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Research paper

Effects of preventive home visits on older people's use and costs of health care services: A systematic review



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ABSTRACT

Introduction: The aim of this study was to systematically review the evidence from randomized controlled trials (RCT) concerning effectiveness of preventive home visit (PHV) programs on older people's use and costs of health and social services. We also evaluated resultant costs-changes achieved with intervention in older people's functioning, quality-of-life (QOL) or mortality.

Materials and methods: A systematic review of published RCTs reporting use and/or costs on PHVs on multimorbid older people was performed. The characteristics and methodological quality of studies were assessed.

Results: Of the 3219 articles screened, 19 met the inclusion criteria. The methodological quality of the trials was principally moderate ($n = 5$) or good ($n = 10$). Of the studies, 12 evaluated the overall costs of health and social services. None of these studies was able to show significant differences in total costs between intervention and control groups. Six studies suggested that PHVs may decrease nursing home admissions and/or hospital days. Seven studies showed some favorable effect on physical functioning, QOL, or mortality, without increasing the total health care costs.

Conclusions: Of the high number of studies investigating efficacy of PHVs on older people, only a few studies explore economic effects. PHVs do not provide overall savings to health care costs, but some interventions might offer some cost-neutral positive effects on functioning, QOL and/or mortality. More studies are needed to clarify the effective aspects of the programs and cost-effectiveness of the PHVs.

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1. Introduction

An ageing population warrants the development of effective preventive interventions to support autonomy and well-being of older people. Preventive home visits have been developed with the aim of improving and maintaining the health and functioning of older people [1]. From the societal perspective they are also intended to reduce hospital and nursing home admissions and to lower the associated health care costs [2,3]. Over the past two decades, there has been an increasing interest in developing preventive home visit programs. A large number of studies have been conducted, especially in Europe, North America, and Japan,

and several systematic reviews on these programs have explored their efficacy [1–6]. The findings have varied across national systems and settings [7].

The effects of the home visiting programs remain controversial [6,8]. Some studies have shown improvements in well-being and slower decline in functioning among those receiving home visit intervention compared with their controls [1] but some have suggested no effects of preventive home visits [6]. Whereas the earlier systematic reviews showed positive effects on functioning [4,5], admissions to institutional care [2,3,5], and mortality [1,2,5], the later reviews suggest less favorable effects [6,8]. There is a heterogeneity in the interventions which have often been poorly described [6]. In addition, the methodological quality of the trials has varied [3,8]. Furthermore, these reviews have been inconsistent in how they have included previous randomized, controlled trials.

Several trials have also focused on the effects of preventive home visits on the use of services [1,6,8]. To our knowledge, only two reviews have investigated cost-effectiveness of preventive

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home visits. One of them was limited to studies that were undertaken in Great Britain [9]. The other one focused only on fall prevention studies [10].

The aim of this systematic review is to examine the effects of home visiting programs on older people's (aged 65+) use and costs of health and social services. We included all randomized, controlled trials comparing the differences in the use of hospitals, social, and health care services, as well as nursing home admissions between the participants receiving intervention compared to their controls. From these studies, we also retrieved other outcomes such as functioning, quality-of-life (QOL), and mortality to assess what can be achieved with the input of money invested in home visits.

2. Methods

2.1. Search strategy

PubMed, Ovid Medline, Cochrane Database, DARE, and Cinahl were systematically searched for randomized controlled trials (RCTs) using terms related to home visits for older people and economic analysis. We used the following terms: [(preventive OR prevention) AND (home care OR home nursing OR house calls OR home visit)] AND aged [MeSH Terms] AND (cost-effectiveness OR economic OR cost-benefit analysis OR costs and cost analysis OR health care costs OR hospital admissions OR nursing home admissions) in all fields. In databases where aged [MeSH Term] search was not possible, search terms (aged OR elderly OR older people OR old) were used. The search process ended in May 2015 and was repeated in February 2016. Reference lists from earlier papers, and reviews were manually searched for additional studies. No language restrictions were imposed.

We included RCTs examining the effects of the preventive home visiting programs on community-dwelling older people's (aged 65+) use and/or costs of health care and social services. We included both those studies that had an economic analysis performed on the data and the studies that had reported data on differences in hospital days and/or nursing home admissions or use of various health and social services.

Preventive home visits are defined as visits to community-dwelling older people, which aim for multidimensional medical, functional, psychosocial, and/or environmental evaluation of their problems and resources [3–5,8]. Based on the definition of preventive home visits, studies that evaluated follow-up home visits directly related to recent hospital discharge, as well as studies in which the intervention was exclusively targeted to fall prevention or cognitive-function, were excluded. Since we focused on older people, many of whom suffer from multiple health problems, studies, which were targeted at people with one specific disease or diagnosis were excluded.

