

Nurse-led physical activity interventions for people with dementia in nursing homes: A systematic review on intervention characteristics and implementation facilitators/barriers

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ABSTRACT

Background: Physical activities are important to maintain and promote physical functioning and activities of daily living in people with dementia. Nurses are in a key position to deliver physical activity interventions in nursing homes. However, synthesized strategies for sustainable implementation of physical activity interventions in nursing homes for people with dementia are lacking.

Objective: We aimed at synthesizing the evidence on nurse-led physical activity interventions and at identifying facilitators and barriers to sustainable implementation of physical activity interventions for people with dementia.

Design: Systematic review.

Review methods: We performed a comprehensive literature search combining database searches (MEDLINE, CINAHL, CENTRAL, Web of Science Core Collection; last search: September 27, 2023) and supplementary search methods (citation tracking, web searching, clinical guideline database searching). We considered studies on nurse-led physical activity interventions for people with dementia living in nursing homes for eligibility; published as journal articles and related material in English, French, German language, without restrictions on primary study design and publication year. Independently and in duplicate, we assessed the references' eligibility and the quality of the included studies. We used the Mixed Methods Appraisal Tool to appraise quality of included studies. We piloted and double-checked data extractions, and summarized the results narratively and graphically (harvest plot). We prospectively registered our review (PROSPERO CRD42021271833).

Results: We identified 24 studies (of which eleven were randomized trials) assessing various interventions that we categorized into *physical exercise* ($n = 8$), *care-integrated physical activity* ($n = 6$), *outdoor or walking activity* ($n = 5$), *technology-supported physical exercise* ($n = 3$), and *dancing* ($n = 2$). Types of outcomes and length of follow-up varied widely. Effects were inconclusive, except for outdoor or walking activities showing an overall positive impact on physical outcomes.

For eight interventions, we identified evidence on implementation barriers (b) and facilitators (f), including staff shortage (b), staff time resources (b), or ease of implementation for staff (f) and adaptability of interventions (f) or refusal to participate of people with dementia (b).

Conclusions: The results of our review provide a comprehensive overview on types, characteristics and effects of nurse-led physical activity interventions for people with dementia in nursing homes. Based on evidence from a range of study designs and sources, we came to the conclusion that all stakeholders involved considered physical activity interventions for people with dementia as useful and relevant. Outcome measures varied widely and a clear conclusion on effectiveness remains open.

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What is already known

- Physical activity may improve physical outcomes of people with dementia living in nursing homes.
- Since nurses are the primary carers in nursing homes, they are in a key position to offer and implement physical activity interventions for people with dementia.

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What this paper adds

- A comprehensive overview of types, characteristics, and effects of nurse-led physical activity interventions for people with dementia living in nursing homes.
- An overview of facilitators and barriers to the implementation of nurse-led physical activity interventions based on evidence from studies with a broad range of designs and from various sources.

1. Introduction

Dementia is a major neurocognitive disorder accompanied by degenerative changes of emotional, social, and physical behavior (World Health Organization, 2016). Increasing dependence of people with dementia leads to formal and informal care (Prince et al., 2013). Around 47 million people are affected around the globe, which corresponds to about 5 % of the world's population aged 65 and older (GBD 2019 Dementia Forecasting Collaborators, 2022). Thus, the World Health Organization recognized dementia as a public health priority (World Health Organization, 2017).

Physical limitations with regard to gait, balance, and muscle strength are common among people with dementia (Beauchet et al., 2008). Physical activity may help to mitigate these symptoms (Forbes et al., 2015). Although the evidence is limited, existing findings suggest that there is a potential to improve physical outcomes – even for severely affected people with dementia (Hall et al., 2021).

Physical activity is defined as any bodily movement produced by skeletal muscles that requires energy expenditure. Exercises are planned, structured, repetitive, and purposeful physical activities aimed at improving or maintaining one or more components of physical fitness. The resulting effects may depend on the intensity and amplitude of the physical activity performance and the person's age (World Health Organization, 2020).

Physical functioning comprises balance-, coordination- and muscle-strength capabilities of the body (Lam et al., 2018). However, there is no unified definition. A core outcome parameter of physical functioning is the rate of falls. As studies have shown, it can be significantly lowered by physical activity in people with dementia (Gulka et al., 2020).

Physical activity is also important to maintain and promote activities of daily living in people with dementia. This is associated with improved independence and correlates with higher quality of life (Campbell et al., 2021; Lam et al., 2018). Activities of daily living refer to tasks individuals have to perform to manage their everyday routines (e.g., eating, clothing, walking, toileting). The most current topical Cochrane review concludes that physical exercise improves the ability to perform activities of daily living in people with dementia (Forbes et al., 2015). To generate clinical effects of physical exercises, a sufficiently strong training stimulus is needed. Thus, the intervention must trigger an adaptation of the trainee's muscle and organ system. Mere tinkering interventions or passive movement trainers, for example, are not sufficient (Ferrauti and Rimmert, 2020).

Physical activity interventions can be provided by healthcare professionals (Roberts et al., 2017). Since nurses and nursing/healthcare assistants are the primary carers in nursing homes, they have a key role in implementing physical activities for people with dementia. There are nurse-led training approaches aiming to achieve relevant physical effects on activities of daily living and physical functioning of people with dementia in nursing homes (Luttenberger et al., 2012). However, no systematic review of such interventions in the nursing home setting exists. To ensure a successful and sustainable implementation of physical activity interventions, it is essential to have an overview of factors facilitating or impeding the interventions. Until now, a systematic synthesis of facilitators and barriers to the implementation of nurse-led physical activities for people with dementia in nursing homes is lacking (Karrer et al., 2020).

Therefore, we aimed at answering the following review questions:

1. Which nurse-led physical activities are used to maintain and promote which physical outcomes of people with dementia living in nursing homes?
2. What are the facilitators and barriers to implementing physical activity interventions for people with dementia in nursing homes?

2. Methods and analysis

We performed a systematic review to (i) describe the characteristics and effects of nurse-led physical activity interventions for people with dementia living in nursing homes and to (ii) determine facilitators and barriers to sustainable implementation of nurse-led physical activity interventions for people with dementia in nursing homes. We prospectively registered our review in the international Prospective Register of Systematic Reviews, PROSPERO CRD42021271833 (Hirt et al., 2021d) and published a detailed systematic review protocol on our methods (Hirt et al., 2021e).

To structure this review report, we applied the updated *Preferred Reporting Items for Systematic review and Meta-Analysis statement* (Page et al., 2021).

2.1. Eligibility criteria

We structured the eligibility criteria according to our review questions. A comprehensive overview of all eligibility criteria is provided in Table 1 and outlined below.

To empirically evaluate nurse-led physical activity interventions for people with dementia living in nursing homes, we included all study designs and related material. Nurse-led physical activities were defined as activities such as exercises, walking or dancing, whereby nurses or nursing assistants are initiators or primary providers of the intervention.

For the population and setting, we defined a cut-off of 75 %. We excluded studies with mixed populations and settings with less than 75 % of people with dementia, unless the results were reported separately. We decided on this cut-off to ensure that the larger majority of the sample are people with dementia. To assess the eligibility regarding the diagnosis, we referred to the dementia status reported by the authors (with or without a formal diagnosis). We did not consider whether residents had a formal diagnosis of dementia.

Since there are several variations and country-specific adaptations of the term “nursing home setting”, we defined it as a setting where people (can) receive 24-hour professional nursing care. Accordingly, we included studies from care homes, homes for aged people and residential aged care facilities (Berg, 2021). We excluded studies conducted in other institutional care facilities, such as assisted living facilities or non-institutional care.

