

The effectiveness of a coordinated preventive care approach for healthy ageing (UHCE) among older persons in five European cities: A pre-post controlled trial

Franse, Carmen Betsy; Grieken, Amyvan; Alhambra-Borrás, Tamara; Valía-Cotanda, Elisa; Staveren, Rob van; Rentoumis, Tasos; Markaki, Athina; Bilajac, Lovorka; Vasiljev Marchesi, Vanja; Rukavina, Tomislav; ...

Source / Izvornik: **International journal of nursing studies, 2018, 88, 153 - 162**

Journal article, Accepted version

Rad u časopisu, Završna verzija rukopisa prihvaćena za objavljivanje (postprint)

<https://doi.org/10.1016/j.ijnurstu.2018.09.006>

Permanent link / Trajna poveznica: <https://urn.nsk.hr/urn:nbn:hr:184:734719>

Rights / Prava: [Attribution-NonCommercial-NoDerivatives 4.0 International/Imenovanje-Nekomercijalno-Bez prerada 4.0 međunarodna](#)

Download date / Datum preuzimanja: **2025-03-08**



Repository / Repozitorij:

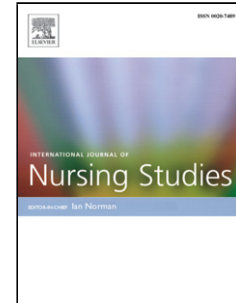
[Repository of the University of Rijeka, Faculty of Medicine - FMRI Repository](#)



Accepted Manuscript

Title: The effectiveness of a coordinated preventive care approach for healthy ageing (UHCE) among older persons in five European cities: a pre-post controlled trial

Authors: Carmen B. Franse, Amy van Grieken, Tamara Alhambra-Borrás, Elisa Valía-Cotanda, Rob van Staveren, Tasos Rentoumis, Athina Markaki, Lovorka Bilajac, Vanja Vasiljev Marchesi, Tomislav Rukavina, Arpana Verma, Greg Williams, Elin Koppelaar, Rens Martijn, Antonius J.J. Voorham, Francesco Mattace Raso, Jorge Garcés-Ferrer, Hein Raat



PII: S0020-7489(18)30214-1
DOI: <https://doi.org/10.1016/j.ijnurstu.2018.09.006>
Reference: NS 3219

To appear in:

Received date: 17-4-2018
Revised date: 7-9-2018
Accepted date: 7-9-2018

Please cite this article as: Franse CB, van Grieken A, Alhambra-Borrás T, Valía-Cotanda E, van Staveren R, Rentoumis T, Markaki A, Bilajac L, Vasiljev Marchesi V, Rukavina T, Verma A, Williams G, Koppelaar E, Martijn R, Voorham AJJ, Mattace Raso F, Garcés-Ferrer J, Raat H, The effectiveness of a coordinated preventive care approach for healthy ageing (UHCE) among older persons in five European cities: a pre-post controlled trial, *International Journal of Nursing Studies* (2018), <https://doi.org/10.1016/j.ijnurstu.2018.09.006>

This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

The effectiveness of a coordinated preventive care approach for healthy ageing (UHCE) among older persons in five European cities: a pre-post controlled trial.

Carmen B. Franse, MSc¹; Amy van Grieken, PhD¹; Tamara Alhambra-Borrás, PhD²; Elisa Valía-Cotanda, MSc²; Rob van Staveren, MSc³; Tasos Rentoumis, MSc⁴; Athina Markaki, MSc⁴; Lovorka Bilajac, MSE, MPH, PhD^{5,6}; Vanja Vasiljev Marchesi, MSE, PhD^{5,7}; Tomislav Rukavina, MD, PhD^{5,6}; Arpana Verma, MD, PhD⁸; Greg Williams, MSc⁸; Elin Koppelaar, PhD⁹; Rens Martijn, MSc⁹; Antonius J.J. Voorham, PhD⁹; Francesco Mattace Raso, MD, PhD¹⁰; Jorge Garcés-Ferrer, PhD²; Hein Raat, MD, PhD^{1*}

Affiliations:

1-Erasmus University Medical Center, department of Public Health, Rotterdam, The Netherlands

2- Polibienestar Research Institute, University of Valencia, Valencia, Spain

3- Zorg Op Noord, Capelle aan den IJssel, The Netherlands

4- Alliance for integrated care, Athens, Greece

5-Faculty of Medicine University of Rijeka, Department of Social Medicine and Epidemiology, Rijeka, Croatia

6-Teaching institute of Public Health Primorsko-goranska County, Branch Office Opatija, Rijeka, Croatia

7-Faculty of Health Studies, University of Rijeka, Department of Public Health, Rijeka, Croatia

8- Manchester Urban Collaboration on Health, Centre for Epidemiology, Division of Population Health, Health Services Research and Primary Care, Manchester Academic Health Science Centre, The University of Manchester, Manchester, United Kingdom

9- Rotterdam University of Applied Sciences, Research Centre Innovation in Care, Rotterdam, The Netherlands

10-Erasmus University Medical Center, Section of geriatric medicine, department of Internal Medicine, Rotterdam, The Netherlands

* Corresponding author address: Hein Raat, Erasmus University Medical Center, department of Public Health, Wytemaweg 80, 3015 CN, Rotterdam, The Netherlands. E-mail: h.raat@erasmusmc.nl

Funding: This work was supported by the European Union, CHAFEA, third health programme, grant number 20131201.

Running title: Effect of coordinated preventive care for healthy ageing

Impact statement: We certify that this work is novel. This study showed that a general template for preventive integrated care aimed at healthy ageing can successfully be implemented in various European settings.

ABSTRACT

Background: Older persons often have multiple health and social problems and need a variety of health services. A coordinated preventive approach that integrates the provision of health and social care services could promote healthy ageing. Such an approach can be organised differently, depending on the availability and organizational structures in the local context. Therefore, it is important to evaluate the effectiveness of a coordinated preventive care approach in various European settings.

Objectives: This study explored the effects of a coordinated preventive health and social care approach on the lifestyle, health and quality of life of community-dwelling older persons in five European cities.

Design: International multi-center pre-post controlled trial.

Setting: Community settings in cities in the United Kingdom, Greece, Croatia, the Netherlands and Spain.

Participants: 1844 community-dwelling older persons (mean age=79.5; SD=5.6).

Methods: The Urban Health Centres Europe (UHCE) approach consisted of a preventive multidimensional health assessment and, if a person was at-risk, coordinated care-pathways targeted at fall risk, appropriate medication use, loneliness and frailty. Intervention and control sites were chosen based on their location in distinct neighbourhoods in the participating cities. Persons in the catchment area of the intervention sites 'the intervention group' received the UHCE approach and persons in catchment areas of the control sites 'the control group' received care as usual. A questionnaire and two measurements were taken at baseline and at one-year

follow-up to assess healthy lifestyle, fall risk, appropriate medication use, loneliness level, frailty, level of independence, health-related quality of life and care use. To evaluate differences in outcomes between intervention group and control group for the total study population, for those who received follow-up care-pathways and for each city separately (multilevel) logistic and linear regression analyses were used.

Results: Persons in the intervention group had less recurrent falls (OR= 0.65, 95% CI = 0.48; 0.88) and lower frailty (B=-0.43, 95% CI= -0.65- -0.22) at follow-up compared with persons in the control group. Physical health-related quality of life and mental well-being was better (B=0.95; 95% CI= 0.14-1.76; and B=1.50; 95% CI=0.15-2.84 respectively). The effects of the UHCE approach were stronger in the subgroup of persons (53.6%) enrolled in care-pathways.

Conclusions: Our study found promising but minor effects for the use of a coordinated preventive health and social care approach for the promotion of healthy ageing of older persons. Future studies should further evaluate effects of coordinated preventive health and social care aimed at healthy ageing.

