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Systematic Review Of Pressure Ulcer Prevention Strategies In Long-Term Care Facilities

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Abstract:

Background: *Pressure ulcers (PUs) are a significant health concern in long-term care facilities, leading to increased morbidity and healthcare costs. Preventive strategies are essential for reducing PU incidence and improving resident outcomes. This systematic review aims to evaluate the effectiveness of PU prevention strategies implemented in long-term care settings.*

Methodology: *A comprehensive search of electronic databases, including PubMed, MEDLINE, CINAHL, and Cochrane Library, was conducted to identify relevant studies published up to 2024. Inclusion criteria encompassed original research studies eva[1]luating PU prevention interventions in long-term care facilities. Data extraction and quality assessment were performed systematically using established tools. Synthesis of findings was conducted through narrative synthesis and, where applicable, meta-analysis.*

Results: *A total of 20 studies were included in the review, comprising randomized controlled trials, cohort studies, and observational studies. Interventions evaluated included support surfaces, repositioning protocols, computerized decision support systems, PU prevention bundles, wound care support teams, and nutritional interventions. The majority of interventions demonstrated effectiveness in reducing PU incidence and prevalence, with some variability in outcomes across studies. The education of nursing staff emerged as a common supporting structure for intervention implementation.*

Conclusion: *The findings of this systematic review highlight the effectiveness of various PU prevention strategies in long-term care settings. Education, technology integration, and multifaceted intervention bundles play crucial roles in improving resident outcomes and reducing healthcare costs associated with PUs. However, further research is needed to*

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strengthen the evidence base and optimize the implementation of preventive interventions in long-term care facilities.

Introduction:

Pressure ulcers (PUs), also known as bedsores or pressure injuries, are a significant concern in long-term care facilities, particularly among older adults [1,2]. These facilities cater to individuals who require extended care due to chronic illnesses, disabilities, or frailty, rendering them particularly susceptible to PUs [3]. Preventing PUs is crucial as they not only cause discomfort and pain but also contribute to serious complications, including infections and delayed healing, leading to prolonged hospitalizations and increased healthcare costs [4,5].

Given the challenges posed by PUs in long-term care settings, there is a growing emphasis on implementing effective prevention strategies [1,6]. A systematic review of existing evidence on PU prevention strategies in long-term care facilities is essential for guiding clinical practice, healthcare leadership decisions, educational initiatives, and future research endeavors. By synthesizing and evaluating the available evidence, this review aims to provide insights into the effectiveness of various interventions and inform best practices for PU prevention in long-term care settings.

This review will examine a range of preventive interventions, including support surfaces, repositioning techniques, nutritional interventions, wound care protocols, and educational programs, among others. It will explore the effectiveness of these interventions in reducing PU incidence, prevalence, and severity, as well as their impact on healing times and resident outcomes. Additionally, the review will assess the feasibility, implementation barriers, and sustainability of these interventions in long-term care facilities.

Understanding the effectiveness and challenges associated with PU prevention strategies in long-term care settings is paramount for optimizing care delivery and enhancing resident well-being. By identifying gaps in the existing evidence and highlighting areas for improvement, this systematic review aims to contribute to the advancement of PU prevention practices in long-term care facilities, ultimately improving outcomes for older adults receiving care in these settings.

Methodology:

In conducting this systematic review, a comprehensive search of relevant literature was conducted to identify studies focusing on pressure ulcer (PU) prevention strategies in long-term care facilities. The search was performed across multiple electronic databases, including PubMed, MEDLINE, CINAHL, and Cochrane Library, covering literature published up to 2024. The search strategy utilized a combination of keywords and MeSH terms related to pressure ulcers, long-term care, prevention strategies, and relevant interventions.

Following the initial search, studies were screened based on predetermined inclusion and exclusion criteria. Inclusion criteria encompassed original research studies, including randomized controlled trials (RCTs), cohort studies, case-control studies, and observational studies, evaluating PU prevention interventions in long-term care settings. Studies involving older adults residing in nursing homes, assisted living facilities, skilled nursing facilities, and similar care facilities were considered. Articles were excluded if they focused solely on acute care settings or pediatric populations.

Upon completion of the screening process, relevant studies were selected for full-text review. Data extraction was conducted systematically, with key information extracted from each included study, including study design, participant characteristics, intervention details,

outcomes assessed, and findings related to PU prevention effectiveness. Methodological quality assessment of included studies was performed using established tools appropriate for each study design, such as the Cochrane Collaboration's Risk of Bias tool for RCTs and the Newcastle-Ottawa Scale for observational studies.

Synthesis of findings was conducted using a narrative approach, summarizing the key findings and themes identified across the included studies. Where applicable, meta-analysis was considered for pooling quantitative data on intervention effectiveness. Subgroup analyses and sensitivity analyses were conducted to explore potential sources of heterogeneity and assess the robustness of the findings.