2.2. Information sources

We combined electronic database searching with supplementary search methods (Cooper et al., 2018). We searched MEDLINE via PubMed, Cumulative Index to Nursing and Allied Health Literature (CINAHL), Cochrane Central Register of Controlled Trials (CENTRAL supplementary search via Cochrane Library), and the Web of Science Core Collection (last search: September 27, 2023). In addition, we conducted one layer of forward and backward citation tracking of included studies using Scopus without further iterations of citation tracking for newly identified eligible references (last search: October 13, 2023). We selected the above-mentioned databases and citation tracking since this combination of search methods has proved to be particularly purposeful in dementia care research (Hirt et al., 2021b). To identify additional non-indexed studies on nurse-led physical activity interventions, we conducted web and guideline searching (last search: October 13, 2023) via Google and Google Scholar, the Guidelines International

Table 1
Inclusion and exclusion criteria.

Domain	Inclusion criteria	Exclusion criteria	Review question
Population	People with all types of dementia with no restriction to concerning severity, gender, age, ethnic background, diagnostic procedures, and number of study participants Health professionals and/or family members of people with dementia and/or nursing home managers with no restriction concerning the number of study participants (if implementation facilitators and barriers are reported to belong to a specific nurse-led physical activity intervention for people with dementia in nursing homes)	People with mild cognitive impairment and mixed samples with less than 75 % people with dementia (if the results are not reported separately) –	1 + 2 2
Setting	Nursing homes and other institutional care settings (e.g., care homes, homes for the aged, residential aged care facilities)	Other institutional care facilities (e.g., assisted living facilities, day care), non-institutional care, or mixed settings with less than 75 % of participants living in nursing homes and other institutional care settings	1 + 2
Intervention	Physical activity interventions (e.g., exercises, walking, dancing) initiated and/or primarily accompanied by nurses or nursing assistants (nurse-led)	Passive movement therapies	1 + 2
Study aim	Empirically assessing the effects/effectiveness/efficacy/feasibility of nurse-led physical activity interventions Empirically determining facilitators and/or barriers to introducing nurse-led physical activity interventions	– –	1 2
Comparison	Every and no comparison	–	1
Outcome	Physical outcomes (e.g., physical functioning [lower and upper body], activities of daily living, falls) reported in the title and/or abstract of a reference	–	1
Phenomena of interest	Empirically assessed implementation facilitators and barriers (e.g., acceptance, feasibility, resources) reported for a specific and evaluated nurse-led physical activity intervention for people with dementia in nursing homes	Opinion- and discussion-based implementation facilitators and barriers Facilitators and barriers assessed in the development phase of an intervention	2
Study design	Experimental (randomized controlled trial) and quasi-experimental studies (controlled clinical trial, before–after study) All primary study designs (e.g. observational, interventional, qualitative, or mixed-methods studies)	Reviews Reviews	1 2
Publication year	No restriction	–	1 + 2
Publication language	English, French, German	–	1 + 2
Publication type	Any published reports of empirical studies (e.g., journal articles, conference proceedings, preprints) Online and offline material associated with the intervention	Abstract-only publications, editorials, commentaries, letters, study protocols, theses, registry entries, books –	1 + 2 1

Network (GIN) library and registry of guidelines in development ([Guidelines International Network, 2021](#)), Forschungs-internetbasierte Plattform (FIT-)nursing care ([Eastern Switzerland University of Applied Sciences, 2021](#)), the Association of the Scientific Medical Societies in Germany (AWMF) ([Association of the Scientific Medical Societies in Germany, 2021](#)), and the German Zentrum für Qualität in der Pflege (ZQP) Foundation ([ZQP Foundation, 2021](#)).

2.3. Search strategy

A detailed report of the search strategy development is published elsewhere ([Hirt et al., 2021e](#)). Informed by existing search strategies, we used a combination of controlled vocabulary, free text terms and synonyms in order to search for dementia, physical activity, and nursing homes ([Forbes et al., 2015](#); [Groot Kormelinck et al., 2021](#); [Hirt et al., 2021a](#)). For peer review within our reviewer team (JH and JV) we used PRESS (Peer Review of Electronic Search Strategies) ([McGowan et al., 2016](#)). File 1 shows the final database-specific search strategies.

2.4. Study selection

Two reviewers (out of JH, JV, IW, and SH) independently assessed titles, abstracts, and full texts for eligibility using Rayyan ([Ouzzani et al., 2016](#)). We discussed disagreements within our team of reviewers.

2.5. Critical appraisal of individual studies

To critically appraise the quality of individual studies, we applied the Mixed Methods Appraisal Tool (MMAT) that offers the possibility to critically assess various study designs ([Hong et al., 2019](#)). After a calibration phase using 10 % of the included studies critically appraised by

three reviewers (JH, IW, or SH), one reviewer (JH or IW or SH) critically assessed individual studies that were double-checked by a second reviewer (JH, IW, JV or SH). We discussed disagreements within the reviewer team (JH, IW, JV, SH).

2.6. Data extraction and synthesis

We piloted a data extraction template developed by one reviewer (JH) and complemented by items taken from the Template for Intervention Description and Replication (TIDieR), using 10 % of the included studies and involving three reviewers (JH, IW, SH). One reviewer (JH, IW or SH) extracted data that were double-checked by a second reviewer (JH, JV, IW or SH) for accuracy. We discussed disagreements within the reviewer team (JH, IW, SH).

2.6.1. Specific to review question 1 (characteristics and effects)

To receive missing information on the characteristics of nurse-led physical activity interventions or in case of incomplete outcome data, we contacted corresponding authors via e-mail ([Hirt et al., 2021e](#)).

To describe the intervention characteristics, we performed a narrative summary report based on tabulated data extractions using numbers and percentages. To provide an overview of the effects of nurse-led physical activity interventions for people with dementia in nursing homes, we designed a harvest plot and narratively summarized its content. Harvest plots give an overview of evidence from studies with multiple designs reporting heterogeneous interventions, outcomes, and other clinical characteristics with differential intervention effects ([Ogilvie et al., 2008](#)).

2.6.2. Specific to review question 2 (facilitators and barriers)

For the synthesis of implementation facilitators and barriers, we thematically categorized quantitative and qualitative results using the

Integrated Sustainability Framework (Shelton et al., 2018; Thomas and Harden, 2008) previously applied (Shoesmith et al., 2021) in a systematic review. The Integrated Sustainability Framework is focused on the long-term implementation of health interventions. It contains items related to factors determining sustainability among clinical contexts and interventions (Shelton et al., 2018). We considered quantitative and qualitative results (e.g., feasibility results concerning the acceptance of the intervention or process evaluations) from study report paragraphs relevant for meeting our review objective on facilitators and barriers. Afterward, we coded and labeled information on facilitators and barriers line by line using MAXQDA (MAXQDA, 2022). Two reviewers (JH and SH) assigned and mutually double-checked information on facilitators and barriers concerning contextual factors (e.g., management and leadership, socio-political context), intervention processes (e.g., training and support, fidelity, adaption), characteristics of the implementer and population (e.g., attitudes, motivation), and characteristics of the intervention (e.g., adaptability, benefits, costs) (Shelton et al., 2018). As a deviation from our protocol (Hirt et al., 2021e), we refrained from synthesizing the results of the individual studies on implementation facilitators and barriers since we identified only a small number of studies. To allow a contextual interpretation, we preferred to report the results related to the intervention.