Trial registration: ISRCTN registry number is ISRCTN52788952. Date of registration is 13/03/2017.

Keywords: Europe, Frailty, Coordinated care, Multidisciplinary, Older persons, Prevention, pre-post controlled trial, Primary care

What is already known:

- As the population of older persons is growing, the number of older persons with social and health problems will also increase.
- A coordinated preventive health and social care approach with a multidimensional health assessment and multidisciplinary coordinated follow-up care was developed to answer the needs of older persons.
- The evidence of coordinated preventive care interventions in improving the health and quality of life of older persons is mixed.

What this paper adds:

- This study found small positive effects in tackling recurrent falls and frailty and promoting physical health-related quality of life and mental well-being among older persons involved who received the intervention.
- The effects of the UHCE approach were generally stronger in the subgroup of persons enrolled in care-pathways.
- A general template for coordinated preventive health and social care aimed at healthy ageing could potentially be successfully implemented in various European settings, although more research is needed to confirm our findings.

BACKGROUND

It is estimated that by 2040, Europeans over 65 years old will account for 27% of the population, compared with 19% in 2015(1). This will be associated with a sharp increase in demand for care. Promotion of healthy ageing is therefore a priority of European policy(2). Older persons often have multiple health and social problems and need a variety of health services(3, 4). However, care in Europe is characterised by a curative and monodisciplinary approach focussed on one illness or disease(5, 6). In addition, a focus on prevention and health promotion could increase healthy life years and reduce the burden on health care resources(6). As a result of this, the demand is growing for a preventive approach in which both health and social care services are provided(6, 7).

A typical coordinated preventive care approach for older persons includes a multidimensional assessment of health and social risks and multidisciplinary coordinated follow-up care(8-11). In many European countries, general practitioners (GPs) are the gatekeepers to specialised care and have a central role in community care(12). A nurse practitioner or physician assistant could alleviate the burden of the GP and act as care coordinator. Evidence for preventive interventions with multidisciplinary coordinated follow-up care is mixed and more research is needed(13-15). Most of these studies have been conducted in Northwest European or American settings, studies in Southern and Eastern European settings are lacking(16-19).

Aspects such as accessibility of primary care, availability of prevention and treatment services and continuity of care vary considerably between European countries(6, 20). A striking example is the difference between European countries in the importance and accessibility of GPs in

community care(12). This has an impact on the role a GP could play and the organization of care. Therefore, it is important to evaluate the effectiveness of coordinated preventive care approaches in various European settings. Coordinated preventive health and social care can be organised in many ways depending on the availability and organizational structures in the local context.

Objective

The Urban Health Centres Europe (UHCE) approach was developed to promote healthy ageing of older persons. The UHCE approach included a preventive multidimensional assessment of health risks and, if indicated, coordinated follow-up health and social care. The UHCE approach was specifically targeted at fall risk, appropriate medication use, loneliness and frailty. This study evaluates the UHCE approach, which we hypothesized had a positive effect on lifestyle, fall risk, appropriate medication use, loneliness, frailty, level of independence, health-related quality of life and care use among community-dwelling older persons.

METHODS

Study design and setting

The effect evaluation of the UHCE approach was conducted in primary care and community settings in five European cities (Greater Manchester, United Kingdom; Pallini, Greece; Rijeka, Croatia; Rotterdam, the Netherlands; and Valencia, Spain) between May 2015 and June 2017. In Manchester, Rijeka, Rotterdam and Valencia a specific pre-post controlled design was applied (21). Randomization was not desirable for these cities that worked with existing GP practices as it was not feasible for GPs to give 'usual care' and care according to UHCE at the same time. In these cities, intervention and control sites (GP practices or primary health centres; PHC) were chosen based on their location in distinct neighbourhoods in the participating cities. Older persons in the catchment area of an intervention site receive an invitation by their physician to join the study in the area where the UHCE approach is applied. Older persons in the catchment area of a control site receive an invitation by their physician to join the study in the area where 'usual care' is applied (Table 1). In Pallini, participants from municipality registers were first randomised by the use of a random numbers table into the intervention group and the control group (Table 1). Participants were afterwards invited to participate in the study by a health team of the municipality employed for this study. Ethical committee procedures have been followed in all cities and approval has been provided. Written informed consent was obtained from all participants. The study was registered as ISRCTN52788952.

Participants

In each city, the initial target population consisted of persons living independently, aged 75 years or older, who were, according to their physician, able to participate in the study for at least 6 months. Persons were not eligible to participate if they were not able to comprehend the information provided in the local language or if they were not able to cognitively evaluate the risks and benefits of participation and were not expected to be able to make an informed decision regarding participation in the study, according to their physician. In two cities; Pallini and Valencia, the age of the target population was lowered to 70 years or older due to difficulties encountered during the inclusion. Persons were invited to participate in the study by their health care provider (Table 1).

Intervention

In the intervention group, persons received care according to the UHCE approach. We used the CREDICI II criteria for complex interventions as a reporting guideline(22), see Supplementary text S1. The development of the UHCE approach followed an intervention mapping approach(23). A general template for the UHCE approach was developed by systematically reviewing the literature to identify evidence based interventions and validated assessment instruments for fall risk, polypharmacy, loneliness and frailty (see www.uhce.eu). Additionally, focus groups and interviews with main stakeholders (older persons, health and social care professionals, caregivers and policy makers) were held to identify their needs and preferences regarding healthy and active ageing. This led to the decision to address loneliness as a separate health problem, in addition to frailty, fall risk and polypharmacy(24) as well as any medical problems which were identified during the assessment that did not belong to the previously

mentioned categories. We furthermore decided to apply an integral conceptual model of frailty, which includes physical as well as social and psychological components and is geared towards a multidisciplinary approach(25).

The general template of the UHCE approach consisted of three stages. In the first stage of the UHCE approach, the older person received a health assessment of fall risk, polypharmacy, loneliness and frailty in order to identify whether the person had an indication of a need for a follow-up care-pathway. A short standardized assessment form was developed for all cities, which consisted of validated instruments. For assessment of fall risk, a validated protocol developed by the Dutch safety research institute was applied[15]. Assessment of polypharmacy followed the common definition of using of five or more different medicines[16], in addition difficulty in taking medications as prescribed was assessed[17]. Assessment of loneliness made use of the social subscale of the Tilburg Frailty Indicator[18] and if loneliness was indicated further assessment with the Jong-Gierveld loneliness scale[19]. The assessment of frailty followed the Tilburg Frailty indicator for indication of frailty[18]. In the second stage of the UHCE approach, shared-decision making took place; the results of the assessments (the indications for care-pathways) were discussed with the older person, a person in charge of care coordination and a physician. Staff encouraged the older person to involve an informal caregiver in the shared-decision making process. Shared-decision making was included in order to develop a care plan which was adapted to the preferences of the older person, which was thought to promote involvement in care-pathways. In the third stage, as a result of the shared decision-making process, a decision on a care plan was made and each participant was referred to care-pathways. The care-pathways aimed to promote healthy ageing among the older

persons by reducing fall risk, inappropriate medication use, loneliness and frailty. Specific interventions were recommended: 1) fall prevention actions; recommended evidence-based interventions were home-based exercise programmes, group exercise programmes and multifactorial assessment and intervention programmes, 2) actions addressing polypharmacy (adherence and/or appropriate prescribing actions); recommended evidence-based interventions focused on self-monitoring programmes to improve adherence and/or multifaceted pharmaceutical care for appropriate prescribing, 3) actions addressing loneliness; recommended evidence-based interventions were social activities and/or support within a group format, and 4) frailty/medical action; recommended evidence-based interventions included group exercise programmes and multidisciplinary care. Additionally in this care-pathway, other medical care which did not fall under care-pathways 1-3 could be given when the healthcare provider deemed this necessary. The care coordinator was asked to monitor the progress of each individual care plan under the supervision of a physician. Follow-up visits could be scheduled if needed. For this purpose, a uniform logbook was developed for all cities which was kept for each older person who received the UHCE approach. In this logbook the care coordinator recorded the outcomes and involvement of the older person and health staff in the three stages (assessment, shared-decision and care-pathways) of the UHCE approach. The results of this logbook, along with the evaluation of other process indicators, were part of the evaluation of process components of the UHCE approach, following the Steckler and Linnan framework(26). This evaluation has previously been described in more detail(24).