2.2. Methodological quality

Two reviewers (H.L. and P.L.) independently evaluated the included studies according to ten criteria of methodological quality. Disagreements were taken to third reviewer (K.P.) and discussed between the reviewers until a consensus was reached. We used a modified rating system for evaluation. In this rating system, we applied the criteria for randomized intervention trials used by Cochrane and collaborators [11] and Joanna Briggs Institute MASTARI critical appraisal tool [12]. In addition, we included the criteria developed by the Evidence-Based Medicine Working Group [13,14]. The criteria are described in Table 1. Each criterion was considered to be worth 1 point. Each item was scored '+', if the criterion was fulfilled, '–' if the criterion was not fulfilled,

Table 1
Evaluation of the quality criteria fulfillment in randomized controlled trials (RCT) examining the effects of preventive home visits on older people's use and costs of health care services.

Study	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	Total
Hendriksen et al., 1984 [30]	±	+	+	–	+	±	±	?	+	?	4
Vetter et al., 1984 [15]	+	+	+	–	+	+	±	–	+	–	6
Pathy et al., 1992 [16]	–	+	±	–	+	±	–	+	+	?	4
van Rossum et al., 1993 [17]	+	+	+	+	+	+	+	+	+	±	9
Stuck et al., 1995 [18]	+	+	+	+	+	+	+	+	+	?	9
Dalby et al., 2000 [31]	+	+	–	+	+	±	±	±	+	±	5
Stuck et al., 2000 [19]	+	+	+	–	±	+	+	+	+	?	7
Hebert et al., 2001 [32]	±	+	+	±	+	+	–	+	+	+	7
Schraeder et al., 2001 [26]	+	–	+	–	+	+	–	+	+	+	7
Bouman et al., 2008 [20]	+	+	+	+	+	+	+	+	+	?	9
Melis et al., 2008 [21]	+	+	–	+	+	+	+	+	+	+	9
Sahlen et al., 2008 [22]	+	±	+	±	+	+	?	?	?	?	4
van Hout et al., 2010 [24]	+	+	+	+	+	+	+	+	+	?	9
Ploeg et al., 2010 [23]	+	+	+	+	+	+	±	±	+	+	8
Frese et al., 2012 [25]	+	±	+	?	+	+	–	–	±	?	4
Kono et al., 2013 [7]	+	+	+	+	+	+	+	+	+	+	10
Brettschneider et al., 2015 [27]	+	+	+	+	+	+	±	–	+	+	8
Fairhall et al., 2015 [28]	+	+	+	+	+	+	+	+	+	+	10
Metzelthin et al., 2015 [29]	+	±	+	+	+	+	–	+	+	+	8

(1) Inclusion and exclusion criteria are satisfactorily described.

(2) Groups are comparable at baseline.

(3) The study has sufficient statistical power to detect an effect and there was a strength calculation.

(4) The randomization method is adequately described and the assignment to treatment groups was truly random.

(5) The measurements and outcome measures are valid and well defined.

(6) The intervention is adequately described.

(7) The dropouts are described and the analyses take them into account.

(8) Intention to treat analysis is applied.

(9) A comparison is made in relation to outcome variables between the groups.

(10) The group assignment is blinded when assessing the outcomes.

+: criterion fulfilled (1 point); –: criterion not fulfilled; ±: criterion partly fulfilled;?: unclear.

High quality: 8–10; moderate quality: 5–7; poor quality: <5 points.

‘±’ if the criterion was partly fulfilled, and ‘?’ if no information was provided or was unclear. The quality of the trial was considered high when a study scored 8–10 points. Scores of 5–7 indicated moderate quality and < 5 poor quality.

No meta-analysis could be completed due to the variability in outcome measures, and heterogeneity in calculations of costs and use of services.

3. Results

3.1. Identification and Selection of studies

We found altogether 19 studies, which had examined the effects of the preventive home visiting programs on older people's use and costs of health and social services. Of these, 16 were found directly in the database searches [7,15–29] and three additional articles [30–32] were found from earlier systematic reviews (Fig. 1).