3. Results

We included 28 studies (Alessi et al., 1999; Alessi et al., 1995; Barisch-Fritz et al., 2022; Bourdon and Belmin, 2021; Chen et al., 2016; Chu et al., 2020; D'Cunha et al., 2021; Galik et al., 2021; Galik et al., 2013; Gebhard and Mess, 2022; Guzmán-García et al., 2013; Henskens et al., 2018b; Henskens et al., 2017; Henwood et al., 2017; Henwood et al., 2015; Hopman-Rock et al., 1999; Jirovec, 1991; Kemoun et al., 2010; Liang et al., 2017; MacAndrew et al., 2019; Slaughter et al., 2015; Slaughter and Estabrooks, 2013; Spildooren et al., 2019; Swinnen et al., 2023; Swinnen et al., 2022; Swinnen et al., 2021; Tappen et al., 2000; Tappen, 1994). For two studies (Barisch-Fritz et al., 2022; Henskens et al., 2018b), we included one additional report each (Henskens et al., 2018a; Krafft et al., 2023). In the following, we no longer refer to these additional reports.

Except for three reports identified via citation tracking (Jirovec, 1991; Swinnen et al., 2022) or web searching (Tappen, 1994), we retrieved all reports from database searching (see literature search and selection process; Supplementary file 2).

3.1. Study characteristics

The included studies were published between 1991 and 2023, half of them in 2017 and later. Many studies took place in the US (7/28; Alessi et al., 1999; Alessi et al., 1995; Galik et al., 2021; Galik et al., 2013; Jirovec, 1991; Tappen et al., 2000; Tappen, 1994) and half were randomized controlled trials (14/28; Alessi et al., 1999; Barisch-Fritz et al., 2022; Chen et al., 2016; D'Cunha et al., 2021; Galik et al., 2021; Galik et al., 2013; Gebhard and Mess, 2022; Henskens et al., 2018b; Hopman-Rock et al., 1999; Kemoun et al., 2010; Swinnen et al., 2023; Swinnen et al., 2021; Tappen et al., 2000; Tappen, 1994).

The number of participants ranged between five and 336 (median: 56; overall 1856). The participants' mean age varied between 77 and 90. Female gender proportions ranged between 57 and 94 % (median: 77 %; missing information in three studies).

The type of dementia was mostly not specified (19/28; Alessi et al., 1995; Bourdon and Belmin, 2021; Chen et al., 2016; Chu et al., 2020; D'Cunha et al., 2021; Galik et al., 2021; Galik et al., 2013; Gebhard and Mess, 2022; Guzmán-García et al., 2013; Henskens et al., 2018b; Henwood et al., 2017; Henwood et al., 2015; Hopman-Rock et al., 1999; Jirovec, 1991; MacAndrew et al., 2019; Slaughter et al., 2015; Slaughter and Estabrooks, 2013; Swinnen et al., 2021; Tappen, 1994). The severity of dementia was often moderate to severe (9/28; Alessi

et al., 1995; Chen et al., 2016; D'Cunha et al., 2021; Galik et al., 2021; Galik et al., 2013; Guzmán-García et al., 2013; Henwood et al., 2017; Henwood et al., 2015; Jirovec, 1991). Seven studies included residents with mild to moderate dementia (Alessi et al., 1999; Barisch-Fritz et al., 2022; Chu et al., 2020; Gebhard and Mess, 2022; Liang et al., 2017; Slaughter et al., 2015; Swinnen et al., 2021). Four studies did not specify the participants' severity of dementia (Henskens et al., 2017; Hopman-Rock et al., 1999; Kemoun et al., 2010; Tappen, 1994). A detailed overview of study characteristics is provided in Table 2.

3.2. Intervention characteristics

The included 28 studies assessed nurse-led physical activity interventions that were thematically categorized into five intervention clusters: *physical exercise* (9/28; Alessi et al., 1999; Alessi et al., 1995; Chen et al., 2016; Gebhard and Mess, 2022; Henwood et al., 2017; Henwood et al., 2015; Kemoun et al., 2010; Slaughter et al., 2015; Slaughter and Estabrooks, 2013), *care-integrated physical activity* (6/28; Galik et al., 2021; Galik et al., 2013; Henskens et al., 2018b; Henskens et al., 2017; Hopman-Rock et al., 1999; Tappen, 1994), *technology-supported physical exercise* (6/28; Barisch-Fritz et al., 2022; D'Cunha et al., 2021; Spildooren et al., 2019; Swinnen et al., 2023; Swinnen et al., 2022; Swinnen et al., 2021), *outdoor or walking activity* (5/28; Bourdon and Belmin, 2021;

Table 2
Characteristics of the included studies (n = 28).

	n (%)
Country	
US	7 (25)
Australia	4 (14)
Belgium	4 (14)
Canada	3 (11)
The Netherlands	3 (11)
France	2 (7)
Taiwan	2 (7)
Austria	1 (4)
Germany	1 (4)
UK	1 (4)
Design	
RCT	14 (50)
Pre-post	6 (21)
CCT	5 (18)
Qualitative	3 (11)
Publication decade	
1990s	5 (18)
2000s	1 (4)
2010s	13 (46)
2020s	9 (32)
Type of dementia	
Not specific	19 (68)
Alzheimer's disease	3 (11)
Various	3 (11)
Not reported	3 (11)
Severity of dementia ^a	
Moderate to severe	9 (32)
Mild to moderate	7 (25)
Mild to severe	6 (21)
Not specified	4 (14)
Moderate dementia	1 (4)
Severe dementia	1 (4)

Abbreviations: CCT = clinical controlled trial; RCT = randomized controlled trial; UK = United Kingdom; US = United States.

^a To categorize the severity of dementia, we used expressions chosen by the authors of the study. In case of missing information, we transferred the range of MMSE and CPS scores into "mild" to "severe" categories (Andersson et al., 2021; The National Institute for Health and Care Excellence, 2018). If information about range was missing, we extracted the standard deviation around the mean to indicate the severity (cf. details in Supplementary file 3).

Chu et al., 2020; Jirovec, 1991; MacAndrew et al., 2019; Tappen et al., 2000), and *dancing* (2/28; Guzmán-García et al., 2013; Liang et al., 2017; Table 2). Nineteen studies had a control group and addressed interventions mostly compared with usual care (12 studies; Barisch-Fritz et al., 2022; Bourdon and Belmin, 2021; Chen et al., 2016; D'Cunha et al., 2021; Gebhard and Mess, 2022; Henskens et al., 2017; Henwood et al., 2017; Hopman-Rock et al., 1999; Slaughter et al., 2015; Swinnen et al., 2023; Swinnen et al., 2021; Tappen, 1994). Except for one study that did not report the intervention's mode of delivery (Liang et al., 2017), all interventions were delivered face-to-face, either individually (19 studies; Alessi et al., 1999; Alessi et al., 1995; Barisch-Fritz et al., 2022; Bourdon and Belmin, 2021; Chu et al., 2020; D'Cunha et al., 2021; Galik et al., 2021; Galik et al., 2013; Henskens et al., 2018b; Henskens et al., 2017; Jirovec, 1991; Kemoun et al., 2010; MacAndrew et al., 2019; Slaughter et al., 2015; Slaughter and Estabrooks, 2013; Swinnen et al., 2023; Swinnen et al., 2022; Swinnen et al., 2021; Tappen et al., 2000) or in a group (8 studies; Chen et al., 2016; Gebhard and Mess, 2022; Guzmán-García et al., 2013; Henwood et al., 2017; Henwood et al., 2015; Hopman-Rock et al., 1999; Spildooren et al., 2019; Tappen, 1994). Nineteen studies reported details on the location of the intervention. Mostly, physical activities were conducted inside or outside the nursing home environment (17 studies; Alessi et al., 1999; Alessi et al., 1995; Bourdon and Belmin, 2021; Chu et al., 2020; Galik et al., 2013; Gebhard and Mess, 2022; Henskens et al., 2018b; Henskens et al., 2017; Hopman-Rock et al., 1999; MacAndrew et al., 2019; Slaughter et al., 2015; Slaughter and Estabrooks, 2013; Spildooren et al., 2019; Swinnen et al., 2023; Swinnen et al., 2022; Swinnen et al., 2021; Tappen, 1994). In two of the 19 studies, the intervention took place in a swimming pool (Henwood et al., 2017; Henwood et al., 2015).