The general template of the UHCE approach was then adapted to the national standards and context of each of the five participating cities. Specific information for each city; on the place

and staff involved in the assessment, staff who acted as care coordinator, type of care and health staff involved in the care-pathways, is reported in Table 1. Initially, the UHCE project aimed to make use of or improve existing care available in the communities. However, in Pallini, Rijeka and Valencia, the availability of existing care was limited or the referral to existing care proved to be difficult. In these cases new care provisions were developed. No additional monetary incentives were provided to health staff involved in existing care. In the settings where new care was developed, staff was hired on a voluntary bases or compensated. No monetary incentives were provided to participants. For some of the interventions participants could borrow materials needed for the intervention (e.g. tablets). Persons in the control group received their usual care. Participants in the control group had access to existing care services delivered in the care-pathways, but not to newly developed services. No coordinated preventive referral to existing care services nor coordinated preventive monitoring of health was in place. In all cities except for Pallini, GPs were the first point of contact and had a gatekeeper function towards existing care services. In Pallini, GPs were scarce and specialist care was directly accessible upon appointment.

Table 1. Study design, procedures and interventions of all cities in UHCE

	Manchester, UK	Pallini, Greece	Rijeka, Croatia	Rotterdam, NL	Valencia, Spain
Source study population	GP list	Municipality/senior centres registers	GP list	GP list	GP list
Method invitation	Letter from GP	Phone calls municipality team	In person by community nurse	Letter from GP	In person by nurse or GP
Age inclusion	≥75 years	≥70 years	≥75 years	≥75 years	≥70 years
Intervention and control group	IG: GP practices in Tameside and Glossop districts. CG: GP practices in South Manchester	Individual randomization of participants from Pallini Municipality/ senior centres	IG: GP practices in Western Rijeka. CG: GP practices in Eastern Rijeka	IG: PHC in Ommoord neighbourhood. CG: PHCs in Oosterflank and Zevenkamp neighbourhoods	IG: PHC in Nou Moles neighbourhood. CG: PHC in El Botanic neighbourhood
Assessment	At home by trained assistant	At senior/health centre by HP	At home by community nurse	At home by trained assistant	At home by trained assistant
Care coordinator	Trained assistant supervised by GP	HP or social worker	Community nurse	Geriatric nurse practitioner	Trained assistant supervised by GP
Type of care in care-pathways	Multiple per pathway; e.g. home adjustment by OT, walking group by volunteers (falls); medication review by GP (polypharmacy); buddying services by volunteers (loneliness); further care by GP (frailty).	Group based endurance and balance training by PE (falls); self-managed medication adherence App (polypharmacy); support groups by psychologist (loneliness); further care by physician (frailty).	Group based balance and strength training by PT (falls and frailty); self-managed medication adherence App (polypharmacy); social group activities (loneliness).	Multiple per pathway; e.g. physiotherapy by PT (falls); medication review by pharmacist (polypharmacy); social activities (loneliness); further care by GP (frailty).	Group based balance and strength training by PT (falls and frailty), medication review according to national protocol by GP (polypharmacy), social support group led by social worker (loneliness).
Care existing or newly developed	All existing; offered by local charity organization and according to practice GP	All newly developed	Falls, frailty and polypharmacy newly developed. Loneliness existing services	All existing, medical care according to practice GP and social care by local organizations	Falls, frailty and loneliness newly developed. Polypharmacy existing protocol

Abbreviations: CG=control group; GP=General practitioner; HP=health professional; IG=intervention group; NL=The Netherlands; OT=occupational therapist; PE=physical educator; PHC=primary care center; PT=physical therapist; UK=United Kingdom.

Measures

Because the UHCE approach acted upon general health outcomes reported in the literature (16-19) as well as health outcomes specific to care-pathways (depending on the care-pathway persons were involved in), we explored the effect of the UHCE approach on various primary outcomes(24). We hypothesized that the UHCE approach would have positive effects on both general outcome measures of healthy lifestyle, level of independence and quality of life as well as specific outcome measures to each care-pathway: fall risk, appropriate medication use, loneliness and frailty. Data was collected at baseline and after 12 months by using a self-report questionnaire and two physical measurements. The instruments and items for which no validated translation was available were translated forward and backward. Forward- and back-translations were discussed by the study team and translation was adapted when needed. In each city, the questionnaire and assessment was piloted in at least five older persons. Misinterpretation of questions were identified and minor changes were made. Measures used are described below. Details of measurement of these measures are described in the Supplementary Text S2.

General health outcome measures

Healthy lifestyle was measured with one item on physical activity, two items on smoking, and three items of The Alcohol Use Disorders Identification Test (AUDIT-C)(27). Frailty was measured with the 15-item Tilburg Frailty indicator (TFI); scores range from 0-15 with higher scores indicating higher levels of frailty(25, 28). Physical frailty was additionally measured with the SHARE-Frailty instrument(29, 30). Malnutrition, a component of physical frailty, was measured with the validated Short Nutritional Assessment Questionnaire 65+ (SNAQ-65+)(31).

Level of independence was measured with the 18-item Groningen activity restriction scale (GARS); scores range from 18-72 with higher scores indicating lower levels of independence(32). Severely limited function was measured with the one-item Global Activity Limitation Index (GALI)(33, 34). Health-related quality of life was measured with the 12-item short-form (SF-12v2), which consists of physical and mental component summary (PCS/MCS) scores (35, 36), and the full 5-item mental well-being scale of the SF-36(37). Scores for SF-12v2 and SF36 range from 0-100 with higher scores indicating higher levels of quality of life or well-being.

Specific health outcomes care-pathways

Fall risk was measured by an item on any falls and an item on recurrent falls in the previous year, an item on fear of falling, and fear of falling while performing several daily activities as measured by the 7-item Falls Efficacy Scale International (FES-I) short version; scores range from 7-28 with higher scores indicating higher levels of fear of falling (38). Appropriate medication use was measured with 10 items of the Medication risk questionnaire (MRQ-10); scores range from 0-10 with higher scores indicating lower levels of appropriate medication use (39). Loneliness was measured with the 6-item version of the Jong Gierveld loneliness scale(40); scores range from 6-18 with higher scores indicating higher levels of loneliness.

Care use

As secondary outcome measures, use of health and social care was measured in the questionnaire. Four items measured, within the past 12 months: the number of visits to a medical doctor, the number of days admitted to a hospital, the hours per week receiving help in

household work due to health problems and the hours per week receiving help in caring for oneself.

Socio-demographic factors

Age (in years), gender, living situation (alone/not alone) and education level were assessed in the baseline questionnaire. Education level was measured by asking the highest level of education completed and categorised according to the 2011 International Standard Classification of Education (ISCED) into 'lower' (ISCED 0-2) and 'higher' (ISCED 3-8)(41).

Analysis

Participant socio-demographic characteristics and health outcomes were evaluated at baseline between the intervention and control group in the total study population and in each city separately by means of chi-square tests for categorical variables and one-way ANOVA for continuous variables.