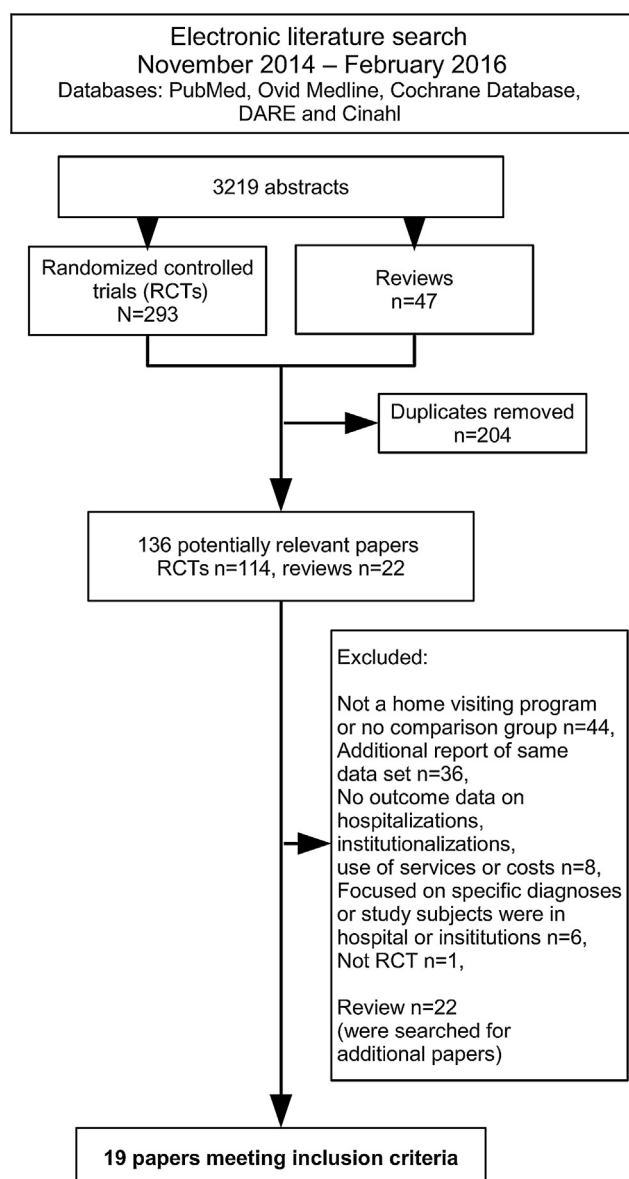


Fig. 1. Search process of the systematic review.

3.2. Study characteristics

The quality of the studies (Table 1) varied: 10 were rated as good quality [7,17,18,20,21,23,24,27–29], five as moderate [15,19,26,31,32], and four as poor [16,22,25,30]. The most common deficiencies in the studies were that randomization methods were not adequately described or valid, dropouts were not described or taken into account in the analysis, and/or intention to treat analysis was not applied or adequately described. Many studies also lacked a description of whether or not the group assignment had been blinded when assessing the outcomes.

The characteristics of the 19 studies are presented in Table 2. The included studies consisted of a total of 11,044 participants (range 142 to 1620). Of the studies, eight were performed on frail subjects or individuals at risk for functional decline [7,21,23,24,28,29,31,32]. However, many of the studies provide fairly little information on the participants' functional or cognitive status [7,15,16,22,26,27,30,31]. Of the studies providing information, most have focused on fairly independent older people [18–20,23–25,28,32]. Most of the studies had been performed on subjects 70 [15,20,21,25,28,29,31] or 75 [17–19,22–24,30,32] years old or older. Only three studies focused on younger subjects (65+) [7,16,26], and one on the oldest-olds (80+) [27].

All studies reported the profession and/or training of the person or persons performing the intervention. A nurse performed the home visits in the majority of studies [15,17–21,23,24,26,29–32], and a care manager/nurse carried out the intervention in two studies [7,22]. In four trials, the nurse had special gerontologic or geriatric training [18,19,21,31], and in two studies, the nurse had some other special training for carrying out the intervention [20,32]. In two trials, a team of professionals delivered the intervention [27,28]. In the remaining two studies, the intervention was performed by a health visitor [16] or a trained medical student [25]. Of all the studies included, 11 out of 19 had an intervention program tailored to the study subjects [15–18,20,23,24,26,28,31,32].

The 15 studies reporting the participants' use of services prior to the intervention showed no baseline differences in these variables between the intervention and control arms. Of the included studies, four failed to provide any data on the health status or functional state of their subjects at the baseline [15,16,22,30]. Only two reported baseline differences between the groups regarding health or functional status [25,29].

3.3. Outcomes

Table 3 shows an overview on the reported outcomes of the studies. Of the included studies, 12 evaluated the effects of preventive home visits on the total costs of the use of a variety of services [7,17–23,26–29]. However, even in these studies, there was a heterogeneity in how and which services were included in cost calculations. None of the studies showed significantly increased or decreased costs of health and/or social services in the intervention groups compared with the control groups. The others reported only the use of services without costs [16,30], or some portion of the services [15,24,25,31,32].

Overall, six studies showed decreased use of some health or social services in the intervention arms compared with their controls [17,18,21,22,25,30]. These studies suggested that the preventive home visits may have positive effects on some of the health care costs by decreasing the nursing home admissions [18,21,22,25], hospitalizations [17,21,30], or length of hospital stays [30]. However, some studies reported simultaneously increased use of social services [21,27,28,30] or visits to general practitioners [16,19,29] in the groups receiving the preventive home visits. Of the studies with decreased costs and/or use of home

Table 2
Characteristics of the studies included in the systematic review.