The duration and frequency of the intervention varied widely from, for example, 25 min uniquely to several times throughout the day. The intervention period ranged from three to 108 weeks. Six of the included studies did not report whether the physical activity interventions were tailored to the individual participants (Alessi et al., 1995; D'Cunha et al., 2021; Guzmán-García et al., 2013; Hopman-Rock et al., 1999; Jirovec, 1991; Spildooren et al., 2019). For 15 studies (Alessi et al., 1999; Alessi et al., 1995; Barisch-Fritz et al., 2022; Chen et al., 2016; Chu et al., 2020; Gebhard and Mess, 2022; Guzmán-García et al., 2013; Henskens et al., 2018b; Henwood et al., 2017; MacAndrew et al., 2019; Slaughter et al., 2015; Spildooren et al., 2019; Swinnen et al., 2023; Swinnen et al., 2022; Swinnen et al., 2021), we extracted or calculated the participants' adherence to the physical activity intervention (adherence rate: range 45–97 %; median: 77 %) (Table 3).

Three studies did not report a rationale for the impact of the intervention on a physical outcome (Bourdon and Belmin, 2021; Hopman-Rock et al., 1999; Spildooren et al., 2019). Seventeen studies transparently reported the material for delivering the intervention (Alessi et al., 1999; Alessi et al., 1995; Barisch-Fritz et al., 2022; Chen et al., 2016; Chu et al., 2020; D'Cunha et al., 2021; Gebhard and Mess, 2022; Guzmán-García et al., 2013; Henwood et al., 2017; Henwood et al., 2015; Jirovec, 1991; Slaughter et al., 2015; Swinnen et al., 2023; Swinnen et al., 2022; Swinnen et al., 2021; Tappen et al., 2000; Tappen, 1994). Three studies lacked transparent information on intervention procedures (Chen et al., 2016; Hopman-Rock et al., 1999; Liang et al., 2017). None of the studies reported on intervention modifications. Eight studies did not mention sufficient details on the professional background and experience of the intervention facilitator (s) (Alessi et al., 1999; Henwood et al., 2015; Jirovec, 1991; Kemoun et al., 2010; Liang et al., 2017; MacAndrew et al., 2019; Slaughter and Estabrooks, 2013; Tappen et al., 2000; Supplementary file 4).

3.3. Critical appraisal

Six of the 14 randomized controlled trials lacked information on the appropriateness of randomization (Alessi et al., 1999; Barisch-Fritz

et al., 2022; Galik et al., 2013; Hopman-Rock et al., 1999; Parkinson and Milligan, 2011; Tappen et al., 2000; Tappen, 1994). Except two studies (Barisch-Fritz et al., 2022; Swinnen et al., 2023), all other randomized controlled trials had comparable groups at baseline. Except from four studies (Barisch-Fritz et al., 2022; Gebhard and Mess, 2022; Hopman-Rock et al., 1999; Swinnen et al., 2023), outcome data were complete for 80 % of the participants or more. Outcome assessors were mostly blinded for some or all outcomes (9 studies; Alessi et al., 1999; Chen et al., 2016; Galik et al., 2021; Galik et al., 2013; Gebhard and Mess, 2022; Henskens et al., 2018b; Swinnen et al., 2021; Tappen et al., 2000; Tappen, 1994). A large majority of participants (> 80 %) adhered to the assigned intervention in six studies (Alessi et al., 1999; Chen et al., 2016; D'Cunha et al., 2021; Galik et al., 2021; Galik et al., 2013; Swinnen et al., 2021; Supplementary file 5).

Of the eleven quasi-experimental studies, six were assessed as being representative of the target population (Alessi et al., 1995; Bourdon and Belmin, 2021; Chu et al., 2020; Henskens et al., 2017; Henwood et al., 2017; Slaughter et al., 2015). Outcome measurements were considered to be appropriate in ten studies (Alessi et al., 1995; Bourdon and Belmin, 2021; Chu et al., 2020; Henskens et al., 2017; Henwood et al., 2017; Henwood et al., 2015; Jirovec, 1991; Slaughter et al., 2015; Slaughter and Estabrooks, 2013; Spildooren et al., 2019). Seven studies had complete outcomes for 80 % of the participants or more (Bourdon and Belmin, 2021; Chu et al., 2020; Henwood et al., 2017; Henwood et al., 2015; Jirovec, 1991; Liang et al., 2017; Spildooren et al., 2019). Three studies considered confounders in their analyses (Henskens et al., 2017; Jirovec, 1991; Liang et al., 2017). Due to the lack of a study protocol (except for one study: Slaughter et al., 2015), we could not assess whether the intervention had been administered as intended (10 studies; Alessi et al., 1995; Bourdon and Belmin, 2021; Chu et al., 2020; Henskens et al., 2017; Henwood et al., 2017; Henwood et al., 2015; Jirovec, 1991; Liang et al., 2017; Slaughter and Estabrooks, 2013; Spildooren et al., 2019; Supplementary file 5).

For one of the two qualitative studies (Guzmán-García et al., 2013; MacAndrew et al., 2019), we could not assess whether the interpretation of results was sufficiently substantiated by data (MacAndrew et al., 2019). Apart from that, we did not assess any critical issues (Supplementary file 5).

3.4. Intervention effects

A summary of the effects per intervention type and outcome ($n = 23$ studies; follow-up range 3–52 weeks, median = 18 weeks) is displayed in Fig. 1 for all included interventions. Information on follow-up or outcomes was not reported in five studies (D'Cunha et al., 2021; Guzmán-García et al., 2013; MacAndrew et al., 2019; Slaughter and Estabrooks, 2013; Swinnen et al., 2022; Swinnen et al., 2021). Therefore, the harvest plot illustrates the results of 23 studies. In the following, we summarize the results.

Dancing: A dancing intervention positively influenced activities of daily living and reduced the number of falls (Liang et al., 2017).

Care-integrated physical activity: For care-integrated physical activity, there was a benefit concerning the number of falls (Galik et al., 2013). However, it was not possible to determine, whether there was an impact on the outcomes regarding activities of daily living (Galik et al., 2021; Galik et al., 2013; Henskens et al., 2018b; Henskens et al., 2017; Hopman-Rock et al., 1999; Tappen, 1994) and physical functioning of the lower limb (Galik et al., 2013; Henskens et al., 2018b). No benefit could be determined for physical functioning of both the upper and lower limbs (Henskens et al., 2018b).

Outdoor or walking activity: Outdoor or walking activities proved to have an unexceptionally positive impact on activities of daily living (Bourdon and Belmin, 2021; Chu et al., 2020) and on physical

Table 3

Characteristics of the identified physical activity interventions and adherence to the intervention (n = 28).