Main effects at follow-up were evaluated for the total study population, as per "intention to treat", using a multilevel modelling approach. Clustering effects at city-level were taken into account. Multilevel linear regression analyses were conducted for continuous outcome variables with group (intervention or control) as independent variable. Multilevel logistic regression was performed for dichotomous outcome variables. We corrected effect estimates of multilevel analyses for covariates, based on literature (42); age, sex, living situation, education level and the baseline status of the outcome variable. Subgroup "per-protocol" analyses were done for persons with an indication for specific care-pathways. We compared

persons in the control group who had an indication with persons in the intervention group who had an indication and enrolled in a care-pathway. Persons who received other types of medical care or did not have an indication but received care, were analysed in a separate 'frailty/medical care-pathway'. We compared persons in the frailty/medical care-pathway with all persons in the control group. We assessed interactions between intervention condition and city, gender, age and education level in the association between intervention condition and all outcomes(24). We applied Bonferroni correction for testing interactions(43) ($P=0.05/45=0.001$). We found significant interaction for 'city', and performed linear and logistic regression analyses per city separately with the same variables as in the main analyses. We considered a P-value of 0.05 or lower to be statistically significant for all other analyses. Multilevel logistic regression analyses and interaction testing were performed using R-3.3.2. All other analyses were performed using SPSS version 23.0 (IBM SPSS Statistics for Windows, Armonk, NY: IBM Corp).

A power calculation has been previously described(24). The target sample size was 1,250 participants in both the intervention group and the control group(24). Accounting for a 20% loss to follow-up, we expected to receive complete data of 1,000 participants in both groups at follow up. We assumed an alpha of 0.05 and power of 0.80 and applied a correction factor to account for the cluster design by city, assuming an average cluster size of 200 older citizens (2,000/10) and an intra-class correlation coefficient of 0.02. On this basis, a treatment difference of 0.25 standard deviation (SD) for continues outcomes such as the SF12 could be detected at follow-up.

RESULTS

Overall, 1,215 persons were included in the intervention group and 1,110 persons in the control group at baseline (Figure 1). At the 12-month follow-up, 986 persons in the intervention group (81.2%) completed the questionnaire and 858 persons in the control group (77.3%) completed the questionnaire (Figure 1). Reasons for drop-out at follow-up were unwillingness to participate, feeling too ill to participate, mortality and relocation. Persons who dropped out of the intervention group after baseline were older ($P<0.001$), lower educated ($P<0.001$) and had a lower level of independence (GARS, $P<0.001$) than persons included in the intervention group at follow-up. Persons who dropped out of the control group only had a lower level of independence (GARS, $P=0.003$) than persons included in the control group at follow-up. Of the 986 persons in the intervention group, information of 15 persons on enrolment in care-pathways was missing or could not be linked to study data. Of those with information, 520 (53.6%) enrolled in any care-pathway during the UHCE study, this differed by city (Figure 1).

At baseline, the average age of persons in this study was 79.5 years ($SD=5.6$), 60.8% of the sample consisted of women, 38.1% were living alone and 51.1% had a lower education level (Table 2). The fear of falling score measured with the short FES-I and loss of independence score were lower and mental health-related quality of life and mental well-being were higher among persons in the intervention group compared to the control group ($P<0.05$). All other characteristics were similar between the groups at baseline. Characteristics by city are presented in Table S1.

Table 2: Socio-demographic, lifestyle and health characteristics by intervention and control group among persons in the UHCE study (N=1844).

	Total N=1844	Control group N=858	Intervention group N=986	P value
Age in years, mean (SD)	79.5 (5.6)	79.7 (5.5)	79.3 (5.7)	0.188
Female gender, N (%)	1122 (60.8)	527 (61.4)	595 (60.3)	0.636
Living alone, N (%)	703 (38.1)	323 (37.7)	380 (38.5)	0.708
Lower education, N (%)	935 (51.1)	429 (50.6)	506 (51.5)	0.705
Healthy lifestyle, N (%)	1265 (69.1)	569 (67.3)	696 (70.7)	0.109
Fear of falling, N (%)	867 (47.0)	410 (47.8)	457 (46.3)	0.538
Fall past year, N (%)	552 (30.2)	267 (31.4)	285 (29.1)	0.278
Recurrent falls past year, N (%)	255 (13.9)	118 (13.9)	137 (14.0)	0.953
Physical frailty (SHARE-FI)	367 (20.2)	180 (21.5)	187 (19.1)	0.204
Severely limited function (GALI), N (%)	319 (17.4)	158 (18.5)	161 (16.4)	0.222
Malnutrition (SNAQ-65+), N (%)	273 (15.4)	112 (13.8)	161 (16.7)	0.093
Fear of falling (short FES-I) , mean (SD)	10.5 (4.7)	10.7 (5.0)	10.3 (4.5)	0.038
Medication risk (MRQ-10), mean (SD)	4.4 (1.6)	4.4 (1.6)	4.4 (1.7)	0.358
Loneliness (short JG), mean (SD)	0.6 (0.7)	0.6 (0.7)	0.6 (0.7)	0.165
Frailty (TFI), mean (SD)	5.1 (3.2)	5.2 (3.2)	5.1 (3.1)	0.632
Loss independence (GARS), mean (SD)	25.0 (9.4)	25.5 (10.2)	24.5 (8.7)	0.022
HRQoL PCS (SF-12), mean (SD)	42.1 (12.0)	41.8 (12.1)	42.3 (11.9)	0.469
HRQoL MCS (SF-12), mean (SD)	50.3 (10.6)	49.3 (10.7)	51.2 (10.4)	<0.001
Mental well-being (SF-36), mean (SD)	74.2 (20.4)	73.0 (20.9)	75.2 (20.0)	0.022

Missing items: Age=1, Gender=0, Living situation=1, Education=13, Healthy lifestyle=14, Fear of falling=0; Fall=16, Recurrent falls=16; SHARE-FI=26; GALI=9; SNAQ-65+=71; short FES-I=18, MRQ-10=22, short JG=23, TFI=8, GARS=3, SF-12=92, SF-36=18. Lower education=ISCED 0-2; Healthy lifestyle= no smoking, no drinking and exercise>1 times a week. For short FES-I (range 7-28); MRQ-10 (range 0-10); short JG (range 6-18); TFI (range 0-15); GARS (range 18-72); higher scores mean worse health or more health risk. SF-12 and SF-36 scores range 0-100 and higher scores means a higher quality of life or better mental well-being. Abbreviations: FES-I= Falls Efficacy Scale International; GALI= Global Activity Limitation Index; GARS=Groningen activity restriction scale; ISCED=International Standard Classification of Education; JG=Jong-Gierveld; MRQ-10=Medication Risk Questionnaire 10; SF-12=short form 12; SF-36=short form 36; SHARE-FI= Survey of Health, Ageing and Retirement in Europe-Frailty Instrument; SNAQ-65+= Short Nutritional Assessment Questionnaire 65+; TFI=Tilburg Frailty Index.

At follow-up, persons in the intervention group had significantly less recurrent falls compared to persons in the control group (10.5% vs. 14.8%; OR= 0.65, 95% CI = 0.48-0.88; Table 3). Frailty was lower among persons in the intervention group compared to persons in the control group (mean=4.9, SD=3.3 vs mean=5.5, SD=3.4; B=-0.43, 95% CI= -0.65- -0.22; Table 3). Physical health-related quality of life was significantly better among persons in the intervention group

compared to persons in the control group (mean=41.8, SD=12.1 vs 40.4, SD=11.5, $B=0.95$; 95% CI= 0.14-1.76; Table 3). Finally, mental well-being was significantly better among persons in the intervention group compared to persons in the control group (mean=74.9, SD=20.5 vs mean=71.8, SD=21.3, $B=1.50$; 95% CI=0.15-2.84; Table 3). No other effects of the UHCE approach on lifestyle, health or quality of life were found. Results by city are presented in Table S2 and S3. In Rijeka, significant positive effects were found for nine outcomes. In Valencia, significant positive effects were found for three outcomes and in Rotterdam for one outcome. In Manchester, significant positive effects were found for one outcome and negative effects for one outcome. No effects were found in Pallini.

Table 3: Prevalence and mean of outcomes at follow-up and effects of the UHCE approach with the control group as reference (N=1844).

