Geriatric Nursing 54 (2023) 76–82

Contents lists available at ScienceDirect

Geriatric Nursing

journal homepage: www.gnjournal.com

Learning from fall-related interventions for older people at home: A scoping review

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ARTICLE INFO

Article history:
Received 29 May 2023
Received in revised form 15 August 2023
Accepted 17 August 2023
Available online xxx

Keywords:
Accidental falls
Aged
Incidence
Risk factors

ABSTRACT

This scoping review aims to provide a better understanding about the fall-related interventions, and the conditions which stand out as effective in decreasing fall risks of older people at home. A total of 28 peer-reviewed papers were included when they reported interventions with an incidence of falls or fall-risk as a primary outcome for older people, focusing on the home environment, from 8 databases. Qualitative examination was complemented by quantitative risk ratio analysis where it was feasible. The interventions regarding incidence of falls had a mean risk rate of 0.75; moreover, interventions using multiple strategies were found relatively successful. The interventions regarding fall risk had a mean hazard rate of 0.66. A considerable number of no-effect ratios were evident. Combining education, home assessment or improvement, and use of technology with implementation by health service experts appears to be the most promising intervention strategy to reduce falls.

Introduction

Europe is expected to have developed into an ageing society by 2050. The number of people aged 75–84 is projected to increase by 56%, and simultaneously fewer people younger than 55 (a 14% reduction) will be living in Europe.[1] An ageing society creates distinct challenges when it comes to the care and independent living of older people. Falling is one of the major health risks for older people living at home. Falling is an 'event that results in a person coming to rest inadvertently on the ground or floor or other lower level',[2] and up to 35% of people aged 65+ and up to 42% of people aged 70+ suffer from falls every year. According to the World Health Organisation (WHO), each year an estimated 37.3 million falls require medical attention due to their severity, with round 684 000 people dying from falls globally.[3] Falls are related to various types of injuries and are regarded as a serious public health issue; moreover, they account for 40% of all injury deaths among older people.[4] Falls can also have a psychosocial impact on people; for example, experiences of falling can lead to social isolation or care home admission.[5] There is a need to develop effective strategies to reduce the risk of falling and promote fall-prevention among older people living at home.

Since the early 1990s, a wide variety of interventions aimed at preventing the risk of falling have been studied, and interventions with various strategies and study designs have been developed. Defining effective fall-prevention interventions is challenging due to the multiple and dynamic factors that interact with fall risks. These can be categorized into factors related to individual physical characteristics, (e.g., problems with balance), environment (e.g., insufficient or misplaced handrails), and behaviour of individuals.[6] The World Health Organization (WHO) has proposed evidence-based recommendations to reduce the incidence of falls among older people. Due to the emphasis on institutional context, occupational therapists are viewed as playing a significant role in delivering effective fall-related interventions.[7] Moreover, individual adherence to fall-prevention interventions is an important factor. Reviewing exercise programme interventions, Simek et al.[8] found that home visits, telephone support, and participant recruitment by health service experts promote adherence. In a qualitative study, Mansson et al.[9] concluded that the use of a digital programme can facilitate long-term adherence among older people. Nevertheless, adherence to fall prevention interventions can be as low as 10%, leading to poor success when measuring

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https://doi.org/10.1016/j.gerinurse.2023.08.014

the effectiveness of the intervention.[10,11] Furthermore, language barriers,[12] motivation to join exercise classes or fall-prevention programmes,[13] and lack of awareness of their benefits,[14] are some of the aspects that can influence older adults' attitudes towards an intervention. Nevertheless, interventions have been focused primarily on hospitals or assisted living settings,[15–17] and relatively few studies have investigated fall risks in the home environment.[18]

We conducted a scoping review to answer a research question "what factors are associated with older people falls in home environment". Based on the literature search, this paper reports the findings of intervention studies aimed at reducing falls and fall risks, their strengths, limitations, and which conditions have proved effective.

Methods

The PRISMA-ScR statement was followed in this scoping review.[19] The protocol was not registered.

Eligibility criteria

Published peer-reviewed papers were included when 1) population was older people, 2) concept was falls or fall-risk related interventions, 3) context was the home environment, 4) papers were written in English, Finnish, Spanish or Swedish, and 4) the number/incidence of falls or fall-risk were the explicit primary outcomes of the studies. No year limitation was set in order to obtain a comprehensive understanding of the phenomena.

