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Development, implementation and evaluation of the effectiveness of a Consistent Practice Intervention

Sirpa Mäki-Turja-Rostedt

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To my family

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SIRPA MÄKI-TURJA-ROSTEDT: Preventing pressure ulcers in long-term older people care –Development, implementation and evaluation of the effectiveness of a Consistent Practice Intervention
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ABSTRACT

Most pressure ulcers (PUs) are preventable. However, PUs exist all over the world and clinical PU prevention practices vary widely. PUs cause suffering for patients, poses challenges to care for organisations, and cause costs for society.

The aim of this study was to develop, implement and evaluate the effectiveness of a Consistent Practice Intervention based on international PU prevention guidelines in long-term older people care (LOPC). The ultimate goal was to produce a transferable PU prevention intervention to improve the quality of care in LOPC facilities.

In the first phase of the study, a systematic review with structured narrative synthesis was conducted in studies (n = 18) from 2005–2017 to map existing literature regarding the effectiveness of earlier interventions aimed at preventing PUs in LOPC, with comparator usual care. In the second and third phase of the study, the Consistent Practice Intervention was developed, implemented and evaluated using OMEBP model. A quasi-experimental intervention study design in LOPC setting was used. Two chosen facilities were randomly allocated into intervention and comparison facilities (facility as randomisation unit). Altogether, 232 residents (91%) (n = 115 in intervention facility/n = 117 in comparison facility) and 141 RNs and PNs (88%, n = 69/72) participated in the study.

Earlier effective interventions reducing the incidence or prevalence of PUs in LOPC were repositioning, nutrition, advanced mattresses, overlays or cushions, use of electronic support in decision-making and PU prevention bundles or programmes. The Consistent Practice Intervention, i.e., a bundle of six PU prevention areas, reduced the number ($p = 0.027$) and severity ($p = 0.020$) of PUs, improved the use of risk assessment ($p < 0.001$) and nutrition assessment instruments ($p < 0.001$), increased consistency in nursing staff's practice for PU prevention in PU risk assessment ($p < 0.001$) and nutrition ($p < 0.001$) and improved nursing staff's PU prevention knowledge in PU risk assessment ($p=0.11$).

In order for the prevention of PUs to be effective, the Consistent Practice Intervention for PU prevention for nursing staff developed in this study could be a solution to implement evidence-based working methods successfully, ensuring PU prevention to improve the quality of care of older people in LOPC facilities

KEYWORDS: Pressure ulcer, prevention, guidelines, evidence-based practice, intervention, quality improvement, long-term care, education

TURUN YLIOPISTO
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TIIVISTELMÄ

Suurin osa painehaavoista (PH) on ehkäistävissä. Siitä huolimatta painehaavoja esiintyy kaikkialla maailmassa ja painehaavojen ehkäisykäytännöt vaihtelevat suuresti. Painehaavat aiheuttavat kärsimystä potilaille, ovat organisaatioille vaikeahoitoisia ja aiheuttavat yhteiskunnalle taloudellisia kustannuksia.

Tutkimuksen tarkoituksena oli kehittää, ottaa käyttöön ja arvioida kansainvälisiin PH-ehkäisyn suosituksiin perustuva yhtenäinen käytäntö. Tutkimuksen tavoitteena oli tuottaa muihin yksiköihin siirrettävissä oleva interventio, jolla voidaan lisätä PH-ehkäisyn hoidon laatua ikääntyneiden palveluyksiköissä.

Tutkimuksen ensimmäisessä vaiheessa tehtiin systemaattinen kirjallisuuskatsaus ja narratiivinen synteesi vuosien 2005–2017 artikkeleista (n = 18) antamaan tietoa aiempien PH-ehkäisyinterventioiden vaikuttavuudesta ikääntyneillä. Toisessa ja kolmannessa vaiheessa kehitettiin, otettiin käyttöön ja arvioitiin yhtenäinen PH-ehkäisykäytäntö käyttäen YHKÄ-mallia. Kvasikokeellinen interventiotutkimus toteutettiin ikääntyneiden palveluyksiköissä, joista tarkoituksenmukaisella otoksella valitut kaksi yksikköä arvottiin interventio- ja vertailuyksiköiksi. 232 asukasta (91 %, n = 115 asukasta interventioyksikkö/117 vertailuyksikkö) ja 141 hoitajaa (88 %, n = 69/72) osallistui tutkimukseen.

Aikaisemmissa tutkimuksissa painehaavoja vähensivät ikääntyneiden yksiköissä asentohoito, ravitsemus, kehittyneet makuu- ja istuinalustat, sähköinen tuki päätöksenteossa sekä PH-ehkäisypaketit ja -ohjelmat.

PH-ehkäisyn yhtenäinen käytäntö -interventio alensi painehaavojen lukumäärää ja -vaikeusastetta ($p = 0.020 – 0.027$), lisäsi PH- ja ravitsemusriskimittarien käyttöä asukkaille ($P < 0.001$), yhtenäisti hoitajien PH-ehkäisyn käytäntöä riskinarvioinnissa ja ravitsemuksessa ($P < 0.001$) ja lisäsi hoitajien PH-ehkäisytietoa riskinarvioinnissa ($p = 0.11$).

Tässä tutkimuksessa kehitetty ja toteutettu yhtenäinen käytäntö -interventio voisi olla yksi ratkaisu vaikuttavaan, näyttöön perustuvaan PH-ehkäisyyn, jolla voidaan lisätä hoitotyön laatua ikääntyneiden palveluyksiköissä.

AVAINSANAT: Painehaava, ehkäisy, suositukset, näyttöön perustuva hoito, interventio, laadun parantaminen, pitkäaikaishoito, koulutus.

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Abbreviations

AHRQ	The Agency for Healthcare Research and Quality's
EPUAP	The European Pressure Ulcer Advisory Panel
FWCS	The Finnish Wound Care Society
LOPC	Long-term older people care
MAStARI	Meta-Analysis of Statistics Assessment and Review Instrument
NICE	National Institute for Health and Care Excellence
NPIAP	The National Pressure Injury Advisory Panel in the US
NPUAP	The National Pressure Ulcer Advisory Panel in the US
NRF	Nursing Research Foundation
OECD	Organisation for Economic Co-operation and Development
OMEBP	Operational Model for Evidence-Based Practices
PH	Painehaava
PN	Practical nurse
PPPIA	The Pan Pacific Pressure Injury Alliance
PRISMA	The Preferred Reporting Items for Systematic reviews and Meta-Analyses
PU	Pressure ulcer
PUP-Ins	The Pressure Ulcer Patient Instrument
PUPK	Pressure Ulcer Prevention Knowledge test
PUPreP	Pressure Ulcer Prevention Practice
RCT	Randomized Controlled Trial
RN	Registered nurse
TENK	Finnish Advisory Board on Research Integrity
TREND	Transparent Reporting of Evaluations with Nonrandomized Designs
US	United States
WHO	World Health Organization
YHKÄ	Yhtenäiset käytänteet

List of Original Publications

This dissertation is based on the following original publications, which are referred to in the text by their Roman numerals:

I Mäki-Turja-Rostedt S, Stolt M, Leino-Kilpi H, Haavisto E. Preventive interventions for pressure ulcers in long-term older people care facilities: A systematic review. *Journal of Clinical Nursing*, 2019; 28(13–14): 2420–2442. https://doi.org/10.1111/jocn.14767

II Mäki-Turja-Rostedt S, Leino-Kilpi H, Korhonen T, Vahlberg T, Haavisto E. Consistent practice for pressure ulcer prevention in long-term older people care: A quasi-experimental intervention study. *Scandinavian Journal of Caring Sciences*, 2021; 35: 962–978. https://doi.org/10.1111/scs.12917

III Mäki-Turja-Rostedt S, Leino-Kilpi H, Koivunen M, Vahlberg T, Haavisto E. Consistent pressure ulcer prevention practice: The effect on PU prevalence and PU stages, and impact on PU prevention—A quasi-experimental intervention study. *International Wound Journal*, 2023; 20(6): 2037–2052. https://doi.org/10.1111/iwj.14067

IV Mäki-Turja-Rostedt S, Leino-Kilpi H, Vahlberg T, Haavisto E. The impact of consistent pressure ulcer prevention practice on nursing staff's PU prevention knowledge: A quasi-experimental intervention study. *Nordic Journal of Nursing Research,* 2024; 24. https://doi.org/10.1177/20571585241265430

1 Introduction

In long-term older people care (LOPC) facilities, the risk for older people to develop a pressure ulcer (PU) is high. The higher risk is caused by older people's aging-related characteristics such as low cognitive and consciousness function, or low nutritional status (Jaul & Calderon-Margalit 2013). In LOPC, the residents usually have several diagnoses of diseases. Older people with comorbidities such as cancer (Stolt et al. 2019), cardiovascular diseases (Jaul et al. 2018), dementia (Cai et al. 2019, Pieper et al. 2012, Stolt et al. 2019), or diabetes (Borsting et al. 2018) are at higher risk of PU. With age, physical activity and moving decrease as well, and limited mobility, long-lasting sitting or lying down may lead to the development of PUs (Cai et al. 2019, Jaul et al. 2013, Manderlier et al. 2019). Immobility may also weaken the general health status (EPUAP/NPIAP/PPPIA 2019) and lead to deterioration of the skin condition and the emergence of PUs (Niederhauser et al. 2012). In addition, PU prevalence in older people has been reported to be related to memory impairment or proximity to death (Beal & Smith 2016, NICE 2014, NRF 2015). Because of the strong association of older age with PU risk and the physiological changes related to ageing, all older patients should be considered at risk of PU (Cowan et al. 2020).

Although most PUs could be prevented (Baker et al. 2016, Black et al. 2011) their number has remained high. PUs must be prevented because they matter strongly for the patient, the organisation, and society. PU prevalence is one of the sensitive quality indicators for nursing care (Oner et al. 2021). For this reason, the role of nursing staff in PU prevention is crucial.

For older people, PUs are painful and cause suffering (García-Sánchez et al. 2019, McGinnis et al. 2015). Pain is the main characteristic in the presence, development, and treatment of PUs (Roussou et al. 2023) and decreases older peoples' quality of life (Gorecki et al. 2009). Thus, older patients with PUs have significantly lower health-related quality of life compared to other groups of patients (Galhardo et al. 2010). Furthermore, PUs cause a risk for secondary infection (Khor et al. 2014) and have an association with mortality and convalescence status (Dhandapani et al. 2014, Khor et al. 2014, Thomas et al. 2013).

For organisations, PUs are a big challenge because healing of a PU requires a lot of time and resources. In healthcare centres, over a quarter of older patients' stage II PUs were still present after 10 weeks (Palese et al. 2015). The healing of stage II PUs took on average almost 23 days, varying from 19 to 31 days on average, depending on size (Palese et al. 2015). For all stage I–IV PUs, only just over 10% were reported to be completely healed in 12 months (Lee 2017). In comparison, stage III or IV PUs seldom respond to traditional wound care, and surgical care is required for healing (Awad et al. 2023).

PUs also have notable significance for society. In OECD countries, 15% of hospital expenditure and activity goes to treating safety failures, such as PUs (Slawomirski et al. 2017). In 2019, PUs cost the US healthcare system an estimated $26.8 billion with 59% of those costs being attributed to stage III and IV PUs (Padula et al. 2019). In the UK, the cost of treating a PU ranged from £1,214 to £14,108 in 2011 (Dealey et al. 2012). In Finland, around 55,000–80,000 patients with PUs are treated every year. The direct cost of PUs that the public must cover annually are approximately EUR 460–920 million (Soppi 2023). The cost of pressure ulcers is estimated to be 2–4 % of the healthcare costs (NPUAP/EPUAP/PPPIA 2014, Soppi 2023). The burden of cost of PUs for patients, healthcare systems and societies is considerable (Dealey et al. 2012, Moore et al. 2011a). For society, the costs of prevention are much lower than the cost of harm. Patient harm is defined as "unintended and unnecessary harm resulting from or contributed to by health care" (Slawomirski et al. 2017).

The importance of evidence and consistence of practice in health care is pointed out by the World Health Organisation (WHO 2012) and the European Union (European Commission 2016). In many countries, legislation emphasises the importance of consistence and research evidence when it comes to methods used in health care (AHRQ 2024, Healthcare Act, 2022, Finnish law 1326/2010). For example, according to Finnish law (1326/2010), healthcare must be based on evidence, good management and practices as well as coherent criteria of treatments. Also, several international and national guidelines regarding the prevention of PUs have been published: the European Pressure Ulcer Advisory Panel (EPUAP), the National Pressure Ulcer Advisory Panel in the US (NPUAP) and the Pan Pacific Pressure Injury Alliance (PPPIA) have made international evidence-based recommendations regarding the prevention of PUs (EPUAP/NPIAP/PPPIA 2019, NPUAP/EPUAP/PPPIA 2014); in Finland, PU prevention recommendations were translated into Finnish by the Finnish Wound Care Society in 2015 and 2019 (FWCS 2015, FWCS 2019). Based on the translations, the Nursing Research Foundation has produced national clinical guidelines for PU prevention (NRF 2015, NRF 2023). Furthermore, from an ethical point of view, it is unethical that it is known how PUs can be prevented, but in

practice, prevention is not realised. PUs can be systematically prevented through better policy and practice.

Despite the guidelines, the clinical practices in preventing of PUs have varied widely, and PU preventive interventions have been implemented only partially or have been based on low-level evidence (Chaboyer et al. 2024, Hoviattalab et al. 2014, Jackson et al. 2016, Joyce et al. 2018, Niederhauser et al. 2012). Today, although evidence-based methods are available and implementation of national patient safety programmes has decreased the prevalence of PUs, all the PU prevention methods are still not widely adopted and used in practice (Källman et al. 2022). Thus, PU prevention guidelines are still needed in practice, because nurses' practice toward PU prevention has a significant negative relationship with lack of policies and guidelines about PU prevention (Vajargah et al. 2022).

To support evidence implementation and consistent evidence-based nursing, the Operational Model for Evidence-Based Practices was developed by the Finnish Nursing Research Foundation (OMEBP, Figure 4, Jylhä et al. 2017, NRF 2018, Suhonen et al. 2019). In the generic OMEPB model, the development and implementation of evidence-based consistent practice proceeds in four steps: 1) Development needs for current practice, where the purpose is to assess whether the current practice is aligned with the best available evidence, such as international guidelines for PU prevention, and to identify change needs in current practice, 2) Plan for consistent practice, where the purpose is to design consistent practice by renewing the current practice in line with the best evidence, 3) Consistent practice, where the purpose is to describe the renewed consistent practice and then, to implement the new, agreed practice, and 4) Evaluation of the practice, where the purpose is to evaluate the practice to ensure consistency.

Maintaining consistent practice is regarded as the basis for effectively delivering quality and safe care. (Barradas Cavalcante et al. 2016, Jylhä et al. 2017). Systematic reviews (Niederhauser et al. 2012, Reddy et al. 2006, Shi et al. 2018, Sullivan et al. 2013) of earlier PU preventive interventions have usually been carried out in various health care settings and have mostly included interventions targeted at acute care settings. This shows a need for intervention research of consistent practice in LOPC.

Nursing staff's knowledge has a fundamental role as a supporting structure, in evidence-based prevention of PUs and in diminishing the suffering and costs caused by PUs. Education for professionals is one of the most commonly used strategies for translating PU prevention guidelines into practice, and thus, positively affects care outcomes as decreased prevalence of PUs (Panteli et al. 2019). Research evidence has shown that a prerequisite for high-quality PU prevention is nursing staff with sufficient knowledge about it (EPUAP/NPIAP/PPPIA 2019). However, earlier studies have indicated a need to

strengthen the PU prevention knowledge. Studies in hospitals have reported insufficient knowledge levels among registered nurses (RNs) or nursing staff on PU prevention (Fulbrook et al. 2019, Grešš Halász et al. 2021). In long-term care, RNs' PU prevention knowledge has been at moderate level (Kim & Lee 2019); however, the knowledge of nursing staff, including employees with lower education level, e.g. assistant nurses, has been less reported (Gunningberg et al. 2015, Wogamon 2016).

This research addresses this gap by striving to add evidence for evidence-based, consistent practice in PU prevention in LOPC, and assessment of whether the intervention contributed to increased staff compliance with new PU prevention practices. To produce new knowledge of effective, transferable intervention in the context of LOPC, a consistent PU prevention practice intervention based on international PU prevention guidelines (NPUAP/EPUAP/PPPIA 2014) was designed. In this study, effectiveness is defined as to what extent the intervention produces the intended outcomes in real- world settings (Skivington et al. 2021). As effectiveness, the impact or effect of the intervention on intended outcomes was reported in Papers II–IV. The term "effect" was used when reporting outcomes with a numeral scale, such as PU prevalence, while "impact" was used in reporting outcomes with a categorical scale. In the Oxford dictionary, "effect" is defined as "a count noun. Something accomplished, caused, or produced; a result, consequence. Correlative to cause", and "impact" is defined as "the act of impinging; the striking of one body against another; collision. Chiefly in Dynamics, in reference to momentum". In sanakirja.org "effect" is defined as "the result or outcome of a cause" and "impact" as "a significant or strong influence; an effect". They are also defined as synonyms for each other, and in Finnish both are translated as "vaikutus".

In this study, interventions refer to any activities to promote PU prevention in LOPC. The intervention developed and implemented in this study was a complex intervention. An intervention might be considered as complex because of the properties of the intervention itself, such as the number of components involved but also through interactions between the intervention and its context (Richards 2015, Skivington et al. 2021). In the intervention of this research, the complexity of the intervention consisted of both the number of components and the interactions between the intervention and the context of LOPC.

The aim of this study was to develop, implement and evaluate the effectiveness of a Consistent Practice Intervention based on international guidelines for PU prevention (NPUAP/EPUAP/PPPIA 2014) focusing on older people in LOPC. Once the intervention is conducted, there is a renewed consistent PU prevention practice in the LOPC facility. The ultimate goal of the study was to produce a transferable intervention ensuring PU prevention to improve the quality of care of older people in LOPC facilities.

The aim was achieved through three phases:

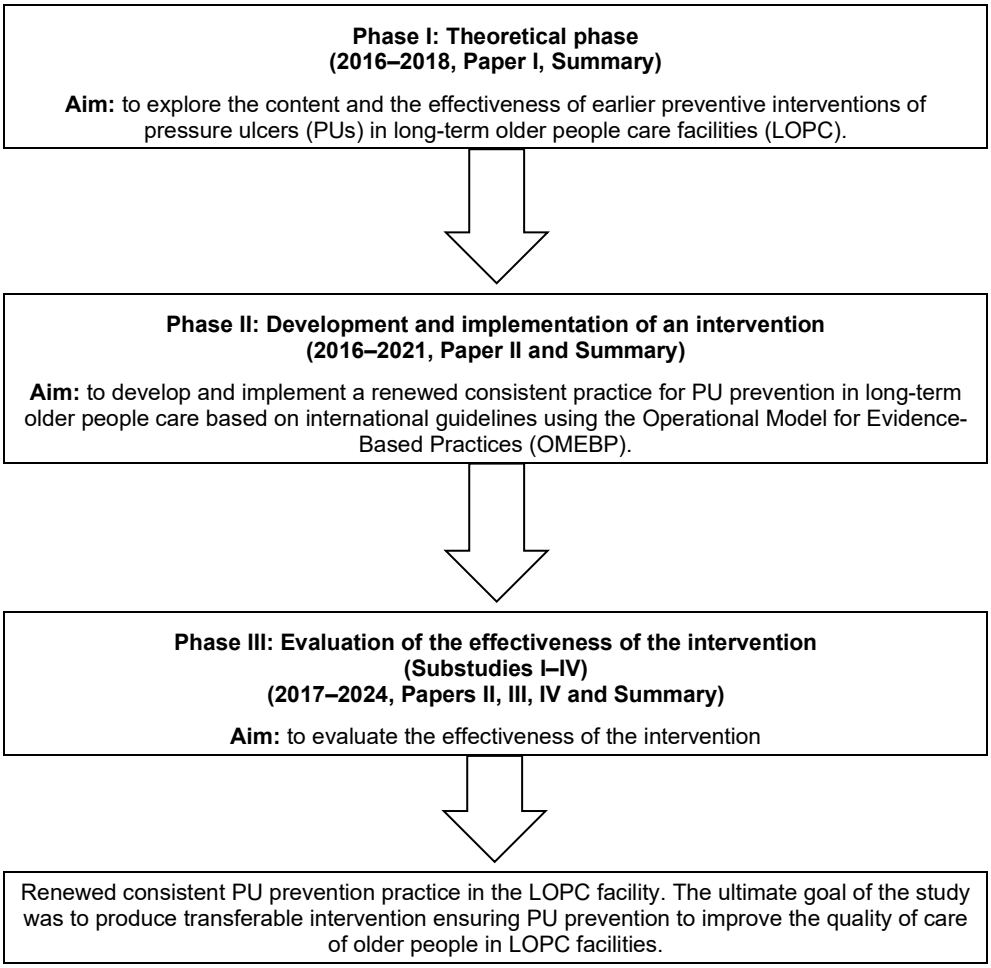

Figure 1. Study phases.

2 Review of the Literature

This chapter takes a look at the existing literature about the topic from 2011 to 2023. The section is divided into two parts:

The first part describes pressure ulcers: the definition and development of PUs, the description of PU stages, and the risk factors for having PUs and PU prevalence in LOPC are provided based on earlier studies and other literature.

The second part describes pressure ulcer prevention: Guidelines for PU prevention and preventive interventions for PU prevention are defined based on earlier studies and other literature and supporting structures for the implementation of PU prevention guidelines into practice are provided based on earlier studies.

2.1 Pressure ulcer

2.1.1 Pressure ulcer definition, development, location, and PU stages

According to international PU prevention guidelines a pressure ulcer is defined as "a localized injury to the skin and/or underlying tissue usually over a bony prominence, caused by pressure, or pressure in combination with shear. It may also be related to medical devices or other objects" (EPUAP/NPIAP/PPPIA 2019). In the guideline, "The recommendation for the prevention and treatment of pressure ulcers/pressure injuries", two terms are used: pressure ulcer and pressure injury. The international recommendation covers a wide range of countries and continents, which is why both commonly used terms have been included in the recommendation. The European Pressure Ulcer Advisory Panel (EPUAP) uses the term pressure ulcer, which is also used in Finland.