	Control group N=858	Intervention group N=986	Adjusted effect estimates	P value
	N (%)	N (%)	OR (95% CI) ^a	
Healthy lifestyle	555 (65.4)	678 (68.9)	0.96 (0.68; 1.34)	0.790
Fear of falling	441 (51.6)	472 (48.1)	0.86 (0.68; 1.08)	0.188
Fall past year	267 (31.3)	280 (28.9)	0.92 (0.74; 1.14)	0.441
Recurrent falls past year	126 (14.8)	102 (10.5)	0.65 (0.48; 0.88)	0.005
Physical frailty (SHARE-FI)	245 (29.4)	236 (24.8)	0.78 (0.60; 1.02)	0.065
Severely limited function (GALI)	176 (20.7)	192 (19.7)	1.09 (0.83; 1.43)	0.539
Malnutrition (SNAQ-65+)	135 (17.1)	145 (15.3)	0.82 (0.62; 1.09)	0.181
	Mean (SD)	Mean (SD)	B (95% CI) ^b	
Fear of falling (short FES-I)	11.5 (5.4)	10.8 (5.2)	-0.25 (-0.60;0.10)	0.167
Medication risk (MRQ-10)	4.4 (1.6)	4.4 (1.6)	0.03 (-0.09;0.15)	0.653
Loneliness (short-JG)	0.7 (0.7)	0.6 (0.7)	-0.10 (-0.24;0.03)	0.128
Frailty (TFI)	5.5 (3.4)	4.9 (3.3)	-0.43 (-0.65;-0.22)	<0.001
Loss independence (GARS)	27.4 (11.9)	26.4 (10.8)	-0.11 (-0.73;0.52)	0.742
HRQoL PCS (SF-12)	40.4 (11.5)	41.8 (12.1)	0.95 (0.14;1.76)	0.022
HRQoL MCS (SF-12)	48.8 (11.3)	50.6 (11.2)	0.52 (-0.32;1.37)	0.224
Mental well-being (SF-36)	71.8 (21.3)	74.9 (20.5)	1.50 (0.15;2.84)	0.029

a) Values are derived from random-intercept multilevel logistic regression models adjusted for clustering by city and adjusted for age, gender, education, living situation and baseline status of the outcome measure.

b) Values are derived from random-intercept multilevel linear regression models adjusted for clustering by city and adjusted for age, gender, education, living situation and baseline status of the outcome measure.

Healthy lifestyle= no smoking, no drinking and exercise >1 times a week. For short FES-I (range 7-28); MRQ-10 (range 0-10); short JG (range 6-18); TFI (range 0-15); GARS (range 18-72); higher scores mean worse health or more health risk. SF-12 and SF-36 scores range 0-100 and higher scores means a higher quality of life or better mental well-being. Abbreviations: B=Beta coefficient; FES-I= Falls Efficacy Scale International; JG=Jong-Gierveld; MRQ-10=Medication Risk Questionnaire 10; OR=Odds ratio; SF-12=short form 12; SF-36=short form 36; SHARE-FI= Survey of Health, Ageing and Retirement in Europe-Frailty Instrument; SNAQ-65+= Short Nutritional Assessment Questionnaire 65+; TFI=Tilburg Frailty Index.

When comparing persons who enrolled in any type of care-pathway with all persons in the control group (Table 4), adjusted significant effects were stronger compared to the whole intervention group for recurrent falls (OR=0.58, 95% CI=0.40-0.85), frailty (B=-0.44, 95% CI=-0.71- -0.17) and physical health-related quality of life (B=1.22, 95% CI=0.24-2.21). Additionally there was a positive effect on loneliness (B=-0.18, 95% CI=-0.35- -0.02). The positive effect on mental well-being was no longer significant.

For persons in the falls, loneliness and frailty/medical care-pathways, significant positive effects were found on frailty and physical health-related quality of life (Table S4). For persons in the falls care-pathway, additional positive effects were found on recurrent falls and loneliness. For persons in the loneliness care-pathway additional positive effects were found on fear of falling measured as single item and recurrent falls. For persons in the frailty/medical care-pathway, additional positive effects were found on fear of falling measured as single item and loneliness. For persons in the polypharmacy care-pathway no positive effects were found.

Table 4: Prevalence and mean of outcomes at follow-up and effects of the UHCE approach for persons enrolled in any care-pathway with the control group as reference (N=1378).

	Control group N=858	Intervention group N=520	Adjusted effect estimates	P value
	N (%)	N (%)	OR (95% CI) ^a	
Healthy lifestyle	555 (65.4)	334 (64.5)	1.04 (0.67; 1.62)	0.848
Fear of falling	441 (51.6)	302 (58.2)	0.83 (0.63; 1.11)	0.215
Fall past year	267 (31.3)	142 (27.6)	0.82 (0.63; 1.06)	0.129
Recurrent falls past year	126 (14.8)	51 (9.9)	0.58 (0.40; 0.85)	0.005
Physical frailty (SHARE-FI)	245 (29.4)	154 (31.0)	0.87 (0.64; 1.18)	0.360
Severely limited function (GALI)	176 (20.7)	126 (24.6)	1.19 (0.86; 1.64)	0.303
Malnutrition (SNAQ-65+)	135 (17.1)	103 (20.6)	1.05 (0.76; 1.46)	0.755
	Mean (SD)	Mean (SD)	B (95% CI) ^b	
Fear of falling (short FES-I)	11.5 (5.4)	12.3 (5.7)	-0.24 (-0.68;0.21)	0.299
Medication risk (MRQ-10)	4.4 (1.6)	4.5 (1.7)	0.08 (-0.07;0.23)	0.312
Loneliness (short-JG)	0.7 (0.7)	0.7 (0.7)	-0.18 (-0.35;-0.02)	0.033
Frailty (TFI)	5.5 (3.4)	5.9 (3.3)	-0.44 (-0.71;-0.17)	0.001
Loss independence (GARS)	27.4 (11.9)	28.3 (12.0)	0.06 (-0.75;0.87)	0.886
HRQoL PCS (SF-12)	40.4 (11.5)	40.3 (11.8)	1.22 (0.24;2.21)	0.015
HRQoL MCS (SF-12)	48.8 (11.3)	46.7 (11.8)	-0.31 (-1.39;0.76)	0.568
Mental well-being (SF-36)	71.8 (21.3)	67.2 (20.6)	0.68 (-1.06;2.41)	0.444

a) Values are derived from random-intercept multilevel logistic regression models adjusted for clustering by city and adjusted for age, gender, education, living situation and baseline status of the outcome measure.

b) Values are derived from random-intercept multilevel linear regression models adjusted for clustering by city and adjusted for age, gender, education, living situation and baseline status of the outcome measure.

Healthy lifestyle= no smoking, no drinking and exercise>1 times a week. For short FES-I (range 7-28); MRQ-10 (range 0-10); short JG (range 6-18); TFI (range 0-15); GARS (range 18-72); higher scores mean worse health or more health risk. SF-12 and SF-36 scores range 0-100 and higher scores means a higher quality of life or better mental well-being. Abbreviations: B=Beta coefficient; FES-I= Falls Efficacy Scale International; JG=Jong-Gierveld; MRQ-10=Medication Risk Questionnaire 10; OR=Odds ratio; SF-12=short form 12; SF-36=short form

36; SHARE-FI= Survey of Health, Ageing and Retirement in Europe-Frailty Instrument; SNAQ-65+= Short Nutritional Assessment Questionnaire 65+; TFI=Tilburg Frailty Index.

Regarding care use, the number of hours per week needing household help due to health problems was reduced among persons in the intervention group compared to persons in the control group (Table S5). There were no effects on the use of doctor visits, hospital admissions and help in self-care.