Study/ Country	Sample size nr I/C	Characteristics of participants	Intervention	Visits per year/duration of intervention in months	Person(s) doing the intervention	Outcome	Quality
Hendriksen et al., 1984 Denmark [30]	n = 572 (285/287)	75 y+ (median 78.5 y), 62% females Living in their homes	Interview visit 4×/year; max 12 visits; structured questionnaire, information; phone contact possibility in between visits	4/36	Nurse	Statistically significantly less hospital admissions, hospital bed days, lower mortality, less emergency medical service calls, more use of social services for intervention group. No difference in admission to nursing homes or home nursing care between groups	4
Vetter et al., 1984 Wales, Great Britain [15]	n = 1148 (577/571)	70 y+ retrieved randomly from two general practices	Interview visit by independent interviewer; home visit 1×/year for two years: information, note card, follow-up for high risk patients	1/24	Nurse	No significant differences between groups in groups in mortality, use of services, subjective view of life, changes in anxiety score or physical disability. In subgroup of Gwent, intervention group had significantly less deaths, and significantly more home help	6
Pathy et al., 1992 Wales, Great Britain [16]	n = 725 (369/356)	65 y+ (mean I 69, C 74), 60% females. Living in domestic accommodation 33% were living alone	Survey via mail; if problems were detected in survey, home visit was issued; referrals to general practitioner and services	Varied/36	Health visitor	Intervention group showed lower mortality, better self-rated health (SRH), less home visits but more visits to the GP. No differences between groups in hospital admissions or admissions to long-term care Mean length of hospital stay was shorter for younger aged group	4
van Rossum et al., 1993 Netherlands [17]	n = 580 (292/288)	75–84 y, 58% females Living in their home with no home nursing care. Thirty-nine percent were living alone, 87% had informal care available, >60% had household disabilities	Home visit 4×/year for 3 years, extra visits if needed; referrals made to GP and services; phone contact possibility in between visits	4+/36	Nurse	No significant difference between groups in SRH, use of services, length of hospital stays or admissions to nursing homes. There was no significant difference between groups in the expenditures of service use per person. The incidence rate ratio for hospital admissions was higher in the control group	9
Stuck et al., 1995 California, USA [18]	n = 414 (215/199)	75 y+ (mean 81 y), 70% females Living in their home. Sixty-four percent were living alone Excluded: severe cognitive or functional impairment, about to move into nursing home, terminal disease, language problems. Ninety-two percent were independent in basic ADL	Annual geriatric assessment for 3 years; visits 4×/year for 3 years (mean 11 visits); phone contact possibility in between visits	4/36	Gerontologic nurse	Intervention group had less permanent nursing home admissions, less dependence in ADL, but more outpatient visits. No significant differences on the hospital admissions, the number of short-term nursing home stays or the use of in-home and supportive services between groups. Cost for each disability-free year of life was approx. \$6000 and the cost of preventing one day of a permanent stay in nursing home was \$35	9
Dalby et al., 2000 Ontario, Canada [31]	n = 142 (73/69)	70 y+ (mean 79 y), 67% females. Thirty-nine percent were living alone. Inclusion criteria: reported functional impairment or admission to hospital in the previous 6 months. Excluded: living in nursing home, previous home visits	Comprehensive assessment; follow-up visits as needed for 14 months. Phone contact possibility in between visits	Varied/14	Nurse with training in gerontology	No significant difference in mortality and health services utilization between groups, except influenza and pneumonia vaccination rates were higher in the intervention group	5

Table 2 (Continued)