Data sources and search

The searches were conducted between March and April 2022 (the most recent search was on 7 April) in Medline, CINAHL, Nursing & Allied Health, Applied Social Sciences Index & Abstracts (ASSIA), Sage, Science Direct, Social Science Premium Collection, Scopus, and Web of Science databases. The search strategies were drafted through research team discussions, in collaboration with the experienced health sciences librarian, who also conducted the actual searches. The search strategy adopted in the case of CINAHL can be found in online Appendix 1. Search terms were: old, old people, elderly, aged, senior, pensioner, fall at home, accident at home, factor, risk, cause, prevent.

Study selection and data extraction

The final search results were exported to the Covidence citation management programme, and duplicates were removed automatically.[20] A two-fold study selection process was conducted: title and abstract screening and full-text screening (see Fig. 1 for details). Each study was evaluated by two authors (MP&AV, SI&TT, TK&RC), and conflicting results were resolved by consensus. A data extraction spreadsheet was modified from previous work by the authors, including citation details, design and methods, setting, population, intervention, comparison, outcomes, and results (see online Appendix 2). The data extraction was conducted by authors (MP, RC, SI, KKR, TK, TT, AV)) individually and cross-checked. Due to the nature of a scoping review, a clinical quality appraisal was not conducted.

Data synthesis

Data were synthesised by outcomes: number/incidence of falls and risk of falls. Individual studies were carefully categorised in terms of study population and the country in which the data were collected. Context is considered a key determinant in intervention studies[21] and was emphasised in the current study using methodologically and contextually varying data.

A forest plot was utilised in view of the fact that that there is considerable heterogeneity in the research design, method, population, outcomes, and analysis. This heterogeneity is due to the variance in disciplinary origins and objectives among the empirical studies. Risk rates (RRs) indicate the risk of falling after the intervention from 0 to 1. For the forest plot, RRs were calculated using follow-up fall risk ratios in an attempt to prioritise long-term effects. One of the studies[22] reported odds ratios (ORs), which were converted to risk ratios and confidence intervals for the current study by applying the formula (1) below, where p_c represents the RR for the control group. [23]

$$RR = \frac{OR}{(1 - p_c) + (OR \times p_c)} \quad (1)$$

Considering that RR refers to intervention effect risk and hazard rate refers to how an intervention changes the rate of experiencing an event,[24] RR is used in the fall incidence analysis and hazard rate is used in the fall risk analysis; both RRs and hazard rates were collected dichotomously. In this simplification, the number of falls was not included in the analysis. In settings where both between-groups and within-subjects results were reported, RRs were drawn from the within-subjects statistics. Parallel interventions in the individual studies are reported on their own separate lines in the forest plot; this is methodologically rationalised and recommended by Yeates and Dunnagan,[25] as separating intervention components allows comparison between effect sizes. In studies in which confidence intervals were not accessible, RRs were accepted, reaching <1 if statistical significance was reported in another form, such as significant difference between groups. If confidence intervals contained 1 or the statistical insignificance was otherwise reported, RR for the individual finding was recorded as 1 = non-effect.

Results

Summary of studies

A total of 28 papers were included (see Fig. 1). The most common reasons for excluding studies were irrelevancy on screening (n=452) or not meeting the inclusion criteria on full-text phase (n=167). The main characteristics and details of interventions of each paper are presented in online Appendix 2. The papers were published between 1994 and 2021, and the population comprised older people living at home. A majority of the studies (n=12) had recruited participants without any other criteria, but some studies included only frail or cognitively impaired older people, or those with chronic conditions, disabilities, psychotropic medication, high fall risk or previous falls. Some study populations consisted of people with a low income or who lived in underserved areas. The size of the study population varied from 35 to 1,565 (mean 312). Most of the studies were randomised controlled trials (RCTs; n=17), followed by pretest-posttest (n=6), quasi-experimental (n=4) and experimental prospective (n=1) designs. Most studies were from Europe (n=9), followed by North America (n=8) and Oceania (n=8), Asia (n=2), and South America (n=1).