In pressure ulcer, the injury/damage to skin is a consequence of exposure to forces causing strong or prolonged direct pressure of the patient's body weight, or shear of skin, which is parallel force to the skin. It can also be a combination of both of these (EPUAP/NPIAP/PPPIA 2019). Pressure occurs when the weight of the body is directed against its base. Shear of the tissues is caused when the patient

slides towards the foot end of the bed with the head end raised or when sliding into a wheelchair or shower chair.

The pressure is greatest on bony prominences such as the hips, sacrum, buttocks and heels. Other areas include, for example, the elbows and shoulder blades (Haavatalo 2023, Zaidi et al. 2024). The heel, sacrum and foot were the most usual locations of PU among older people in nursing homes (Sugathapala et al. 2023). Typical PU locations of older residents with severe care dependency are the sacral region (45%) and the heels (25%) (Hahnel et al. 2017); similarly, among older people admitted to palliative home care service with a maximum life expectancy 6 months, the most common anatomical PU site is the sacrum/coccyx (72.9%) (Artico et al. 2018). PUs caused by medical devices are often located in other places than bony prominences; they are usually located in mucous membranes, such as the mouth, lip or nose, caused by an endotracheal or a nasogastric tube, for example (Coyer et al. 2013).

The causal pathway for PUs is a complicated process (Figure 2). In single cells, the injury mechanism is cell deformation damage. At both cell and tissue level, the injury mechanism may be inflammation-related damage or ischemia and reperfusion damage. Besides causing direct damage, these mechanisms also interact with each other. Cell deformation may thus act as a trigger for inflammation and the formation of oedema can disrupt the capillary network, reducing nutrient supply to tissues, or cause lymphatic blockages that reduce the clearance of metabolic waste products (EPUAP/NPIAP/PPPIA 2019).

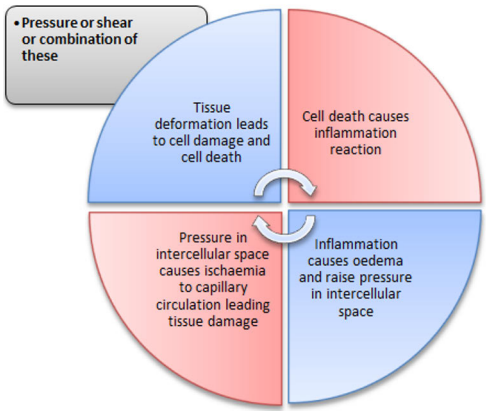

Figure 2. The causal pathway for PU.

Pressure ulcer stages are classified internationally into six categories: four categories according to the depth of the damage caused and two unknown depth of PU categories, i.e., suspected deep tissue injury and unstageable PU (NPUAP/EPUAP/PPPIA 2014, Table 1). The most common PU stages reported with older people are stages I and II (Sugathapala et al. 2023)

Table 1. International NPUAP/EPUAP pressure ulcer classification (NPUAP/EPUAP/PPPIA, 2014).

Category/stage I: nonblanchable erythema	Intact skin with non-blanchable redness of a localized area usually over a bony prominence. Darkly pigmented skin may not have visible blanching; its colour may differ from the surrounding area. The area may be painful, firm, soft, warmer or cooler as compared to adjacent tissue. Category/Stage I may be difficult to detect in individuals with dark skin tones. May indicate “at risk” individuals (a heralding sign of risk).
Category/stage II: partial thickness skin loss	Partial thickness loss of dermis presenting as a shallow open ulcer with a red-pink wound bed, without slough. May also present as an intact or open/ruptured serum filled blister. Presents as a shiny or dry shallow ulcer without slough or bruising.* This Category/Stage should not be used to describe skin tears, tape burns, perineal dermatitis, maceration or excoriation.*Bruising indicates suspected deep tissue injury.
Category/stage III: full thickness skin loss	Full thickness tissue loss. Subcutaneous fat may be visible but bone, tendon or muscle are not exposed. Slough may be present but does not obscure the depth of tissue loss. May include undermining and tunneling. The depth of a Category/Stage III pressure ulcer varies by anatomical location. The bridge of the nose, ear, occiput and malleolus do not have subcutaneous tissue and stage III pressure ulcer can be shallow. In contrast, areas of significant adiposity can develop extremely deep stage III pressure ulcers. Bone and tendon is not visible or directly palpable.
Category/stage IV: full thickness tissue loss	Full thickness tissue loss with exposed bone, tendon or muscle. Slough or eschar may be present on some parts of the wound bed. Often include undermining and tunnelling. The depth of a Category/Stage IV pressure ulcer varies by anatomical location. The bridge of the nose, ear, occiput and malleolus do not have subcutaneous tissue and these ulcers can be shallow. Category/Stage IV ulcers can extend into muscle and/or supporting structures (e.g., fascia, tendon or joint capsule) making osteomyelitis possible. Exposed bone/tendon is visible or directly palpable.
Unstageable: depth unknown	Full thickness tissue loss in which the base of the ulcer is covered by slough (yellow, tan, grey, green or brown) and/or eschar (tan, brown or black) in the wound bed. Until enough slough and/or eschar is removed to expose the base of the wound, the true depth, and therefore Category/Stage, cannot be determined. Stable (dry, adherent, intact without erythema or fluctuance) eschar on the heels serves as ‘the body’s natural (biological) cover’ and should not be removed.
Suspected deep tissue injury: depth unknown	Purple or maroon localized area of discoloured intact skin or blood-filled blister due to damage of underlying soft tissue from pressure and/or shear. The area may be preceded by tissue that is painful, firm, mushy, boggy, warmer or cooler as compared to adjacent tissue. Deep tissue injury may be difficult to detect in individuals with dark skin tones. Evolution may include a thin blister over a dark wound bed. The pressure ulcer may further evolve and become covered by thin eschar. Evolution may be rapid exposing additional layers of tissue even with optimal treatment.

2.1.2 Risk factors for pressure ulcer

Several factors have been described as risk factors for individuals to develop a PU. According to literature of international guidelines, risk factors for PU development include activity and mobility limitations, skin status, perfusion, oxygenation and circulation factors, the key figures of nutrition, moisture, body temperature, old age, sensory perception limitations, blood markers and general and mental health status (EPUAP/NPIAP/PPPIA 2019).

Classification of the factors that cause risk for individuals is done by dividing them into two groups: mechanical boundary conditions and individual tolerance. Mechanical boundary conditions mean the greatness of power and duration of time of the mechanical loads, and the mechanism of their action such as compression or shear. Tolerance of the individual includes anatomy of the body, such as prominence of bony structures, tissue structure and mechanical characteristics, tissue repair capacity, and transport and thermal characteristics of tissues (Coleman et al. 2014).

Older people are at higher risk of PUs due to a wide range of risk-increasing characteristics, such as age, multiple comorbidities and living in an aged care facility (EPUAP/NPIAP/PPPIA 2019, Latimer et al. 2019, Nakashima et al. 2018, Sugathapala et al. 2023). Also, with age, physical activity and moving decreases, and immobility, long-lasting sitting or lying down may lead to the development of PUs (Cai et al. 2019, Manderlier et al. 2019). Immobility may also weaken the general health status (Skogestad et al. 2016) and lead to weakening of the skin condition and the appearance of PUs (Coleman et al. 2012). Older people with comorbidities such as cancer (Aljezawi & Tubaishat 2018, Cai et al. 2019), cardiovascular diseases (Gillespie et al. 2014), dementia (Cai et al. 2019) or diabetes (Borsting et al. 2018) are at higher risk of having PUs. PUs in older people have also been reported to be associated with memory disorders or proximity to death (Artico et al. 2018, Estabrooks et al. 2015, Martinsson et al. 2018). In the variation in PUs between facilities, residents were more likely to have higher PU rates in facilities located in areas with low socioeconomic status or in facilities in rural areas compared with major city areas (Jorgensen et al. 2018).

2.1.3 Prevalence of pressure ulcers in long-term older people care

PUs exist worldwide in LOPC. Globally, the PU prevalence for any stage was 11.6 % in 30 studies with 355,784 older people (Sugathapala et al. 2023). However, the reported PU prevalence varied a lot (Anthony et al. 2019). Factors related to variation in the prevalence numbers included country, PU stages, dementia

diagnosis, proximity to death, age, mobility, or ongoing development of PU protocols.

PU stages varied in the PU prevalence numbers reported from LOPC facilities since year 2012 (Table 2). PU prevalence varied depending on country or whether the PU stage I was included (= all PU stages included) or not (= PU stage I excluded) for prevalence accounting. PU prevalence including stage I and more PUs was reported in Finland, Italy, Switzerland, New Zealand, Portugal and Germany. In these studies, in 10–105 LOPC facilities, in the years 2013–2018, variation of 4.3–12% in PU prevalence rates variation was identified (Carryer et al. 2017, Courvoisier et al. 2018, Hahnel et al. 2017, Lopes et al. 2020, Palese et al. 2020, Stolt et al. 2019). PU prevalence including stage II PUs or higher was reported in the United States, Italy, Spain, and Germany. In these studies from the years 2012–2018 including 1,047–2,936,146 LOPC residents, the PU prevalence was 3.5–12.0% (Ahn et al. 2016, CMC 2015, Hernández-Martínez-Esparza 2021, Raeder et al. 2020, Rasero et al. 2015).

In residents with dementia, PU prevalence increased during the last year before death from 4.6% to 9.5% (Estabrooks et al. 2015). In a home palliative care unit in Italy and in patients from a palliative care register in Sweden with a dementia diagnosis and who died in a nursing home in the years 2012–2015 (574–16,428 patients, mean age 72.1–86.7 years, during 6 months before death–at death), the reported PU prevalence in stage I–IV or unknown PUs was 13.1–15.0% (Artico et al. 2018, Martinsson et al. 2018).

Depending on the age of residents, the number of PUs varies even in the same facilities. For example, in various facilities in Japan in 2017, the numbers of people with PUs including PU stage I was 9.2 per 1,000 population in those aged ≥ 65 years but increased to 44.6 in those aged ≥ 80 years. (Nakashima et al. 2018). Also, in New Zealand, in 2016, PU prevalence in nursing home facilities was 8% in those over 65 years but rose to 12% in those older than 85 years (Carryer et al. 2017).

In Australia, among older people ≥ 65 years with limited mobility, the prevalence of PUs in 2014–2015 was 10.8% within the first 36 hours of their hospital admission. (Latimer et al. 2019). However, it was reported that high frequency of unsafe movements may also cause PUs in older people (Budri et al. 2020). Organisations with ongoing development of PU prevention protocols seemed to have lower prevalence rates (Righi et al. 2020).

Table 2. PU prevalence in LOPC.

PU PREVALENCE IN LOPC

	AUTHOR/ COUNTRY	NUMBER OF LOPC FACILITIES OR RESIDENTS/ PATIENTS	YEARS	PU PREVALENCE (%)
ALL PU STAGES INCLUDED	Carryer et al. 2017/ New Zealand, Courvoisier et al. 2018/ Switzerland, Hahnel et al. 2017/ Germany, Lopes et al. 2020/Portugal, Palese et al. 2020/ Italy, Stolt et al. 2019/ Finland.	10–105 LOPC facilities	2013–2018	4.3–12.0
PU STAGE I EXCLUDED	Ahn et al. 2016, CMC 2015/ The United States, Hernández-Martínez-Esparza 2021, Spain, Raeder et al. 2020/ Germany, Rasero et al. 2015/ Italy.	1,047–2,936,146 residents	2012–2018	3.5–12.0
RESIDENTS WITH DEMENTIA	Artico et al. 2018/Italy,	574 patients	2012–2016	13.1
	Martinsson et al. 2018/Sweden,	16,428 residents	2012–2015	At dead 15.6
	Estabrooks et al. 2015/Canada	36 nursing homes	2009–2010	Increased during the last year before death from 4.6% to 9.5%
DEPENDING ON THE AGE	Nakashima et al. 2018/Japan,	1126 residents	2017	9.2 per 1,000 population in those aged ≥ 65 years, 44.6 per 1,000 population in those aged ≥ 80 years
	Carryer et al. 2017/ New Zealand.	276 residents	2016	8% in those over 65 years 12% in those over 85 years
L**IMITED MOBILITY**	Latimer et al. 2019/Australia	1047 patients	2014–2015	10.8% within the first 36 hours of their hospital admission

2.2 Pressure ulcer prevention

2.2.1 Guidelines for pressure ulcer prevention

In PU prevention, evidence-based international guidelines for consistent practice exist. The latest updates were by the National Pressure Injury Advisory Panel (NPIAP), the European Pressure Ulcer Advisory Panel EPUAP) and the Pan Pacific Pressure Injury Alliance (PPPIA) in 2014 and 2019 (EPUAP/NPIAP/PPPIA 2019, NPUAP/EPUAP/PPPIA 2014). Based on these international guidelines, several national PU prevention guidelines have also been translated or drawn up in many countries (NICE 2014, NRF 2015, NRF 2023). International guidelines for preventing pressure ulcers include various recommendations concerning areas such as risk assessment, skin assessment and care, nutrition, repositioning and support surfaces (EPUAP/NPIAP/PPPIA 2019, NPUAP/EPUAP/PPPIA 2014). According to studies mostly conducted in acute care, the prevention of PUs can be improved by using evidence-based clinical practice guidelines (Beal et al. 2016, Connor et al. 2023, Martin et al. 2017). Some studies conducted in LOPC have also shown this improvement (Wölzer et al. 2023, Wogamon 2016).

Risk assessment has been recommended in international PU prevention guidelines (EPUAP/NPIAP/PPPIA 2019) as practice to identify individuals who are at potential PU risk. Risk assessment should be done first at every admission to healthcare, identifying those who are at risk of PU, which is then followed by full screening with a PU risk assessment tool. The advantage of risk assessment scales, such as the commonly used Braden scale for older people (Bergstrom et al. 1987), is that they provide a structural approach for risk assessment in practice (EPUAP/NPIAP/PPPIA 2019). Later, it has been reported that risk assessment should also include risk factors other than those represented in the risk assessment tool, such as skin status, diabetes, perfusion and oxygenation, fever, advanced age, blood tests, or general health status (Berlowitz 2014). However, there is also reported uncertainty of whether use of the Braden risk assessment tool makes any difference to PU incidence compared to risk assessment using clinical judgement and training (Kottner et al. 2023). This also applies to risk assessment using the Waterlow tool (Waterloo 1985) or the Ramstadius tool (Ramstadius 2000, Moore et al. 2019).

Skin assessment in PU prevention is as an essential component of any PU risk assessment and should be conducted as soon as possible after admission; in addition, during repositioning, a brief assessment should be done of pressure points, such as bony prominences, the sacrum, ischial tuberosities, greater trochanters and heels (EPUAP/NPIAP/PPPIA 2019). Skin assessment should

include a visual inspection with touch and palpation for differences in skin temperature and tissue consistency. When education was provided to health professionals on assessment of skin colour, texture and warmth, it was reported to lead to significant reduction of PU rates in older people care setting within 12 weeks (Rosen et al. 2006).

Nutrition research identifies the association between the nutritional status and PUs (Chen et al. 2023). Nutrition plays a vital role in the prevention and treatment of PUs. Nutrients are needed for the growth, preservation and repair of body tissues. Well-nourished individuals are at lower risk of developing PUs compared to malnourished individuals (NPUAP/EPUAP/PPPIA 2014). The Academy and ASPEN defined adult malnutrition "as the presence of two or more of the following characteristics: insufficient energy intake, unintended weight loss, loss of muscle mass, loss of subcutaneous fat, localized and generalized fluid accumulation, and decreased functional status" (White et al. 2012, page 277).

Nutrition screening should be conducted on admission to the facility with a tool that is valid to the patient group to be assessed. One example of the nutritional assessment tools is the Mini Nutritional Assessment (MNA®), which was developed for older people and classifies them as malnourished, at risk of malnutrition, or well-nourished (NPUAP/EPUAP/PPPIA 2014).

Repositioning and early mobilisation of patients is an essential component in the prevention of PUs. PUs cannot exist without pressure on the tissue. Prolonged periods of lying or sitting on the same body part and failing to redistribute pressure can lead to continuous deformation of soft tissues, eventually causing tissue damage (EPUAP/NPIAP/PPPIA 2019).

A variety of pressure-reducing support surfaces, such as beds, mattresses (e.g. standard or foam), mattress overlays and seat cushions aim to distribute the surface pressure of the body more evenly or change high and low pressures between the body and support with filling and emptying of air-filled cells (McInnes et al. 2015). Support surfaces prevent PUs by decreasing the damage to tissues caused by pressure by distributing the mechanical burden imposed on the skin and soft tissues resulting from patient immobility (NPUAP/EPUAP/PPPIA 2014). In a systematic review including 65 RCTs, Shi et al. (2018) compared the effects of different support surfaces in reducing PU incidence and comfort. They showed that powered active air surfaces and powered hybrid air surfaces probably reduce PU incidence compared to standard hospital mattresses. However, the participants did not perceive them as comfortable compared to standard hospital surfaces. Overall, it is uncertain which support surface is the most effective for preventing pressure ulcers (Shi et al. 2018).

2.2.2 Preventive interventions for pressure ulcer prevention

Systematic reviews for PU prevention interventions have usually been carried out in various health care settings and mostly include interventions targeted at acute care settings. In the reviews, preventive interventions targeted in long-term care were scarce, only 4 out of 24 interventions (Niederhauser et al. 2012), 10 out of 59 interventions (Reddy et al. 2006), 6 out of 65 interventions (Shi et al. 2018), and 8 out of 26 interventions (Sullivan et al. 2013). In these reviews, the interventions conducted in long-term or long-term older people care were support surfaces (7 studies), repositioning, exercise and incontinence care and nutrition (one study each) (Reddy et al. 2006), quality improvement programme (3 studies) and staff education (1 study) (Niederhauser et al. 2012), quality improvement programme (4 studies), prevention programme (2 studies) and training (1 study) (Sullivan et al. 2013), and support surfaces (8 studies) (Shi et al. 2018). In these studies, only a few interventions were effective (Reddy et al. 2006), the level of evidence was weak lacking randomisation and control groups or reported process measures, which made it difficult to determine whether the interventions contributed to increased staff compliance with new PU prevention practices (Niederhauser et al 2012), or there was lack of information on daily care processes and their measurement to better understand their influence on outcomes (Sullivan et al. 2013). Also, in RCTs, most prevention evidence was weak (Shi et al. 2018). Recently, one scoping review of PU prevention interventions conducted solely in nursing homes settings was published by Yang et al. (2023) considering 40 studies. In these studies, to promote the implementation of routine PU prevention practices, quality improvement, training and education were common interventions. Less research has been conducted on evidence-based practice, device-assisted PU prophylaxis, nursing protocols, and clinical decision support systems.

Educational interventions to improve PU prevention knowledge in hospitals have consisted of the use of face-to-face or virtual education training sessions on PUs, or both (Esche et al. 2015, Karimian et al. 2020), as well as an electronic clinical decision support system for PU prevention defined as a computer program that generated a resident-tailored protocol for PU prevention (Beeckman et al. 2011). In nursing homes, the following educational interventions have been used: implementation of multiple PU prevention guidelines (van Gaal et al. 2010), an electronic clinical decision support system for PU prevention (Beeckman et al. 2012), and construction of a framework for nursing homes by analysing the nursing competency for PU management, followed by implementation of suitable PU education programmes (Lee et al. 2022).

2.2.3 Supporting structures for the implementation of PU prevention guidelines into practice

The implementation of PU prevention practice requires supporting structures. In the literature review of Stadnyk et al. (2018) including 41 articles published between 2010 and 2017, five multilevel factors were identified as factors facilitating an organisational culture to prevent PUs and promote the implementation of PU prevention practices in older people care in health care: leadership, education, ongoing quality improvement, clinical practice based on best practice and standardized care bundles, and unit-level champions.

Leaders' prioritisation of PU prevention empowered frontline staff to embed PU prevention as part of 'routine' care (Stadnyk et al. 2018). For implementing evidence-based practice, organisational support and prioritisation of PU prevention for frontline staff members by leadership, visible presence of leaders and paying attention to daily function by them have been considered essential (Fleiszer et al. 2016, Hartmann et al. 2016, Sharkey et al. 2013). Heavy workload has been identified as a barrier to desired quality outcomes in PU prevention (Sharkey et al. 2013).

The main emphasis of the change effort is on education, but it requires support from leadership for an ongoing commitment to professional development and protected education time and resources for development. Staff education is important in order to increase knowledge and build capacity to decrease PUs and includes annual PU prevention sessions with training (Stadnyk et al. 2018). The availability of research articles and education sessions for nurses on searching and evaluating research evidence have also been mentioned (Morgan 2012).

Ongoing quality improvement is a necessary facilitator for PU prevention and improved patient outcomes. Involving frontline staff in the development, planning, implementation, and evaluation of change efforts enhances participation and compliance and increases responsibility for care. Evaluating organisational culture change frequently enables modifications to be made (Stadnyk et al. 2018).

Clinical practice based on best practice and standardised care bundles facilitates the accomplishment of organisational culture and is affiliated with the education, attitudes and values of frontline staff to ensure that PU prevention practices are embedded as part of routine care, strengthening an evidence-based practice culture (Stadnyk et al. 2018). It has also been considered important to collect evidence on which bundles of PU prevention are best suited to the context of older people care and its contextual features (Niederhauser et al. 2012, Soban et al. 2011).

Unit-level champions have been used to foster changes in nursing homes (Sharkey et al. 2013, Woo 2017). To accomplish any practice change, unit-level champions are needed. For PU prevention, these champions are frontline staff with

advanced training in wound care and PU prevention. They drive cultural change by educating, mentoring, supporting, and empowering other frontline staff to integrate clinical practice guidelines for PU prevention into their daily practice. (Stadnyk et al. 2018).

In addition, in implementation of evidence to practice, one reported supporting structure is implementation of methods by which evidence can systematically be distributed into practice by nursing staff (Edwards et al. 2017). Various implementation methods have been used, such as the "Champions for Skin Integrity model" (Edwards et al. 2017) and the Iowa model (Iowa Model Collaborative 2017, Pittman et al. 2015). The Finnish national implementation model, the Operational Model for Developing Evidence-Based Practices (OMEBP, Jylhä et al. 2017, NRF 2018) developed by the Nursing Research Foundation and updated in 2024 (NRF 2024), is a generic model for use for implementation of the guidelines. The OMEBP model was developed to support evidence implementation and evidence-based practice in nursing (NRF 2018). The basis of the OMEBP model is the supporting structures, such as producing and condensing research information, at the international, national, regional and operating unit level, which are preconditions for evidence-based action. These support structures ensure the production and availability of reliable evidence, ensuring competence and development of consistent practices based on evidence, implementation, evaluation and follow-up. (NRF 2024).