DISCUSSION

Principal findings

Using a pre-post controlled design, we explored the effects of the UHCE approach on multiple outcomes of the lifestyle, health and quality of life among older persons in five European cities. The UHCE approach showed minor positive effects in tackling recurrent falls and frailty and promoting physical health-related quality of life and mental well-being compared to care as usual. Effects were stronger in the subgroup of persons who enrolled in care-pathways.

Interpretation

It is promising that we found positive effects of the UHCE approach on tackling recurrent falls and frailty and promoting physical health-related quality of life and mental well-being. However, the effect sizes of these outcomes were minor for the whole intervention group and minor or small for the subgroup of persons who enrolled in care-pathways. Furthermore, our study was exploratory in the sense that we measured effects on multiple outcomes which increases the chances of finding false positive results due to chance alone. Several systematic reviews report favourable effects of similar interventions on falls, functional decline, nursing home admissions and mortality(16, 18, 19), but others do not(17, 44). Effects on quality of life are less studied and evidence is of low quality(17). A possible reason for the small effects found in our study is that only around half of the persons in the intervention group enrolled in care-pathways. The dose in which older persons take-up complex care interventions is rarely studied and could impact on the effectiveness of interventions(19, 26). For professionals, parts of the intervention might be time consuming or difficult to apply(42, 45). For older persons, health and mobility problems can be barriers to engagement in interventions(45, 46). The effects of

the UHCE approach on health and quality of life were stronger when evaluating the subsample of persons enrolled in care-pathways. When analysing care-pathways separately, positive effects on fall outcomes, frailty and quality of life were found in persons who followed the falls prevention, frailty and/or loneliness care-pathways. As part of the falls prevention and frailty care-pathways most persons received physical exercise programmes. There is ample evidence on the benefits of physical exercise programmes for the prevention of falls and risk of falling in older populations(47-49) and to a lesser extent frailty(50), mental health and quality of life(51, 52). The polypharmacy care-pathway did not decrease inappropriate medication use for persons enrolled in this care-pathway. The MRQ-10 instrument used to measure inappropriate medication use might have not been sensitive enough to detect a change.

To our knowledge this was the first coordinated preventive care study conducted in multiple European settings. Most of the studies on coordinated preventive health and social care have been conducted in the US, Canada or Northwest Europe(16-19). In these settings, care for older persons was greatly improved during the 1980s to 1990s and care interventions after that time might have been of little extra benefit(19). This could explain the low uptake of care in the Northwest European cities Manchester and Rotterdam. In these cities, qualitative analyses of logbooks revealed that many older persons reported that they did not enrol in a care-pathway because they were already involved in other care. Most positive effects of the UHCE approach were found in Rijeka, where all persons in the intervention group enrolled in a care-pathway. Possible explanations for the high uptake of care in Rijeka were a high morale to engage in activities among participants and regular monitoring of the care process by community nurses who had a personal relationship with the participants and acted as care coordinator in this

study. Establishment of a trusted relationship is important for improvement of uptake and adherence to care interventions among older persons(46). This therefore could be a key component of future studies. These studies could quantitatively explore to what extent the bond between patient and care provider impacts on effectiveness.

In our study, not using additional inclusion criteria such as frailty or multi-morbidity might also have impacted on enrolment in care-pathways as participants could have been too healthy to need care. However, frail persons might in turn not be fit and willing enough to engage in preventive care. Evidence on effective intervention components of coordinated care interventions and target populations has been mixed(16, 19). In a meta-analysis, Beswick et al. found reductions in nursing home admissions for populations with increased death rates and no benefits for any specific type of intervention among multifactorial interventions(19). Though, Stuck et al. found that only interventions with a multidimensional geriatric assessment, regular follow-up visits and targeted at persons at lower risk for death were effective in reducing functional decline(16). More research is needed to uncover the effective elements and target groups of complex coordinated preventive care interventions for older persons. In order to identify these elements, reporting of the development and evaluation of these complex interventions should be streamlined(22, 53). It could also be possible that structured and preventive monitoring and promotion of the health of older persons could result in stronger health benefits within a longer time span, as our study only measured effects in one year. Future studies should investigate the long-term effects of a coordinated preventive care approach for older persons.

Strengths and Limitations

The main strength of our study is that we implemented the UHCE approach in five diverse European cities. This provides information on the effectiveness and generalisability of a coordinated preventive care approach in various European settings. With the use of a uniform questionnaire and measurements we were able to apply the same evaluation design in all cities and there were few missing data. There were also some limitations. First, although we almost reached our targeted sample size for the intervention group, we did not for the control group. Especially in Pallini and Rotterdam there were difficulties including persons in the control group despite attempts to boost participation. Selective inclusion cannot be excluded, although differences between control group and intervention group at baseline were small. To account for differences in sample size between cities, we used a multilevel modelling approach in analyses. Persons lost to follow-up in the intervention group were older and had a lower level of independence compared to persons in the intervention group included in the analyses. Therefore, the UHCE approach might have reached a relatively healthy group of older persons. Secondly, we applied a non-randomised design, which makes results subject to confounding variables. However, differences between persons in the control and intervention group at baseline were small. Third, whereas the UHCE project initially aimed to make use of existing care provisions, this was not always possible in all settings. This may have impacted the acceptability of the UHCE approach, especially in cases where health staff was newly employed, who were unfamiliar to the older participants.

Conclusions

Our study found promising but minor effects for the use of a coordinated preventive health and social care approach for the promotion of healthy ageing of older persons. Future studies

should further evaluate the effects of coordinated preventive health and social care aimed at healthy ageing in diverse European settings. The main challenge is participation in care of this vulnerable older population. Therefore, effective strategies are needed to promote engagement in care, tailored to the needs of older persons. More research is needed to determine the specific effective components of coordinated preventive health and social care that contribute to health improvements of older persons.

Acknowledgements

We would like to thank all participating older persons and all organizations and professionals involved in the UHCE project for their contributions to the UHCE study. We especially would like to thank the following individuals for their contributions to this study: Filian Looman, Eline Speijer and Petra de Vries.

Author contributions

HR, AJJV and RVS designed initial study protocol and wrote the funding proposal. CF and HR specified the initial study protocol with regards to the design, measurements, data management and analysis plan. EV, TR, LB advised on the use of research methods. TA, EV, TR, LB, RvS, AV, GW coordinated the intervention in each city. CF did the analyses. CF drafted the manuscript and AvG and HR supervised the writing process. All authors critically revised the manuscript for important intellectual content. All authors approved the final manuscript.

Conflict of interest

The authors declare that they have no competing interests

Availability of data

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Consent for publication

Not applicable.

Sponsor's role

This work was supported by the European Union, CHAFEA, third health programme, grant number 20131201.

Ethical approval and consent to participate

Ethical committee procedures have been followed in all cities and institutions involved, and approval has been provided. The names of the review board and the approval references are: Manchester, United Kingdom: NRES Committee West Midlands - Coventry & Warwickshire; 06-03-2015; 15/WM/0080; NRES Committee South Central – Berkshire B; 29-20-2014; 14/SC/1349; Pallini, Greece: The Ethics and Scientific board - Latriko Palaiou Falirou Hospital; 04/03/2015; 20150304-01; Rijeka, Croatia: The Ethical Committee - Faculty of Medicine University of Rijeka; 07-04-2014; 2170-24-01-14-02; Rotterdam, The Netherlands: Medische Ethische Toetsings Commissie (METC) – Erasmus MC Rotterdam; 08/01/2015; MEC-2014-661; Valencia, Spain: Comisión de Investigación - Consorcio Hospital General Universitario de Valencia. 29/01/2015; CICHGUV-2015-01-29. Written consent is obtained from all participants.