The fall-risk-related strategies used in interventions can be categorised as physical exercise (EXE), education (EDU), home assessment/improvement (HOME), health care professionals' follow-up visit/call/video (PROF), physical examination/treatment (EXAM), technology (use of devices; TECH), meal delivery/nutrition (NUTR), and medication (MED). The interventions were conducted using one of above-mentioned strategies (n=8) or as a combination of two (n=9) or more strategies (n=11; see Table 1 for details). The interventions were aimed at reducing falls (n=17) or fall risks (n=7) or both (n=4). The incidence of falls tended to be measured on the basis of self-reported falls (calendars/diaries), while fall risk was measured by means of different instruments. The interventions took place at

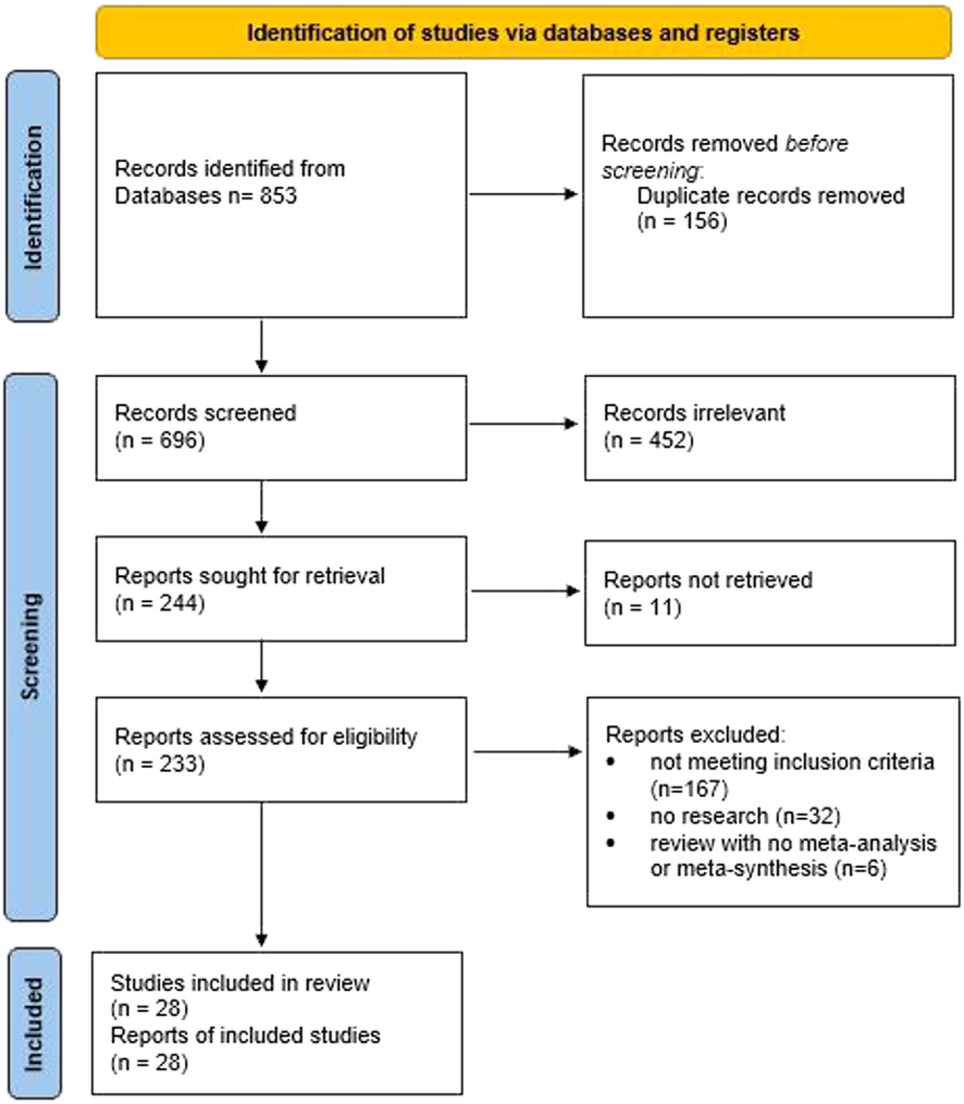

Fig. 1. PRISMA flow diagram.[35]

participants' homes (n=22), health care facilities (n=5), or other locations (n=1). The follow-up period was usually 12 months (n=8), followed by 6 months (n=5) as the second most common follow-up period. Two studies had 18-month follow-up, one had 11-month follow-up, and others had a follow-up period ranging from 1 to 16 weeks (n=8).