Moreover, contextual feature may influence the success of the implementation of complex interventions in LOPC and should be taken in account when planning supportive structures. The literature review of Peryer et al. (2022), including 33 process evaluations of complex interventions conducted in care homes, studied potential mechanisms of evidence-based practice changes in complex settings. They concluded that study implementation in care home was most effective when the intervention was co-produced, with agreed purpose, and with adequate resources to incorporate within existing routines and care practices (Peryer et al. 2022).

After the success of the implementation of the intervention and significant reduction in the prevalence of PUs as well as achievement of care staff's practice change, the practice still needs supportive activities to maintain the sustainability of the intervention (Fleiszer et al. 2016, Stadnyk et al. 2018).

2.3 Summary of the literature

Pressure ulcer is injury to the skin and underlying tissue, caused by prolonged pressure on the skin (EPUAP/NPIAP/PPPIA, 2019). PUs are classified in stages based on the depth of the damage caused. Most PUs are preventable (Baker et al.

2016, Black et al. 2011) and recommendations for PU prevention are established in the evidence-based international guidelines for PU prevention.

However, despite the existence of guidelines, the clinical practices in PU prevention vary in organisations and the PU prevention guidelines are not implemented or widely used in practice (Källman et al. 2022) even though PUs exist all over the world in all healthcare environments. In addition, some population groups, such as older people, have characteristics that raise their risk for having a PU which creates an increased need to pay attention to prevention.

The prevention of PUs is crucial because of the remarkable effect of PUs on individuals, organisations and society. For individuals, PUs are non-intended, adverse events that cause daily pain, suffering and decreased quality of life. In organisations, PUs require a lot of resources because they are long-lasting and heal slowly. For society, the costs of care of PUs are high whereas the costs of PU prevention are much lower than the cost of harm. PUs must therefore be systematically prevented with effective interventions based on international guidelines.

Implementation of evidence-based guidelines into practice needs attention. Existing international literature reveals a need for research of consistent practice for PU prevention in the context of LOPC. Earlier research on PU prevention interventions has mostly been conducted in acute care. There is a need for effective PU prevention interventions and implementation models for evidence-based PU prevention practice based on international guidelines in the context of LOPC.

To produce PU prevention of sufficient quality in LOPC, decrease suffering, and achieve cost savings in PU treatment, a commonly agreed consistent practice for PU prevention that is based on evidence may be one solution.

3 Aims of the study

The aim of this study was to develop, implement, and evaluate the effectiveness of a Consistent Practice Intervention based on international guidelines of pressure ulcer (PU) prevention (NPUAP/EPUAP/PPPIA 2014) focused on older people in long-term care facilities (LOPC) (Figure 1). The ultimate goal of the study was to produce transferable intervention ensuring PU prevention to improve the quality of care of older people in LOPC facilities.

The study has been divided into three phases: theoretical phase, development and implementation of an intervention, and evaluation of the effectiveness of the intervention (substudies I–IV, Figure 1).

The research questions were:

I Theoretical phase

1. What interventions have been conducted in long-term older people care facilities on the prevention of PUs and how effective have the interventions been (Paper I)

II Development and implementation of an intervention

III Evaluation of the effectiveness of the intervention

2. What is the effectiveness of the intervention
    - on nursing staff's consistent practice for PU prevention in line with international guidelines? (Paper II)
    - on the prevalence of PUs? (Paper III)
    - on PU prevention practices implemented for residents? (Paper III)
    - on nursing staff's PU prevention knowledge? (Paper IV)

The effectiveness was evaluated by assessing the change and direction of the outcome of the question. Based on this, the following hypotheses were presented:

After the intervention, compared to the comparison facility, in the intervention facility:

- pressure ulcer prevention practice has changed and become more consistent and in line with international pressure ulcer prevention guidelines,
- the prevalence of PUs and the residents' highest stages of PUs has decreased more,
- pressure ulcer prevention implemented for residents has improved more and
- the nursing staff's pressure ulcer knowledge has improved more.

4 Materials and Methods

This chapter describes the materials and methods used in study phases I–III. Various design settings, sampling samples, instruments, data collection as well as types of analysis were used to obtain a comprehensive picture of the effectiveness of earlier used PU prevention interventions in a systematic review and in the quasi-experimental intervention study (Table 3).

Table 3. Study design, setting, sampling, data collection, instruments and data analysis.

PHASE	AIM	DESIGN, SETTING, SAMPLING	INSTRUMENT, DATA COLLECTION	DATA ANALYSIS
PHASE I: THEORETICAL PHASE		Systematic review Articles from LOPC setting; overall, 2664 references were screened in • PubMed (MEDLINE) (839) • CINAHL (531) • Web of Science Core Collection (616) • Scopus (487) • Cochrane Wounds Group Specialized Register (29) • Cochrane Central Register of Controlled Trials (162) Research articles (n = 18)	In electronic databases: Literature search and selection of the studies confirmed by two independent researchers (Paper I, Figure 1), based on eligibility criteria (Table 4)	Characteristics of the studies and the data of the content and effectiveness of the interventions were extracted and tabulated. The data of the interventions were analysed by narrative synthesis according to Popay et al. (2006)
PHASE II: DEVELOPMENT AND IMPLEMENTATION OF THE INTERVENTION		Based on the International PU prevention guidelines (NPUAP/EPUAP/PPPIA 2014) and using the OMEBP-model with four steps, a renewed consistent practice for PU prevention was developed and implemented. The content of the renewed consistent PU prevention practice was a bundle of six PU prevention areas: risk assessment, skin assessment and skin care, nutrition, repositioning, pressure relieving devices, and documentation.		
PHASE III: EVALUATION OF THE EFFECTIVENESS OF THE INTERVENTION	Substudies I – IV all refer to the same intervention study.	A quasi-experimental intervention study, Two conveniently chosen LOPC-facilities, randomly allocated on facility level to the intervention or the comparison group (Figure 3) (the unit of randomisation = facility).		

	Substudy I: To evaluate the effectiveness of the intervention on nursing staff's PU prevention consistent practice in line with evidence-based international guidelines.	Sample: All registered and practical nurses. Intervention group: invited n = 76, analysed n = 69 before the intervention/ n = 61 after the intervention. Comparison group: invited n = 85, analysed n = 72 before the intervention/ n = 51 after the intervention.	Pressure Ulcer Prevention Practice Instrument (PUPreP instrument) Data collection before and after	Statistical analysis with SPSS Statistics for Windows 23 (IBM Corp., Armonk, NY)
	Substudy II: To evaluate the effectiveness of the intervention on PU prevalence and the residents' highest PU stage.	Sample: All residents. Intervention group: invited n = 122, analysed n = 113 before the intervention/ n = 95 after the intervention. Comparison group: invited n = 133, analysed n = 116 before the intervention / n = 80 after the intervention.	Pressure Ulcer Patient instrument (PUP-Ins) Data collection before and after	Statistical analysis with SPSS Statistics for Windows 26 (IBM Corp., Armonk, NY)
	Substudy III: To evaluate the effectiveness of the intervention on PU prevention practices implemented for residents.	Sample: All residents. Intervention group: invited n = 122, analysed n = 113 before the intervention/ n = 95 after the intervention. Comparison group: invited n = 133, analysed n = 117 before the intervention / n = 80 after the intervention.	Pressure Ulcer Patient instrument (PUP-Ins) Data collection before and after	Statistical analysis with SPSS Statistics for Windows 26 (IBM Corp., Armonk, NY)

	Substudy IV: To evaluate the effectiveness of the intervention on Nursing staff's knowledge on evidence-based PU prevention and early-stage treatment practices.	Sample: All registered and practical nurses. Intervention group: invited n = 76, analysed n = 69 before the intervention/ n =61 after the intervention. Comparison group: invited n = 85, analysed n = 72 before the intervention/ n = 51 after the intervention.	Knowledge test: Pressure Ulcer Prevention Knowledge (PUPK) Data collection before and after	Statistical analysis with SPSS Statistics for Windows 26 (IBM Corp., Armonk, NY)

LOPC = long-term older people care, OMEBP = Operational Model for Evidence-based practices, PU = pressure ulcer

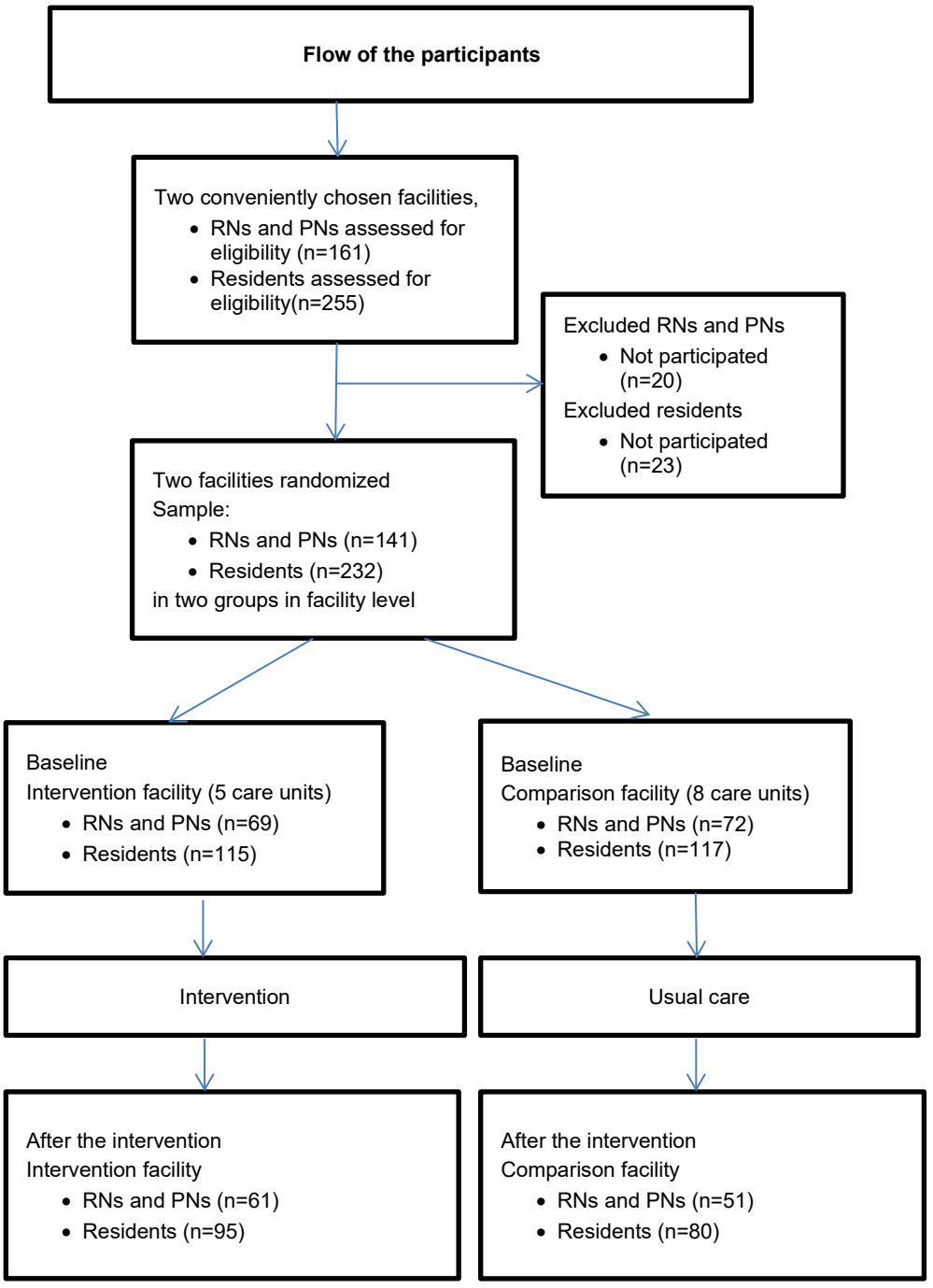

Figure 3. Flow of the participants.

4.1 Study design, setting and sampling

Theoretical phase

In the first phase of the study, a systematic review was conducted in studies reported in 2005–2017 to map the existing literature regarding the earlier interventions aimed at preventing PUs in LOPC. The aim was to explore the content and the effectiveness of earlier used interventions and also to use the findings in planning the method and content of the intervention in this study. The effectiveness of the interventions was estimated by investigating the outcomes PU incidence, PU prevalence or PU healing time. During the review, other outcomes, i.e. PU prevention knowledge and PU prevention practices implemented for resident, were also found to estimate the effectiveness of PU prevention interventions, and these outcomes were also chosen for estimating the effectiveness of the intervention in this study. Of the outcomes PU incidence, PU prevalence and healing time, PU prevalence was chosen as one of the outcomes in the study, because it was most frequently used in earlier studies and provides a clear estimate for the effectiveness of prevention of PUs. A systematic review is appropriate when the goal is to conduct a systematic search, evaluate, and synthesise research evidence, following established guidelines for review procedures (Grant & Booth 2009). The systematic review was required for this topic because in order to promote high-quality care in LOPC facilities with the intervention of this study, it is important to systematically find, evaluate and analyse effective PU prevention interventions conducted previously in this context. Overall, 2,664 references were screened in PubMed (MEDLINE) (839), CINAHL (531), Web of Science Core Collection (616), Scopus (487), Cochrane Wounds Group Specialized Register (29) and Cochrane Central Register of Controlled Trials (162). The included research articles (n = 18) were conducted in LOPC settings in the USA (4), the Netherlands (3), Canada (2), the United Kingdom, Ireland, USA/ Canada, Italy, Belgium, Norway, China (Hongkong), France and one unknown country.

Development and implementation of an intervention

In the second phase, in a public long-term older people care (LOPC) facility in Finland, an intervention, renewed consistent practice for PU prevention for nursing staff was developed and implemented based on international PU prevention guidelines (NPUAP/EPUAP/PPPIA 2014) using the Operational Model for Evidence-Based Practices (OMEBP, Figure 4, NRF 2018). International PU prevention guidelines were chosen because they are based on research evidence and are widely accepted in use in globally. Also, the results of the systematic

review were used in planning the content of the intervention (Paper I). Two LOPC facilities were conveniently chosen and randomly allocated to intervention and comparison facilities (Figure 3). In total, the intervention facility included five and the comparison facility eight care units, all of them providing all day and night care units for older people and corresponding to each other.

Intervention

The content of the renewed consistent PU prevention practice was a bundle of six PU prevention areas: risk assessment, skin assessment and skin care, nutrition, repositioning, pressure-relieving devices, and documentation. In the comparison care facility, standard PU prevention practice was continued. The PU prevention practices at baseline in the intervention and comparison facility were described in Paper II.

The Operational Model for Evidence-Based Practices (OMEBP, Figure 4, Jylhä et al. 2017, NRF 2018, Suhonen et al. 2019) was used in the development and implementation of renewed consistent PU prevention practices. The model was chosen because it is well known and has been used before in Finnish health care (Suhonen et al. 2019). The generic OMEBP model is developed by the Finnish Nursing Research Foundation (NRF 2018). In the model, the development and implementation of consistent practice proceeds in four steps: 1) Development needs for current practice, where the purpose is to assess whether the current practice is aligned with the best available evidence, such as international guidelines for PU prevention, and to identify change needs in current practice, 2) Plan for consistent practice, where the purpose is to design consistent practice by renewing the current practice in line with the best evidence, 3) Consistent practice, where the purpose is to describe the renewed consistent practice and then, to implement the new, agreed practice, and 4) Evaluation of the practice, where the purpose is to evaluate the practice to ensure the consistency.

Next comes a description of the foot-prints in the four steps used in the intervention according to the OMEBP model (Figure 4, NRF 2018) in the development and implementation of the renewed consistent PU prevention practice in this study.

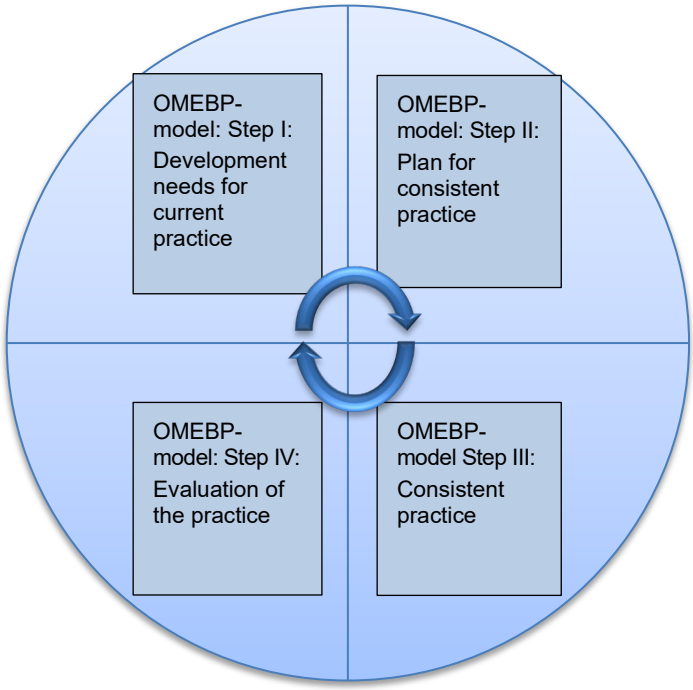

Figure 4. The OMEBP model, modified from NRF 2018 (https://hotus.fi/en/supporting-structures-of-ebp/).

OMEBP model: Step I: Development needs for current practice (Jan–Feb 2016)

The current practice of the nursing staff's PU prevention was assessed with the Pressure Ulcer Prevention Practice (PUPreP) instrument. In all care units in the intervention and comparison facilities, this baseline data was collected two weeks before the intervention. Also, in a meeting before the intervention, head nurses and researchers confirmed consensus on the research protocol. Two wound contact persons, one RN and one PN, from all five units were also appointed by head nurses.

The "Development needs for current practice" step (Figure 5, Paper II) included an orientation meeting and the first development meeting for head nurses, RNs and PNs. During the three-hour orientation meeting, researchers briefed participants on the research purpose, its various steps, and the roles of different actors. Presentations of evidence-based practices and OMEBP were also given.

In the first development meeting, the results of the baseline data of the current PU prevention practice in the facility were reported to nursing staff. Additionally, an authorised wound care nurse gave a presentation on international guidelines for PU prevention and early identification (NPUAP/EPUAP/PPPIA 2014), and the international PU classification system was introduced. The participants, discussed with researchers and authorised wound care nurse the current practice and compared it with international PU prevention guidelines, with the goal of identifying development needs in the current practice. (Figure 5)

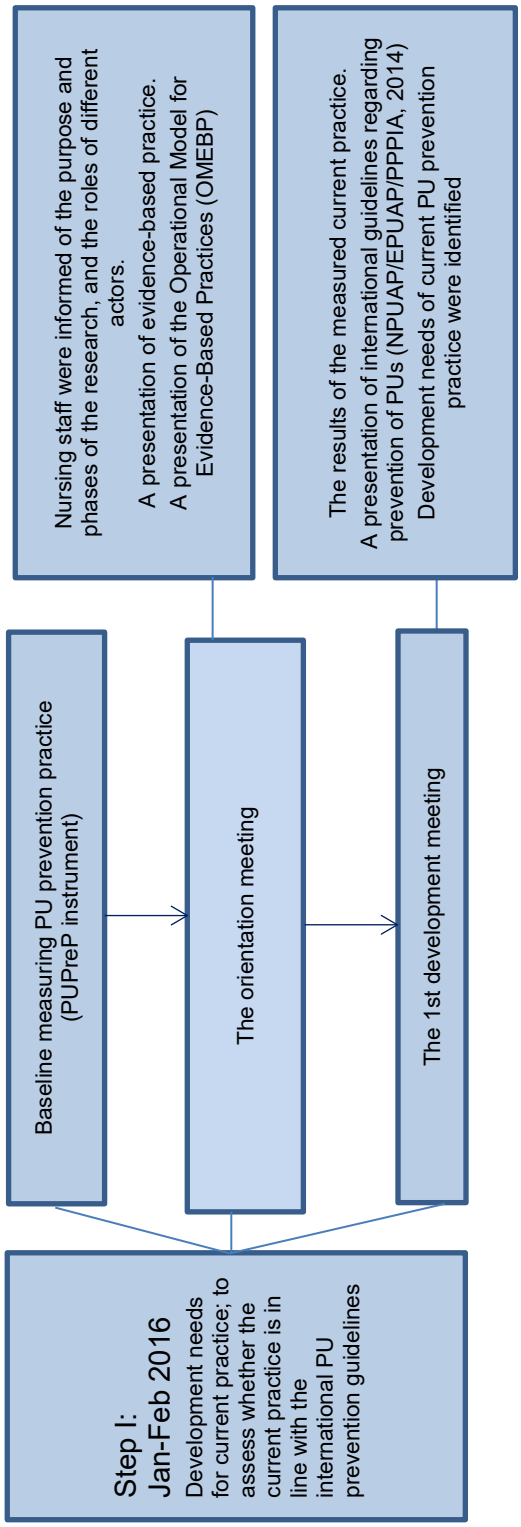

Figure 5. Development needs for current practice (modified from Paper II).

OMEBP model: Step II: Plan for consistent practice (Feb 2016)

In the second step (Figure 6, Paper II), the purpose was to plan the renewed consistent practice by making changes to the current PU prevention practice of the facility in line with the international guidelines (NPUAP/EPUAP/PPPIA 2014). The step "Plan for consistent practice" included the second and third development meetings, attended by head nurses and two wound contact persons from every unit and led by the researchers along with two authorised wound care nurses.

In this second development meeting, six content areas from the international PU prevention guidelines were chosen. These were risk assessment, skin assessment and skin care, nutrition, repositioning, pressure-relieving devices, and documentation. In these areas, the planning of updated actions and documentation in the facility was now started. The national PU prevention guidelines (NRF 2015), based on international guidelines (NPUAP/EPUAP/PPPIA 2014), were used as a tool in these meetings. Before the third development meeting, head nurses and wound contact persons in each unit worked independently tailoring one of the chosen PU prevention content areas.