Study	Intervention	Intervention type ^a	Comparison(s)	Mode of delivery	Location	When and how much ^b	Tailoring	Adherence (%)
Alessi et al., 1995	Physical activity	Physical exercise	Active control	Face-to-face/ individual	Everywhere in the nursing home (daily care routines)	4/d, 5/w, 9w	No	75
Alessi et al., 1999	Combined daytime physical activity plus nighttime environmental program	Physical exercise	Active control	Face-to-face/ individual	Everywhere in the nursing home (daily care routines)	4/d, 5/w, 14w	Yes	85
Barisch-Fritz et al., 2022	Cognitive and physical tasks (InCoPE-app)	Physical exercise (technology-supported)	Usual care	Face-to-face/ individual	NR	60m, 2/w, 18w	Yes	52
Bourdon and Belmin, 2021	Invite residents to visit the enriched garden	Outdoor or walking activity	Usual care	Face-to-face/ individual	Outside the nursing home	Several/d, 4/w, 6m	Yes	NR
Chen et al., 2016	Elastic band exercises	Physical exercise	Usual care	Face-to-face/ group	NR	40m, 3/w, 6m	Yes	97
Chu et al., 2020	One-on-one walking	Outdoor or walking activity	No comparison	Face-to-face/ individual	Outside and inside the nursing home	2–4/w, 16w	Yes	93
D'Cunha et al., 2021	Virtual group cycling	Physical exercise (technology-supported)	Usual care	Face-to-face/ individual	NR	25m (unique)	No	NA
Galik et al., 2013	Function focused care	Care-integrated physical activity	Active control	Face-to-face/ individual	Everywhere in the nursing home (daily care routines)	Throughout the day, 6m	Yes	NA
Galik et al., 2021	Function and behavior focused care	Care-integrated physical activity	Active control	Face-to-face/ individual	NR	Throughout the day, 12m	Yes	NA
Gebhard and Mess, 2022	Physical activity	Physical exercise	Usual care	Face-to-face/ group	Outside and inside the nursing home	60min, 2/w, 12w	Yes	71
Guzmán-García et al., 2013	Latin ballroom dance	Dancing	No comparison	Face-to-face/ group	NR	35m, 2/w, 6w	No	85
Henskens et al., 2017	Movement-oriented restorative care	Care-integrated physical activity	Usual care	Face-to-face/ individual	Living room in the nursing home	Throughout the day, 12m	Yes	NA
Henskens et al., 2018a/b	Activities of daily living training	Care-integrated physical activity	Active control	Face-to-face/ individual	Everywhere in the nursing home (daily care routines)	Throughout the day, 6m	Yes	55
Henwood et al., 2015	Water gymnastics	Physical exercise	No comparison	Face-to-face/ group	Swimming pool	45m, 2/w, 12w	Yes	NA
Henwood et al., 2017	Water gymnastics	Physical exercise	Usual care	Face-to-face/ group	Swimming pool	45m, 2/w, 12w	Yes	63
Hopman-Rock et al., 1999	Psychomotor activation	Care-integrated physical activity	Usual care	Face-to-face/ group	Separate room in the nursing home	2/w, 6m	No	NA
Jirovec, 1991	Assisted walking	Outdoor or walking activity	No comparison	Face-to-face/ individual	NR	30m, 5/w, 4w	No	NR
Kemoun et al., 2010	Physical activity exercises	Physical exercise	No intervention	Face-to-face/ individual	NR	60m, 3/w, 15w	Yes	NR
Liang et al., 2017	Multicomponent intervention (including dancing, horticulture therapy, and physical activity therapy, among others)	Dancing	No comparison	NR	NR	NR	Yes	NR
MacAndrew et al., 2019	Assisted walking	Outdoor or walking activity	No comparison	Face-to-face/ individual	Outside the nursing home	30m, 7/w, 3w	Yes	80
Slaughter and Estabrooks, 2013	Sit-to-stand activity	Physical exercise	No comparison	Face-to-face/ individual	Everywhere in the nursing home (daily care routines)	4/d	Yes	NA
Slaughter et al., 2015	Sit-to-stand exercises	Physical exercise	Usual care	Face-to-face/ individual	Everywhere in the nursing home (daily care routines)	4/d, 7/w, 6m	Yes	45
Spildooren et al., 2019	Music-supported video-based training	Physical exercise (technology-supported)	No comparison	Face-to-face/ group	Exercise room in the nursing home	30m, 3/w, 3w	No	84
Swinen et al., 2021	Exergaming	Physical exercise (technology-supported)	Usual care	Face-to-face/ individual	Exercise room in the nursing home	15m, 3/w, 8w	Yes	83
Swinen et al., 2022	Exergaming	Physical exercise (technology-supported)	No comparison	Face-to-face/ individual	Exercise room in the nursing home	15 min, 3/w, 8w	Yes	79
Swinen et al., 2023	Exergaming	Physical exercise (technology-supported)	Usual care	Face-to-face/ individual	Exercise room in the nursing home	30 min, 3/w, 12w	Yes	62
Tappen et al., 2000	Assisted walking	Outdoor or walking activity	Active control	Face-to-face/ individual	NR	30m, 3/w, 16w	Yes	NA
Tappen, 1994	Functional skill training	Care-integrated physical activity	Usual care	Face-to-face/ group	Separate room in the nursing home	150m, 5/w, 20w	Yes	NR

Abbreviations: d = days; m = months; NA = percentage/calculation not available/possible; NR = not reported; w = weeks.

Notes: Text quotes for each item are provided in the Supplementary file 3.

^a Interventions were clustered thematically.^b We report the frequency and the duration of the intervention as well as the number of sessions; example: '4/d, 5/w, 14w' = four times per day, five times per week, for a period of 14 weeks.

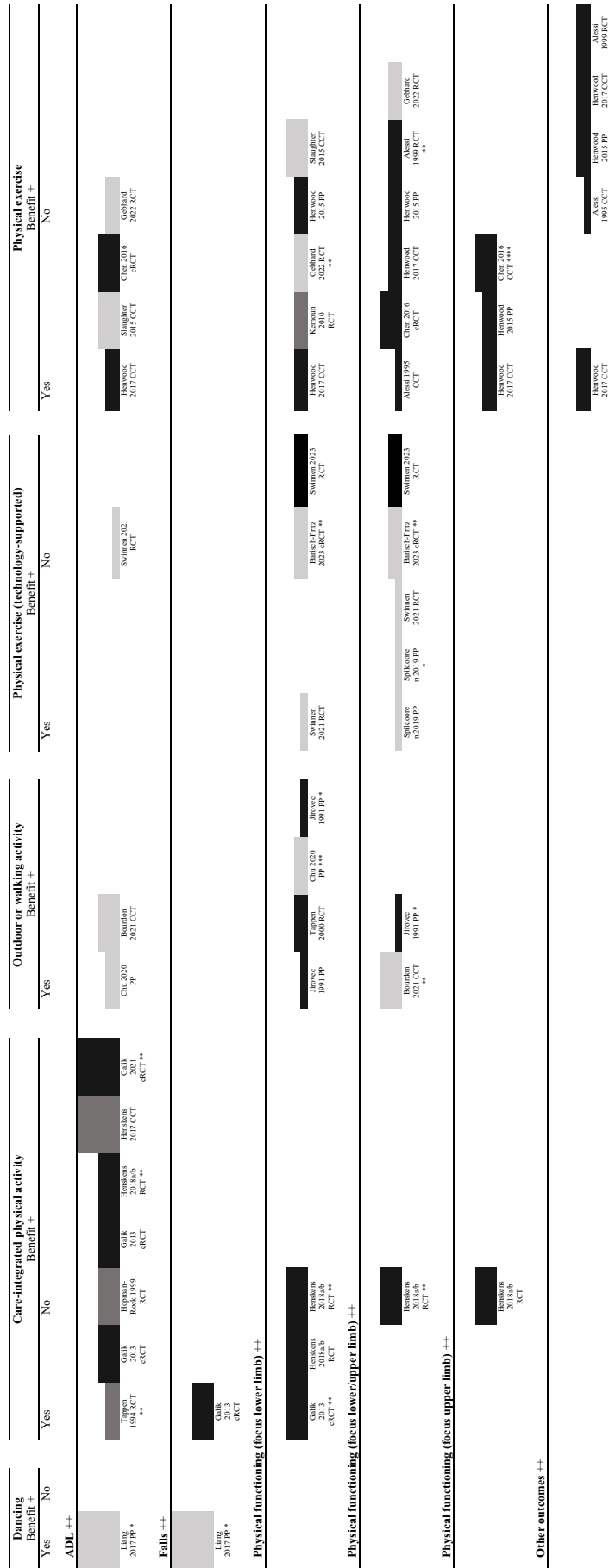


Fig. 1. Harvest plot with effect (benefit/no benefit) per intervention type and grouped outcomes.