Study/ Country	Sample size nr I/C	Characteristics of participants	Intervention	Visits per year/duration of intervention in months	Person(s) doing the intervention	Outcome	Quality
Stuck et al., 2000 Switzerland [19]	n = 791 (264/527)	75 y+ (mean 82 y), 74% females Community-residing Excluded those living in institutional care, not speaking German, having a terminal disease. Participants were randomized in stratified groups according to their baseline risk. Fifty-five percent were living alone. Thirty percent were dependent in their IADL	Annual geriatric assessment for 3 years; visits 4×/year for 3 years; consultation with geriatrician, recommendations were conducted in in-home visits	4/36	Nurse with training in gerontology	Intervention group had less dependence in IADL, better gait and balance scores, more influenza vaccinations and more visits to primary care provider, but there were no differences between groups in basic ADL, admissions to nursing homes or mortality. High baseline risk group had significantly more nursing home admissions Intervention group had higher health care costs in 1st and 2nd year of follow-up, but in 3rd year the preventions of nursing home admissions resulted in savings that offset the original costs	7
Hebert et al., 2001 Quebec, Canada [32]	n = 503 (250/253)	75 y+ (mean 80 y), 64% females At risk of functional decline (more than one risk factor in Sherbrooke Postal Questionnaire) Spoke French or English. Forty-five percent were married	Assessment by evaluation program; GP consultation; visit or phone contact 1×/month for one year; phone contact possibility in between visits	Max 12/12	Trained nurse	No difference between the groups related to health service utilization, mortality, QOL or functional decline	7
Schraeder et al., 2001 Illinois, USA [26]	n = 941 (530/411)	65 y+ (mean 76 y), 73% females Community-dwelling. Forty-nine percent lived alone At least one risk factor from a list: hospitalized in the previous 6 months, lived alone, lacked a caregiver, were taking four or more prescription medications, had difficulty walking, had limitations in ADL and/or memory, were incontinent of urine or stool, experienced multiple illnesses or disabilities requiring special care 27% had restricted activity bed days	In-home/at office assessment; visits (mean 7.5) as needed during 2-year follow-up. Phone contact possibility	4/24	Registered nurse	Mortality reduced significantly in intervention group. No differences between groups in hospital admissions, length of stay or Medicare payments	7
Bouman et al., 2008 Netherlands [20]	n = 330 (160/170)	70–84 y (mean 76 y), 60% females. Thirty-five percent lived alone. Living at home. Excluded: SRH moderate to good, regular home nursing care, or in waiting list to a nursing home	Home visits 8×/18 months; phone contact possibility in between visits	8/18	Home nurse with specific training	Intervention group received more devices and in-home modifications. No differences between groups in nursing home admissions, hospital use, QOL, ADL, or inpatient health care or total costs	9

Table 2 (Continued)

Study/ Country	Sample size nr I/C	Characteristics of participants	Intervention	Visits per year/duration of intervention in months	Person(s) doing the intervention	Outcome	Quality
Melis et al., 2008 Netherlands [21]	n = 151 (85/66)	70 y+ (mean 82 y), 75% females Living in their homes or in a home for the aged. Frail: had problems in cognition, nutrition, behavior, mood or mobility 53% had at least one dependency in ADL 51% received home care. Mean MMSE 22	Geriatric assessment; up to 6 visits during 3 months	Up to 6/3	Geriatric specialist nurse	For intervention group hospitalization and institutionalization costs were less, home care, day care and meals-on-wheels were more expensive. More people in intervention experienced an improvement in well-being without a decline in functional performance. Treatment reported cost-effective with a willingness to pay 34,000€ per successful treatment	9
Sahlen et al., 2008 Sweden [22]	n = 542 (196/346)	75 y+ (mean 80 y), 55% females All living in their homes independently without home help or home nursing care	Visits 2×/year for 2 years; visits followed a structured program and lasted 1.5–3 h	2/24	Nurse or care manager	Intervention group gained 63 more QALYs compared to the control group. Intervention group used significantly less elderly care, and got more influenza vaccinations. There was no difference between groups in use of hospital beds. Cost were about 14,000€/QALY	4
Van Hout et al., 2010 Netherlands [24]	n = 651 (331/320)	75 y+ (mean 81 y), 69% females. Fifty-five percent lived alone. Living in their homes. Those included reported COOP-WONCA worst quartile in at least 2 of 6 charts. Excluded: terminally ill, dementia, living in residential home. Fourteen percent cognitive impairment, mean no of chronic diseases 2	RAI-HC assessment; visits up to 4×/year during 18 months (mean 3); individual care plan, GP consultation	Up to 4/18	Home nurse	No statistical differences between groups on time until death and institutionalization. The persons in intervention group with poorest self-rated health had a significantly higher risk to be admitted to a hospital compared with the control group	9
Ploeg et al., 2010 Ontario, Canada [23]	n = 719 (361/358)	75 y+ (mean 81 y), 53% females. Thirty-four percent lived alone. Persons at risk of functional decline (more than one risk factor in Sherbrooke Postal Questionnaire). Excluded: received home care, lived in an institution, received palliative care, was scheduled for major elective surgery in the next year or was planning to leave the country	Comprehensive assessment; visits (mean 3) during 1 year; information, referrals to health care and support services; note card; physician consultation. Phone contact possibility in between visits	3/12	Nurse	No differences between groups in costs of health and social services, hospital admissions, number of patients admitted to a long-term care home, or costs of prescription drugs	8
Frese et al., 2012 Germany [25]	n = 1620 (630/990)	70 y+ (mean 82 y). Seventy-one percent females, 25% lived alone, 12% had severe dementia	Step assessment and visit 1×/year for 1–2 years (mean 1.3 visits)	1/24	Trained medical student	Intervention group had a better chance of staying in the community: not dying or being admitted to a nursing home	4

Table 2 (Continued)

