: 4.58 Post: 0.38 Follow-up: 1.90	NA

Intervention type	Author (year)	Contents of the intervention	Effect	Rate of falls	Number of falls
Environmental adaptations				Nursing home C (a single qualified professional involved) Pre: 3.26 Post: 5.43 Follow-up: 1.08	NA
	Capezuti et al. (2007)	Intervention on restrictive side rail usage: Individual consultation, staff education, development of care plan for each resident, multidisciplinary care conference	Positive	Group that reduced restrictive side rails Pre: 0.12 Post: 0.06	NA
	Köpke et al. (2012)	Guideline-based multicomponent intervention on use of physical restraints: Staff education for physical restraint avoidance, additional training for nominated key nurses, structured support from nursing home leaders and managers	Neutral	Group that continued restrictive side rails Pre: 0.03 Post: 0.02	NA
				Intervention 23.1%	528
				Control 26.1%	565
	Rask et al. (2007)	Fall management program: Organizational leadership buy-in and support, a designated facility-based falls coordinator, an interdisciplinary team, intensive education and training, strategies for reducing physical restraint use, and ongoing consultation and oversight by advanced practice nurses	Neutral	Quarter 1 (falls/per 100 residents per month) Intervention: 17.3 Control: 15.0	NA
				Quarter 2 Intervention: 17.8 Control: 16.4	NA
				Quarter 3 Intervention: 17.7 Control: 17.9	NA
				Quarter 4 Intervention: 16.4 Control: 18.9	NA
	Gulpers et al. (2011)	EXBELT intervention: Institutional policy change, staff education, consultation for nurses to reduce the use of belt restraints, alternative interventions (hip protectors, sensor mats, etc.)	Neutral	Intervention Pre: 18% Post: 16%	NA
				Control Pre: 16% Post: 16%	NA
	Detweiler et al. (2009)	Wander garden: Dementia wander garden on the use of scheduled psychiatric medications	Positive	Intervention NA	38.7% Decrease Pre: 212 Post: 130
				Control NA	7.9% Decrease Pre: 76 Post: 70
	Grant et al. (2022)	Lighting intervention: Dynamic lighting schedule upgrade (daytime, evening, night lighting) in residence rooms		Pre-intervention (falls per resident days) Intervention: 6.94 Control: 6.62	Intervention: 297 falls over 44,005 resident-days Control: 190 falls over 28,305 resident-days
				Post-intervention (falls per 1,000 resident days) Intervention: 4.82 Control: 8.44	Intervention: 173 falls over 19,903 resident-days Control:

Intervention type	Author (year)	Contents of the intervention	Effect	Rate of falls	Number of falls
					173 falls over 34,266 resident-days
Technological adaptations	Lapane et al. (2011)	Pharmacist-led multicomponent intervention: Automated medication monitoring plans for falls and delirium	Neutral	Intervention Control	285.4 315.0
	Colon-Emeric et al. (2009)	Computerized order entry algorithms: Multidisciplinary development, algorithm design	Neutral	-	Pre: 40 Post: 40
Staff education and training programs	Bonner et al. (2007)	Student-led demonstration project on fall prevention: Staff educational sessions, peer leadership trainings, interdisciplinary team rounds, weekly meetings	Positive	Falls over 60 days	Pre: 16.1% Post: 9.0% NA
	Nelson et al. (2008)	Safe patient-handling and movement program: Training in ergonomic patient handling techniques, providing equipment and resources for safer handling practices, implementation of safer patient transfer protocols	Positive	Fall in past 180 days	Pre: 11 Post: 3
	Muniz et al. (2020)	CHROME criteria: Staff training, diagnosis-based prescription, consultancy, and audits by external experts	Positive	Overall fall rate (number of events per 100 beds per year) Wave 1: NA Wave 2: 67.3 Wave 3: 72.0 Wave 4: 35.5 Wave 5: 32.7	NA
	Teresi et al. (2018)	Resident-to-Resident Mistreatment: Staff training (recognition and implementation of guidelines)	Neutral	Intervention (falls per 100 resident-years) Control (falls per 100 resident-years)	Pre: 24.4 Post: 18.0 Pre: 24.0 Post: 23.5
					553 residents had fall (out of 601 residents) 551 residents had fall (out of 600 residents)

Note. NA = Not applicable, Pre = pre-intervention, Post = post-intervention.