Incidence of falls

The intervention strategies among the studies focusing on incidence of falls were EXE (n=11), EDU, (n=16), HOME (n=9), PROF (n=7), EXAM (n=2), TECH, (n=3), NUTR (n=1) and MED (n=1). The studies had a mean RR of 0.75. Excluding the studies with no effect, the mean RR was calculated as 0.53, that is, where falls were reduced by approximately half.

Interventions using multiple strategies stood out as having higher overall effects (Fig. 2). For example, interventions combining EDU, TECH, and HOME were more promising than home improvements alone. Similarly, interventions combining EDU and EXE had more effect if they were combined with health care professional follow-up visits or calls (PROF), regarded here as a third intervention strategy.

Among the stand-alone interventions, a study about home modifications preventing falls produced the highest effect size in the data.[26] However, HOME-categorised interventions did not produce highly consistent results in the bigger picture. EDU was identified as the intervention strategy that drew perhaps the most inconsistent results; nearly half (12) of the total of 26 interventions produced non-significant results in relation to effectiveness, with EDU included in eight of them. Null hypothesis of non-existent effect was most prominent in the categories of EXE, EDU, and NUTR. The latter, however, included only one intervention study focusing on meal deliveries, where the effect of nutrition decreasing falls was not supported (no-effect ratio = 1.00).

Different intervention strategies varied within the relatively considerable number of no-effect ratios. Null effect was found in 55% of the interventions including exercise, 44% including education, 43% including a healthcare professional implementation, 33% including technological solutions, 33% including physical examination and treatment interventions, and 22% including home interventions. In addition, the sole nutrition intervention was found to be non-effective, while the sole medication intervention was found to be effective. The wide confidence intervals reported in the studies imply that some of the findings are in need of additional evidence. For example,

Table 1
Summary of intervention protocols and outcomes.

Study	Intervention								Outcome	
	EXE	EDU	HOME	PROF	EXAM	TECH	NUTR	MED	falls	risk of falls
Batchelor et al. 2012[36]	x	x							x	x
Bernocchi et al. 2019[37]	x	x		x					x	
Boongird et al. 2017[38]	x	x							x	
Campbell et al. 1997[39]	x	x						x	x	x
Campbell et al. 1999[30]	x							x	x	
Cezar et al. *2021*[40]	x									x
Crowell & Sokas 2020[26]			x						x	x
Day et al. 2002[41]	X		x		x				x	
Gallo et al. 2018[42]	x									x
Huang & Acton 2004[43]		x							x	
Logghe et al. 2009[44]	x	x							x	
Maggi et al. 2018[45]		x	x						x	
Markle-Reid et al. 2010[46]		x		x					x	
Migliarese et al. 2016[47]	x	x		x						x
Nikolaus & Bach 2003[48]		x		x					x	
Palvanen et al. 2014[49]		x	x		x				x	
Peel et al. 2000[50]	x	x	x		x					x
Pérula et al. 2012[51]	x	x		x					x	x
Plautz et al. 1996[52]		x	x						x	
Robertson et al. 2001[53]	x	x		x					x	
Taylor et al. 2021[54]	x	x	x	x					x	
Tchalla et al. 2013[22]						x			x	
Thiamwong et al. 2020[55]	x	x								x
Thomas et al. 2018[56]							x		x	
Thompson 1996[57]		x	x			x			x	
Tiefenbachová & Zeleníková 2019[58]		x								x
Van Haastregt et al. 2000[59]				x					x	
Yates & Dunnagan 2001[25]	x	x					x			x

*HCPs = health care professionals
EXE=physical exercise, EDU=education, HOME=home assessment /improvement, PROF=HCPs visit/call/video. EXAM=physical examination/treatment, TECH=technology (devices), NUTR=meal delivery/nutrition, MED=medication

the stand-alone intervention of HOME stands out with a relatively high RR, but lacks a confidence interval. Similarly, multiple-strategy interventions including EXE, EXAM, and HOME, as well as EDU, TECH and HOME remain in need of additional evidence. Among the stand-alone interventions, MED demonstrated the most promising results.