Results:

Our search yielded a total of 753 publications, from which duplicate studies were identified and removed by screening the titles, resulting in a reduced pool of 312 articles (Figure 1). Upon further scrutiny of abstracts to eliminate duplicate and irrelevant data not aligned with the scope of our review, an additional 163 articles were excluded. Subsequently, 149 full-length articles underwent thorough evaluation, leading to the exclusion of 133 articles due to overlapping or inconclusive data. Ultimately, 20 pertinent studies meeting our inclusion criteria were included in the final review (Figure 1)

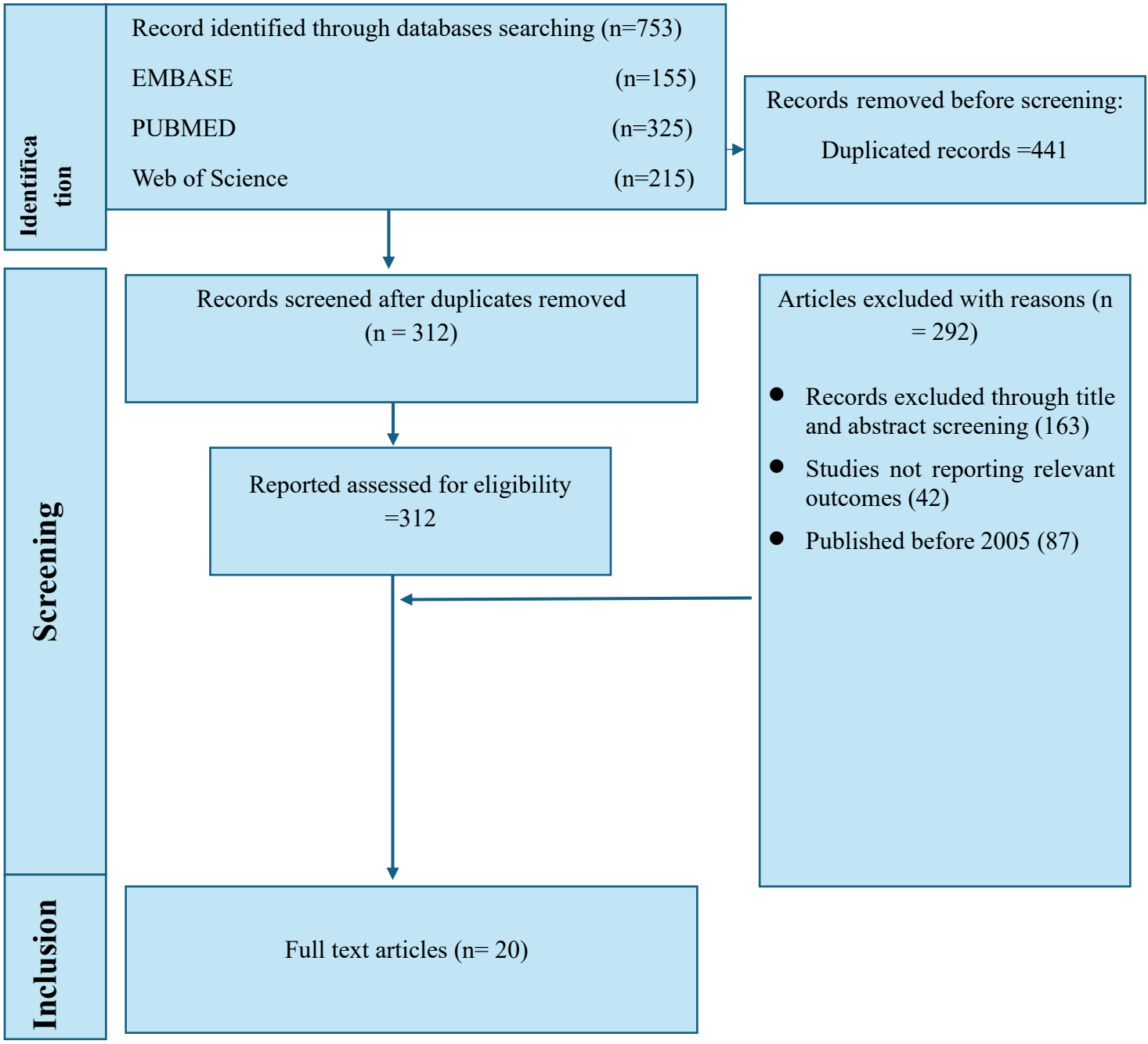

Figure 1: The PRISMA figures showing the steps to choose the studies for systematic review

In this comprehensive review, a total of 20 studies were meticulously examined and detailed in Table 1. The array of study designs encompassed randomized controlled trials (n = 10), comparable cohort or case-control studies (n = 3), and descriptive or case series (n = 6), offering a multifaceted perspective on the subject matter. Notably, the bulk of the research (n = 13) was conducted and published between 2010 and 2020, reflecting a contemporary focus on the issue at hand. These studies were predominantly situated in Long-Term Care (LTC) settings, comprising nursing homes (n = 11), LTC facilities (n = 7), nursing and rehabilitation centers (n = 1), and a nursing facility (n = 1). Geographically, the research was dispersed

across various regions, including the USA (n = 4), the Netherlands (n = 3), Canada (n = 2), and individual studies conducted in the United Kingdom, Ireland, USA/Canada, Italy, Belgium, Norway, China (Hong Kong), and France (n = 1 each). However, one study did not specify the country. The sample sizes exhibited a wide range, spanning from 21 to 94,789 participants, indicative of the diverse scales of investigation within the field. The age demographic of participants varied from 60 to 100 years, with reported mean ages ranging from 73.2 to 92.5 years, capturing a broad spectrum of elderly populations. The duration of follow-up ranged from three weeks to ten years, allowing for nuanced insights into the progression and outcomes over time. Methodologically, the studies employed various assessment instruments, including the EPUAP scale for Pressure Ulcers (PUs) (n = 14), the Stirling PU grading system (n = 1), standardized evidence-based assessments (n = 1), or methods categorized as unclear (n = 1), as delineated in Table 1.