Study/ Country	Sample size nr I/C	Characteristics of participants	Intervention	Visits per year/duration of intervention in months	Person(s) doing the intervention	Outcome	Quality
Kono et al., 2013 Japan [7]	n = 323 (161/162)	65 y+ (mean 80 y), 74% females. Twenty-eight percent lived alone. Mean Barthel index 91. Living at their homes. Those included were at risk of functional decline: LTCL system support level 1 or 2. Excluded: using formal long-term care services	Visit 2×/year for 2 years; structured multidimensional assessment with 5 key elements: locomotion, daily activities, social contacts or relationships with other people, health conditions, signs of abuse; provided recommendations	2/24	Community health nurse or care manager	Functional status and depression improved among intervention group compared to control group. No difference between groups in mean health care costs, the mean per person health care costs for outpatient clinic utilization, or hospital care costs	10
Brettschneider et al., 2015 Germany [27]	n = 305 (150/155)	80 y+ (mean 85 y), 69% females. Sixty-five percent lived alone. Living at their homes or discharge from hospital to home already planned. Excluded: no language skill in German, cognitive impairment, care level over 1 23% had some care dependency	Multidimensional geriatric assessment; multi-professional team consultation in 3 weeks; 2 booster visits during circa 2–3 months from the assessment visit; follow-up 18 months	3/3	Trained personnel: nursing scientist/psychologist/sociologist	No significant differences between groups in mortality, QOL, hospital and nursing home admissions, nursing visits, informal care and outpatient physician services	8
Fairhall et al., 2015 Australia [28]	n = 241 (120/121)	70 y+ (mean 83 y), 61% females. Forty-six percent lived alone. Those included met CHS criteria for frailty. Excluded: resided in an aged care facility, had severe cognitive impairment, had a life expectancy under 12 months Mean MMSE 26, mean Barthel 93	Geriatric evaluation and management; individualized intervention; medication review; management of chronic conditions; 10 physiotherapy visits and individualized home program	10+/12	Interdisciplinary team	The prevalence of frailty was significantly lower in the intervention group at 12 months. No differences between groups in hospital admissions, or nursing home admissions. Costs per person achieving transition out of frailty were \$15,955 and for frail subgroup \$41,428. In very frail subgroup the intervention was dominant: both more effective and less costly than control	10
Metzelthin et al., 2015 Netherlands [29]	n = 346 (193/153)	70 y+ (mean 77 y), 58% females. Forty-nine percent lived alone Frail: GFI score 5 or higher Mean GFI score 7.0	Assessment; GP consultation or team meeting; 2nd home visit, treatment plan together with subject; toolbox of guidelines; need for follow-up was determined; 24-month follow-up	2/6	Nurse	There were no differences between groups in functional status, QOL, hospital use, long-term care, informal care or in-home modifications, and no statistical difference in total costs. Intervention group used more primary care	8

nr I/C: number of participants in intervention/control groups; n: number of participants; y: years of age; I: intervention group; C: control group; SRH: self-rated health; GP: general practitioner; ADL: activities of daily living; IADL: instrumental activities of daily living; QOL: quality-of-life; QALY: quality-adjusted life year; HRA: health risk assessment; RAI-HC: the resident assessment instrument for home care; LTCL: long-term care insurance system; CHS: The Core Humanitarian Standard; GFI: Groningen Frailty Index (range 0–15; higher score indicates more severe frailty). COOP-WONCA charts: overall health, physical fitness, changes in health, daily activities, mental health, social activities (scoring range 1 = excellent to 5 = very bad). Risk factors in Sherbrooke Postal Questionnaire: five items including living situation, medications, mobility, sensory deficits and memory problems (positive answer to two or more indicates a risk).

Table 3
Effects of preventive home visit interventions on the use and costs of health care services, physical functioning or functional performance, quality-of-life (QOL), and mortality.