Risk of falls

The next analysis was of the subdata relating to intervention studies with an outcome of fall risks. The intervention strategies were EXE (n=9), EDU (n=8), HOME (n=2), PROF (n=2), EXAM (n=1), NUTR (n=1), and MED (n=1). The intervention studies regarding risks of falling

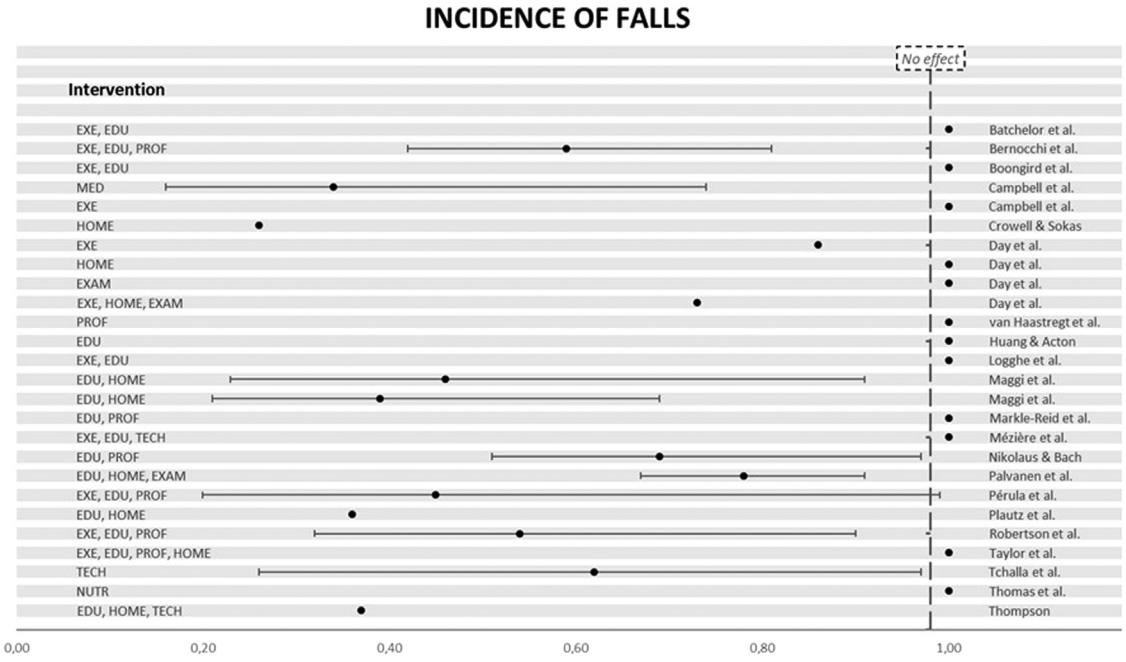

Fig. 2. Forest plot for the fall risk rates by interventions.

Table 2
The effect of interventions relating to fall risks

Study	Intervention	Hazard rate
Effect		
Cezar et al.[40]	EXE	0.50
Crowell & Sokas[26]	HOME	0.26
Peel et al.[50]	EXE, EDU, HOME, EXAM	0.80
Thiamwong et al.[55]	EXE, EDU	0.61
No effect		
Gallo et al.[42]	EXE	1.00
Migliarese et al.[47]	EXE, EDU, PROF	1.00
Factor-related effect		
Tiefenbachov & Zeleníkova[58]	EDU	[See Appendix II]
Yates & Dunnagan[25]	EXE, EDU, NUTR	[See Appendix II]

had a mean hazard rate of 0.66. Excluding the studies with no effect, the mean RR was calculated as 0.52 (Table 2).

Among the various intervention strategies HOME emerged as a significant factor in decreasing fall risks; it was effective in both studies that focused on household adaptations (e.g., floor plans including staircase modifications, clutter removal, carpeting and lighting, and assistive equipment including handrails, chair lifts and shower seats).

More than a fifth (21%) of the 19 interventions produced non-significant results with regard to effectiveness. Two of the seven (29%) EXE interventions and one of the five EDU interventions produced non-significant results. This is in line with the previous findings of this study, where the effect of education on falling was evaluated as having inconsistent evidence.

Discussion

A total of 28 studies reported interventions aimed at reducing falls or fall risks among older people in the home environment. Among the interventions that were successful in producing a significant reduction in falls, the incidences of falls were reduced by half, on average. EDU was the most frequently applied and tested intervention strategy. The findings imply that education, combined with other types of interventions – especially with home visits or improvement and technology as a multiple-intervention strategy – is particularly promising in fall prevention. However, the differences between the various intervention strategies does not allow any more far-reaching conclusions due to the wide confidence intervals between risk ratios.