Table 1: General characteristics of the included studies (N=20)

Author & year of publication	Year	Design	LOPC setting	Country	Sample Participants (completed)	Intervention group (completed)/control or comparison group (completed)	Patients' characteristics	Length of follow-up
Support surfaces (Mattresses, overlays and cushions; n = 6)								
Chang et al [7]	2021	Case series	Hospital units	Kenya	5	5/0	Ulcer, including traumatic ulcer, venous stasis ulcer, lymphedema from Kaposi sarcoma, neuropathic ulcer, and bullous drug eruption	6 months
Lessin et al [8]	2020	Retrospective	Hospital units	Tanzania	267		traumatic spinal injury	6 months
van Leen et al. [9]	2011	RCT	Nursing home (n = 1)	Netherland	83 (74)	42 (37)/41 (37)	patients with Norton score 5–12, no PU in previous 6 months	6 months
van Leen et al. [10]	2013	RCT	Nursing home (n = 1)	Netherland	42 (39)	20 (19)/21 (19)	patients with Braden score 6–19, no PU	12 months

Ricci et al. [11]	2013	RCT	LTC units (n = 2)	Italy	50 (50)	25 (25)/25 (25)	patients with Braden score 8–14 or Norton scale 6–12, no PU or PU stage 1	4 weeks
van Leen et al. [12]	2014	An explorative longitudinal study	Nursing homes	Netherland	22648 (13230)	475 (293)/ 22173 (12937)	patients with Braden scale =<20	10 years/7 years
Hampton and Collins [13]	2005	Prospective longitudinal study	Nursing home (n = 1)		21 (13)		patients with PU stage 0–2 (Stirling)	6 months
Brienza et al. [14]	2010	RCT	Nursing homes (n = 12)	USA	232 (180)	113 (86)/119 (94)	residents, using wheelchairs 6 or more hours/day with Braden scores <=18 (combine activity and mobility score <=5), no PU	6 months or until PU, discharge from the facility, withdrawal from the study, or death.
Repositioning (n = 3)								
Bergstrom et al. [15]	2014	RCT	LTC facilities (n = 27)	USA and Canada	967 (942)		residents with Braden scores 13–14 or 10–12, no PU	3 weeks
Moore et al. [16]	2011	RCT	LTC of the older person hospital (n = 12)	Republic of Ireland	213 (197)	99 (88)/114 (109)	older persons, at risk of PU development (Braden activity and mobility components)	4 weeks
Vanderwee et al. [17]	2006	RCT		RCT Older care nursin	235 (235)	122 (122)/113 (113)	patients with stage 1 PU.	5 weeks

				g homes (n = 16) Belgium				
Computerized decision support systems (n = 3)								
Shannon et al. [18]	2012	RCT	Nursing and rehabilitation centers (n = 2)	USA	133 (133) .	83 (83)/50 (50)	patients at risk of PUs, the historical control including 270 residents from the same facilities	6 months or until discharge, death or PU,
Fossum et al. [19]	2011	Quasi-experimental study	Nursing homes (n = 15)	Norway	2007 Baseline 491, 2009:480,	2007, Intervention group 1:167, Intervention group2: 172, control group 152 residents 2009, Intervention group 1:200, Intervention group 2:158/control group 122	residents	8 months
Olsho et al. [20]	2014	An interrupted time series design	Nursing homes(n = 25)	USA	6,161,	3,463/2,698	residents	12 months after full implementation
PU prevention bundle or programme (n = 3)								
Keen and Gaudario [21]	2014	Descriptive study	One unit in care home		The first audit: 28 residents/-,The second		residents	The second audit almost a year after the programme had been implemented

					audit: 30			
Kwong et al. [22]	2011	A quasi-experimental pretest–posttest study	Nursing home (n = 1)	China (Hong Kong)	122–124		residents	12 weeks
Tippett [23]	2009	A prospective 6-year evaluation	Nursing facility (n = 1)	USA	The average monthly nursing home census during the study was 137 (range from 120 to 145)			2 years before the implementation of the wound programme and +4 years post-implementation
					Wound care support team (n = 2)			
Stern et al. [24]	2014	RCT	LTC facilities (n = 12)	Canada	181/127	101 (71)/80 (56)	residents with PU stage 2 or more	4–14 months per facility: The control period 3–12 months,
Nobrega et al. [25]	2009	A retrospective study	Five units in one geriatric LTC facility	Canada	2003:112, 2005:127		residents	Data derived from the database over two 12-weeks periods: 2003 and 2005
Nutrition (n = 1)								
Pouyssegur et al. [26]	2015	RCT	Nursing homes (n = 7)	France	175 (154)	88 (82)/87(72)	residents	6 weeks

A diverse range of interventions aimed at preventing pressure ulcers (PUs) was implemented across the studies detailed in Table 2. The predominant intervention was the utilization of support surfaces, including mattresses, overlays, and cushions (n = 6), followed by repositioning (n = 3), computerized decision-making support for PU prevention (n = 3), PU prevention bundles or programs (n = 3), wound care support teams (n = 2), and nutritional interventions (n = 1).

Both single and complex interventions were employed across the studies, each comprising various components and support structures to facilitate implementation. Education emerged as the most commonly utilized support structure for interventions, with varying degrees of treatment fidelity reported. Here, we delve into the descriptions of the interventions, namely support surfaces, repositioning, computerized decision-making support for PUs, PU prevention bundles or programs, wound care support teams, and nutritional interventions, along with their associated support structures and treatment fidelity.