Abbreviations: ADL = activities of daily living; CCT = cluster-randomized controlled trial; cRCT = cluster-randomized controlled trial; PP = pre-post study; RCT = randomized controlled trial.

Notes: + Benefit based on the statistical significance of an outcome result. ++ Outcomes based on clinical association: activities of daily living were described as such or assessed with Barthel Index; falls were described as such; we grouped outcomes as physical functioning when a specific physical function was addressed (e.g., stand up); other outcomes included for example weight and calories/kcal.

Five studies are not included in this figure: Three studies did not focus the reporting of the effects of the intervention, i.e., physical outcomes (D'Cunha et al., 2021; Guzmán-García et al., 2013; Swinnen et al., 2022); one study did not report the results for an outcome that we grouped to physical functioning (focus lower limb) (MacAndrew et al., 2019); one study did not report the length of follow-up but resulted in benefit (without statistical significance) of physical functioning (Slaughter and Estabrooks, 2013).

*Benefit (without information on statistical significance was provided/applicable); **two different outcomes were categorized in this outcome group for this effect direction; ***three different outcomes were categorized in this outcome group for this effect direction; ****five different outcomes were categorized in this outcome group for this effect direction.

Bars: Each bar corresponds to one or more outcomes assessed in a study (see **, ***, **** for more information on the number of outcomes summarized).

Bar color: XXXXXX = Persons with severe dementia were part of the study sample; XXXXXX = Persons with severe dementia were not part of the study sample; XXXXXX = No information whether persons with severe dementia were part of the study sample.

Bar height: Length of maximum follow-up measured for an outcome. Lengths of follow-up were transferred into weeks and range from 3 to 52 weeks. Weeks were then clustered in steps of 10: 1–10 weeks = 1 bar height unit (minimum) to 51–60 weeks = 6 bar height units (maximum).

functioning of the upper and/or lower limb (Bourdon and Belmin, 2021; Chu et al., 2020; Jirovec, 1991; Tappen et al., 2000).

Technology-supported physical exercise: Technology-supported physical exercises did not show any beneficial impact on activities of daily living (Swinnen et al., 2021). Results were divergent considering physical functioning of the upper and/or lower limb (Barisch-Fritz et al., 2022; Spildooren et al., 2019; Swinnen et al., 2023; Swinnen et al., 2021).

Physical exercise: Physical exercises had a beneficial impact on physical functioning with a focus on the upper limb (Chen et al., 2016; Henwood et al., 2017; Henwood et al., 2015). Results were divergent considering activities of daily living (Chen et al., 2016; Gebhard and Mess, 2022; Henwood et al., 2017; Slaughter et al., 2015), physical functioning with a focus on the lower limb (Barisch-Fritz et al., 2022; Gebhard and Mess, 2022; Henwood et al., 2017; Henwood et al., 2015; Kemoun et al., 2010; Slaughter et al., 2015), as well as on the lower and upper limbs (Alessi et al., 1999; Alessi et al., 1995; Barisch-Fritz et al., 2022; Chen et al., 2016; Gebhard and Mess, 2022; Henwood et al., 2017; Henwood et al., 2015), and on other outcomes such as weight or calories/kcal (Alessi et al., 1999; Alessi et al., 1995; Henwood et al., 2017; Henwood et al., 2015).

3.5. Feasibility and implementation facilitators/barriers

Ten studies (36 %) explored feasibility and process outcomes of the interventions and twelve studies (43 %) assessed implementation facilitators and barriers (Table 4). In the following, we summarize the results.

Dancing: From a caregiver perspective, various benefits for participants but also for non-participants (i.e., observers of the interventions) were observable, such as an improvement of mobility and affective states.

Participants confirmed a positive impact, for example positive emotions, feelings, and social inclusion. Limited mobility of people with dementia, lack of enjoyment from the part of caregivers, and staff shortage proved to be barriers to the implementation of the intervention (Guzmán-García et al., 2013).

Care-integrated physical activity: Caregivers were mostly able to motivate participants to perform activities. However, caregivers reported difficulties to remember all information provided in the training sessions. They also mentioned difficulties to motivate residents for walking activities. The majority of caregivers experienced benefits from the intervention. Even though not all shared this opinion, they considered the integration of physical activity into care as generally useful. Barriers to implementation were fatigue, misunderstanding of tasks, unwillingness/(health) decline of people with dementia, omission of activity stimulation, high workload and work pressure. Additional training sessions, interdisciplinary consultations, and more time proved to be facilitators of the intervention (Henskens et al., 2018b; Henskens et al., 2017).

Outdoor or walking activity: Caregivers rated a one-on-one walking intervention as very acceptable (Chu et al., 2020). Assisted walking proved to be beneficial for participating residents and caregivers. This intervention was experienced as joyful and offered the possibility of building rapport with participating residents. Nurses and persons with dementia rated it as meaningful. The outdoor setting proved to be a facilitator for sustainable motivation of people with dementia (MacAndrew et al., 2019). Additional facilitators were group walks in the afternoon during individual time slots (rather than strictly tailored times) as well as the involvement of therapists, family members, and volunteers (MacAndrew et al., 2019). Barriers were refusal to take part, desire to return, fatigue, additional strain on nursing staff, and high outside temperature (MacAndrew et al., 2019).

Physical exercise (technology-supported): A virtual group cycling intervention was experienced positively and found meaningful by activity managers. This was confirmed by participating residents. They experienced it as immersive and it contributed to recalling anecdotes from the past. However, a safety screening of this intervention proved to be necessary (D'Cunha et al., 2021). Barriers to the intervention were challenges with accessing and following the visuals while cycling (D'Cunha et al., 2021). An app-based intervention received a good usability rating by participants (Barisch-Fritz et al., 2022). However, barriers for its use were navigation within the app, small font size, and unclear scientific terminology (Barisch-Fritz et al., 2022). An exergame intervention was assessed as comfortable and enjoyable by participants (Swinnen et al., 2023). Facilitators were on-time and personal feedback by the person who delivered the intervention, being physically active while playing, feeling safe, a positive and not disturbing audio-visual design of the exergaming, tailored intensity levels, and it's not too easy and not too difficult or complex (Swinnen et al., 2023; Swinnen et al., 2022). Barriers for its use were game dislike and knee pain of individuals (Swinnen et al., 2023).

Physical exercise: Two study sites participated in a sit-to-stand activity. The intervention uptake differed between the two sites. However, audit and feedback of healthcare aides were associated with an increased level of activity uptake (Slaughter and Estabrooks, 2013). Facilitators of the implementation of an aquatic exercise were personal testimonials from the facility and that the facility proactively assisted the participants to come to the swimming pool. Barriers to conduct aquatic exercise were the preparation time before the start of the intervention and an externally located swimming pool (Henwood et al., 2017). A physical activity program was assessed as very positive by participants (Gebhard and Mess, 2022). Facilitators were that the intervention was carried out in the garden and its voluntary nature of participation (Gebhard and Mess, 2022).

4. Discussion

To answer our first review question, we included all types of nurse-led physical activity intervention studies (i.e., randomized trials, controlled trials, before-after studies) to provide a comprehensive overview of existing interventions and their characteristics. We identified multiple nurse-led physical activities or activities for people with dementia living in nursing homes that we categorized into five intervention types: *classic or technology supported physical exercises, care-integrated physical activity, outdoor or walking activities, and dancing*.