In contrast to the interventions that managed to produce significant effects in relation to fall prevention, a considerable number of studies produced no effect. This can be explained with low-effect sizes appearing to plague fall prevention programmes. Meaning, it is usual to identify those subpopulations with the highest risk and focus interventions on them – for example, people with sports injuries or certain diagnoses.[27–29] Similarly, the highest-effect sizes among the individual studies in the reviewed literature were identified in Crowell and Sokas's[26] study on low-income seniors aged 60+ and adults with disabilities and in Campbell et al.'s[30] study on seniors aged 65+ currently taking psychotropic medication.

State of the art intervention strategies including technological solutions were not common in the data. This is interesting finding, since in the feasibility and adaptation study of Mansson et al. (2020),[9] digital technology as part of the intervention was demonstrated to reduce the fall risk by promoting the empowerment of older people via increased confidence, connection with others, and comfort. This highlights the need for further research to identify the potential of smart technology in fall-preventing interventions. In the future, reviews focusing on technology-related interventions will become more relevant when smart technology and robotics solutions are developed and matured to the point that they can be used in private homes.

Inconsistency between interventions and outcome measures makes it difficult to evaluate the reasons why certain interventions were effective and others were not. For example, with EDU, interventions entailed variating information about home hazards, personal fall risks or appropriate shoes, delivered via leaflets or personally or in group sessions by health professionals. In general, the study reports did not reveal which elements of interventions may or may not have been effective or whether all the elements were necessary. Also, due the different outcome measurements, there was no possibility to analyse if some of the methods within interventions were more effective than others. Other possible reasons for variating results are different follow-up periods and self-report-based measurements. All above mentioned are commonly known challenges with complex interventions.[31]

In line with the results of Simek et al.[8] and Mansson et al.,[9] this study also suggests that the effectiveness of interventions could be improved through personal follow-up contact with health care professionals. That said, one explanation for non-effect might lie with the fact that intervention designs were mainly health professional-oriented and aimed at changing the life of independent people from the outside, rather than being based on personal empowerment, for example. Residents did not seem to have participated in the design processes. When developing future interventions, co-designing with residents as part of the intervention design process – via focus groups or participatory workshops – could help understand participants' needs, enhance learning and empowerment, and, consequently, increase the effectiveness of interventions.[9,32,33] Moreover, this approach could be beneficial when designing or implementing intervention studies to address multiple risk factors – behavioural, intrinsic, and extrinsic – together through a co-creation approach.

Limitations

This review was conducted using rigorous and transparent methods guided by the PRISMA-ScR statement.[19] However, the review may not have identified all fall-related interventions, e.g. due to the exclusion of certain papers on the basis of language. A further limitation is that the samples used in the studies were relatively small, which resulted in wide confidence intervals. This is reflected in the fact that it is difficult to interpret the significant differences between the individual findings. In addition, many studies did not provide any information about confidence intervals at all, as is often the case in intervention studies. As Cohen[34] notes, the reason studies do not report confidence intervals for their effect sizes may be that these intervals are so unfavourably large. Moreover, the heterogeneity across studies did not allow for the opportunity to use meta-analysis to estimate the impact of the interventions.

Conclusion

The field of fall-related intervention studies is wide-ranging, and individual interventions tend to be complex. It is therefore difficult to demonstrate the effectiveness of interventions. Combining education, home assessment or improvement, and the use of technology, in conjunction with implementation by health service experts appears to be the most promising intervention strategy to reduce falls, while promoting fall prevention at the same time. There is no stand-alone intervention that covers both of these outcomes. Improvements are required in order to implement fall-related interventions in homes more effectively and in a way that addresses multiple risk factors (i.e., behavioural, intrinsic, and extrinsic) to promote their long-term effectiveness.

Funding

This research was conducted in conjunction with the 'Human-centered solar smart technology design for healthy aging' (SOL-

TECH) project, supported by the Jane and Aatos Erkko Foundation. The foundation did not award a specific grant for this review.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Supplementary materials

Supplementary material associated with this article can be found in the online version at doi:10.1016/j.gerinurse.2023.08.014.

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