REFERENCES

1. Eurostat. Population structure and ageing: European Union, 1995-2013; 2014 [05/01/2017]. Available from: http://ec.europa.eu/eurostat/statistics-explained/index.php/Population_structure_and_ageing.
2. European Innovation Partnership on Active and Healthy Ageing. Specific Action on innovation in support of 'Personalized health management, starting with a Falls Prevention Initiative' Brussels: European Commission; 2013. Available from: https://ec.europa.eu/eip/ageing/sites/eipaha/files/library/51a44f911f647_a2_action_plan.pdf.
3. Andrew MK, Mitnitski A, Kirkland SA, Rockwood K. The impact of social vulnerability on the survival of the fittest older adults. *Age Ageing*. 2012;41(2):161-5.
4. Mendes de Leon CF, Glass TA, Berkman LF. Social engagement and disability in a community population of older adults: the New Haven EPSE. *Am J Epidemiol*. 2003;157(7):633-42. PubMed PMID: 12672683.
5. Glasby J. The holy grail of health and social care integration. *BMJ*. 2017;356:j801. doi: 10.1136/bmj.j801. PubMed PMID: 28209566.
6. Kringos DS, Boerma WGW, Hutchinson A, Saltman RB, European Observatory on Health S, Policies. Building primary care in a changing Europe 2015.
7. Nolte E, Knai C, McKee M, Organizacion Mundial de la S, European Observatory on Health S, Policies. Managing chronic conditions : experience in eight countries. Copenhagen: World Health Organization on behalf of the European Observatory on Health Systems and Policies; 2009.
8. Frich LM. Nursing interventions for patients with chronic conditions. *J Adv Nurs*. 2003;44(2):137-53. Epub 2003/10/03. doi: 2779 [pii]. PubMed PMID: 14521681.
9. Markle-Reid M, Browne G, Weir R, Gafni A, Roberts J, Henderson SR. The effectiveness and efficiency of home-based nursing health promotion for older people: a review of the literature. *Med Care Res Rev*. 2006;63(5):531-69. Epub 2006/09/07. doi: 63/5/531 [pii]
10.1177/1077558706290941. PubMed PMID: 16954307.
10. Markle-Reid M, Browne G, Gafni A. Nurse-led health promotion interventions improve quality of life in frail older home care clients: Lessons learned from three randomized trials in Ontario, Canada. *J Eval Clin Pract*. 2013;19(1):118-31.
11. Liebel DV, Friedman B, Watson NM, Powers BA. Review of nurse home visiting interventions for community-dwelling older persons with existing disability. *Med Care Res Rev*. 2009;66(2):119-46. Epub 2008/12/31. doi: 1077558708328815 [pii]
10.1177/1077558708328815. PubMed PMID: 19114607.
12. Eurostat. Healthcare personnel statistics - physicians: European Commission; 2017 [cited 2017 17/11/2017]. Available from: http://ec.europa.eu/eurostat/statistics-explained/index.php/Healthcare_personnel_statistics_-_physicians#Further_Eurostat_information.
13. Cattani M, White M, Bond J, Learmouth A. Preventing social isolation and loneliness among older people: a systematic review of health promotion interventions. *Ageing Soc*. 2005;25:41-67. doi: DOI 10.1017/S0144686X04002594. PubMed PMID: ISI:000227072000004.
14. Hagan R, Manktelow R, Taylor BJ, Mallett J. Reducing loneliness amongst older people: a systematic search and narrative review. *Aging Ment Health*. 2014;18(6):683-93. Epub 2014/01/21. doi: 10.1080/13607863.2013.875122. PubMed PMID: 24437736.
15. Dickens AP, Richards SH, Greaves CJ, Campbell JL. Interventions targeting social isolation in older people: a systematic review. *BMC Public Health*. 2011;11:647. Epub 2011/08/17. doi: 1471-2458-11-647 [pii]

- 10.1186/1471-2458-11-647. PubMed PMID: 21843337; PubMed Central PMCID: PMC3170621.
16. Stuck AE, Egger M, Hammer A, Minder CE, Beck JC. Home visits to prevent nursing home admission and functional decline in elderly people: systematic review and meta-regression analysis. *JAMA*. 2002;287(8):1022-8. Epub 2002/02/28. doi: jma10044 [pii]. PubMed PMID: 11866651.
17. Mayo-Wilson E, Grant S, Burton J, Parsons A, Underhill K, Montgomery P. Preventive home visits for mortality, morbidity, and institutionalization in older adults: a systematic review and meta-analysis. *PLoS One*. 2014;9(3):e89257. Epub 2014/03/14. doi: 10.1371/journal.pone.0089257
- PONE-D-13-47215 [pii]. PubMed PMID: 24622676; PubMed Central PMCID: PMC3951196.
18. Huss A, Stuck AE, Rubenstein LZ, Egger M, Clough-Gorr KM. Multidimensional preventive home visit programs for community-dwelling older adults: a systematic review and meta-analysis of randomized controlled trials. *J Gerontol A Biol Sci Med Sci*. 2008;63(3):298-307. Epub 2008/04/01. doi: 63/3/298 [pii]. PubMed PMID: 18375879.
19. Beswick AD, Rees K, Dieppe P, Ayis S, Gooberman-Hill R, Horwood J, et al. Complex interventions to improve physical function and maintain independent living in elderly people: a systematic review and meta-analysis. *Lancet*. 2008;371(9614):725-35. Epub 2008/03/04. doi: S0140-6736(08)60342-6 [pii]
- 10.1016/S0140-6736(08)60342-6. PubMed PMID: 18313501; PubMed Central PMCID: PMC2262920.
20. World Health Organization. Primary health care : now more than ever 2008.
21. Miller JN, Colditz GA, Mosteller F. How study design affects outcomes in comparisons of therapy. II: Surgical. *Stat Med*. 1989;8(4):455-66. PubMed PMID: 2727469.
22. Mohler R, Kopke S, Meyer G. Criteria for Reporting the Development and Evaluation of Complex Interventions in healthcare: revised guideline (CRDECLI 2). *Trials*. 2015;16:204. doi: 10.1186/s13063-015-0709-y. PubMed PMID: 25935741; PubMed Central PMCID: PMC4461976.
23. Bartholomew LK, Parcel GS, Kok G. Intervention mapping: a process for developing theory- and evidence-based health education programs. *Health Educ Behav*. 1998;25(5):545-63. Epub 1998/10/13. PubMed PMID: 9768376.
24. Franse CB, Voorham AJJ, van Staveren R, Koppelaar E, Martijn R, Valia-Cotanda E, et al. Evaluation design of Urban Health Centres Europe (UHCE): preventive integrated health and social care for community-dwelling older persons in five European cities. *BMC Geriatr*. 2017;17(1):209. doi: 10.1186/s12877-017-0606-1. PubMed PMID: 28893178; PubMed Central PMCID: PMC5594491.
25. Gobbens RJ, Luijckx KG, Wijnen-Sponselee MT, Schols JM. Towards an integral conceptual model of frailty. *J Nutr Health Aging*. 2010;14(3):175-81. PubMed PMID: 20191249.
26. Steckler ABLL. Process evaluation for public health interventions and research. San Francisco, Calif.: Jossey-Bass; 2002.
27. Bush K, Kivlahan DR, McDonell MB, Fihn SD, Bradley KA. The AUDIT alcohol consumption questions (AUDIT-C): an effective brief screening test for problem drinking. Ambulatory Care Quality Improvement Project (ACQUIP). Alcohol Use Disorders Identification Test. *Arch Intern Med*. 1998;158(16):1789-95. PubMed PMID: 9738608.
28. Gobbens RJ, van Assen MA, Luijckx KG, Wijnen-Sponselee MT, Schols JM. The Tilburg Frailty Indicator: psychometric properties. *J Am Med Dir Assoc*. 2010;11(5):344-55. doi: 10.1016/j.jamda.2009.11.003. PubMed PMID: 20511102.
29. Romero-Ortuno R, Walsh CD, Lawlor BA, Kenny RA. A frailty instrument for primary care: findings from the Survey of Health, Ageing and Retirement in Europe (SHARE). *BMC Geriatr*. 2010;10:57. Epub 2010/08/25. doi: 1471-2318-10-57 [pii]
- 10.1186/1471-2318-10-57. PubMed PMID: 20731877; PubMed Central PMCID: PMC2939541.
30. Romero-Ortuno R. The Frailty Instrument for primary care of the Survey of Health, Ageing and Retirement in Europe predicts mortality similarly to a frailty index based on comprehensive geriatric