Study	Hospital admissions/length of stay	Other services	Nursing home admissions	Physical functioning/functional limitations	QOL	Mortality	Total costs
Hendriksen et al., 1984 [30]	↓	↑	±	N.A.	N.A.	↓	N.A.
Vetter et al., 1984 [15]	N.A.	±	N.A.	±	±	± ¹	N.A.
Pathy et al., 1992 [16]	± ²	±	±	N.A.	↑	↓	N.A.
van Rossum et al., 1993 [17]	↓	↓	±	±	±	±	± ³
Stuck et al., 1995 [18]	±	↑	↓	↑	N.A.	±	± ⁴
Dalby et al., 2000 [31]	±	±	N.A.	N.A.	N.A.	±	N.A.
Stuck et al., 2000 [19]	±	↑	±	↑ ⁵	N.A.	N.A.	±
Hebert et al., 2001 [32]	±	N.A.	±	±	±	±	N.A.
Schraeder et al., 2001 [26]	±	N.A.	N.A.	N.A.	±	↓	±
Bouman et al., 2008 [20]	±	±	±	±	±	±	±
Melis et al., 2008 [21]	↓	±	↓	±	↑	±	±
Sahlen et al., 2008 [22]	±	±	↓	↑	↑	↓	±
van Hout et al., 2010 [24]	↑	N.A.	±	±	±	±	N.A.
Ploeg et al., 2010 [23]	±	±	±	±	±	±	±
Frese et al., 2012 [25]	N.A.	N.A.	↓	N.A.	N.A.	↓	N.A.
Kono et al., 2013 [7]	±	N.A.	N.A.	↑	N.A.	N.A.	±
Brettschneider et al., 2015 [27]	±	↑	±	N.A.	±	±	±
Fairhall et al., 2015 [28]	±	N.A.	±	↑	±	N.A.	±
Metzelthain et al., 2015 [29]	↑	↑	±	±	±	N.A.	± ⁶

N.A.: not reported; ±: reported, no significant difference between groups; ↓: mortality/use of stated services lower in the intervention group; ↑: use of stated services higher for intervention group, improved physical functioning and/or QOL or less functional limitations in the intervention group; (1) In subgroup analysis one study site showed significantly lower mortality. (2) In a subgroup analysis, younger age group in intervention group showed shorter hospital stays than control participants of respective age. (3) The study reported costs of community care services hospital costs, long-term institutional care costs, and costs from the home visits. (4) The costs showed savings from nursing home days and extra costs for increased physician visits and intervention costs. Investigators calculated extra costs/the disability-free years gained by intervention (\$6000) or the number of days avoided in nursing homes (\$35). (5) IADL and the gait balance scores improved in the intervention group compared with the controls. (6) Mean health care costs were significantly higher in the intervention group, but there was no difference in the total health and social services costs.

care services, one reported significant reduction of home care costs for the intervention group compared with their controls [22], whereas one reported higher home care costs [21].

3.3.1. Cost-effectiveness

Eleven studies showed some favorable effect on physical functioning [7,18,19,22,28], QOL [16,21,22] or mortality [16,22,25,26,30], of which seven also reported costs [7,18,19,21,22,26,28]. Thus, these seven studies suggested that favorable effects were produced cost-neutrally.

Some studies reported cost-effectiveness by means of calculating the costs per gains achieved by intervention [18,19,21,22,28]. Stuck et al. reported costs of preventive home visits being \$6000 for each gained disability-free year and \$35 for each prevented day of permanent stay in a nursing home [18]. In their later study, the average yearly health care costs were higher in the intervention group at the beginning of the follow-up, but during the third follow-up year, the prevention of nursing home admissions resulted in substantial savings that offset the total costs [19]. Melis et al. suggested that the treatment was cost-effective with a willingness to pay 34,000€ per “a successfully treated patient” (patients gained improvement in well-being without a decline in functional performance) [21]. Sahlen et al. found preventive home visits to be cost-effective with willingness to pay about 14,000€ per gained quality-adjusted life year [22]. Fairhall et al. reported the costs being \$15,955 per person who achieved transition out of frailty. They conducted a subgroup analysis and reported that in the very frail subgroup, the intervention was both cheaper and more effective than no intervention [28].

3.3.2. Factors affecting the outcomes

We could not identify any common characteristics in the interventions or participants, which would be responsible for the favorable effects [7,16,18,19,21,22,25,26,28,30]. The mean age of the subjects was 79 years both in studies with positive and negative results. Of the studies reporting decreased functional status of participants, two good-quality trials suggested favorable

effects on use of services or QOL [17,21] whereas one showed increased use of services [29]. The number of home visits ranged from one to 14 in studies with favorable effects, with six of the 10 studies with beneficial effects having four or more home visits [18,19,21,26,28,30]. Of all the studies reporting a tailored intervention program [15–18,20,23,24,26,28,31,32], three showed some favorable effects [18,26,28]. Most of the interventions were delivered by a nurse. Thus, there was no apparent relationship between the number of home visits, the program being tailored or fixed, or what kind of professional delivered the home visits, and the favorable outcomes.

4. Discussion

Of all 19 studies included in our systematic review, 10 showed that preventive home visits may decrease nursing home admissions or hospital days, or achieve cost-neutral, favorable effects on older people's functional status, QOL, or mortality. All studies had a high number of participants in the study arms, and most studies were evaluated to have moderate or good methodological quality. However, there was a considerable heterogeneity between the trials in their study methods, reporting, study populations, interventions, and length of follow-up. Therefore, we could not perform a meta-analysis.