Support surfaces featured prominently in six studies, wherein a variety of mattresses, overlays, and cushions were utilized. Typically, advanced intervention surfaces were compared against standard ones, as evidenced in studies by Brienza et al. (2010) [14], van Leen et al. (2013, 2011) [9,10], Ricci et al. (2013) [11], and Hampton and Collins (2005) [13]. For instance, van Leen et al. (2014) implemented a step-by-step approach, replacing standard viscos-elastic mattresses with more advanced support surfaces like viscos-elastic mattresses with static air overlays or low air-loss systems [12]. Supporting structures for these interventions included providing staff with copies of the EPUAP-NPUAP guidelines (Ricci et al., 2013) [11], offering training and coaching to nursing staff (van Leen et al., 2014) [12], or ensuring residents received properly fitted wheelchairs and cushions, checked weekly by seating specialists (Brienza et al., 2010) [14]. However, fidelity of treatment was not consistently reported across these studies.

Repositioning emerged as a key intervention in three studies conducted by Bergstrom et al. (2014) [15], Moore et al. (2011) [16], and Vanderwee, Grypdonck, Bacquer, & Defloor (2006) [17], each exploring distinct patient turning schedules and positions. Notably, repositioning techniques involving back and 30 degrees or 90 degrees tilt were consistently employed across all studies [16,17]. Patient turning schedules varied, ranging from every 2 to 6 hours. Additionally, one study incorporated offloading the heels from the bed during repositioning [16]. In all instances, education served as the primary support structure for the interventions. The educational content varied, encompassing instructions on executing the intervention and topics pertinent to PU prevention [15–17]. To ensure fidelity of treatment, measures such as comparing observed patient positions with reported turns [15,16] or conducting unannounced visits to the wards by researchers or study nurses were implemented [16,17]. These strategies were crucial in maintaining adherence to the repositioning protocols and accurately assessing their effectiveness in preventing pressure ulcers.

Computerized support in decision-making for PU prevention was a focal point in three studies, either serving as a direct guide for care or as an integral component of care planning decisions [18–20]. These interventions leveraged decision algorithms and resident-specific physiological data stored in databases to facilitate tailored care approaches. For instance, in one study, a computer program utilized decision algorithms based on resident physiological factors to recommend skin care products, absorbent briefs, and mattresses [18]. Another study employed a computerized decision support service (CDSS) system, which utilized the Risk Assessment Pressure Scale (RAPS) and the Mini Nutritional Assessment (MNA) scale results to propose evidence-based interventions for care planning [19]. Additionally, in another study, electronic nursing documentation was utilized to provide weekly reports on residents' changing PU risk factors, facilitating the redesign of workflow and process improvements biweekly [20]. Education emerged as a common supporting structure across these interventions, with varying timing, duration, and topics covered, including PU prevention, treatment, and device usage training [18,19]. Moreover, mentoring, researcher visits to units, or telephone calls were employed as additional supporting structures [18–20] to bolster the implementation process. To ensure fidelity of treatment, measures such as daily records of

care actions and assessments by nursing staff, as well as monitoring of activities by external teams, were implemented [18].

Pressure ulcer prevention bundles or programs were implemented in three studies, each comprising distinct elements and approaches to care [21–23]. In the bundle developed by Keen and Gaudario (2014), elements such as surface and skin inspection, mobility maintenance, incontinence management, and nutritional support were included [21]. Following a one-hour educational session for staff, a bundle chart was completed for residents deemed at high or very high risk of PUs. Based on the assessment results, the responsible nurse planned the frequency of care for each resident. Kwong et al. (2011) implemented a PU prevention program with two main components: a focused training course and a prevention protocol [22]. The training course, comprising a two-hour lecture and four hours of skills training, covered topics related to PU prevention and evidence-based interventions. The prevention protocol delineated PU prevention care tasks to be performed at specific times. Tippett (2009) utilized a comprehensive "Wound Program" involving an interdisciplinary team, intensive training, and evidence-based PU prevention protocols [23]. Initial and follow-up training, including the use of the Braden scale, PU assessment, treatment, prevention, and support surface utilization, was provided by a physician consultant or nursing supervisors. Annual mandatory training sessions were conducted for all staff, with in-service training provided routinely. In all interventions, supporting structures included education on the bundle concept and NPUAP/EPUAP guidelines, as well as knowledge tests on PU prevention [21]. Monitoring of fidelity of treatment was conducted twice a week by visiting RNAs [22]. These strategies ensured consistent adherence to protocols and optimized the effectiveness of PU prevention efforts across the studies.

A wound care support team played a crucial role in two studies, employing different approaches to educate nursing staff on PU prevention and treatment. In one study (Nobrega et al., 2009), the support team educated nursing staff weekly at bedside, providing observation and counseling on PU prevention and treatment. In contrast, the other study utilized a biweekly remote support team that worked alongside a skin and wound care expertise nurse [24]. This remote team supported the expertise nurse, who visited and educated nursing staff weekly at bedside and in group sessions [24]. The composition of the wound care support team varied, including hospital-based expert multi-disciplinary wound care teams [24] or a geriatrician and a clinical nurse specialist [25]. However, the fidelity of treatment was not explicitly reported in these studies.

In one study, nutrition served as the intervention. Nursing homes implemented a six-week dietary intervention, supplementing the standard institutional diet with eight cookies daily, each containing 11.5 g protein and 244 kcal. This nutritional supplementation aimed to address specific dietary needs and potentially contribute to PU prevention and management efforts [26].