During the third development meeting, the head nurses and wound contact persons continued the planning of renewed consistent PU prevention practice under the guidance the researchers and authorised wound care nurses. The renewed consistent practice, the "Procedure for PU Prevention in LOPC Facility" (Paper II), was now completed. A written procedure was produced including the six areas of consistent practice as follows: 1) how and when to act and 2) how and when to document. An agreement on yearly PU prevention education for nursing staff as well as using the procedure as part of the orientation programme for new nursing staff was also made.

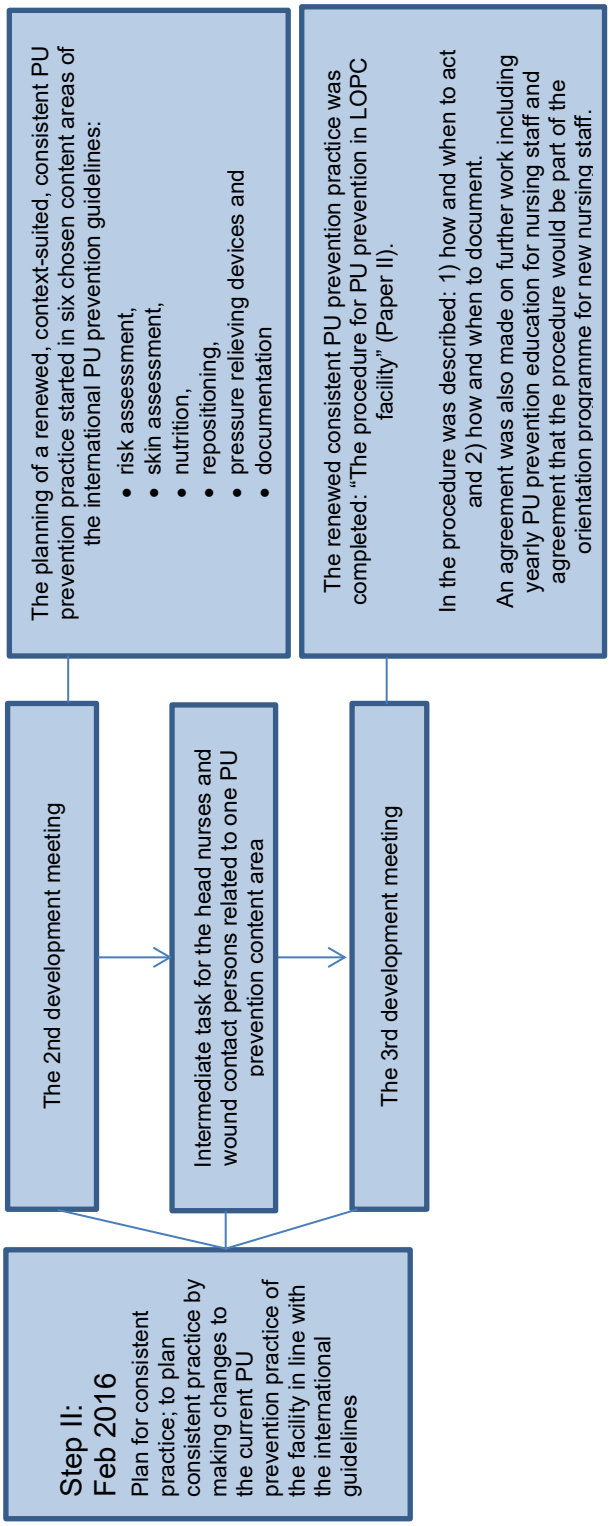

Figure 6. Plan for consistent practice (modified from Paper II).

OMEBP model: Step III: Consistent practice (Mar–Dec 2016)

In the third step (Figure 7, Paper II), the purpose was to describe the new procedure for the nursing staff, and then, to implement the renewed consistent PU prevention practice. First, units in the intervention facility had unit meetings where the researcher with the head nurse, and together the nursing staff went through the new procedure. A copy of "Procedure for PU Prevention in LOPC Facility" was also sent to nursing staff's personal e-mail and detailed on the facility's internal web pages. Following this, the implementation of the updated PU prevention practices began immediately. The entire nursing staff worked in accordance with the "Procedure for PU Prevention in LOPC Facility". In each unit, the wound contact persons facilitated the implementation of the updated practice by showing an example and mentoring others.

As a supporting structure, nursing staff were educated monthly in six 90-minute face-to-face education sessions on the nursing staff's "wishes" topics: risk assessment, skin assessment and skin care, nutrition, pressure-relieving devices and, as secondary prevention of PUs, wound care. Also, participants were given a pocket-size version of the Braden scale instructions and the international PU classification system. The nursing staff members were also encouraged to use online material on PU prevention. Additionally, a researcher and an authorized wound care nurse were available for nursing staff to answer their questions (Figure 7).

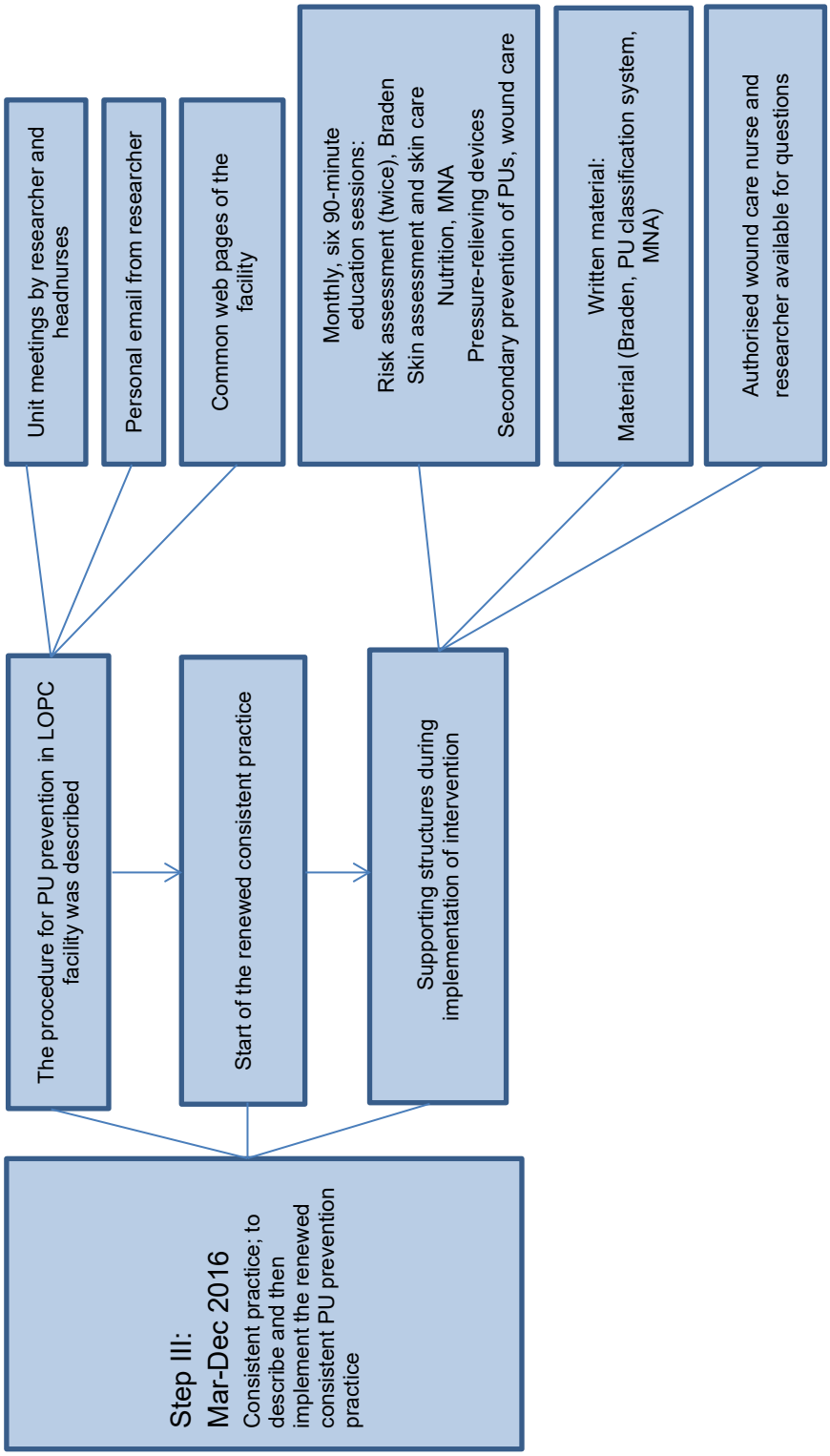

Figure 7. Consistent practice (modified from Paper II).

OMEBP model: Step IV: Evaluation of the practice (Jan 2017)

In the fourth step, the purpose was to evaluate the renewed practice and to ensure that no variation in practice occurred (Figure 8, Paper II). However, to follow the progress of the implementation of the new practice, the researcher visited the intervention units repeatedly at random times already from Step III. At these visits, were discussed the progress of the intervention and possible problems with the head nurses and nursing staff. After ten months of renewed new practice, the second data were collected with the PUPreP instrument for evaluation of the nursing staff's consistent PU prevention practice after the intervention.

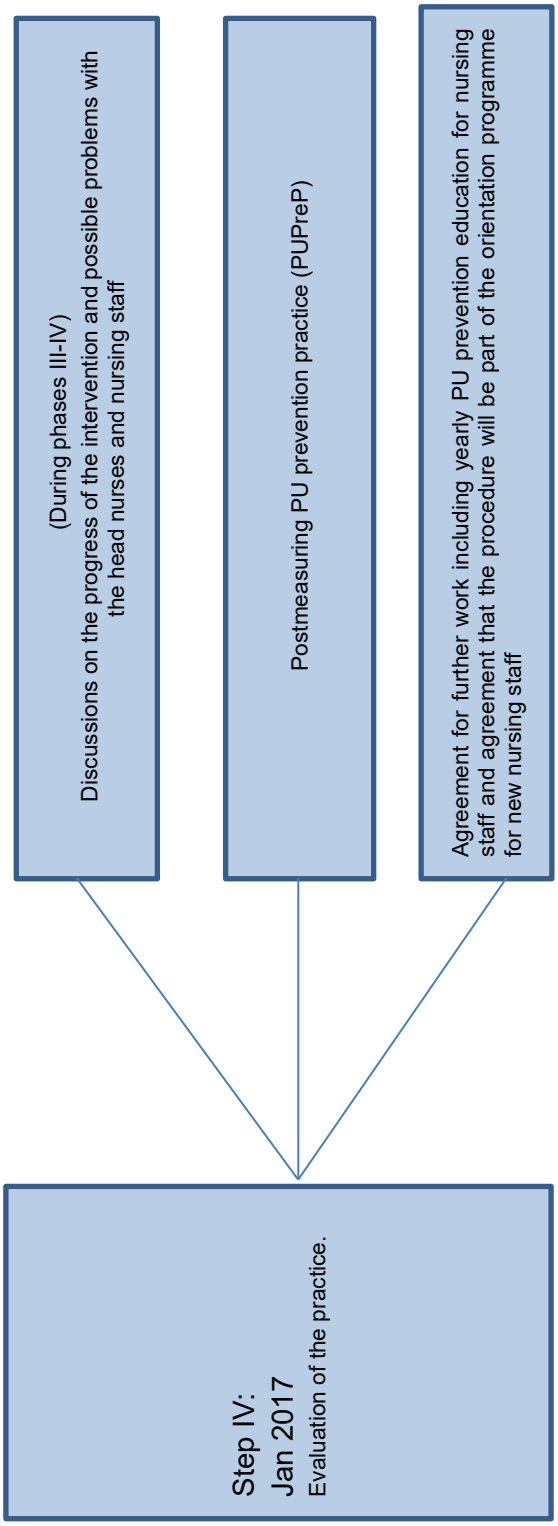

Figure 8. Evaluation of the practice (modified from Paper II).

Evaluation of the effectiveness of the intervention

In phase III the effectiveness of the intervention was evaluated against the research hypotheses (chapter 3) by outcomes:

1) Nursing staff's consistent practice for PU prevention in line with evidence-based international guidelines (nursing staff's perspective),
2) Prevalence of PUs and the residents' highest PU stage,
3) PU prevention practices implemented for residents (resident perspective), and
4) Nursing staff's PU prevention knowledge.

Two facilities were conveniently chosen and randomly allocated by pulling from a hat to intervention and comparison facilities (Figure 3). The unit of randomisation was facility. In total, the intervention facility included five and the comparison facility eight care units. The facilities were located within the same wellbeing services county but in different cities, fifty kilometres apart.

In substudies I and IV, registered nurses (RNs) and practical nurses (PNs) were invited to the study in the intervention facility (n = 76) and the comparison facility (n = 85). Before and after the intervention, all RNs and PNs (n = 161) of the facilities were asked to complete a questionnaire in the study. Of these, 141 (88 %, n = 69/72) participated and completed the questionnaire before the intervention. After the intervention, 112 (n = 61/51) RNs and PNs responded to the questionnaire (Figure 2, Paper II).

In substudies II and III, all residents (n = 122 intervention/n = 133 comparison) in the facilities were invited to participate in the study, which included permission for their skin assessment and use of their patient records. Of these, 232 residents (91.0%) (n = 115 in intervention facility/n = 117 in comparison facility) participated. Additionally, all RNs and PNs (n = 161, 76 intervention/85 comparison) were invited to participate, with 141 (88%, n = 69/72) RNs and PNs participating.

4.2 Data collection and instruments

Phase I: Theoretical phase

In the systematic review (Grant & Booth 2009), the data was collected from articles published between the years 2005–2017 from six electronic databases (PubMed (MEDLINE), CINAHL, Web of Science Core Collection, Scopus, Cochrane Wounds Group Specialized Register and Cochrane Central Register of

Controlled Trials). The search terms were pressure ulcer, prevention and intervention and their synonyms, tailored for each database (Paper I). The eligibility criteria for the studies are described in Table 4. The outcomes of PU incidence and PU prevalence were chosen as they are the most direct measures of success in preventing PUs. The outcome Healing time (any reported healing time) was chosen to measure as the effectiveness of the intervention on secondary prevention. Measuring specific outcomes may be a criterion for including studies in a review when the intervention aims to prevent a particular outcome (Thomas et al. 2023).

The retrieval process (Paper I) was confirmed in two phases by two independent researchers and study selection was made against the eligibility criteria for the studies (Table 4). Based on this, 18 articles were included in the review. The methodological quality of the studies was evaluated by using the MAStARI critical appraisal checklist of the Joanna Briggs Institute for three study designs (Paper I, JBI 2014). The characteristics of the studies and data of the content and effectiveness of the interventions included in the studies were extracted and tabulated using a data extraction sheet developed for this study (Paper I).

Table 4. Eligibility criteria for articles in systematic review.

A study published between 2005–2017
Description of an intervention with pre- and post-tests, focusing on the prevention of PUs as primary or secondary outcome
Comparator usual care
Implemented in long-term older people care facilities
Persons over 65 as study population or subsample
Clinical outcomes of the intervention reported as incidence or prevalence of PUs or as healing time
English language

Phases II–III: Development and implementation of an intervention and Evaluation of the effectiveness of the intervention

In the second and third phase of the study, the data were collected using three instruments: the Pressure Ulcer Prevention Practice (PUPreP) instrument (substudy I), the Pressure Ulcer Patient Instrument (PUP-Ins), (substudy II and III) and the Pressure Ulcer Prevention Knowledge test (PUPK), (substudy IV) (Table 5). The data was collected at baseline and after the intervention, in January 2016 and January 2017. Paper and pencil method was used. The PUPreP instrument, a

structural questionnaire, and the PUPK, a knowledge test, were shared to nursing staff for answering and collected back by head nurses. The background section of the PUP instrument was filled from electronic databases by the researcher and an authorised wound care nurse together with nursing staff. In the PUP instrument, the descriptions of skin condition and PUs were done by the researcher together with an authorised wound care nurse during skin assessments.

Pressure Ulcer Prevention Practice (PUPreP) instrument (substudy I)

The data of nursing staff's Pressure Ulcer Prevention Practice were collected using the structured questionnaire Pressure Ulcer Prevention Practice (PUPreP) instrument based on international PU prevention guidelines, developed for this study (Haavisto et al. 2021, Haavisto et al. 2022, NPUAP/EPUAP/PPPIA 2014). The six subscales of the PUPreP instrument were measured separately to see which PU prevention areas had improved after the intervention (Table 5).

The Pressure Ulcer Patient Instrument (PUP-Ins) (substudy II and III)

The data of the residents' PU prevalence, the highest stages of PUs and PU prevention practices implemented for residents were collected with the Pressure Ulcer Patient Instrument (PUP-Ins) developed based on previous studies, (Eriksson et al. 2003, Lepistö 2004, Lepistö et al. 2006, Mattila et al. 2011), and international PU prevention guidelines (NPUAP/EPUAP/PPPIA 2014). The items of residents' PU prevention practices movement and repositioning, and pressure-relieving devices differed and were used in part depending on whether the resident was a person who is bedridden, seated or walking (Table 5).

The Pressure Ulcer Prevention Knowledge test (PUPK) (substudy IV)

The data to evaluate nursing staff's knowledge of PU prevention practices was collected with a knowledge test: the Pressure Ulcer Prevention Knowledge test (PUPK), developed based on a previous study (Mattila et al. 2011), and the international PU prevention practice guidelines (NPUAP/EPUAP/PPPIA 2014) Table 5).

Table 5. Instruments used to measure outcomes in substudies I–IV.

Substudy Outcome	Instrument Subscales Background questions	Number of items	Scale range	Example of an item	References
Substudy I Nursing staff's PU prevention practice: • Frequency of practices • Agreed PU prevention practice in the unit	**Pressure ulcer prevention practice instrument (PUPreP):** Risk assessment Skin assessment and skin care Nutrition Repositioning Pressure-relieving devices Documentation Background questions on characteristics	51: 11 8 7 13 8 4 9	Frequency of practices: A four-point Likert rating scale with the option "I don't know" (1=never, 2=sometimes, 3=often, 4=always, 5=I don't know), The option "I don't know" was interpreted as "never". The reachable score of item was 4; the higher, the better. The reachable total scores of subscales were calculated so that the values of items were summed and divided by the number of responses when at least 70% of items were answered. Agreed PU prevention practice in the unit: A dichotomous scale for an agreed PU prevention practice in the unit (1=no, 2=yes. The reachable score of item was 1; the higher, the better. The reachable total scores of subscales were calculated so that the values of items were summed and divided by the number of responses when at least 70 % of items were answered.	Frequency of practices: We do a risk assessment for every patient when they come to our ward. Agreed PU prevention practice in the unit: We have an agreement on the way of acting on this on the ward.	NPUAP/EPUAP/PPPIA, 2014, Haavisto et al. 2021, Haavisto et al. 2022, Copyright 2015 © Eriksson, Korhonen

Substudy II Residents PU prevalence and the highest stage of PUs	**The pressure ulcer patient instrument (PUP-ins),** part of instrument: PUs: localisation, stage, and description of PUs Background questions: characteristics, diagnosed diseases and length of stay in facility	16 13	Dichotomous (1=yes, 2=no) and open-ended questions Structured and open-ended questions.	The resident has non-blanchable redness of localised skin area that do not disappear by changing position.	NPUAP/EPUAP/PPPIA, 2014, Eriksson et al. 2003; Lepistö 2004, Lepistö et al. 2006, Mattila et al. 2011, Copyright 2015 © Eriksson, Hietanen
Substudy III PU prevention practices implemented for residents.	**The pressure ulcer patient instrument (PUP-ins),** part of instrument: Mental health Movement and reposition Pressure-relieving devices Skin assessment Nutrition Urinary continence or bowel retention Background questions: characteristics, diagnosed diseases and length of stay in facility	32 : 2 15 2 4 6 3 13	Dichotomous (1=yes, 2=no), multiple-choice and open-ended questions	The skin assessment for the patient is conducted: 1. In every work shift, especially to the areas of bony prominences, 2. Daily, during care and repositioning, 3. Weekly, during care and repositioning, 4. Always for every admission to the unit	NPUAP/EPUAP/PPPIA, 2014, Eriksson et al. 2003, Lepistö 2004, Lepistö et al. 2006, Mattila et al. 2011 Copyright 2015 © Eriksson, Hietanen
Substudy IV Nursing staff's PU prevention knowledge	**The pressure ulcer prevention knowledge test (PUPK):** Development and risk factors PU classification PU risk assessment	34: 5 5 4	Dichotomous answer options (1=yes, 2=no; a correct answer was scored as one point and wrong or missing answer as zero points; the higher, the better. The reachable score of subscales was 5 except in risk	The most important factor causing development of a pressure ulcer is prolonged, perpendicular, external pressure.	NPUAP/EPUAP/PPPIA, 2014, Mattila et al. 2011, Mäkinen et al. 2020, Parisod et al. 2021 Copyright 2015 © Eriksson, Hietanen

	PU prevention with repositioning PU prevention with pressure-relieving devices PU prevention with nutrition Skin assessment and skin care Background questions: the nursing staff's current position, education, length of experience, participation in additional training, self-evaluation of own PU prevention skills, and self-evaluation of additional training needs	5 5 5 5	assessment where it was 4. The reachable total score was 34)		

4.3 Data analysis

Phase I: Theoretical phase

The systematic review focused on the content and effectiveness of studies of earlier PU prevention interventions (Paper I). The characteristics of the studies were described, and the extracted information of interventions was categorised based on the similarity of the content of the interventions Using inductive analysis (Elo & Kyngäs 2008), categories of the content were formulated (Paper I). The data of the interventions was analysed by narrative synthesis according to Popay et al. (2006). The effectiveness of the interventions was estimated by researching the outcomes: PU incidence, PU prevalence or PU healing time. The evidence related to effectiveness was categorised dichotomously (Paper I).

Phases II–III: Development and implementation of an intervention and Evaluation of the effectiveness of the intervention

In phases II–III, the analysis of quantitative data included statistical analysis of comparison of changes in outcomes (Table 6, Papers II–IV) within facilities, and between intervention facility and comparison facility at baseline and one year after the intervention. Continuous variables were described with means and standard deviations (normally distributed variables) and with medians and interquartile ranges (non-normally distributed variables). Categorical variables were described with frequencies and percentages. Data was analysed with IBM SPSS Statistics for Windows 23 in substudy I and IBM SPSS Statistics for Windows 26 (IBM Corp., Armonk, NY) in substudies II–IV (IBM Corp., Armonk, NY). The level of significance was set at $p \leq 0.05$.