Our study is the first systematic review examining primarily the cost-benefits of preventive home visits to older people, as earlier reviews have either focused on the findings of health state and functional status [1–6,8], or had otherwise limited selection of studies [9,10]. We performed a rigorous systematic review by determining our inclusion criteria prior the selection of studies so that we could comprehensively involve preventive home visit trials reporting the use and/or costs of health and social services. Furthermore, we comprehensively searched databases, and also manually searched reference lists, of articles to find all potential trials. The heterogeneity of the studies is a weakness for this review. The variety in the outcome measures and in the means of reporting made it impossible to perform a meta-analysis.

Furthermore, limited description of interventions across studies restricted exploration of the factors affecting the outcomes, especially the mediators of effective and non-effective interventions. Publication bias might also affect our study, since studies with positive findings may be more commonly published.

The methodological quality of the studies included varied somewhat, but a majority of the trials were evaluated to have adequate quality. It is worth noticing that of the studies included, only four were of poor quality, but all of these studies reported some positive effects [16,22,25,30], which may mean that these results were biased due to poor study methodology. In the trials with moderate or good methodological quality, the most common methodological problems were inadequate description of dropouts and blinding. Not blinding the assessors and inadequate inclusion of dropouts in analyses may also produce bias towards positive findings.

The early review [5] suggested a more favorable view on the preventive home visits and their efficacy compared to our systematic review. Most of the early studies of preventive home visits did not report use of services or costs. Furthermore, the earliest studies may have been able to show better efficacy than the latest studies, since the health and social services for the comparison arms were not as well-developed in those early times as today. The health care and social services, including prevention, have improved in later years for older people, making it more challenging to show differences between the intervention and control arms. Several of the latest studies, however, also presented efficacy of the preventive home visits on the functioning, QOL, mortality, and use of health and social services [7,25,28].

There are other factors that might also underestimate the true effects of interventions. One study included had relatively low power [31], which might lead to underestimation of the effectiveness of the intervention in this trial. The intervention and follow-up duration varied greatly between the studies, from three months to a maximum of three years of intervention and ten years of follow-up. A few studies had relatively light intervention [15,23,27,29], thus probably decreasing the efficacy. However, there were other negative trials with a high number of home visits [20,32], as well as some positive trials with a low number of home visits [7,22,25].

None of the studies examining total costs demonstrated that the intervention program would affect the overall health care and social services costs. Due to the different sources of costs included and different ways of calculating the costs and measuring cost-effectiveness, comparisons between the studies were impossible to perform. However, several of the studies showed positive effects for the study subjects' functioning, QOL, and mortality. Therefore, if effects on functioning, QOL, or mortality were positive, the programs could be considered to be cost-effective, even if the total costs were similar between the intervention and control arms [7,18,19,21,22,26,28]. In this respect, our findings were in line with some earlier reviews, which reported some programs being efficient in improving certain dimensions of well-being and functionality, and even lowering mortality [1,3].

The included trials fail to provide answers regarding whom the preventive home visiting programs should be targeted to and what kind of intervention should be delivered. We could not detect common characters in trials explaining which programs proved cost-effective. Only two studies reported intervention programs that were delivered by multidisciplinary team [27,28], and only one included a geriatrician [28]. Due to the lack of such studies, it is impossible to make conclusions of the effectiveness of interventions delivered by a multidisciplinary team based on this systematic review. However, in other contexts among frail older people, this has been the most effective way of delivering preventive strategies [33,34]. Most trials did not report the

intervention program in detail. In addition, many studies reported poorly regarding the extent to which the intervention program was applied according to the original plan. Partial or unsuccessful application of the intervention procedures might diminish the effects of otherwise successful home visiting programs. Moreover, most trials failed to report the compliance of the subjects of the intervention procedures. Low compliance might be a sign of poorly designed intervention protocol, and it will dilute the effects of intervention. These findings stress the importance of extensive but definite reporting of the elements of intervention programs and subject compliance in further studies, to clarify the effective aspects of the interventions. Moreover, in further studies more focus should be given to the interventions delivered by multidisciplinary teams and geriatric expertise.

5. Conclusions

In conclusion, preventive home visiting programs might yield positive effects on functioning, well-being, and mortality cost-neutrally. The aspects responsible for efficacy of the programs remain unclear. Since the population of older adults is growing, future research is needed to find effective ways to improve and maintain the health of older persons while keeping costs of the health care and social services reasonable.

Ethical statement

We ensure that our systematic review article was performed according to the ethics of research and according to the ethical guidelines. All the authors have a significant contribution to the conception, design, execution, or interpretation of the reported study. We have written an original study with appropriate citations and quotations. As the article is a systematic review of earlier published articles, we did not arrange any intervention on patients or volunteers, nor does the article contain any data of individual patients or volunteers. We have written our article following the general guidelines on systematic reviews.

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Disclosure of interest

The authors declare that they have no competing interest.

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