Table 2: The characteristics of interventions used to prevent ulcers

Study	Intervention	Control	Protocol/Notes
Chang et al (2021) [7]	Intervention: two-component compression bandage	none, only selected cases with positive outcomes	
Lessing et al (2020) [8]	low-cost outpatient protocol for prevention and treatment	patients without pressure ulcers	
van Leen et	Standard cold foam	Standard cold	No repositioning

al. (2011) [9]	mattress with a static air overlay	foam mattress	before development of a grade 2 PU
van Leen et al. (2013) [10]	Static air overlay mattress placed on top of viscoelastic foam mattress	Viscoelastic foam mattress	No repositioning at night before development of a grade 1 PU
Ricci et al. (2013) [11]	Three-dimensional mattress overlay	Viscoelastic mattress overlay	Repositioning every 2 hr., alternating lateral (30 degrees) and supine position; Protocols based on EPUAP-NPUAP guidelines
van Leen et al. (2014) [12]	2002: Viscoelastic foam mattress 2005–2011: PU protocol of 3 steps: 1. Visco-elastic mattress 2. Static air overlay if developed category1 PU 3. Repositioning every 3–4 hr. if PU still developed 4. Low air-loss system if PU still developed	Visco-elastic foam mattress received by all patients	-
Hampton and Collins (2005) [13]	Pressure reducing viscos-elastic foam mattress	Standard mattress	Education not supplied to nurses or care assistants in the nursing home
Brienza et al. (2010) [14]	Air, viscous fluid, or gel and foam cushion in wheelchair	7.6-cm crosscut foam cushion in wheelchair	Participants received a new, properly fitted wheelchair; Treatment began with seating assessment by research team's seating specialist
Bergstrom et al. (2014) [15]	Turning schedules at 2-, 3-, or 4-hr intervals on high-density foam mattresses	-	Documentation by CNAs and PSWs at each repositioning episode
Moore et al. (2011) [16]	Repositioning using 30 degrees tilt every three hours during the night, heels offloaded	Repositioning every six hours at night, using 90 degrees lateral rotation	Clinical staff recorded each repositioning episode
Vanderwee et al. (2006) [17]	Repositioning alternately every 2 hr. in lateral position (30 degrees) and 4 hr. in supine position on a 7 cm viscos-elastic foam overlay mattress	Repositioning every 4 hr. on the same mattress	Heels elevated from mattress by cushion; Nurse noted every repositioning on turning schedule at the bedside
Shannon et al. (2012)	PU prevention programme (PUPP) guided by	-	Based on resident's factors and PU risk,

[18]	decision algorithms		program chose skin care products, absorbent briefs, and mattresses
Fossum et al. (2011) [19]	Computerized decision support systems (CDSS) integrated into electronic healthcare record	-	CDSS based on Risk Assessment Pressure Scale (RAPS) and Mini Nutritional Assessment (MNA) scale
Olsho et al. (2014) [20]	Integrated reports + process improvements	-	Weekly reports gathered on resident PU risk factors; Biweekly redesigned workflow to integrate reports into day-to-day practices
Keen and Gaudario (2014) [21]	Introduction of SKIN bundle concept to staff	-	Documentation used in SKIN bundle implementation: Surface, Skin Inspection, Keep Moving, Incontinence, Nutrition
Kwong et al. (2011) [22]	PU prevention programme for nursing homes	-	Focused training for care providers and nurses; Prevention protocol included risk assessment, assessments, interventions, referrals
Tippett (2009) [23]	Wound programme including interdisciplinary team, intensive training, evidence-based protocols	-	Prevention protocols based on Braden scale risk assessment; Residents receive interventions based on risk level
Stern et al. (2014) [24]	Phase 1: Education by advance practice nurses (APNs) Phase 2: Remote support by APNs	-	Education and support provided by APNs; Research assistants collected data on PU healing rates
Nobrega et al. (2009) [25]	Pressure ulcer team (geriatrician and clinical nurse specialist)	-	Team discussed ulcer management techniques, made recommendations, and observed nursing staff
Pouyssegur et al. (2015) [26]	Addition of protein cookies to standard diet	-	Study involved observation of weight evolution, cookie consumption, and

			follow-up visits

The effectiveness of interventions varied across studies in reducing the incidence or prevalence of pressure ulcers (PUs). Among the interventions examined were support surfaces, repositioning, computerized decision-making support, PU prevention bundles or programs, and nutritional interventions, each showcasing varying degrees of effectiveness.

Support surfaces were found to effectively decrease both the incidence and prevalence of pressure ulcers (PUs) in various studies. In an RCT conducted by Brienza et al. (2010), the use of an air, viscous fluid, and foam cushion, or a gel and foam cushion, significantly reduced the incidence of PUs near the ischial tuberosities. Only one participant (0.9%) in the intervention group developed a PU compared to eight (6.7%) in the control group ($p = 0.04$) [14]. Similarly, van Leen et al. (2014) implemented a three-step prevention strategy in a nursing home setting, where a standard viscos-elastic mattress was replaced by a static air overlay if signs of PU developed. Subsequent steps included repositioning and, if necessary, replacing the resident's mattress with a low air-loss system. This intervention led to a significant reduction in the prevalence of stage 2–4 PUs from 8.7% to 3.7% in 2011. Following the introduction of the three-step model in 2005, PU prevalence dropped to 0.5% within one year and remained between 1.2% and 2.6% for the remainder of the study period ($p < 0.001$–0.002) [12]. Furthermore, Hampton & Collins (2005) observed a significant reduction in PU prevalence by changing the standard mattresses of 21 nursing home residents to viscos-elastic foam mattresses and cushions, resulting in an 82.5% decrease. However, the significance of these results was not explicitly reported in their study [13].