In analysis of characteristics of nursing staff (substudies I and IV) education, work experience, frequency of work with PU prevention and identification, frequency of treating PU patients, access to information about PU, Mann-Whitney U-test for non-normally distributed continuous variables, and Pearson chi-square test or Fisher's exact test for categorical variables were used to compare the participants' characteristics between the groups (Table 6, Paper II and Paper IV).

In analyses of residents' characteristics (Substudy II) gender, age, length of stay in facility, diseases, height, weight, fever, smoking, health condition, mobility, diet and urinary incontinence independent sample t-test were used for normally distributed continuous variables, Mann-Whitney U-test was used for non-normally distributed continuous variables, and Pearson chi-square test or Fisher's exact test were used for categorical variables (Table 6, Paper III).

Data of PU prevention practice (PUPreP) was collected in substudy I (Table 6, paper II). Clinical outcomes of the consistent practice were frequency of practices, which measured how often the practices were in line with international PU prevention guidelines, and agreement on the practices in care units, which measured whether the practice was agreed in the care unit in line with PU prevention guidelines. Mean variables of given Likert scale values were calculated in six PU prevention areas. Mean variables were calculated so that the values of items were summed and divided by the number of responses when at least 70% of items were answered. Missing values were not replaced by other values (Paper II). It was not possible to account for clustering with accurate statistical analysis because of the small number of participants, 7–17, per unit. According to the statistician, the results obtained in the analysis would not have been reliable enough. However, all intervention units participated together in consistent practice planning as well as in all education sessions at the same time, which may have reduced the effect of environment in a single unit. Also, the effectiveness of the intervention was intended to be measured on facility-level.

Independent sample t-test was used for testing difference of the frequency of practices and Mann-Whitney U-test for testing difference of agreement on the practices within groups. In comparison of frequency of practices between the groups before and after the intervention, independent sample t-test was used and in comparison of agreement on practices between the groups before and after the intervention, Mann-Whitney U-test was used. Two-way ANOVA were used in comparison of the differences in the changes between groups in frequency of practices. The differences in the change between groups for agreement on practices were measured by using two-way ANOVA; inverse normal scores transformation (Blom's method) (table 6, Paper II).

Effect sizes were calculated to interpret the importance of results (Goulet-Pelletier et al. 2018) between the groups after the intervention (Table 6) and the importance of change in consistent practice between the groups (Table 6, Paper II). Effect size was calculated using Cohen's d as mean difference between intervention and comparison groups (by divided a pooled standard deviation) and Common language effect size f for median difference. Effect size shows how meaningful the difference between groups is, as well as indicating the practical significance of a research outcome. A large effect size shows that a research finding has practical significance, while a small effect size indicates limited practical significance. In Cohen d, with 0.2 being small, 0.5 represents a moderate effect size and 0.8 a large effect size (Goulet-Pelletier et al. 2018).

The internal consistency reliability of the sum variables of the instrument in this data was assessed by computing Cronbach alphas (Table 6, Paper II).

Data of pressure ulcer patients (PUP-instrument) was collected in substudies II and III (Paper III). The outcomes of PU prevalence, the residents' highest PU stage and PU prevention practices implemented for resident were measured. Power analysis was calculated referring to previous research studies (Kim et al. 2013): The prevalence of PU stages II–IV after the intervention was estimated to be 10% in the control group and 1% in the intervention group. The required sample size to detect this difference was 100 residents in both groups with 80% power and alpha of 0.05. Missing values were not replaced with other values. The clustered structure of the data was not used because of the small number of participants per unit in substudies I and IV.

Participants' characteristics between the groups were compared by using independent sample t-test for normally distributed continuous variables, Mann-Whitney U-test for non-normally distributed continuous variables, and Pearson chi-square test or Fisher's exact test for categorical variables.

Wilcoxon Signed Rank Test for non-normally distributed continuous variables and for ordinal variables, and McNemar's test for dichotomous variables were used in testing differences in PU prevalence, the residents' highest PU stage and PU prevention practices implemented for residents within the groups (Paper III).

Mann-Whitney U-test for non-normally distributed continuous variables and for ordinal variables, and Pearson chi-square test or Fisher's exact test for dichotomous variables were used in comparing the differences of PU prevalence, the residents' highest PU stage and PU prevention practices implemented for residents between groups (Table 6, Paper III).

To interpret the importance of results in PU prevalence between the groups, effect sizes were provided as Odds ratio (95% confidence interval). To interpret the importance of results in highest stages of PUs between the groups, group differences were provided using Hodges-Lehmann estimate for median difference (95% confidence interval) (Table 6). To interpret the importance of results in PU prevention practices implemented for residents, effect sizes were provided as Odds ratio (95% confidence interval) for dichotomous variables and group differences as Hodges-Lehmann estimate for median difference (95% confidence interval) for non-normally distributed continuous variables (Table 6).

Data of nursing staff's PU knowledge (PUPK test) was collected in substudy IV. Mann-Whitney U-test for non-normally distributed continuous variables, and Pearson chi-square test or Fisher's exact test for categorical variables was used to compare the participants' characteristics between the groups (Table 6, Paper IV).

Total sum and subscales of Pressure Ulcer Prevention Knowledge test (PUPK test) were calculated by summing up the correct answers of items. A correct answer was scored as one point and wrong or missing answer as zero points.

Differences in subscales of PU knowledge before and after the intervention within groups were tested by using Mann-Whitney U-test and in total scale of PU knowledge, by using Independent sample t-test. Frequencies and percentages of correct answers in single items of the PUPK test were calculated before and after the intervention, and differences before and after the intervention within the groups were tested by using Pearson chi-square test or Fisher's exact test.

Differences in changes in total sum of PU knowledge between the groups were tested by using 2-way analysis of variance (group×time interaction effect), and differences in changes in subscales of PU knowledge between the groups by using ordinal logistic regression (group×time interaction effect) (Table 6, Paper IV).

Table 6. Data-analysis of outcomes in substudies I–IV

SUBSTUDY OUTCOME	INSTRUMENT	ANALYSIS
SUBSTUDY I **NURSING STAFF'S PU PREVENTION PRACTICE:**	Pressure Ulcer Prevention Practice instrument (PUPreP)	
• **FREQUENCY OF PRACTICES**		Comparison of frequency of practices of the groups before and after the intervention: • Independent sample t-test Difference in the frequency of practices within groups: • Independent sample t-test Differences in the changes between groups in frequency of practices: • Two-way ANOVA To interpret the importance of results between the groups: • Effect sizes were provided (Effect size was calculated using Cohen's d as mean difference between intervention and comparison groups by divided a pooled standard deviation) To assess the internal consistency reliability of the sum variables of the instrument in this data: • By computing Cronbach alphas
• **AGREED PU PREVENTION PRACTICE IN THE UNIT**		Comparison of agreement on practices of the groups before and after the intervention: • Mann-Whitney U-test Difference of agreement on the practices within groups: • Mann-Whitney U-test Differences in the change between groups for agreement on practices: • Two-way ANOVA using Inverse normal scores transformation (Blom's method) To interpret the importance of results between the groups: • Effect sizes were provided (Effect size was calculated using common language effect size f = U1/n1n2)

SUBSTUDY II **RESIDENTS' PU PREVALENCE**	The Pressure Ulcer Patient Instrument (PUP-Ins)	Differences in PU prevalence within the groups: • Wilcoxon signed rank test for non-normally distributed continuous variables and for ordinal variables • McNemar's test for dichotomous variables Differences between groups in PU prevalence: • Mann-Whitney U-test for non-normally distributed continuous variables and for ordinal variables • Pearson chi-square test or Fisher's exact test for dichotomous variables To interpret the importance of results between the groups: • Effect sizes were provided as Odds ratio (95% confidence interval)
RESIDENTS' HIGHEST STAGE OF PUS		Differences in the residents' highest PU stage within the groups: • Wilcoxon signed rank test for non-normally distributed continuous variables and for ordinal variables • McNemar's test for dichotomous variables Differences between groups in the residents' highest PU stage: • Mann-Whitney U-test for non-normally distributed continuous variables and for ordinal variables • Pearson chi-square test or Fisher's exact test for dichotomous variables To interpret the importance of results between the groups: • Group differences were provided using Hodges-Lehmann estimate for median difference (95% confidence interval)

SUBSTUDY III **PU PREVENTION PRACTICES IMPLEMENTED FOR RESIDENTS**	The Pressure Ulcer Patient Instrument (PUP-Ins)	Differences in PU prevention practices implemented for residents within the groups: • Wilcoxon signed rank test for non-normally distributed continuous variables and for ordinal variables • McNemar's test for dichotomous variables Differences between groups in PU prevention practices implemented for residents: • Mann-Whitney U-test for non-normally distributed continuous variables and for ordinal variables • Pearson chi-square test or Fisher's exact test for dichotomous variables To interpret the importance of results: • Effect sizes were provided as Odds ratio (95% confidence interval) for dichotomous variables and group differences as Hodges-Lehmann estimate for median difference (95% confidence interval) for non-normally distributed continuous variables
SUBSTUDY IV **NURSING STAFF'S PU PREVENTION KNOWLEDGE**	The Pressure Ulcer Prevention Knowledge test (PUPK)	Differences of PU knowledge before and after the intervention within groups: • Pearson chi-square test or Fisher's exact test in single items of PU knowledge • Mann-Whitney U-test in subscales of PU knowledge • Independent sample t-test in total scale of PU knowledge Differences in changes of PU knowledge between the groups: • 2-way analysis of variance (group×time interaction effect) in total sum of PU knowledge • Ordinal logistic regression (group×time interaction effect) in subscales of PU knowledge

4.4 Ethical considerations

Good scientific practice and research ethics were followed in all phases of the study process: in the design, conduct, and analysis phases as determined by the Finnish Advisory Board on Research Integrity (TENK 2012 and 2023) and conforming to the declaration of Helsinki (WMA 2013). Ethical approval (43/2015) was obtained from the Ethics Committee of the University of Turku. Permissions to conduct the study and data collection were given by the participating organisations. A data protection register notification was made and presented as part of the ethical approval and the research permit application. Permissions to use instruments were given by copyright owners of the instruments.

The ultimate goal of this study was to produce transferable intervention ensuring nursing staff's evidence-based practice in PU prevention in LOPC. The study aims to provide a consistent, evidence-based PU prevention practice and thus give nursing staff possibility to improve their knowledge in PU prevention. The results could be utilised in health care research, health care education and clinical practice in LOPC facilities. From an ethical perspective, the topic and aim of this study can be justified because the knowledge achieved aimed to increase evidence-based care for older people and diminish individuals' suffering by increasing their skin integrity without painful wounds. Using the international PU prevention guidelines is supposed to achieve the following: to reduce the incidence of PUs and the number of residents with PUs, which increases older people's well-being and patient safety in long-term older people care facilities, and to reduce the costs caused by the PUs. Therefore – because they aim for good – the research is justified.

Phase I: Theoretical phase

The systematic review was reported according to the PRISMA guidelines (Paper I). Ethical approval was not required since the data comprised previously published empirical studies.

Phases II–III: Development and implementation of an intervention and Evaluation of the effectiveness of the intervention

In substudies I and IV, the nursing staff were informed about the research. They had an opportunity to ask questions before and during the research. They were also informed about voluntariness to participate and the possibility to discontinue participation without consequences. In addition they were informed that responding to the questionnaire was considered as consent to participate. The researcher gave the questionnaires in numbered envelopes to headnurses in the units who delivered

them to nursing staff and who also collected them anonymously afterward. To protect respondents' identity, identification numbers for nursing staff were not used in the study.

In substudies II and III, residents' rights were protected through voluntary participation with informed consent given and by informed possibility to withdraw from the study at any time without explanation (WMA 2013). Residents, as vulnerable participants, and their close relatives or legal representatives were informed about the study by the nursing staff using the handouts provided by the researcher. They were also informed about voluntariness to consent and possibility to discontinue participation at any stage of skin assessment. After a possibility to ask questions, during the next days they were given a written informed consent form, collected by the nursing staff, to allow the researcher and specialised wound care nurse to assess their skin condition and use the data of their patient records. If the resident was unable to understand the consent question presented to him or her because of illness, permission was given by the resident's close relative or legal representative.

The privacy of the participants and confidentiality of the data was protected (WMA 2013, GDPR 2016). The residents were treated with respect during the examination, and they were guaranteed physical protection of privacy while their skin was exposed. The research data was pseudonymised by the researcher before being transferred to the matrix. The original questionnaires were stored in a locked place without names or identity identification numbers. The transferred data was stored in password-protected files in the researcher's computer in a matrix for statistical analyses. In addition to the researcher, the data was accessible to the statistician during the analysis phase. The users needed a user identification and a password in order to access the files. Identification information of individual residents was not available for the research group or in the research report either. However, during data collection, the researcher and wound care nurse were aware of whose data was concerned because they performed skin assessment for all the residents, and at the same time, collected the background data for the study from their electronical patient records. The collected research material will be destroyed by the researcher after the acceptance of the doctoral thesis.

5 Results

In this chapter, the results of phase I, Theoretical phase, and phases II–III, Development and implementation of an intervention and Evaluation of the effectiveness of the intervention, are reported. The results are first reported by research questions and then gathered together. The main results of the study are briefly summarised at the end of this chapter. The detailed descriptions of the results are presented in the original publications (Papers I–IV).

5.1 Interventions conducted earlier in LOPC facilities on the prevention of PUs

A systematic review was conducted to identify earlier interventions and their effectiveness targeting the prevention of PUs in LOPC (Paper I). The systematic review included 18 studies with the following study designs: ten RCTs, three comparable or case control studies, and five descriptive studies or case series. The methodological quality of the studies varied. (Paper I, JBI 2014).

According to the systematic review (Paper I), in LOPC, a variety of interventions targeting the prevention of PUs in LOPC were used. The most common interventions were support surfaces (mattresses, overlays and cushions, (n = 6), repositioning (n = 3), use of support of electronic program in decision-making in PU prevention (n = 3), PU prevention bundle or programme (n = 3), wound care support teams (n = 2) and nutrition (n = 1).

The studies reviewed included both single and complex interventions comprising various components and support structures to promote implementation. Also, to define the degree to which the implementation followed the planned intervention, treatment fidelity was reported. Education was the most frequently used support structure of the interventions. The treatment fidelity varied.

The effectiveness of the interventions was estimated by investigating the outcomes: PU incidence, PU prevalence or PU healing time. According to the systematic review, the effectiveness of the interventions varied. One third of the reported interventions were effective. Effective interventions aimed at preventing PUs in LOPC included repositioning with change of back position and 30-degree tilting every three hours combined with the heels offloaded from the bed (Moore et

al. 2011b), nutritional intervention where extra protein and calories were served (Pouyssyger et al. 2015), use of advanced mattresses, overlays or cushions in beds or wheelchairs (Brienza et al. 2010, Hampton 2005, van Leen et al. 2014), use of support of electronic program in decision-making in PU prevention (Olsho et al. 2014, Shannon et al. 2012) and PU prevention bundles or programmes consisting of components of best practices (Kwong et al. 2011, Tippett 2009). The majority (n = 6) of the effective interventions (n = 7) successfully reduced the incidence or prevalence of PUs with one intervention reducing both, whereas the only intervention with outcome healing time did not improve it (Paper I).

Next, an overview of the effectiveness of interventions in the systematic review is reported (Paper I): support surfaces, repositioning, support of electronic program in decision-making, pressure ulcer bundle or programme and nutrition:

Support surfaces were effective in reducing the incidence and prevalence of PUs. In the RCT study of Brienza et al. (2010), using an air, viscous fluid, and foam cushion or a gel and foam cushion decreased the incidence of PUs in the buttocks. The prevalence of PUs was also reduced by a prevention strategy (van Leen et al. 2014) where a standard visco-elastic mattress was replaced by a static air overlay and repositioning was started for those residents who had developed stage I PU and, if this did not help, the mattress was replaced by a low air-loss system. National nursing home results showed a straight line in reduction of the prevalence of stage II–IV PUs. After introducing the strategy, the PU prevalence dropped to 0.5% and remained at a rate from 1.2% to 2.6% (van Leen et al. 2014). The prevalence of PUs was also reduced by 82.5% (no p-value) in nursing home by replacing residents' standard mattresses by visco-elastic foam mattresses with visco-elastic cushions (Hampton & Collins 2005).

Repositioning using 30-degree tilt every three hours during the night-time, in combination with the heels elevated from the platform reduced PUs. The incidence of PUs was 3% in the intervention group compared to 11% in the control group (Moore et al. 2011).

Use of electronic support in decision-making in PU prevention in choosing the skin care products, absorbent underpants and mattresses, based on the risk of PU or having a PU, reduced the incidence of PUs by 67% (Shannon et al. 2012). Additionally, health information technology was used in nursing homes in compiled reports to identify residents' changing PU risk factors. The use of these reports, after redesigning nursing staff's workflow and improving processes, was associated with reductions in PU incidence (Olsho et al. 2014).

PU prevention bundle or programme reduced PU incidence and prevalence. A wound programme including prevention protocols (Tippett 2009) or a focused training course for NLCPs and nurses (Kwong et al. 2011) reduced the PU incidence and prevalence. After the programme, Tippett (2009) reported a decrease

in PU incidence from 5.2% to 0.7%, a reduction of 86%, and an incidence of 0.06%. Kwong et al. (2011) reported (no p-value) a decrease in PU incidence from 2.5% to 0.8% and in PU prevalence from 9% to 2.5% after the programme.

Nutritional intervention with cookie supplementation reduced the PU prevalence (Pouyssegur et al. 2015). Analysis showed a significant reduction in PU prevalence from 23.9% to 8.0% in the intervention group.

5.2 Development and implementation of the consistent PU prevention practice

The results of the development and implementation phase in the intervention facility are described in this chapter. The potential of evidence-based practice changes in the LOPC setting and study implementation in LOPC setting was promoted by conducting a co-produced intervention, with agreed purpose and possibility to incorporate renewed consistent PU prevention practice within existing routines and care practices (Peryer et al. 2022). The implemention strategies used were education and awareness-increasing activities (Panteli et al. 2019), leadership support (Stadnyk et al. 2018), the structure through which the change effort was conducted, i.e., the OMEBP model (Hartman et al. 2016, NRF 2018). Next, the results of the four steps of OMEBP and preventative interventions (five PU prevention areas) to be implemented for residents are described:

Development needs for current practice:

- The baseline measurement of PU prevention practice with the PUPreP instrument guided by the researcher reached 69 RNs and PNs (90.8 %)
- The orientation meeting for head nurses, RNs and PNs, conducted once, duration 3.0 hours, delivered by three researchers and two authorised wound care nurses, reached 33 RNs and PNs. The content comprised information for nursing staff, the purpose and phases of the research and the roles of different actors, a presentation of evidence-based practice and a presentation of the Operational Model for Evidence-Based Practices (OMEBP).
- The first development meeting for head nurses, RNs and PNs, conducted once, duration 3.0 hours, delivered by three researchers and two authorised wound care nurses, reached 29 RNs and PNs. The content was information for the nursing staff of the baseline results of the measured current PU prevention practices and a presentation of international guidelines regarding prevention of PUs (NPUAP, EPUAP, PPPIA 2014), after which current practices were together compared with international guidelines (NPUAP, EPUAP, PPPIA 2014) and development needs of current PU prevention practice were identified.

Plan for consistent practice:

- The 2nd development meeting for head nurses and wound contact persons, conducted once, duration 3.0 hours, delivered by three researchers and two authorised wound care nurses, reached 4 head nurses and 9 wound contact persons. The content was the planning of a renewed, context-suited, consistent PU prevention practice in the six content areas of the international PU prevention guidelines which had been chosen: risk assessment, skin assessment, nutrition, repositioning, pressure-relieving devices and documentation. These six preventive interventions for PUs to be implemented were chosen based on effective interventions in line with the findings from the systematic review and according to international PU prevention guidelines.
- Independent intermediate task for the head nurses and wound contact persons to go on planning reached 4 head nurses and 10 wound contact persons.
- The 3rd development meeting for head nurses and wound contact persons conducted once, duration 1.5 hours, delivered by three researchers and one authorised wound care nurse, reached 3 head nurses and 5 wound contact persons. The content was to complete the renewed consistent PU prevention practice: the Procedure for PU prevention in LOPC facility (Paper II), including agreement as to how and when to act and to document. An agreement was also made on yearly PU prevention education for nursing staff, as well as an agreement that the procedure will be part of the orientation programme for new nursing staff.

The Consistent Practice Intervention, the Procedure for PU prevention in LOPC facility, was described in:

- Unit meetings conducted separately altogether 5 times, duration one 1.5 hours, delivered by the researcher and headnurse of the unit, reaching 50 RNs and PNs.
- Personal e-mails, conducted once, delivered by the researcher reached 73 RNs and PNs.
- Common webpages of the facility, delivered by the researcher via headnurses, reached 73 RNs and PNs.
- Start of using immediately the renewed Consistent Practice Intervention intended reached 73 RNs and PNs.

Evaluation and follow-up of the practice:

- Measuring PU prevention practice with the PUPreP instrument, guided by the researcher, reached 61 RNs and PNs.

Supporting structures for nursing staff used to promote implementation of the consistent PU prevention practice:

- A presentation of risk assessment (Braden), conducted twice, duration of both 1.5 hours, delivered by the authorised wound care nurse, reached 33 RNs and PNs.
- A presentation of skin assessment and skin care, conducted once, duration 1.5 hours, delivered by the authorised wound care nurse, reached 26 RNs and PNs.
- A presentation of nutrition and nutrition risk assessment MNA, conducted once, duration 1.5 hours, delivered by a dietician, reached 19 RNs and PNs.
- A presentation of pressure-relieving devices, conducted once, duration 1.5 hours, delivered by two persons with expertise in pressure-relieving devices, reached 13 RNs and PNs.
- A presentation of wound care as secondary prevention of PUs, conducted once, duration 1.5 hours, delivered by an authorised wound care nurse, reached 15 RNs and PNs.
- Material for reading (Braden, PU classification system, MNA), dosed separately altogether three times, delivered by the researcher after the presentations, reached RNs and PNs, but their number is unknown.
- Nursing staff had possibility to consult the authorised wound care nurse and to consult and discuss with the researcher during visits; this reached RNs and PNs, but their number was not counted.