The identified interventions were heterogeneous and designed for residents with different severity of dementia. The included studies assessed various outcomes, such as activities of daily living, physical functioning, and falls. This did not allow us to further synthesize the results of the individual trials to provide a condensed picture of the interventions and related effects. The heterogeneity also applies to time resources and personnel resources required for implementation, as well as to the necessary equipment and training materials. These results are consistent with previous results stating that there is currently no gold standard for promoting physical activity in nursing homes but different approaches are going to be developed and tested (Forbes et al., 2015).

Our synthesis shows that in some studies, the follow-up periods were rather short (a few weeks). Care-integrated physical activity interventions had the longest intervention periods and physical exercise interventions the shortest follow-up periods. While care-integrated physical activities may be easier to integrate into daily routines, exercise-based interventions often require additional effort and time. Thus, additional time resources must be available for training. Training materials, such as weights and ribbons must be set up and, if necessary, dismantled (Henskens et al., 2018b). This might partly explain differences regarding the follow-up period.

Table 4
Feasibility outcome(s), measurement(s), and results and reported implementation facilitators and barriers (sort by intervention type; n = 13 studies).

Study Intervention	Feasibility outcome (s) (measurement(s))	Feasibility and process results	Implementation issues related to the Integrated Sustainability Framework (Shelton et al., 2018)		
			Implementer and population characteristics	Processes	Intervention characteristics
<i>Dancing</i> Guzmán-García et al., 2013 Latin ballroom dance	Participants' and caregivers' experience (personal interview)	Caregivers' experience: - Various benefits for participants were observed: behavior, affective states, mental stimulation, socializing/communication, mobility, reminiscence, and physical health - Benefit for non-participants/observers was observed: affective states, reminiscence, and mobility - Family members noticed that residents were happier and commented on a positive activity for the home environment - Carers reported that dancing was trust-building, provided a means for acceptable social touch, facilitated exchange between caregivers and residents, enhanced verbal and non-verbal communication, and contributed to discovered details of people's lives and capabilities - The intervention might be cost-effective - No attrition, falls, or sexual disinhibited behaviors were reported during the study Participants' experience: - Dancing triggered positive emotions and feelings (joyful, excited, cheerful) - Residents felt younger; memories about former mobility, gracefulness and dancing experiences - Participants identified with their fellow dancers and felt to be a part of a group Some participants felt renewed vigor and had a sense of fitness and vitality	Barriers: - Mobility problems hindered participation for some residents - Lack of enjoyment on the part of caregivers	NI	NI Barriers: - Staff shortage - Disregard of professional role
<i>Care-integrated physical activity</i> Henskens et al., 2018a, 2018b Activities of daily living training	Compliance to the intervention (staff questionnaire)	- 69 % of the time, nursing staff succeeded in letting residents perform care tasks independently - 66 % of the time, staff managed to stimulate the participants to perform more activity of daily living activities independently - 70 % of the time, ambassadors succeeded in motivating other staff members to stimulate residents	Barriers: - Fatigue or refusal of the resident, omission of stimulating activities of daily living on the part of caregivers, lack of understanding with regard to tasks on the part of residents. - Insufficient knowledge on the part of caregivers regarding the importance of stimulation or - Insufficient stimulation of activities of daily living	NI	Barriers: - High workload and work pressure (sometimes faster to take over care tasks by staff)

(continued on next page)

Table 4 (continued)

Study Intervention	Feasibility outcome (s) (measurement(s))	Implementation issues related to the Integrated Sustainability Framework (Shelton et al., 2018)			
		Feasibility and process results	Implementer and population characteristics	Processes	Intervention characteristics Context
Henskens et al., 2017 Movement-oriented restorative care	Compliance to the intervention (staff structured interview; staff and family caregivers' questionnaire)	- Caregivers reported difficulties remembering all the information gathered from the training sessions - Caregivers were able to stimulate independence during meals, bedtime, and in activities of daily living, but reported more difficulties in stimulating activities such as walking - 78.6 % of caregivers experienced benefits from the intervention, compared to 22 % of family caregivers; 89.5 % of family caregivers were willing to continue with the intervention	Barriers: - Health decline of participants	Facilitators: - Additional training sessions - Consultations with other disciplines - More time for implementation	Facilitators: - Meaningful rated activity by staff Barriers: - Understaffing and limited time
Outdoor or walking activity Chu et al., 2020 One-on-one walking	Acceptance (Modified-Treatment Evaluation Inventory)	Rated as very acceptable by nursing home staff	NI	NI	Facilitators: - Person-centered, individualized, approach Barriers: - NI
MacAndrew et al., 2019 Assisted walking	Staff perspectives (personal interview)	Various benefits for the residents and caregivers - Participating residents appeared to enjoy the activity; during the program and in the weeks after completion of the program, they appeared to be calmer, happier, more communicative and social, less resistive to care - Taking some participants for walks outside the facility was considered as positive - Intervention helped caregivers build rapport with participating residents: Therefore, caregivers were able to support residents more easily with regard to activities of daily living - Perceived benefits for participants and staff far outweighed the concerns, and this was an intervention that they would like to see continued	Barriers: - Refusal to participate, desire to stop walking, fatigue	NI	Barriers: - Additional strain on caregivers - High outside temperature (> 30 °C) Facilitators: - Outdoor activity - Involving therapists, family members, and volunteers for conducting walks
Physical exercise (technology-supported) Barisch-Fritz et al., 2022 Cognitive and physical tasks (InCoPE-app)	Usability (participants' questionnaires and interviews)	Good usability	NI	NI	Barriers: - Navigation within the app - Small font size - Unclear scientific terminology Facilitators: - Low-threshold usability
D'Cunha et al., 2021 Virtual group cycling	Participants' and activity managers' experience (personal interview)	Participants' experience: - Intervention was seen to be nice, interesting, immersive, and enjoyable - Participants recalled anecdotes from their past Activity managers' experience: - Positive experience for participants, different from the usual routine, promoted opportunity for physical exercise and social interaction between residents, reduction of social isolation, increased self-efficacy - Personally memorable and meaningful activity for participants	Barriers: - Some participants faced challenges with physical accessibility and equipment - Challenging for the participants to keep cycling and follow with the pace of the cyclist recording the experience	Facilitators: - Safety screening	NI

Spildooren et al., 2019 Music-supported video-based training	Participants' motivation (Intrinsic Motivation Inventory), credibility and expectancy (Credibility and Expectancy Questionnaire), and emotion (Observed Emotion Rating Scale)	Motivation: - Participants mostly found the exercise program enjoyable and important - Exercise program was mostly not accompanied with feelings of anxiety or nervousness - With increasing difficulty, participants found the program still enjoyable and achievable without experiencing anxiety Credibility and expectancy: - Overall credibility was high - Expectancy increased over time Emotion: - Overall positive emotions were shown over time	NI	NI	NI	NI
Swinnen et al., 2022 Exergaming	Participants' experience (personal interview)	NI	NI	Facilitators: - On-time and personal feedback by facilitator	Facilitators: - Being physically active while playing - Feeling safe - Positive and not disturbing audio-visual design of the exergaming - Tailored intensity levels - Not too easy and not too difficult or complex	NI
Swinnen et al., 2023 Exergaming	Participants' experience (personal interview)	Playing the exergames was comfortable and enjoyable	Barriers: - Came dislike - Knee pain	NI	Facilitators: - Not too easy and not too difficult or complex	NI
Physical exercise Gebhard and Mess, 2022 Physical activity	Participants' experience (focus groups)	- Training program was categorized as very positive - No group mentioned aspects they disliked	Facilitators: Being outside in the garden	Facilitators: Voluntary nature of participation	NI	NI
Henwood et al., 2017 Water gymnastics	Program implementation (measurement not reported)	NI	Facilitators: Facility's proactivity about preparing and delivering participants to the pool, and supported staff helping with the project	Facilitators: Personal testimonials from the facility spoke to the better behavior and well-being of participants	NI	Barriers: - Preparation time - Externally swimming pool located
Slaughter et al., 2015 Sit-to-stand activity	Knowledge translation interventions (demonstration of the activity and related documentation); Intervention uptake (documentation of resident performance; nursing aides' personal interview)	Intervention uptake: - Intervention uptake differed in two facilities. In one facility, the uptake was relatively constant, in the other facility the uptake increased over time	NI	Facilitators: - Audit and feedback healthcare aides were associated with an increased level activity uptake in a facility where initial uptake was weak	NI	NI

Abbreviations: NI = no information.