Repositioning, involving a 30-degree tilt every three hours during the night, coupled with offloading heels from the bed, proved to be a significant intervention in reducing the incidence of pressure ulcers (PUs). Moore et al. (2011) observed a notable decrease in PU incidence, with rates dropping to 3% in the experimental group compared to 11% in the control group (incidence rate ratio 0.27, 95% CI 0.08–0.93, $p = 0.038$). Additionally, computerized decision-making support systems demonstrated efficacy in PU prevention [16]. In the study by Shannon et al. (2012), the implementation of a computer program to select skin care products, absorbent briefs, and mattresses based on PU risk significantly reduced PU incidence. The experimental group exhibited a PU incidence of 12%, compared to 36% in the control group ($\chi 2 = 10.770$, $p = 0.001$), reflecting a substantial 67% reduction in PU incidence [18]. Furthermore, leveraging health information technology in nursing homes to compile weekly reports identifying residents' PU risk factors led to significant reductions in PU incidence when accompanied by redesigned workflows and process improvements [20]. This intervention was associated with a statistically significant reduction in PU incidence, with a baseline PU incidence of 4.6% (IRR = 0.409, $p < 0.035$) [20].

Pressure ulcer prevention bundles or programs have demonstrated significant effectiveness in reducing both PU incidence and prevalence. In a study by Tippett (2009), the implementation of a wound program consisting of prevention protocols led to a remarkable reduction in PU incidence [23]. Pre-initiative PU incidence averaged 5.19%, which decreased to 0.73% post-initiative, marking an 86% reduction. By the fourth year of the program, PU incidence further decreased to 0.06%, reflecting a remarkable 99% reduction ($p < 0.0001$) [23]. Similarly, Kwong et al. (2011) reported a decrease in PU incidence from 2.5% to 0.8%, and a decrease in PU prevalence from 9% to 2.5% following the implementation of a focused training course

for non-licensed care providers (NLCPs) and nurses. Although they did not report the statistical significance of these results, the observed reductions indicate the effectiveness of the program in PU prevention [22].

Moreover, nutritional interventions have been shown to significantly reduce PU prevalence. Pouyssegur et al. (2015) found a significant reduction in PU prevalence in the intervention group from 23.9% to 8.0% (p = 0.001), compared to a non-significant reduction in the control group from 15.3% to 6.9% (p = 0.11). Subgroup analysis further confirmed the positive impact of cookie supplementation alone on PU reduction (p = 0.031) [26].

Table 3: The outcomes as reported by the studies

Author & year of publication	Dosing	Supporting structures	Fidelity of treatment	Outcomes Assessment	Instrument	PU Incidence reduced	PU Prevalence reduced	PU Healing time reduced	Significantly reduced cost of treatment
Support surfaces (Mattresses, overlays and cushions; n = 6)									
Chang et al (2021) [7]	Six months while patient in bed.	NR	NR	Improvement of the cases	PU-classification scale				Yes
Lessing et al (2020) [8]	Six months while patient in bed.	NR	NR	Improvement of the cases	PU-classification scale			Yes	Yes
van Leen et al. (2011) [9]	Six months while patient in bed.	NR	NR	Development of grade 2, 3, and 4 PUs at the heel or in the sacral/hip region.	PU-classification scale of EPUAP Stage 2–4	Yes			No
van Leen et al. (2013)[10]	Six months while patient in bed.	NR	NR	Development of grade 2–4 PUs A weekly inspection	PU-classification scale of EPUAP	Yes			No

				of the skin. The data was collected by one researcher.	stage 2–4				
Ricci et al. (2013) [11]	28 days while patient in bed.	Investigators from both units had 4 meetings.	NR	PU incidence. PUs was assessed on the day of the screening and days 7, 14, 21 and 28.	PU-classification scale of EPUAP stage 1–4	No			?
van Leen et al. (2014) [12]	10 years /7 years While patient in bed. 2.3% received alternating mattresses and 13% received static air mattresses.	In 2005 the nursing staff was trained and afterwards coached 3 months by a specialist wound nurse.	NR	PU prevalence.	PU-classification scale of EPUAP stage 1–4		Yes		Yes
Hampton and Collins (2005) [13]	6 months while patient in bed.	NR	NR	PU incidence.	Stirling PU grading system		Yes		?
Brienza et al. (2010) [14]	6 or more hours per day, while using a	Wheelchairs and cushions were checked weekly by the seating specialist aided by occupational	The research staff monitored actual daily	PU incidence near ischial tuberosities,	PU-classification scale of EPUAP	Yes Yes			Yes No

	wheelchair.	therapy students.	sitting time by periodically sampling.						
Repositioning (n = 3)									
Bergstrom et al. (2014) [15]	2-, 3-, or 4-hr intervals	By the study team in facility in 2 to 3 days.	Supervisors observed and recorded participants' positions hourly.	PU on the coccyx or sacrum, greater trochanter or heels.	PU-classification scale of EPUAP stage 1–4	No			No
Moore et al. (2011) [16]	Every three hours	Education, before beginning the study for both groups:	The researcher visited the wards at random times.	PU incidence that occurred during the 28 days of the study.	PU-classification scale of EPUAP	Yes			Yes
Vanderwee et al. (2006) [17]	5 weeks while patient in bed.	Before the start of the study, all nurses followed a training session of PU classification (PUCLAS).	Nurse was responsible for follow-up of adherence to the protocol.	PU incidence.	PU-classification scale of EPUAP	Yes			No
Computerized decision support systems (n = 3)									
Shannon et al. (2012) [18]		PU prevention education was given for nurses by a nurse certified in the PUPP at the beginning and by trained senior nursing staff repeatedly at the end of the study.	The fidelity of treatment was ensured by keeping in each shift and a daily record of actions of care and assessments by nursing staff	Reduction in the incidence of nosocomial PUs.	PU-classification scale of NPUAP stage 1–4	Yes			Yes