The preventative interventions (five PU prevention areas) to be implemented for residents, intended reach to target population, desired frequency of dose, content, professional groups deemed responsible for delivery and justifications for the choices are described in Table 7. The sixth PU prevention area, Documentation, was incorporated into other PU prevention areas and exact description of how to document in patient records was given in ’Procedure for PU Prevention in LOPC Facility’ (Paper II). Assumed mechanisms of actions in this study were education, awareness-increasing activities (Panteli et al. 2019), leadership support (Stadnyk et al. 2018), co-production and incorporation of new practice within existing routines and the care practice (Peryer et al. (2022). In addition, structure through which the change effort was implemented, i.e., the OMEBP model (Hartman et al. 2016, NRF 2018), as well as the use of wound contact persons to promote changes in units (Sharkey et al. 2013) were used as assumed mechanisms.

Table 7. The preventive interventions to be implemented for residents.

INTERVENTION Intended reach to target population	DESIRED FREQUENCY OF DOSE AND CONTENT	PROFESSIONAL GROUPS DEEMED RESPONSIBLE FOR DELIVERY	JUSTIFICATIONS FOR THE CHOICES
RISK ASSESSMENT **All residents in the intervention facility**	Assessing verbally the resident's PU risk within two days of admission in the unit. Risk assessment using the Braden Scale 6–23 in conjunction with drawing up a service plan within a month of admission in the unit. The risk assessment is renewed in an interim assessment every six months/ or when there are changes in the resident's health condition.	The nurse on duty The primary nurse The primary nurse/ RNs and PNs	International PU prevention guidelines (NPUAP/ EPUAP/PPPIA 2014), local conditions and preferences to incorporate the intervention to existing routines and care practices
SKIN ASSESSMENT AND SKIN CARE **All residents in the intervention facility**	<u>Skin Assessment</u> The condition of the resident's skin and tissue is assessed and documented in conjunction with the first shower after admission in the unit. Following the initial assessment, the condition of the skin and tissue is assessed and documented at least once a week in conjunction with showers, with any findings documented. If there are large amounts of excretions on the resident's skin, the condition of the skin is assessed during every diaper change and documented daily. Skin assessment findings include the following: warmth of the skin, blanchable redness of the skin, non-blanchable redness of the skin (PU already present), tissue oedema, tissue hardening, broken skin.	RNs and PNs RNs and PNs RNs and PNs RNs and PNs	International PU prevention guidelines (NPUAP/ EPUAP/PPPIA 2014), local conditions and preferences to incorporate the intervention to existing routines and care practices.

	<u>Skin Care</u> Cream, chosen and brought by relatives, is always applied to the skin after the showers and otherwise when needed.	RNs and PNs	
	Diapers are changed according to individual needs.	RNs and PNs	
	The wash cream, used as soap, instructions for use are checked to determine whether it should be rinsed off with water or not.	RNs and PNs	
	When putting on diapers, the resident's skin should not be left too wet in order to avoid maceration.	RNs and PNs	
	The skin must never be rubbed or massaged.	RNs and PNs	
	Medical equipment (e.g. catheters) must never press on the skin. It is also important to take the material and size of clothing into consideration.	RNs and PNs	
NUTRITION **All residents in the intervention facility**	The MNA test is conducted and documented in the resident's documentation within three months of admission in the unit.	The primary nurse	Scientific evidence (Paper I), international PU prevention guidelines (NPUAP/ EPUAP/PPPIA 2014), local conditions and preferences to incorporate the intervention to existing routines and care practices.
	After the initial assessment, the MNA test is conducted and documented when necessary, e.g. in the event of weight loss.	RNs and PNs	
	The resident is weighed once a month.	RNs and PNs	
	Upon resident's admission in the unit, the food portion sizes are assessed, making changes when necessary, taking into consideration the condition of the resident's mouth and possible difficulty swallowing. If necessary, meals or parts of meals may be ordered in puréed form. If problems arise, a nutritional therapist is consulted.	RNs and PNs	
	The need for extra energy or protein is assessed based on weight, appetite, pressure ulcer risk, condition of the skin, and possible wounds.	RNs and PNs	

	Primary sources of extra energy are oil, butter, and cream. If problems arise, the situation is discussed in a multiprofessional team, also considering the option to use nutritional supplements, e.g. Nutridrink, Cubitan. Adequate fluid intake is ensured at every meal. The resident is assisted in drinking, and the intake of fluids is monitored using a fluid list, if necessary.	 Registered nurse, next of kin, physician, nutritional therapist RNs and PNs	
REPOSITIONING **All bed-bound residents in the intervention facility**	<u>Bed-bound resident</u> During the daytime, repositioning is implemented in conjunction with mealtimes. Pressure-relieving positions/repositioning methods are used. A 30-degree tilt, with the resident on side-lying position, is favoured. Particular attention is paid to keeping heels elevated off the surface. If the resident moves his/her legs, friction-reducing wound care products may be helpful. Direct contact of bony prominences with one another (e.g. knees together) is prevented Monitoring of sleep and wakefulness, (in use in both facilities, Vivago monitoring) is in the intervention facility used also as a supplementary tool to determine a suitable time for changing the resident's position during the nighttime. During the nighttime, duration of repositioning is assessed on an individual basis based on PU risk, need for sleep, and the surface used. The resident's sleep should also be ensured.	 RNs and PNs RNs and PNs RNs and PNs RNs and PNs RNs and PNs	Scientific evidence (Paper I), international PU prevention guidelines (NPUAP/ EPUAP/PPPIA 2014), local conditions and preferences to incorporate the intervention to existing routines and care practices.

All seated residents in the intervention facility	The resident's position is changed in pairs in order to prevent pressure and shear of his/her skin and tissue.	RNs and PNs	
	<u>Seated resident</u> The resident's autonomy and movement is supported in all daily activities.	RNs and PNs	
	The resident's ability to change position is monitored. If he/she cannot do it independently, he/she is assisted in changing position.	RNs and PNs	
	The resident is seated for a maximum of 3 hours. The resident's seating position is fixed if he/she has slid down in the chair.	RNs and PNs	
PRESSURE-RELIEVING DEVICES **All residents in the intervention facility**	A common decision regarding the resident's mattress based on risk assessment is made (a usual foam mattress, advanced foam mattress or alternating pressure-air mattress; available in both facilities).	RN, physiotherapist and representative of the device centre	Scientific evidence (Paper I), international PU prevention guidelines (NPUAP/ EPUAP/PPPIA 2014), local conditions and preferences to incorporate the intervention to existing routines and care practices.
	A decision regarding the resident's seat cushions and heel protectors is made and it is ensured that they are ordered.	RNs	
	The nurse monitors possible complications arising from mattress (e.g. occurrence of pressure ulcer).	RNs	
	The resident's repositioning is continued regardless of the use of a pressure-distributing mattress (including "motorised" mattress). Unnecessary layers of bed linen are avoided in order to ensure that the mattress works.	RNs and PNs	
	Transfer sheets must not be left under the resident.	RNs and PNs	
	The minimum height for the surface of the mattress and the upper edge of the bed railing is 22 cm.	RNs and PNs	

5.3 Effectiveness of the intervention on nursing staff's consistent practice for PU prevention

In total, 141 (88%) RNs and PNs from two LOPC facilities participated in the study, 69 in the intervention and 72 in the comparison group (Paper II). The drop-out in the intervention group was 8 participants and in the control group 21 participants. No special reasons were detected that might explain the differences in the losses to follow-up between the two study groups.

The hypothesis (Chapter 3) was that after the intervention, PU prevention practice has changed into more consistent and in line with international pressure ulcer prevention guidelines in the intervention group, compared to the comparison group.

The clinical outcomes of the consistent practice were frequency of practices, which measured how often the practices were in line with international PU prevention guidelines, and agreement on the practices in care units, which measured whether the practice was agreed in the care unit in line with international PU prevention guidelines.

Frequencies of practices

At baseline (Paper II), the intervention group had a higher mean in frequency of PU prevention practices nutrition ($p = 0.032$) and pressure-relieving devices ($p < 0.001$). Also, both groups were already quite well in line with international PU prevention guidelines in the PU prevention practices repositioning (mean: 3.46/ 3.40) and skin assessment and skincare (mean: 3.42/ 3.36).

After the intervention, the frequency of PU prevention practices in risk assessment ($p < 0.001$) and nutrition ($p < 0.001$) was statistically significantly more positive in the intervention group compared with the comparison group (Table 8). Also, in the change between the groups, the frequency of PU prevention practices in risk assessment ($p = 0.005$) and nutrition ($p = 0.029$) was statistically significantly more positive in the intervention group compared with the comparison group (Table 8, Paper II). However, there were also some outcome measures that did not show significant differences in favor of the intervention (Paper II).

Agreement on PU prevention practice in care unit:

At baseline (Paper II), no statistical differences were found between the intervention and the comparison group with respect to agreement on PU prevention practices in the care units.

After the intervention, agreement on consistent practice in PU prevention in the care unit was significantly more positive in the intervention group in all six

variables: risk assessment ($p < 0.001$), skin assessment and skincare ($p < 0.001$), nutrition ($p < 0.001$), repositioning ($p < 0.001$), pressure-relieving devices ($p < 0.001$) and documentation ($p < 0.001$) compared with the comparison group (Table 8, Paper II). In addition, after the intervention, between the groups, change in agreement on consistent practice in PU prevention in the care unit was significantly more positively improved in the intervention group in all six variables: risk assessment ($p = 0.002$), skin assessment and skincare $p = 0.007$), nutrition ($p = 0.011$), repositioning ($p = 0.009$), pressure-relieving devices ($p = 0.014$) and documentation ($p < 0.001$) compared with the comparison group (Paper II).

5.4 Effectiveness of the intervention on prevalence of PUs and the residents' highest PU stage

Data on 232 skin assessment of 232 residents (n = 115 in intervention group and n = 117 in comparison group) were collected at baseline, in January 2016. After the intervention, in January 2017, the corresponding number was 176 residents (n = 96/80). After the intervention, 56 participants were missing because 48 residents had died, one was in hospital and four had been moved to another facility; in three cases, the reasons are unknown. The number of participants in the comparison group had decreased more than in the intervention group (19 residents in intervention/37 residents in comparison group) (Paper III). No specific reasons were detected that might explain the differences in the losses to follow-up between the two study groups.

The hypothesis (Chapter 3) was that after the intervention, the prevalence of PUs and the residents' highest stages of PUs have decreased more in the intervention group compared to comparison group.

At baseline, significant differences were found between the intervention group and the comparison group in the residents' characteristics in some diseases ($p = 0.026–0.048$) and in health status, movement and diet ($p = 0.002–0.027$). After the intervention, no statistical differences were found between the intervention group and the comparison group with respect to residents' characteristics (Paper III, Paper III in supporting information).

Prevalence of PU

At baseline, no statistically significant differences were found between the intervention group and the comparison group with respect to the prevalence of PUs ($p = 0.167–1.00$) (Paper III). Most PUs in both groups were located in the sacrum, buttock and hip areas, other areas of the feet, and heels.

After the intervention, PU prevalence had decreased more in the intervention group compared to the comparison group. A statistically significant difference between the intervention and the comparison group was seen in the prevalence of PUs in the sacrum, buttock and hip areas, 2.1% intervention vs 12.5% comparison ($p = 0.007$), and heels 0.0% intervention vs 10.1% comparison ($p = 0.001$), in all areas in the prevalence of PU stages I–IV ($p = 0.027$), and all areas stages II–IV ($p = 0.008$) (Table 9, Paper III).

Residents' highest stage of PUs:

At baseline, no statistically significant differences were found between the intervention group and the comparison group with respect to residents' highest stage of PUs ($p = 0.137–0.646$) (Paper III). Stage I was the most common PU stage.

After the intervention, PU stages have decreased more in the intervention group compared the comparison group. A statistically significant difference between the intervention and the comparison group was shown in the residents' highest stage of PUs in the sacrum, buttock and hip areas, heels and in all areas ($p = 0.003–0.020$). In addition, in the comparison group, residents' PU stages showed an increased negative trend in the heels and all areas (Table 9, Paper III)

5.5 Effectiveness of the intervention on PU prevention practices implemented for residents

Data from patient records of 232 participating residents were collected (n = 115 in intervention group and n = 117 in comparison group) at baseline. After the intervention, the corresponding numbers were 176 residents (n = 96/80); 53 participants were missing because 48 residents had died, one was in hospital, and four had been moved to another facility (Paper III). No specific reasons were detected that might explain the differences in the losses to follow-up between the two study groups.

The hypothesis (Chapter 3) was that after the intervention, the PU prevention implemented for residents has improved more in the intervention group compared to the comparison group.

At baseline (Paper III), there was a significant statistical difference between the intervention group and the comparison group in the following variables: PU Risk assessment instrument used, Skin assessment daily used time for, Skin assessment duration, Weight monitoring, Nutrition risk assessment instrument in use, Nutritional supplements, Duration of repositioning at night, Use of sliding sheet, Use of lifting belt, and Mattresses ($p < 0.001–0.027$).

After the intervention, the PU prevention implemented for residents had improved positively statistically significantly more in the intervention group compared to the comparison group. There was a significant difference between the intervention group and comparison group in the variables PU Risk assessment instrument used, Skin assessment time, Weight monitoring, Nutrition risk assessment instrument used, Nutritional supplements used, Time (minutes) used for repositioning in daytime, Time (minutes) used for repositioning at nighttime, Seated resident, when transferring, shearing or stretching resident's skin is avoided, and lifting belt is used, Walking resident is activated to independent moving, Mattresses, Foam mattress and Diaper changes per day ($p < 0.001–0.042$), (Table 9, Paper III). However, there were also outcome measures that did not show significant differences in favor of the intervention (Paper III).

5.6 Effectiveness of the intervention on nursing staff's PU prevention knowledge

The hypothesis (Chapter 3) was that after the intervention, the nursing staff's PU knowledge has improved more in the intervention group compared to the comparison group.

The total number of participating RNs and PNs was 141 at baseline and 112 after the intervention. In the intervention facility, there were 69 participants at baseline and 61 after the intervention. In the comparison facility, the corresponding numbers were 72/51. The drop-out was 8 participants in the intervention group and 21 participants in the control group. No specific reasons were detected that might explain the differences in the losses to follow-up between the two study groups. Most participants were PNs: at baseline, 91% (intervention facility)/89.9% (comparison facility) and after the intervention, 81%/84%. At baseline and after the intervention, the comparison group had more work experience in the current work unit than the intervention group ($p = 0.005$), and after the intervention, the intervention group had participated more in PU education and had read more guidelines about PU prevention and early identification (Paper IV).

Nursing staff's PU prevention knowledge

At baseline, the comparison group had better knowledge in PU risk assessment ($p = 0.011$) and the intervention group in nutrition ($p = 0.004$). No other differences were found between the intervention and the comparison group. Total sum of the PU prevention knowledge of the participants was 26.85 (intervention group)/27.03 (comparison group) ($p = 0.702$) at baseline (the reachable range for the total scores minimum 0 to maximum 34), and 28.66/27.83 ($p = 0.079$) after the intervention.

After the intervention, change in the knowledge in PU risk assessment improved significantly more in the intervention group compared to the comparison group ($p = 0.011$) (Table 8, Paper IV). The difference in change in total sum of PU knowledge between the groups was not significant ($p = 0.129$), but in the intervention group, the PU prevention knowledge improved significantly ($p < 0.001$) while it did not improve in the comparison group ($p = 0.133$). After the intervention, the difference between groups in the knowledge regarding PU prevention with pressure-relieving devices ($p = 0.020$) was statistically significantly better in the intervention group compared with the comparison group. Within the intervention group, a statistically significant improvement was seen in PU risk assessment ($p = 0.001$), PU prevention with pressure-relieving devices ($p = 0.005$), skin assessment and skin care ($p = 0.012$) and in the total sum of PU knowledge ($p < 0.001$). Within the comparison group, no statistically significant improvement was seen (Paper IV).

After the intervention, both groups had high knowledge in PU development and risk factors and skin assessment and skin care (mean 4.57–4.72/4.58–4.67). The intervention group also had high knowledge in PU risk assessment (mean 3.54). Both groups had moderate knowledge in PU classification (mean 3.08/3.35) (Paper IV).

Nursing staff's PU prevention knowledge in single items

After the intervention, in single items of the PUPK test (Paper IV), PU prevention knowledge improved statistically significantly ($p = 0.010–0.048$) in 6 items in the intervention group. The improvement was seen in the subscales PU risk assessment (2 items), PU prevention with repositioning (1 item), PU prevention with pressure-relieving devices (2 items), and skin assessment and skin care (1 item). The knowledge worsened ($p = 0.042–0.050$) in two items; both were in the subscale PU classification. Meanwhile, in the comparison group, PU prevention knowledge improved significantly ($p = 0.043–0.046$) in 2 single items which were in the subscales PU prevention with pressure-relieving devices and PU prevention with nutrition.

After the intervention, 100% of the participants in both groups gave correct answers to single items in PU development and risk factors; the intervention group to 2 items and the comparison group to 3 items. In addition, 100% of the participants in the intervention group answered correctly one of the single items in PU prevention with repositioning and in the comparison group, one of the items in the subscale PU prevention with nutrition.

The least well-known single items among the participants both at baseline and after the intervention were in PU classification: two items in both the intervention and the comparison group (Paper IV).

5.7 Summary of the main results

According to the systematic review, there were many ways to prevent PUs in LOPC facilities, but no single, most effective way could be identified from the evidence available to date. Evidence of effective preventive interventions of PUs in LOPC settings was found but also a lack of systematic evidence obtained with randomized trials in this area, especially concerning PU prevention bundles or programmes. Most of the randomised trials added evidence for the use of mattresses and cushions or repositioning in PU prevention. In addition, new outcomes to measure the effectiveness of intervention were found, such as PU prevention practices implemented for residents and PU prevention knowledge, which were added as the outcomes of effectiveness of the intervention in this study. Effective interventions to reduce the incidence or prevalence of PUs in LOPC facilities were the use of electronic programme decision-making support systems in PU prevention, PU prevention programmes, repositioning using 30-degree tilt every three hours during the night and heels offloaded from the bed, changing into more advanced mattresses, or the use of more advanced cushions in wheelchairs, or adding protein and energy supplements to diet.

To add systematic evidence for effective PU prevention in LOPC based on international guidelines (NPUAP/EPUAP/PPPIA 2014) the Consistent Practice Intervention study was conducted.

In this study, a renewed Consistent Practice Intervention for PU prevention was conceptualised, implemented and evaluated. Following the OMEBP model, the intervention was developed in an iterative process consisting of baseline assessment of PU prevention practices, an orientation meeting, and three development meetings with one independent intermediate task. Eventually, the intervention included the following main components: risk assessment, skin assessment, nutrition, repositioning, pressure-relieving devices and documentation and was recorded in the Procedure for PU prevention in LOPC facility. An agreement was made on yearly PU prevention education for nursing staff, as well as an agreement that the procedure would be part of the orientation programme for new nursing staff. In implementation of the intervention, the Procedure for PU prevention in LOPC facility was described in unit meetings, personal e-mails and common webpages of the facility. Supporting structures for nursing staff to promote implementation of intervention, comprised presentations including the topics of risk assessment (Braden), skin assessment and skin care, nutrition and

nutrition risk assessment MNA), pressure-relieving devices and wound care. In addition, material for reading (Braden, PU classification system, MNA) and nursing staff's possibility to consult an authorised wound care nurse and to consult and discuss with the researcher during visits were used (Paper II).

In the evaluation phase, the effectiveness of the Consistent Practice Intervention was examined for four outcomes: nursing staff's consistent PU prevention practice, PU prevalence and PU stages, PU prevention practices implemented for resident and nursing staff's PU prevention knowledge.

- Effectiveness of the intervention was shown on nursing staff's consistent practice: After the intervention, the frequency of PU prevention practices in risk assessment and nutrition was statistically significantly more positive in the intervention group compared with the comparison group. Also, the frequency of PU prevention practices in line with international guidelines in risk assessment and nutrition was also more improved in the intervention group compared to the comparison group. In addition, after the intervention, agreement on consistent practice in PU prevention in the care unit was significantly more positive in the intervention group in all six variables: risk assessment, skin assessment and skincare, nutrition, repositioning, pressure-relieving devices and documentation compared with the comparison group. Moreover, agreement on consistent practice in PU prevention in the care unit in the intervention group was more improved compared to the comparison group in all six variables: risk assessment, skin assessment and skincare, nutrition, repositioning, pressure-relieving devices, and documentation (Table 8, Paper II).
- Effectiveness of the intervention was shown on the prevalence of PUs: after the intervention, a statistical difference between the intervention and the comparison group was shown in the prevalence of PU in the sacrum, buttock and hip areas and heels, in all areas in the prevalence of PU stages I–IV and in all areas in PU stages II–IV. Also, after the intervention, a statistical difference between the intervention and the comparison group was shown in the residents' highest stage of PUs in the sacrum, buttock and hip areas, heels and in all areas. In addition, in the comparison group, residents' PU stages showed an increased negative trend in the heels and all areas (Table 9, Paper III).
- Effectiveness of the intervention was shown on PU prevention practices implemented for residents: after the intervention, a difference was seen between the intervention group and comparison group in the variables PU Risk assessment instrument used, Skin assessment time, Weight monitoring, Nutrition risk assessment instrument used, Nutritional

supplements used, Time (minutes) used for repositioning in daytime, Time (minutes) used for repositioning at night-time, Seated resident, when transferring, shearing or stretching resident's skin is avoided and Seated resident, when transferring, lifting belt is used (Table 9, Paper III).

- Effectiveness of the intervention was shown on nursing staff's PU prevention knowledge: after the intervention, the knowledge in PU risk assessment improved significantly more in the intervention group compared to the comparison group (Table 8, Paper IV).

The Consistent Practice Intervention was developed and implemented with four steps as planned. The intervention improved consistency in nursing staff's PU prevention practice well, decreased PU prevalence and stages of PUs well, and increased resident-implemented PU prevention practices and nursing staff's PU prevention knowledge quite well. However, there were also some outcome measures that did not show significant differences in favor of the intervention (Papers II– IV).