- assessment. *Geriatr Gerontol Int.* 2013;13(2):497-504. Epub 2012/09/22. doi: 10.1111/j.1447-0594.2012.00948.x. PubMed PMID: 22994136; PubMed Central PMCID: PMC3530023.
31. Wijnhoven HA, Schilp J, van Bokhorst-de van der Schueren MA, de Vet HC, Kruijzena HM, Deeg DJ, et al. Development and validation of criteria for determining undernutrition in community-dwelling older men and women: The Short Nutritional Assessment Questionnaire 65+. *Clinical Nutrition.* 2012;31(3):351-8. PubMed PMID: 22119209.
 32. Suurmeijer TP, Doeglas DM, Moum T, Briancon S, Krol B, Sanderman R, et al. The Groningen Activity Restriction Scale for measuring disability: its utility in international comparisons. *Am J Public Health.* 1994;84(8):1270-3. PubMed PMID: 8059884.
 33. van Oyen H, Van der Heyden J, Perenboom R, Jagger C. Monitoring population disability: evaluation of a new Global Activity Limitation Indicator (GALI). *Soz Praventivmed.* 2006;51(3):153-61. PubMed PMID: 17191540.
 34. Berger N, Van Oyen H, Cambois E, Fouweather T, Jagger C, Nusselder W, et al. Assessing the validity of the Global Activity Limitation Indicator in fourteen European countries. *BMC Med Res Methodol.* 2015;15:1. doi: 10.1186/1471-2288-15-1. PubMed PMID: 25555466; PubMed Central PMCID: PMC4298058.
 35. Haywood KL, Garratt AM, Fitzpatrick R. Quality of life in older people: a structured review of generic self-assessed health instruments. *Qual Life Res.* 2005;14(7):1651-68. Epub 2005/08/27. PubMed PMID: 16119178.
 36. Ware J, Jr., Kosinski M, Keller SD. A 12-Item Short-Form Health Survey: construction of scales and preliminary tests of reliability and validity. *Med Care.* 1996;34(3):220-33. Epub 1996/03/01. PubMed PMID: 8628042.
 37. Ware JE, Jr., Sherbourne CD. The MOS 36-item short-form health survey (SF-36). I. Conceptual framework and item selection. *Med Care.* 1992;30(6):473-83. PubMed PMID: 1593914.
 38. Yardley L, Beyer N, Hauer K, Kempen G, Piot-Ziegler C, Todd C. Development and initial validation of the Falls Efficacy Scale-International (FES-I). *Age Ageing.* 2005;34(6):614-9. PubMed PMID: 16267188.
 39. Barenholtz Levy H. Self-administered medication-risk questionnaire in an elderly population. *Annals of Pharmacotherapy.* 2003;37(7-8):982-7. PubMed PMID: 12841804.
 40. De Jong Gierveld J, Van Tilburg T. The De Jong Gierveld short scales for emotional and social loneliness: tested on data from 7 countries in the UN generations and gender surveys. *Eur J Ageing.* 2010;7(2):121-30. doi: 10.1007/s10433-010-0144-6. PubMed PMID: 20730083; PubMed Central PMCID: PMC2921057.
 41. Organisation for Economic Co-operation and Development. *Classifying educational programmes : manual for ISCED-97 implementation in OECD countries.* Paris: Organisation for Economic Co-operation and Development; 1999.
 42. Metzelthin SF, van Rossum E, de Witte LP, Ambergen AW, Hobma SO, Sipers W, et al. Effectiveness of interdisciplinary primary care approach to reduce disability in community dwelling frail older people: cluster randomised controlled trial. *BMJ.* 2013;347:f5264. Epub 2013/09/12. PubMed PMID: 24022033; PubMed Central PMCID: PMC3769159.
 43. McDonald JH, University of D. *Handbook of biological statistics.* Baltimore, Maryland: Sparky House Publishing; 2009.
 44. Bouman A, van Rossum E, Nelemans P, Kempen GI, Knipschild P. Effects of intensive home visiting programs for older people with poor health status: a systematic review. *BMC Health Serv Res.* 2008;8:74. Epub 2008/04/05. doi: 1472-6963-8-74 [pii] 10.1186/1472-6963-8-74. PubMed PMID: 18387184; PubMed Central PMCID: PMC2364620.

45. Metzelthin SF, Daniels R, van Rossum E, Cox K, Habets H, de Witte LP, et al. A nurse-led interdisciplinary primary care approach to prevent disability among community-dwelling frail older people: a large-scale process evaluation. *Int J Nurs Stud*. 2013;50(9):1184-96. Epub 2013/02/07. doi: S0020-7489(12)00458-0 [pii] 10.1016/j.ijnurstu.2012.12.016. PubMed PMID: 23384696.
46. Provencher V, Mortenson WB, Tanguay-Garneau L, Belanger K, Dagenais M. Challenges and strategies pertaining to recruitment and retention of frail elderly in research studies: a systematic review. *Arch Gerontol Geriatr*. 2014;59(1):18-24. doi: 10.1016/j.archger.2014.03.006. PubMed PMID: 24745811.
47. El-Khoury F, Cassou B, Charles MA, Dargent-Molina P. The effect of fall prevention exercise programmes on fall induced injuries in community dwelling older adults: systematic review and meta-analysis of randomised controlled trials. *BMJ*. 2013;347:f6234. Epub 2013/10/31. PubMed PMID: 24169944; PubMed Central PMCID: PMC3812467.
48. Gillespie LD, Robertson MC, Gillespie WJ, Lamb SE, Gates S, Cumming RG, et al. Interventions for preventing falls in older people living in the community. *Cochrane Database Syst Rev*. 2009(2):CD007146. Epub 2009/04/17. doi: 10.1002/14651858.CD007146.pub2. PubMed PMID: 19370674.
49. Howe TE, Rochester L, Neil F, Skelton DA, Ballinger C. Exercise for improving balance in older people. *Cochrane Database Syst Rev*. 2011(11):CD004963. Epub 2011/11/11. doi: 10.1002/14651858.CD004963.pub3. PubMed PMID: 22071817.
50. Theou O, Stathokostas L, Roland KP, Jakobi JM, Patterson C, Vandervoort AA, et al. The effectiveness of exercise interventions for the management of frailty: a systematic review. *J Aging Res*. 2011;2011:569194. Epub 2011/05/18. doi: 10.4061/2011/569194. PubMed PMID: 21584244; PubMed Central PMCID: PMC3092602.
51. Bridle C, Spanjers K, Patel S, Atherton NM, Lamb SE. Effect of exercise on depression severity in older people: systematic review and meta-analysis of randomised controlled trials. *Br J Psychiatry*. 2012;201(3):180-5.
52. Park SH, Han KS, Kang CB. Effects of exercise programs on depressive symptoms, quality of life, and self-esteem in older people: a systematic review of randomized controlled trials. *Appl Nurs Res*. 2014;27(4):219-26. doi: 10.1016/j.apnr.2014.01.004. PubMed PMID: 24602398.
53. Campbell M, Fitzpatrick R, Haines A, Kinmonth AL, Sandercock P, Spiegelhalter D, et al. Framework for design and evaluation of complex interventions to improve health. *BMJ*. 2000;321(7262):694-6. Epub 2000/09/15. PubMed PMID: 10987780; PubMed Central PMCID: PMC1118564.

CAPTIONS

Figure 1. Flowchart of participants through trial