Fossum et al. (2011) [19]	NR	Two 45-min education sessions for registered nurses (RNs) and nursing aides (NAs) offered twice with the same content.	NR	PU prevalence.	PU-classification scale of EPUAP stage 1–4		No[b]		No
Olsho et al. (2014) [20]	Biweekly	Use off staff educators and certified nurse assistant (CNA) mentors.	NR	PU incidence.	PU-classification scale of EPUAP	Yes			Yes
PU prevention bundle or programme (n = 3)									
Keen and Gaudario (2014) [21]	Each shift	The education designed and given by the tissue viability nurse included information of the SKIN bundle concept and NPUAP/EPUAP (2009) guidelines.	NR	PU occurrence.	PU-classification scale of EPUAP		No[b]		?
Kwong et al. (2011) [22]	Each care task	The research team, experienced nurses, delivered a two-hour lecture and four hours of skills training sessions to the NLCPs and nurses.	Fidelity of treatment was monitored twice a week by two visiting RNAs.	PU prevalence and incidence.	Unknown: The prevalence form and incidence form was used to document stage of the PUs.	Yes	Yes		?
Tippett (2009) [23]	Part of the routine shift reporting and charting.	All staff was trained initially by the physician consultant.	NR	PU incidence of all stages nosocomial PUs.	PU-classification scale of NPUAP stage 1–4	Yes	Yes		Yes
Wound care support team (n = 2)									
Stern et al. (2014) [24]	Phase 1: once a week, for		NR	Secondary outcome healing time, PU	PU-classification scale of EPUAP	No	No	No	No

	three months Phase 2: Biweekly, during 1–11 months			incidence and prevalence.	stage 1–4				
Nobrega et al. (2009) [25]	Weekly	NR	NR	Prevalence of PUs.	standardized evidence-based assessment		Yes		No
Nutrition (n = 1)									
Pouyssegur et al. (2015) [26]	Daily	NR	NR	Secondary outcome episodes of PUs.			Yes		Yes

Discussion:

This review delved into the effectiveness of preventive interventions for pressure ulcers (PUs) in long-term care of the elderly (LOPC) facilities. Effective interventions identified to reduce PU incidence in LOPC facilities included computerized decision-making support systems in PU prevention, as evidenced by two studies [18,20] covering 6,161 residents. Additionally, PU prevention programs, as demonstrated in one study by Tippett (2009) involving a monthly census over six years with 137 residents, proved effective [23]. Repositioning strategies, specifically utilizing a 30-degree tilt every three hours during the night and offloading heels from the bed, were identified as effective in reducing PU incidence, as demonstrated in a study by Moore et al. (2011) with 197 residents [16]. Moreover, the use of more advanced cushions in wheelchairs was found to be effective in reducing PU incidence, as indicated in a study by Brienza et al. (2010) involving 180 residents [14].

This review highlights effective interventions for reducing the prevalence of pressure ulcers (PUs) in long-term care of the elderly (LOPC) facilities. PU prevention programs, as demonstrated in a study by Tippett (2009) involving a monthly census over six years with 137 residents, were found to effectively reduce PU prevalence [23]. Similarly, changing to more advanced mattresses, as shown in a study by van Leen et al. (2014) covering 91,857 residents [12], and adding protein and energy supplements to the diet, as indicated in a study by Pouyssegur et al. (2015) with 154 residents, were also effective in reducing PU prevalence [26]. However, the review did not identify any studies reporting effective interventions to improve the healing time of PUs. Most studies did not report the healing times of PUs with the various interventions used, and one study [24] reported non-significant healing times of PUs.

This review examined a range of interventions aimed at preventing pressure ulcers (PUs) in long-term care of the elderly (LOPC) facilities, categorized into primary and secondary prevention strategies. Primary prevention interventions were implemented before the

occurrence of any PU, while secondary prevention interventions were conducted after a resident had developed a PU, with the aim of preventing worsening and promoting healing by eliminating or reducing risk factors. Our findings corroborate previous research, such as Reddy et al. (2006), which identified support surfaces as the most common intervention for PU prevention [27]. However, our review expanded upon previous findings by identifying additional interventions not included in prior reviews, such as interventions involving computerized decision-making support in PU prevention, PU prevention bundles or programs, and wound care support teams. Unlike previous reviews, which predominantly focused on single-component interventions in long-term care (LTC) settings, our review revealed the development of both complex and single interventions for PU prevention in LOPC settings. Importantly, both complex and single interventions were found to be effective. This underscores the flexibility in choosing and implementing interventions tailored to the resources and context of the facility, providing opportunities for comprehensive PU prevention strategies in LOPC facilities.

The education of nursing staff emerged as the most frequently reported supporting structure to facilitate the implementation of interventions in preventing pressure ulcers (PUs). However, we observed a lack of coherence in reporting supportive structures, echoing findings by Jackson et al. (2016) that highlight unclear implementation of preventive PU guidelines [28]. Our review's findings align with previous systematic reviews, such as Reddy et al. (2006), which found that more advanced static support surfaces, compared to standard hospital mattresses, were associated with lower PU incidences across various settings [27]. Similarly, our results support previous findings suggesting the potential effectiveness of nutritional supplements in PU prevention [29]. Unlike earlier reviews where the composition of the best nutrients remained unclear or varied based on individual characteristics, one study in our review reported generally effective use of the same amount of supplement in LOPC settings [26].