The main results of the effectiveness of the Consistent Practice Intervention are collected in two tables: The most important results concerning the nursing staff's consistent PU prevention practice and nurses' PU prevention knowledge are presented in Table 8 and all the results concerning the main outcome PU prevalence and the residents' highest PU stages and most important results concerning PU prevention practices implemented for the residents are presented in Table 9. To limit the number of results, these tables only display all the results for the primary outcome and the most important secondary outcomes. The detailed results are presented in papers II–IV.

Table 8. Effectiveness of the intervention on nursing staff's consistent PU prevention practice and PU prevention knowledge (most important results reported).

		AFTER THE INTERVENTION					DIFFE-RENCE IN CHANGE BETWEEN GROUPS
OUTCOME	**GROUP**	**MEAN (SD)**	**MEDIAN (IQR)**	**DIFFERENCE BETWEEN GROUPS (95 % CI)**	**p- value**	**EFFECT SIZE**	**p-value**
CONSISTENT PU PREVENTION PRACTICE (Substudy I, on paper II):							
FREQUENCY OF PRACTICE, IN LINE WITH PU PREVENTION GUIDELINES							
Risk assessment	Intervention Comparison	3.14 (0.56) 2.51 (0.64)		0.63 (0,39 – 0.87)[4]	<0.001	1.12[6]	0.005[1]
Nutrition	Intervention Comparison	2.91 (0.66) 2.31 (0.54)		0.61 (0.37 – 0.85)[4]	<0.001	0.92[6]	0.029[1]
AGREED PU PREVENTION PRACTICE IN THE UNIT, IN LINE WITH PU PREVENTION GUIDELINES							
Risk assessment	Intervention Comparison		2.00 [0.43] 1.00 [0.40]	0.64 (0.46 – 0.91)[5]	<0.001	0.85[7]	0.002[2]
Skin assessment and skin care	Intervention Comparison		2.00 [0.27] 1.33 [0.88]	0.38 (0.13 – 0.63)[5]	<0.001	0.76[7]	0.007[2]
Nutrition	Intervention Comparison		1.86 [0.43] 1.14 [0.60]	0.57 (0.29 – 0.71)[5]	<0.001	0.79[9]	0.011[2]
Repositio-ning	Intervention Comparison		2.00 [0.00] 1.69 [1.00]	0.15 (0.00 – 0.54)[5]	<0.001	0.75[7]	0.009[2]
Pressure-relieving devices	Intervention Comparison		1.88 [0.72 1.13 [0.50]	0.38 (0.14 – 0.63)[5]	<0.001	0.76[7]	0.014[2]
Documen-tation	Intervention Comparison		2.00 [0.50] 1.38 [0.75]	0.50 (0.25 – 0.50)[5]	<0.001	0.78[7]	<0.001[2]
NURSES' PU PREVENTION KNOWLEDGE (Substudy IV, on paper IV)							
PU risk assessment	Intervention Comparison	3.54 (0.74) 3.41 (0.73)		0.00 (0.00 –0.00)[5]	0.246[3]		0.011[8]

1 Two-way ANOVA
2 Two-way ANOVA, Inverse normal scores transformation (Blom's method) was used for outcomes
3 Mann-Whitney U-test
4 Mean difference (95% confidence interval)
5 Hodges-Lehmann estimate for median difference (95% confidence interval)
6 Effect size was calculated using Cohen's d as mean difference between intervention and comparison groups by divided a pooled standard deviation
7 Effect size was calculated using common language effect size f = U1/n1n2
8 Ordinal logistic regression, groupxtime interaction effect

Table 9. Effectiveness of the intervention on PU prevalence, residents' highest PU stages (Reported all results) and PU prevention practices implemented for residents (Reported most important results).

OUTCOME	GROUP	N (%)	MEDIAN [IQR]	DIFFERENCE BETWEEN GROUPS (CONFIDENCE INTERVAL)	p-value
PU PREVALENCE (Substudy II, on paper III)					
Sacrum, buttock and hip areas, PU stages I–IV	Intervention Comparison	2 (2.1) 10 (12.5)		0.15 (0.03 – 0.71)[4]	0.007[1]
Other areas of the feet	Intervention Comparison	7 (7.3) 3 (3.8)		1.99 (0.50 – 7.97)[4]	0.515[2]
Heels, PU stages I–IV	Intervention Comparison	0 (0.0) 8 (10.1)		NA[6]	0.001[2]
All areas PU stages I–IV	Intervention Comparison	9 (9.4) 17 (21.3)		0.38 (0.16 – 0.92)[4]	0.027[1]
All areas PU stages II–IV	Intervention Comparison	0 (0.0) 6 (7.5)		NA[6]	0.008[1]
RESIDENTS HIGHEST PU STAGES (Substudy II, on Paper III)					
Sacrum, buttock and hip areas	Intervention I II III IV Comparison I II III IV	 2 (2.1) 0 (0.0) 0 (0.0) 0 (0.0) 7 (8.8) 2 (2.5) 1 (1.3) 0 (0.0)		NA[6]	0.006[3]
Heels	Intervention I II III IV Comparison I II III IV	 0 (0.0) 0 (0.0) 0 (0.0) 0 (0.0) 5 (6.4) 2 (2.6) 0 (0.0) 0 (0.0)		NA[6]	0.003[3]
All areas PU stages I–IV	Intervention I II III IV Comparison I II III IV	 9 (9.4) 0 (0.0) 0 (0.0) 0 (0.0) 11 (3.8) 4 (5.0 2 (2.5) 0 (0.0)		NA[6]	0.020[3]

PU PREVENTION PRACTICES IMPLEMENTED FOR RESIDENTS, in electronic patient records (Substudy III, on Paper III)					
PU risk assessment instrument used	Intervention Comparison	73 (77.7) 0 (0.0)		NA[6]	< 0.001[1]
Skin assessment time	Intervention Comparison		0.2 [0.12] 0.2 [0.17]	0.05 (0.00 – 0.08)[5]	0.018[3]
Weight monitoring	Intervention No 1–6 times a year Monthly Comparison No 1–6 times a year Monthly	 13 (13.7) 67 (70.5) 15 (15.8) 13 (16.7) 64 (82.1) 1 (1.3)		2.28 (1.11 – 4.70)[4]	0.023[3]
Nutrition risk assessment instrument used	Intervention Comparison	46 (50) 1 (1.3)		79 (11 – 592)[4]	<0.001[1]
Nutritional supplements used	Intervention Comparison	16 (17.4) 5 (6.3)		3.08 (1.07 – 8.82)[4]	0.030[1]
Time (minutes) used for repositioning in daytime	Intervention Comparison		0.5 [0.25] 0.3 [0.13]	0.17 (0.08 – 0.22)[5]	< 0.001[3]
Time (minutes) used for repositioning at night-time	Intervention Comparison		0.3 [0.13] 0.1 [0.13]	0.15 (0.08 – 0.17)[5]	< 0.001[3]
Seated resident, when transferring, shearing or stretching resident's skin is avoided	Intervention Comparison	29 (100) 23 (82.1)		NA[6]	0.017[1]
Seated resident, when transferring, lifting belt is used	Intervention Comparison	4 (13.8) 0 (0.0)		NA[6]	0.042[1]

1 Pearson chi-square test.
2 Fisher's exact test.
3 Mann-Whitney U-test.
4 Odds ratio (95% confidence interval)
5 Hodges-Lehmann estimate for median difference (95% confidence interval)
6 OR not available due to zero frequency

6 Discussion

In this chapter, the main results of the systematic review (Phase I) and the quasi-experimental intervention study (Phases II–III) are discussed, as well as the validity and reliability of the study. Finally, practical implications for nurse directors, nursing practice, policy makers and nursing education are discussed, along with suggestions for further research. More detailed discussions are presented in Papers I–IV.

6.1 Discussion of the results

The aim of this study was to develop, implement and evaluate the effectiveness of a Consistent Practice Intervention based on international guidelines for PU prevention (NPUAP/EPUAP/PPPIA 2014), focusing on older people in LOPC. The study was divided into three phases: theoretical phase including a systematic review, development and implementation of an intervention, and evaluation of the effectiveness of the intervention (substudies I–IV, Figure 1).The consistent practice was a bundle of six PU prevention areas: risk assessment, skin assessment and skin care, nutrition, repositioning, pressure-relieving devices, and documentation. Development and implementation was done by using the four steps of the OMEBP model.

After the conducted intervention, there was a renewed consistent PU prevention practice in the LOPC facility. The ultimate goal of the study was to produce a transferable intervention ensuring PU prevention to improve the quality of care of older people in LOPC facilities.

6.1.1 Interventions conducted in LOPC facilities on the prevention of PUs

The systematic review identified a variety of interventions and evaluated their effectiveness, targeting the prevention of PUs in LOPC facilities, at primary or secondary level of prevention, or both (Paper I). Among the interventions, support surfaces were the most common PU prevention intervention as also seen in previous findings (Reddy et al. 2006). However, in this review, other interventions

for preventing PUs were also found that were not included in previous reviews. These were interventions with electronic systems to support decision-making in PU prevention, PU prevention bundle or programme and wound care support teams (Fossum et al. 2011, Keen & Gaudario 2014, Kwong et al. 2011, Nobrega et al. 2009, Olsho et al. 2014, Shannon et al. 2012, Stern et al. 2014, Tippett 2009).

The effective interventions, identified in the review that reduced the incidence or prevalence of PUs or both were electronic decision-making support systems (Olsho et al. 2014, Shannon et al. 2012), PU prevention programmes (Tippett 2009), change into more advanced mattresses or cushions (Brienza et al. 2010, van Leen et al. 2014), ideal repositioning frequency (Moore et al. 2011b), or protein and energy supplements in diet (Pouyssegur et al. 2015).

This study supports previous systematic reviews concerning mattresses in various settings (Reddy et al. 2006), where more advanced static support surfaces were associated with lower incidences of PUs. The results also support previous findings suggesting that the use of nutritional supplements may be useful in the prevention of PUs (NPUAP/EPUAP/PPPIA 2014). However, in the review of this study it was found (Pouyssegur et al. 2015) that in the LOPC the use of the same amount of supplement was generally effective, which is opposite to the results of Reddy et al. (2006) of unknown or NPUAP/EPUAP/PPPIA's (2014) individual composition of the best nutrients. Generally, an effective amount of supplement simplifies residents' daily nutrition care, is more likely to be implemented, and frees up nursing staff's resources for patient care.

In this review, an ideal night-time repositioning for PU prevention in LOPC was found, showing significant reduction of PU incidence (Moore et al. 2011). In an earlier systematic review (Reddy et al. 2006), an ideal repositioning in reducing PUs was not identified although optimal repositioning is important to reduce pressure over vulnerable areas of the body (NPUAP/ EPUAP/ PPPIA 2014) without disturbing the resident's sleep too often during the night.

In this review, bundling the best PU prevention practices and implementing them in in-house programmes (Kwong et al. 2011, Tippett 2009) were found to be effective PU prevention interventions in LOPC facilities. This supports earlier studies in various settings that showed corresponding results, but the level of evidence in the studies was weak (Niederhauser et al. 2012). Bundled best practices are relatively inexpensive to establish, but still, to provide strong evidence of the effectiveness of different bundles in LOPC, RCT studies and studies with comparison groups are needed.

Complex interventions (Olsho et al. 2014) were developed for the prevention of PUs in LOPC settings after the review of Reddy et al. (2006), where the types of earlier interventions in LTC settings were mostly single, including one component. This study identified that both complex and single interventions could be effective

for PU prevention against the outcome PU prevalence or PU incidence in LOPC facilities (Paper I) which gives the possibility to choose and implement interventions depending on the resources of the care facility. However, this study also found that only one third of the identified interventions in LOPC were effective.

Education of the nursing staff was used as a supporting structure to promote the implementation of the interventions, but the way of reporting the supportive structures was not coherent. Overall, a clear need for consistent guidelines for the implementation of interventions in LOPC-facilities was found in this study. Although there was international and national guidelines for the prevention of PUs (Hotus 2015, NPUAP/EPUAP/PPPIA 2014) on which to base planning of interventions, in line with Jackson et al. (2016), no clear implementation method for PU prevention guidelines has previously been found. Based on this review and international PU prevention guidelines, a multicomponent Consistent Practice Intervention, including education as supportive structure, was successfully developed and implemented using the OMEBP model.

6.1.2 Effectiveness of the intervention on nursing staff's consistent practice for PU prevention

The implemented intervention was effective on consistent practice in six PU prevention areas in two ways: First, by showing significant differences between the groups and a significant change in the frequency of the PU prevention practices in line with international guidelines after the intervention, and second, by showing significant differences between the groups and a significant change in agreement in PU prevention practice in units after the intervention (Paper II).

At baseline, the frequencies of PU prevention practices in the six areas varied compared to evidence-based PU prevention guidelines; the frequencies of nutrition and documentation were low, while those of repositioning and skin assessment and skin care were high. These results supports other studies reporting low or partial adherence to evidence-based PU prevention guidelines (Hoviattalab et al. 2014, Källman et al. 2022, Niederhauser et al. 2012).

This study showed, as hypothesised, that the nursing staff's frequency of PU prevention practice in line with PU prevention guidelines improved positively in more PU prevention areas in the intervention facility compared to the comparison facility. The practices of risk assessment and nutrition improved positively significantly more in the intervention facility than in the comparison facility. In the intervention facility, after the intervention, the nursing staff's frequency of use of PU prevention practices was significantly higher than before the intervention in four prevention areas. In two areas which did not improve statistically significantly

a tendency of improvement was also seen. This study supports the results of other studies (Lavallee et al. 2019a, Lavallee et al. 2019b) where some areas of the PU prevention practice bundle improved more than others. However, this study showed that after the intervention, the level of all frequencies in PU prevention practices was good, contrary to other studies (Downie et al. 2013, Lavallee et al. 2019b). Also, this study showed a clinical significance (Goulet-Pelletier et al. 2018) in the effect of the results in all six prevention areas. In this study, in change between the groups the effect sizes showed the importance of results and practical significance in frequency of practices and in agreement with PU prevention practices. (Paper II) (Goulet-Pelletier et al. 2018).

Furthermore, this study supports the findings of a previous studies (Korhonen et al. 2020, Niederhouser et al. 2012) that highlighted the importance of head nurses' support in implementing consistent practices. The results are consistent with a study by Lavallee et al. (2017), which showed that a multifaceted model to facilitate the implementation of evidence-based practice improved the uptake of EBP and protocol availability in a residential setting for older people. This study also indicates that, similar to studies conducted in acute care (Beal et al. 2016, Martin et al. 2017), PU prevention can be improved in the LOPC setting as well by using evidence-based clinical practice guidelines. Wogamon et al. (2016) reported similar results with limited data collected in a nursing home, after educating nursing assistants. The OMEBP model (NRF 2018) used for the guideline implementation in this study appears to be effective for implementing evidence-based PU prevention practice in LOPC facilities and may have enhanced the effectiveness of the intervention. When the renewed consistent practice was integrated into the workflow, the practitioners became valuable experts. Additionally, this study provided the consistent practice 'Procedure for PU Prevention in LOPC Facility' (Paper II) developed with the OMEBP model as a useful tool in the LOPC context.

This study showed significantly positive improvement in all six areas of agreement on the PU prevention practices in the intervention care facility. This result is a significant indication of the effectiveness of the intervention, because in a systematic review (Lavallee et al. 2017), full implementation of the elements of the care bundles was rare.

6.1.3 Effectiveness of the intervention on prevalence of PUs and the residents' highest PU stage

The implemented intervention reduced effectively the PU prevalence and the residents' highest stages of PUs in the sacrum, buttock and hip areas, and heels, which are the most common PU areas (Paper III).

As hypothesised, PU prevalence decreased more in the intervention facility compared to the comparison facility. At baseline, PU prevalence in both facilities including PUs stage I and higher was at the same level as the PU prevalence reported by Carryer et al. (2017) and Stolt et al. (2019). PU prevalence including PUs of stage II and higher was also at the same level in the intervention facility, but lower in the comparison facility compared to the PU prevalence reported by other studies (Ahn et al. 2016, Raeder et al. 2020). After the intervention, PU prevalence in both facilities including PUs of stage I and higher was at the same level with the prevalences reported in other studies (Carryer et al. 2017, Stolt et al. 2019), but PU prevalence in the intervention facility was significantly lower than in the comparison facility. After the intervention, the prevalence of PUs including those of stage II and higher was lower in the intervention facility but higher in the comparison facility when compared to other studies (Ahn et al. 2016, Raeder et al. 2020). Additionally, the prevalence of PUs including stage II and higher was significantly lower in the intervention facility than in the comparison facility. This shows that the conducted Consistent Practice Intervention was effective.

As also hypothesised, in the intervention facility the PU stages decreased more compared to the comparison facility: when at baseline, PUs were mostly stage I and II PUs in both facilities, after the intervention, there were no PUs of stage II or higher in the intervention facility. This means that in terms of the effect of the intervention, PUs were detected at stage I and none of them developed into stage II PUs or led to the resident's skin breaking. In contrast, in the comparison facility, the stages of PUs worsened, and after the intervention, there was a significant difference between the intervention and comparison facility in PU stages.

This study was able to show the effectiveness of the conducted intervention in decreasing PUs in the most common PU areas. As shown in other studies conducted in LOPC (Artico et al. 2018, Hahnel et al. 2017, Moore et al. 2011), also in this study most PUs were located in the sacrum, buttock and hip areas, and at the heels. In contrast to other studies (Artico et al. 2018, Hahnel et al. 2017, Moore et al. 2011b), after the intervention, there were no PUs in the heels and only two stage I PUs in the sacrum, buttock, and hip areas.

Although in this study, the residents' PU risk-increasing characteristics were multiple (Paper III), the intervention was effective. The residents in this study also had characteristics reported in several other studies that increased their PU risk: high mean age, over 83/85 years, and living in older people care facilities (Carryer et al. 2017, Nakasima et al. 2018). The residents also had multiple PU risk increasing co-morbidities (Artico et al. 2018, Borsting et al. 2020, Cai et al. 2019, Gillespie et al. 2014); three-quarters of the residents had different vascular or memory diseases, and a quarter had type 2 diabetes or musculoskeletal disease. In addition, two out of three residents had only satisfactory or poorer health status;

additionally, approximately half of the residents were partly or totally immobile, all of which increase the risk for PU (Cai et al. 2019, Skogestad et al. 2016). Still, after the intervention, none of the intervention facility residents had broken skin caused by PUs.

6.1.4 Effectiveness of the intervention on PU prevention practices implemented for residents

The implemented intervention was effective on PU prevention practices implemented for residents by improving the use of the PU risk assessment instrument, the skin assessment time, time used for repositioning in daytime and night-time, PU prevention with nutrition by using nutrition risk assessment instrument and nutritional supplements, weight monitoring, avoiding shearing or stretching seated resident's skin and using lifting belt when transferring (Table 9, Paper III). However, although some of the PU prevention practices implemented for residents improved according to patient records, not all of them did. For example, the use of more advanced mattresses had not changed after the intervention. The reason may be that many residents already had advanced mattresses in use before the intervention, but it must also be considered that the results on the use of preventative measures were not stratified for the actual PU risk for individual care residents. However, this study confirms the results of other studies (Hoviattalab et al. 2014, Källman et al. 2022, Niederhouser et al. 2012) which argued that in spite of available evidence-based PU prevention methods and decreased PU prevalence, not all PU prevention methods are widely adopted and used in practice. Other reasons require more research. Also, implemented versus documented PU prevention for residents should be compared in future.

6.1.5 Effectiveness of the intervention on nursing staff's PU prevention knowledge

The intervention was effective in terms of nursing staff's PU prevention knowledge (Paper IV). The results confirm recommendations to use education as part of interventions to improve nursing staff's PU prevention knowledge (Karimian et al. 2020, Kim et al. 2019, Saleh et al. 2019), but are opposite to a study by Porter-Armstrong et al. (2018) who argued that further information is needed because of the low-certainty evidence provided. In this study, PU prevention knowledge was improved by face-to-face education (Figures 5 and 7), supporting earlier results (Esche et al. 2015). However, in the study of Karimian et al. (2020) virtual education training sessions for nurses also improved their PU prevention knowledge.

As hypothesised, in PU risk assessment the nursing staff's PU prevention knowledge improved more in the intervention facility compared to the comparison facility. In addition, in the intervention facility, the nursing staff's knowledge improved or remained at good level in most PU prevention knowledge areas. However, PU classification knowledge remained at moderate level. The explanation could be that PU classification was not one of the prevention areas in the intervention, but also that although it was described in a presentation of international guidelines regarding PU prevention and was given to participants as pocket-size written material during the implementation, it was not included in the items of supportive face-to-face education (Figure 7).

This study identified that in LOPC, at baseline, the nursing staff's PU prevention knowledge was mostly at good level. The results confirm an earlier study about nurses' knowledge level conducted in long-term care (Kim et al. 2019) but are opposite to results reported for nursing staff's PU prevention knowledge in hospital (Fulbrook et al. 2019). In this study, differing from Kim et al.'s (2019) study, most of the nursing staff were practical nurses with vocational education working in a long-term care setting. These results are opposite to earlier studies of the knowledge improvement need mentioned, especially among employees with lower levels of education (Clarkson et al. 2019, Gunningberg et al. 2015, Jiang et al. 2020, Parisod et al. 2021). However, most studies concerning PNs' or NAs' PU prevention have been conducted in acute care or hospital settings. More research in LOPC setting is needed in view of nursing staff with lower level education.

This study showed that the context-tailored intervention was effective in improving PU prevention knowledge. The study confirms an earlier study conducted in the nursing home context (Lee et al. 2022) and emphasised the importance of understanding the environmental context in the implementation of PU prevention guidelines (van Gaal et al. 2010). Similarly to the study of van Gaal et al. (2010), this study adds evidence that research on context-tailored interventions may be effective for the improvement of PU prevention practice knowledge. In van Gaal et al.'s (2010) study, an educational intervention that allowed organisations to implement PU prevention guidelines improved the PU prevention knowledge of hospital nurses, but not the knowledge of nurses in the nursing home context.

The intervention improved PU prevention knowledge. Most PU prevention areas improved or remained at good level after the intervention. However, the intervention did not seem to be effective on the PU classification knowledge, which remained at moderate level.

6.2 Validity and reliability of the study

In this chapter, validity and reliability of the study are discussed. During the study, the validity and reliability were reviewed throughout the study phases. More detailed discussions are presented in Papers I–IV.