Explanations: Implementer and population characteristics (e.g., skills/expertise, attitudes, motivation, population characteristics); processes (e.g., training and support, fidelity, adaption, communication, planning); intervention characteristics (e.g., adaptability, benefits, costs, burden, fit with population and context); contextual factors (e.g., funding/resources, management and leadership, climate/culture, socio-political context, staffing/turnover, structural characteristics) (Shelton et al., 2018).

Some of the interventions focused primarily on the impact of physical activities on the lower limb. This approach has also been described in the context of general physical or physical-cognitive training interventions for people with dementia (Forbes et al., 2015). It bears the risk of neglecting the promotion of physical skills having a central influence on balance and walking abilities, for example, skills concerning the upper extremities and the trunk (Lee et al., 2020).

The study results on the effects of exercise on lower and upper limb function are inconsistent. The deviations may be due to the different interventions focusing on either the lower or upper limb, as well as the different levels of training stimulus used. For example, nurse-led exercise programs presumably influence the body to adapt more strongly to the training stimulus than potentially lower-threshold interventions like indoor walking (Russ et al., 2021).

Regarding our results, all studies which included lower limb-focused outdoor walking activities showed positive effects on activities of daily living and on physical functioning (Bourdon and Belmin, 2021; Chu et al., 2020; Jirovec, 1991; Tappen et al., 2000). This might be explained by the high and comparatively homogeneous acceptance rates during the implementation of the intervention. Participants reported high motivation concerning the outdoor setting and reminiscence aspects of these interventions (Chu et al., 2020; MacAndrew et al., 2019). In comparison, physical exercise interventions showed heterogeneous adherence rates which were in line with the varying motivation ratings of these interventions (Henwood et al., 2015; Slaughter and Estabrooks, 2013). Therefore, future interventions for people with dementia should consider the necessity to keep participants motivated throughout the program and beyond.

Due to the nature and complexity of most of the identified interventions, it remains unclear which intervention components of the included interventions primarily influence certain physical functions or positively influence activities of daily living (Skivington et al., 2021). Outcomes may also correlate, for example, improvements in physical functioning may have a positive influence on activities of daily living. For example muscle strength is a central, but not the only component of good gait coordination and therefore walking safety (Wang et al., 2020). Which intervention is best suited to promote certain physical outcomes and activities of daily living or functional areas that has not yet been clarified (Valenzuela et al., 2023).

To answer our second review question, we identified feasibility outcomes, implementation facilitators, and/or implementation barriers of the included nurse-led physical activity interventions only in one third of the included studies. Due to this small amount of data, the answer of our second review question has to be used with caution. This is exacerbated by the fact that the methods used to collect and analyze implementation data in most of the studies were only partially rigorous, as they were vaguely explained or not explained at all. Further, there is a high degree of heterogeneity in the results of implementation aspects.

Taken together, nurses and participants considered most of the identified interventions as useful and enjoyable. Participation in preferred physical activities and an individually tailored compilation of exercises for people with dementia facilitate the implementation of physical activities in care homes. In addition, an easy way of implementation with a short preparation time as well as the possibility of group exercises proved to be favorable facilitating factors for caregivers.

Barriers include caregivers' lack of knowledge about positive effects of physical activities, insufficient time resources/material resources for the implementation and unclear documentation processes. Most of the extracted facilitators and barriers are consistent with the existing literature addressing physiotherapists' perceived motivators and barriers to introduce physical activity interventions for older residents in long-term care facilities (Baert et al., 2015, 2016). Since most of the studies did not assess facilitators and barriers, we cannot claim that the extracted facilitators and barriers cover all determinants influencing the implementation of nurse-led physical activity interventions for people with dementia in nursing homes.

Of note, we did not consider studies that were not aligned to an evaluated intervention. Another approach may have led to the eligibility of further studies (Gebhard and Mir, 2021). Due to this, evidence generated on a more general level, i.e., implementation of physical activities for all populations in nursing homes (Narsakka et al., 2022), might be of high importance for implementers (Hirt et al., 2021c). Further research in this field should systematically evaluate nurse-led physical activity interventions for people with dementia in nursing homes and also consider implementation facilitators and barriers. The Medical Research Council framework for developing and evaluating complex interventions may help researchers to identify key implementation aspects of complex interventions. This proves to be a prerequisite for designing and comprehensively conducting research with a diversity of perspectives and with an appropriate choice of methods (Skivington et al., 2021).

4.1. Methodological limitations

Our objective was to provide a comprehensive overview of intervention characteristics and effects of evaluated nurse-led physical activity interventions for people with dementia in nursing homes. Determinants for the implementation of these interventions were of interest as well. However, our search strategy had some limitations. First, we did not consider further iterations of citation tracking of newly identified eligible studies. Second, we did not follow pertinent protocols to identify ongoing or unpublished studies. This may have resulted in the neglect of further studies contributing to the body of knowledge provided here. However, when comparing the included studies from pertinent reviews, we were not able to identify further nurse-led physical activity interventions for people with dementia. We are aware that many interventions for people with dementia are designed to maintain quality of life and to reduce dementia-associated symptoms, such as agitated or aphatic behavior. Third, we have focused exclusively on the effects of interventions addressing physical functioning and skills concerning activities of daily living, knowing that a significant improvement of physical function and activities of daily living can also influence quality of life (Physical Activity Guidelines Advisory Committee, 2018). Fourth, we acknowledge that the eligible studies were only from high-income countries, despite a thorough search of the literature. Finally, we acknowledge that our review was not primarily designed to assess the effectiveness of interventions. Due to common design limitations of the included studies (e.g. small sample sizes, studies without a control group), effects may only show trends. Future reviews could limit their eligibility criteria to studies with a control group or randomized trials and thoroughly assess effectiveness, taking into account study quality.

5. Conclusions

The results of our review provide a comprehensive overview of types, characteristics, and effects of nurse-led physical activity interventions for people with dementia living in nursing homes. We identified facilitators and barriers to the implementation based on evidence from a broad range of studies with various designs and from different sources. We highlighted the need to conduct systematic assessments of implementation facilitators and barriers of physical activity interventions and to consider them integrally in dementia-related intervention research. This would be central to the development of effective and sustainable interventions in clinical practice.

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CRediT authorship contribution statement

Julian Hirt: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Janine Vetsch:** Writing – review & editing, Validation, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Inga Weissenfels:** Writing – review & editing, Validation, Investigation, Data curation. **Steffen Heinrich:** Writing – review & editing, Writing – original draft, Validation, Supervision, Resources, Project administration, Methodology, Investigation, Data curation, Conceptualization.

Data availability

All data supporting the results of this study are openly available in the article or in Supplementary files.

Declaration of Competing Interest

All authors declare that there is no competing interest.

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