While previous systematic reviews did not identify the ideal repositioning frequency or degree to reduce PUs across various settings, our review identified the effectiveness of a 30-degree tilt position with repositioning every three hours at night in LOPC facilities, as reported by Moore et al. (2011) [16]. Optimal repositioning is crucial as it helps alleviate pressure over vulnerable areas of the body, as emphasized by guidelines. These findings underscore the importance of tailored and evidence-based interventions in PU prevention, especially in the specific context of LOPC facilities.

The findings of our review resonate with Dykes and Collins (2013), who advocate for the integration of health information technology tools as part of complex interventions in pressure ulcer (PU) prevention [30]. They suggest that nursing record systems can be seamlessly integrated into the clinical workflow of practicing nurses, providing valuable data on preventive measures to mitigate adverse outcomes like PUs.

In response to the increasing prevalence of PUs, care facilities have adopted comprehensive PU prevention programs bundling together best practices. While earlier reviews across various settings have shown the effectiveness of multifaceted, multidisciplinary programs in preventing PUs, the level of evidence has been deemed weak [31]. Our review, however, identified significantly effective PU prevention bundles or programs in both prospective 6-year evaluations and quasi-experimental pretest-posttest studies within LOPC settings.

These bundled best practices offer a cost-effective approach to PU prevention implementation. However, to establish robust evidence of their effectiveness, randomized controlled trials (RCTs) are warranted. Additionally, successful implementation of these bundles requires careful consideration of which best practice bundles are most suitable for the

unique context of older people's care. Gathering such evidence is essential to inform decision-making and optimize PU prevention efforts in LOPC facilities [31,32].

In the context of long-term care for older people (LOPC), there is a pressing need for evidence-based, targeted interventions to prevent pressure ulcers (PUs). Technology, in particular, holds promise and is likely to play an increasingly important role in this area. Innovative healthcare technologies, such as pressure sensors embedded in mattresses, could provide real-time data on prolonged pressure, indicating areas at increased risk for PUs [33]. Similarly, sensors integrated into clothing, sheets, and wheelchairs could trigger alarms when pressure is detected in the same area over an extended period, alerting caregivers to take preventive measures [34–36].

Studies have shown that older patients with PUs often exhibit advanced age, cognitive and consciousness impairments, low nutritional status, and comorbidities such as Parkinson's disease and chronic illnesses [2,37]. These characteristics are typical of residents in LOPC facilities and must be considered when designing and implementing interventions. Looking ahead, there is a growing recognition of the importance of involving older individuals themselves in the prevention of PUs, depending on their capabilities and resources [38]. Collaborative interventions developed in partnership with older adults could empower them to actively participate in PU prevention efforts, promoting autonomy and enhancing overall well-being.

Healthcare leaders and administrators can leverage the results of this review to make informed decisions regarding the selection and implementation of effective PU prevention interventions. By identifying and adopting interventions with proven efficacy, they can work towards improving the overall quality of care within their facilities. Furthermore, the review findings have implications for education within the healthcare sector. They can serve as foundational knowledge for the development of healthcare education programs, both at the undergraduate and continuing education levels. By incorporating evidence-based PU prevention practices into curriculum and training initiatives, nursing students and healthcare professionals can enhance their understanding and competency in this critical area of care. This review can serve as a valuable resource for educators, empowering them to equip nursing students with the necessary knowledge and skills to effectively prevent PUs and other wounds in clinical practice. Lastly, from a research perspective, this review offers a comprehensive overview of existing evidence on preventive interventions for PUs in LOPC settings. It can serve as a foundational reference for researchers interested in further investigating and advancing our understanding of PU prevention strategies tailored to the unique needs of older adults in long-term care.

While this review provides valuable insights into preventive interventions for pressure ulcers (PUs) in long-term care for older people (LOPC) settings, it is important to acknowledge certain limitations. Firstly, the included studies varied in terms of design, sample size, and intervention components, which may introduce heterogeneity and affect the generalizability of the findings. Additionally, the quality and rigor of the included studies may vary, potentially impacting the reliability of the evidence synthesized in this review. Furthermore, the focus of this review was on interventions targeting PU prevention, and therefore, other factors that may influence PU development or healing, such as comorbidities, wound care practices, and environmental factors, were not comprehensively addressed. Moreover, while efforts were made to identify relevant studies through comprehensive search strategies, it is possible that some relevant literature may have been missed, leading to potential publication bias. Additionally, the review may be subject to language bias, as only studies published in English were included. Lastly, the review primarily focused on quantitative evidence, and

therefore, qualitative insights or perspectives from key stakeholders, such as residents, caregivers, or healthcare providers, were not extensively explored. Despite these limitations, this review provides a valuable synthesis of existing evidence on PU prevention interventions in LOPC settings, offering insights for clinical practice, healthcare leadership, education, and future research endeavors.

In conclusion, this review provides valuable insights into preventive interventions for pressure ulcers (PUs) within the context of long-term care for older people (LOPC). The findings have significant implications for clinical practice, healthcare leadership, education, and research. At the clinical level, the evidence-based guidelines identified in this review offer a roadmap for defining best practices in PU prevention. By implementing these guidelines, LOPC facilities can enhance the consistency and quality of care provided to residents, ultimately improving outcomes and reducing the incidence of PUs. Education within the healthcare sector stands to benefit from this review, as it provides a foundation for the development of educational programs and training initiatives. By incorporating evidence-based PU prevention practices into curriculum and training, nursing students and healthcare professionals can enhance their knowledge and skills in this critical area of care.

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