6.2.1 Validity and reliability of the data collection

Interventions conducted in LOPC facilities on the prevention of PUs and effectiveness of the interventions

The systematic review has strengths and limitations. Notably, the expertise in informatics from the library was utilised during the search process. The six electronic databases used cover extensively the topic of PU research and more comprehensive, the subject of health sciences. The versatility of the search words pressure ulcer, prevention and intervention study and their synonyms provided a large number of citations on the subject, showing that the targeted search covered the topic extensively. A systematic study selection process involved three phases by two independently working researchers, which minimised subjective selection bias. This makes the review repeatable.

Some limitations in the data collection of the systematic review exist: English language, subjectivity in the synthesis process and heterogeneity of the interventions. In the review, only studies published in English were included. However, to avoid publication bias in the review, the data was collected from several databases and included papers from many journals and several cultures, also from non-English-speaking areas, which increases the coverage of the review and provides a comprehensive overview of the evidence. Heterogeneity concerning PU prevention research has also been reported by other studies (Lechner et al. 2021, EPUAP/NPIAP/PPPIA 2019), and efforts are made to develop an agreed standardised set of outcomes to increase the comparability of clinical trial results (Lechner et al. 2019, Lechner et al. 2021).

Nursing staff's consistent practice for PU prevention in line with international guidelines and nursing staff's PU prevention knowledge

The strength of this intervention-study was the high participation rate of nursing staff (88%), which increases the reliability of the results. The study sample was representative of the LOPC nursing staff both in the intervention and the comparison facility, based on the high participation rate, and of the typical group of residents in LOPC facilities. Also, the intervention reached the nursing staff well,

as planned: the orientation day, the development days, unit meetings, personal e-mails and common web pages of the facility.

The study had some limitations related to reduction of nursing staff, nursing staff's participation in the monthly supportive education sessions, difference at baseline between the intervention and the comparison group in work experience in the current work unit, and clustering within units.

Nursing staff reduction was carried out both in the intervention and the comparison facility during the implementation. In addition, long-term substitutes rotated between institutions, and this caused some changes in the composition of the nursing staff. In this situation, the "Procedure for PU Prevention in LOPC Facility", i.e., the written instructions for the renewed PU prevention practice, had already been produced and used for three months, and were also used as part of new workers' orientation. In addition, the researcher visited the intervention facility to promote the implementation of the intervention. However, it is possible that the situation may have increased the haste and stress caused by a greater workflow and new nursing staff members and might thus have caused bias to the results. In addition, not all nursing staff members participated in the supportive education sessions. Some worked in the care units or were off duty. However, these facts were known, and the target was that nursing staff members who participated in these supportive education sessions, especially the wound contact persons, 'shared the message' in their own units. It was agreed, that the wound contact persons facilitated the implementation of the updated practice by showing an example and mentoring others working as 'unit-level champions' (Sharkey et al. 2013, Woo 2017). Finally, clustering within facility made it possible that responses from participants were not totally independent. However, it was not possible to assess this with statistical analysis due to the small number (7–17 per unit) of participants. The limitations of the study should be considered when generalising the results.

Prevalence of PUs, the residents' highest PU stage and the PU prevention practices implemented for residents

The strength of this study was the high participation rate of residents (91%), which increases the reliability of the results. The study sample was representative of the LOPC residents both in the intervention and the comparison facility based on the high participation rate and the typical group of residents in LOPC facilities. In addition, sample size justification was ensured by producing power analysis before the data collection (See chapter 4.3): the required sample size was reached for the study. The consistency of the results was improved by the accuracy in data collection: the same two persons, a registered nurse specialised in wound care and

the researcher, assessed the skin of all the residents in the intervention and the comparison facility and used a systematic instrument, the EPUAP scale of PUs stages 1–4 (NPUAP/EPUAP/PPPIA 2014), in the assessment.

The same two persons, a registered nurse specialised in wound care and the researcher, also collected all the data from patient records on participants' characteristics and the PU prevention practices implemented for residents both in the intervention and the comparison facility, which improved the consistency of the data. This increases the reliability of the study. However, not all the answers to the PUP-instrument were reported in patient records and were thus inquired from the nursing staff who cared for the residents, which may have had an impact on the results. This study indicated missing documentation in PU prevention practices in patient records. Inaccuracies in the content and coherence of nursing documentation in long-term care have also been found in other studies (Kalideen et al. 2022, Tuinman et al. 2017).

6.2.2 Validity and reliability of the instruments

Pressure ulcer prevention practice (PUPreP) instrument

The content of the instrument was based on international PU prevention guidelines (NPUAP/EPUAP/PPPIA 2014). Content validity was evaluated by a multidisciplinary expert panel specialised in wound care until a consensus was reached. The panel did not calculate the Content Validity Index (I-CVI) (Haavisto et al. 2021, Haavisto et al. 2022). They argued that the instrument demonstrated appropriate internal consistency and validity. The psychometric properties of the PUPreP instrument were assessed using data collected between May 2018 and January 2019. The internal consistency of the instrument's sum variables was at a desirable level (> 0.70, Steiner et al. 2015), except for pressure-relieving devices (0.52). The instrument showed appropriate validity.

In this study, to assess the internal consistency of the instrument in the data used, the alphas for sum variables of the outcome frequency of practices were calculated before and after the intervention (DeVellis 2003). They were high (0.74–0.88), in three of the six variables: risk assessment, nutrition and repositioning. However, they varied partially before, after or at both measurement points (0.22–0.75) in three sum variables: documentation (0.64 before/0.74 after), skin assessment and skin care (0.47 before/0.55 after) and pressure-relieving devices (0.22 before/0.40 after). Especially the sum variable pressure-relieving devices was under the acceptable value both before and after the intervention may reduce the reliability of the results. It is possible that not all items in this sum variable represent the same variable. The limited internal consistency of some sum-

scores means that the results of the study are prone to uncertainties and bias and thus should be interpreted with caution. However**,** a validated instrument on the topic was not available at that time. It is notably, that the Likert responses 'I don't know' were interpreted as 'never' in both groups in the analysis phase. This may have impacted the results of the study even though this interpretation was consistently used in both groups and before and after the intervention.

Pressure ulcer patient (PUP) instrument

The content of the PUP-instrument was based on international PU prevention guidelines (NPUAP/EPUAP/PPPIA 2014) and previously used versions of the instrument (Eriksson et al. 2003, Lepistö 2004, Lepistö et al. 2006, Mattila et al. 2011). The content of the instrument was evaluated by an expert panel consisting of a plastic surgeon and nurses specialised in wound care. The version of the instrument updated in 2015 was used in this study. The instrument should be updated according to the latest guidelines (EPUAP/NPIAP/PPPIA 2019) and its validity should be evaluated.

Pressure ulcer prevention knowledge test (PUPK) instrument

The content of the PUPK instrument was based on international PU prevention guidelines (NPUAP/EPUAP/PPPIA 2014) and the previously used version of the instrument (Mattila et al. 2011). A physician and a nurse specialised in PUs were involved in the development of the instrument (Mattila et al. 2011), and the instrument was evaluated by an expert panel until a consensus was reached. The Content Validity Index (I-CVI) was not calculated. The instrument used in this study was the version updated in 2015. The instrument has been further developed and validated (Mäkinen et al. 2020, Parisod et al. 2021).

6.2.3 Validity and reliability of the results

In the systematic review, to some extent, the heterogeneity of the interventions made it challenging to synthesise the evidence. The interventions varied in terms of study designs, samples, participants and follow-up periods. This variety of the interventions may have weakened the evidence of the synthesis. Also, some shortcomings related to the criteria used for critical appraisal in the systematic review must be taken into account: as they lack reflection of two sources of risk of bias, i.e., the attrition bias due to risk of systematic differences between study groups in the number and the way participants are lost from a study (Nunan et al. 2018) and the quality of randomisation (Higgins et al. 2024).

The methodological quality of the studies was evaluated with the JBI MASTARI criteria (JBI 2014). The strength of the review was that in many studies included in the review the same instrument for outcome measurement was used, the scale of EPUAP of the PUs. (Paper I). However, the quality of studies was partly quite poor in other sections (Paper I), impeding the generalisability of the results of the review. However, to gain a wide understanding of the subject and to identify different interventions, all the assessed studies were included in the review. The methodological analysis showed that there was in particular a lack of well-designed RCTs, especially concerning PU prevention bundles or programmes. (Paper I).

In the intervention study, various sources of bias must also be taken into account such as lack of randomisation, lack of blinding of intervention and outcome measurement, attrition bias, potential contamination of control group and lack of precision due to multiple statistical tests.

The possibility of selection bias must be taken into account in interpretation of the results because in the study, the two facilities were chosen conveniently, after which they were randomly allocated into intervention and comparison facility. Convenience sampling was used because in the area, all three facilities with more than one hundred residents were asked to participate in the study, but only two of them were willing to participate. This means that there was no possibility to choose two of three facilities randomly. However, to prevent the participants or personnel in the facilities from knowing the forthcoming allocations, it was not done until after recruitment was confirmed, as it should be done (Higgins et al. 2024). Another possible bias rising from the randomisation process is that the risk of the estimated effect of intervention may be biased by confounding; the main reason is that the very small number of clusters (k=2) are prone to uncertainties and bias (Higgins et al. 2024). This must considered in interpretation of the results.

Blinding was not feasible and was not used in the study, which may have increased the bias due to the awareness of the nursing staff both in the intervention and comparison facility. However, the control conditions reflect real life of PU prevention accurately, i.e., no specific intervention was administrated to the control group.

According to Nunan et al. (2018), over-recruitment can help to prevent important attrition bias. In this study, the calculated power analysis for the main outcome appointed the need of 100 residents for both study groups. In this study, the number of residents was 115 in the intervention group and 117 in the comparison group. This may have prevented the attrition bias.

Potential contamination of the control group has to be taken into account. However, the intervention and control facilities were located fifty km apart from each other, which reduced the risk of contamination bias.

Also, the risk of bias in favour of the intervention due to the frequent presence of the researcher in the intervention units must be taken into account, and longer follow-up periods under conditions of newly normalised real PU prevention practice after intervention are needed to show the maintenance of the effect of the intervention.

Finally, the primary outcome of the study was PU prevalence, not PU incidence. It must be considered that some PUs may have occurred during residents' hospital days or at home in newly admitted residents. However, at both measuring points, the possibility that the residents had been in hospital was the same. Also, new residents were not recruited to the study which shows that wherever the residents included in the research had got their PUs, they had healed during the conducted intervention because they no longer existed at the measuring point after the intervention.

The effectiveness of the intervention on nursing staff's consistent practice for PU prevention in line with international guidelines

Potential risk of bias and/or lack of precision due to different response rates at the measuring points and the groups has to be considered. In all the items of frequency of consistent practice, the response rate was over 50%, which strengthens these results of the outcome of the consistent practice in the study. However, among items of Agreement of consistent practice, there were some items where the response rate was lower. Items with low response rates always have a risk that a minority group within the population might dominate the sample and skew the results, which has to considered when interpreting and generalising the results (Bowling 2005).

In addition, the risk of spurious finding due to Alpha error has to be considered because the study (sample size) was planned for evaluation of the main outcome PU prevalence, not the outcome Consistent practice. Therefore, because hypotheses in a study are each tested at a $P < 0.05$ level for significance, some may emerge statistically significant by chance (Type 1 or false positive errors) (Andrade 2020).

The effectiveness of the intervention on the prevalence of PUs, the residents' highest PU stage and on PU prevention practices implemented for residents

The generalisability (the external validity) of the results on the prevalence of PUs and the residents' highest PU stage is good due to the high participation rate of the residents. All residents (n = 122 intervention/n = 133 comparison) in the facilities were invited to participate in the study. The invitation included permission to

assess their skin and to use their patient records. Of these, 232 (91.0%), (n = 115 in intervention facility/ (n = 117) in comparison facility) residents participated. The validity of the analysis and study results has been enhanced by using a statistician in planning accurate data analysis and in analysing the data.

The effectiveness of the intervention on nursing staff's PU prevention knowledge

Also in the data of the nursing staff's PU prevention knowledge the response rate was high (88%), which increases the generalisability (external validity) of the results. In addition, the validity of the analysis and study results has been enhanced by using a statistician in planning accurate data analysis and analysing the data. However, the risk of spurious finding due to Alpha error has to be considered in this outcome as well. It has to be noted that the study (sample size) was not planned for evaluation of this outcome. Because the study was powered for the outcome PU prevalence, there is a possibility that the study could be either overpowered or underpowered for other outcomes (Andrade 2020).

6.2.4 Validity and reliability of the intervention

The process of development and implementation of the intervention will be discussed in this chapter. According to Craig et al. (2008), the best practice to start systematically developing an intervention is by using the best available evidence and appropriate theory. The construct of this intervention was created by synthesising the scientific knowledge based on a systematic review (Paper I), international PU prevention guidelines (NPUAP/EPUAP/PPPIA 2014) and by using an implementation model, the OMEBP model (NRF 2018, NRF 2024). The four-step OMEBP model made development and implementation of the intervention into practice systematic and foreseeable. The OMEBP model was chosen because it is a generic model, well known, and has been used before in Finnish health care (Suhonen et al. 2019). This study showed that the OMEBP model worked well in the development and implementation of PU prevention intervention and in transferring evidence to practice. The four steps of the model are repeatable.

To ensure transparency, replicability and effectiveness of the intervention the reporting should include a published description of the intervention (Duncan et al. 2020, Hoffman et al. 2014). For this purpose, in this study, the public reporting involved careful documenting of the details and outcomes of the intervention (Papers II–IV). TREND Statement (Des Jarlais et al. 2004) was additionally used in public reporting to reveal possible deficiencies in the research (Paper II).

According to Moore et al. (2015), in evaluation of the process of the intervention, the context, implementation and mechanism of impact should be considered in interpretation of the outcomes (Moore et al. 2015). In this study, the context was taken into account in the intervention process by involving nursing staff in the development of the consistent PU prevention practice and by using their local expertise when tailoring the consistent practice into residents' daily care routines. Giving nursing staff, as local experts, the possibility to participate in the decision-making process to renew the consistent practice may have promoted the adoption of the new practice (Nembhard et al. 2006, Peryer et al. 2022). In the context of LOPC, most residents have memory disorders, which means that the daily responsibility for taking care of PU prevention practice mostly falls on the nursing staff and it is good have a practice to put into use in the daily activities of nursing care.

According to Moore et al. (2015), the emphasis of process evaluation shifts towards providing greater confidence in conclusions about effectiveness by assessing the quantity and quality of what was delivered. In this study, the frequency of dosing and how delivery of the intervention was achieved has been described in detail (Paper II, Paper III), which is a strength of this study. Face-to-face learning was most used in delivering the intervention: in Step I in presentations of evidence-based practice and the OMEBP model, in Step II in presentation of international PU prevention guidelines, and in Step III in supportive education sessions. These aspects, such as contextual factors, frequency of dosing, how delivery of the intervention was achieved and nursing staff's participation in the development and implementation of consistent practice is included in results and discussion of results, and more details are found in papers II–IV. However, an attempt was made to describe the mechanism of impact: participants' responses to and interactions with the intervention but may partly remain unclear. The process evaluation would have provided greater confidence in conclusions about effectiveness by assessing the quantity and quality of what was delivered (Moore et al. 2015). Process evaluation, exploring the way in which the intervention was implemented would help to interpret the results and might provide more valuable insights into why the Consistent Practice Intervention worked successfully and how it could be optimised even more. However, in the planning of the intervention the process evaluation, exploring the way in which the intervention was implemented, was not planned in advance. According to Peryer et al. (2022), the potential of evidence-based practice changes in the LOPC setting is promoted by conducting co-produced intervention, with agreed purpose and possibility to incorporate renewed new practice into existing routines and care practices. All these components were included in this study and may have promoted the successful work of the Consistent Practice Intervention. Also, all the key factors mentioned in

by Peryer et al. (2022) were included in this study both in the development as well as in implementation phase of the intervention, i.e., thus avoiding procedural drift by using the OMEBP model, participatory action and learning. The implementation strategies used in this study were education and awareness-increasing activities (Panteli et al. 2019), leadership support (Stadnyk et al. 2018), structure through which the change effort was supported, i.e., the OMEBP model (Hartman et al. 2016, NRF 2018), and use of wound contact persons to promote changes in units (Sharkey et al. 2013, Woo 2017). Monitoring and feedback were not used as implementation strategy in this study. Instead, the "obtained worker feedback" strategy, described in the study of Bunger et al. (2017) was used in this study, but as a supportive structure for implementation. It involved formal and informal discussions with nursing-staff, and head nurses asked about their opinions and any problems experienced with the implementation plan. However, monitoring and feedback as implementation strategy would explain the mechanisms of change. Therefore, to increase understanding of working mechanisms of actions, future research building on this study should be conducted, with descriptions of a programme theory and logic model for the intended implementation of practice changes. Perhaps the results of the outcome "nursing staff's consistent practice" might also be considered in interpretation of whether the nursing staff was committed to implement the prevention practices and accept them. In these results they answered whether the PU practice was implemented and agreed in the facility. The potential impact of systematic involvement of care residents and their representatives in the intervention development was estimated to be low. In the context of LOPC, most residents have memory disorders, which means that the daily responsibility for taking care of PU prevention practice mostly falls on the nursing staff and it was good have a practice to put into use in the daily activities of nursing care. However, those residents, who are still capable to understand the purposes and procedures of nursing actions and the residents' relatives should be encouraged to participate actively in PU prevention in future.

One weakness of the study is also that no piloting was done before the implementation of the intervention. However, conducting of this intervention study took a year, and piloting would have taken one year more in another unit, which would have demanded a lot more resources. Piloting would have given information of the feasibility of the intervention: the feasibility of recruitment, randomisation, retention, assessment procedures, new methods, and implementation of the novel intervention (Leon et al. 2011). However, the intervention was tailored to the intervention facility and was made together with the staff, in which case it can be considered potentially feasible in recruitment, as content and implementation were planned and decided together. Also, the intervention was not novel, nor were any new methods used because the OMEBP model has been used before in Finish

healthcare (Korhonen et al. 2015). Even so, it does not mean that it was not important to assess the feasibility before the actual intervention, e.g. by interviewing nursing staff before implementation.

The strengths of the intervention were that it was based on the international guidelines for PU prevention, the advancement by using the OMEBP model (NRF 2018) and working together during development of the renewed consistent practice.

6.3 Practical implications

Based on the results of this study, the following practical implications for nursing directors, nursing practice, policy makers and education can be presented.

Practical implications for nursing directors:

- The nursing directors in health care can use this knowledge about the consistent practice in planning, implementing and evaluating PU prevention in LOPC facilities aimed at the development of the quality of care.
- These results can be useful for nursing directors in promoting an organisational culture that prioritises PU prevention through reinforcement of its importance.

Practical implications for nursing PU prevention practice:

- This study produced an effective, renewed PU prevention practice, which was commonly agreed by nursing staff, evidence-based, and tailored for LOPC facility level. The consistent practice “Procedure for PU Prevention in LOPC Facility” reported here is available for use and can be tailored for use elsewhere as well.
- This study can be used as an example of the implementation of guidelines in LOPC facilities by using the Operational Model for Developing Evidence-Based Practices (OMEBP).

Practical implications for policy makers:

- Because of increasing numbers of residents in LOPC in many countries as a result of population ageing, the results of the study can be used in political decision-making related to quality assurance strategies to support the work on PU prevention of sufficient quality aimed at achieving cost savings in PU treatment.

Practical implications for education:

- The findings of this study should be used in nursing education and in planning and implementation of healthcare education programmes of evidence-based practice to nurses and practical nurses.

6.4 Suggestions for further research

- In this study, an effective PU prevention practice was developed and implemented. To maintain the quality of care in the prevention of PUs, the related supporting structures of organisations should be studied in LOPC. This includes examining how to support the implementation of interventions in a feasible and effective manner within organisations.
- During the implementation of new PU prevention interventions, documenting should be examined. Documenting, coupled with further sources of data, such as dose, reach and fidelity of implementation, would tell about the activity of the implementation.
- The developed Consistent Practice Intervention was effective in the LOPC context in prevention of PUs. It should also be utilised in other settings of older people care, such as home care or secondary care, and its effectiveness should be studied in those contexts.
- Older persons are unique. This uniqueness should be considered when planning and implementing interventions in the context of LOPC facilities by emphasising the important role of nursing staff mainly consisting of licensed practical nurses in PU prevention as well as the crucial role of residents in participating in PU prevention. However, there must also be a sufficient number of staff who manage the evidence-based practice.

- PU prevention knowledge test should also be developed for self-directed residents and their relatives in home care and in LOPC facilities. In the future, the developed knowledge test for patients and their families will aid in enhancing their guidance on the self-care of PU prevention at home with scarce nursing resources.

- Healthcare technology should be examined in PU prevention in LOPC to help nursing staff and residents in decision-making concerning PU risk factors, for example to make decisions of repositioning at the right time. Technology such as pressure sensors in mattresses, cloths, sheets or wheelchairs that produced online data of pressure with increased PU risk

or smart diapers that measure urination frequency to ideal diaper chance duration should be actively tested and taken into use in LOPC.

- Nursing staff should have regular education about PU development, risk factors and their assessment, and the implementation of PU prevention practices of nutrition, repositioning, skin care and pressure-relieving devices. This means that research of structure is needed of effective continuous training of PU prevention practice in LOPC.
- Important research needs lie in the evaluation of the long-term maintenance of newly implemented practices and in robust and feasible process evaluations alongside with evaluation of patient-specific effects.

7 Conclusions

This multicomponent Consistent Practice Intervention produced an effective, renewed PU prevention practice, which was commonly agreed by nursing staff, evidence-based, and tailored for LOPC facility level. A consistent practice, "Procedure for PU Prevention in LOPC Facility", was developed to guide activities in PU prevention practices in the LOPC context. The intervention has the potential to be used, reproduced and transferred to other long-term older people care facilities.

The study serves as a model for the implementation of PU prevention guidelines in LOPC facilities by using the Operational Model for Developing Evidence-Based Practices (OMEBP) in the development and implementation of a consistent PU prevention practice. The use of a systematic implementation model made the steps in the process accurate and foreseeable.

This study produced a transferable intervention for the purpose of PU prevention of sufficient quality in LOPC aimed at decreasing suffering and achieving cost savings in PU treatment. As a result of this study, the PU prevalence and stages of PUs decreased, and as a consequence, the residents' suffering may decrease, the treatment of PUs may become easier, and cost savings in PU treatment may be achieved.

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