

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

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34 **Running title:** Effect of coordinated preventive care for healthy ageing

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

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40

41 **ABSTRACT**

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

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

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

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

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

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

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

67 **Results:** Persons in the intervention group had less recurrent falls (OR= 0.65, 95% CI = 0.48;
68 0.88) and lower frailty (B=-0.43, 95% CI= -0.65- -0.22) at follow-up compared with persons in
69 the control group. Physical health-related quality of life and mental well-being was better
70 (B=0.95; 95% CI= 0.14-1.76; and B=1.50; 95% CI=0.15-2.84 respectively). The effects of the
71 UHCE approach were stronger in the subgroup of persons (53.6%) enrolled in care-pathways.

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

76

77 **Trial registration:** ISRCTN registry number is ISRCTN52788952. Date of registration is
78 13/03/2017.

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

81

82 **What is already known:**

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

90 **What this paper adds:**

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

99

100 **BACKGROUND**

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

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

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

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

126 **Objective**

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

134

135

136 **METHODS**

137 **Study design and setting**

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

155

156 **Participants**

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

166 **Intervention**

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

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

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

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

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

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

237

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.

238 **Measures**

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

253 *General health outcome measures*

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

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

268 *Specific health outcomes care-pathways*

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

277 *Care use*

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

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

283 *Socio-demographic factors*

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

288

289 **Analysis**

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

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

302 persons in the control group who had an indication with persons in the intervention group who
303 had an indication and enrolled in a care-pathway. Persons who received other types of medical
304 care or did not have an indication but received care, were analysed in a separate
305 'frailty/medical care-pathway'. We compared persons in the frailty/medical care-pathway with
306 all persons in the control group. We assessed interactions between intervention condition and
307 city, gender, age and education level in the association between intervention condition and all
308 outcomes(24). We applied Bonferroni correction for testing interactions(43) ($P=0.05/45=0.001$).
309 We found significant interaction for 'city', and performed linear and logistic regression analyses
310 per city separately with the same variables as in the main analyses. We considered a P-value of
311 0.05 or lower to be statistically significant for all other analyses. Multilevel logistic regression
312 analyses and interaction testing were performed using R-3.3.2. All other analyses were
313 performed using SPSS version 23.0 (IBM SPSS Statistics for Windows, Armonk, NY: IBM Corp).
314 A power calculation has been previously described(24). The target sample size was 1,250
315 participants in both the intervention group and the control group(24). Accounting for a 20%
316 loss to follow-up, we expected to receive complete data of 1,000 participants in both groups at
317 follow up. We assumed an alpha of 0.05 and power of 0.80 and applied a correction factor to
318 account for the cluster design by city, assuming an average cluster size of 200 older citizens
319 (2,000/10) and an intra-class correlation coefficient of 0.02. On this basis, a treatment
320 difference of 0.25 standard deviation (SD) for continues outcomes such as the SF12 could be
321 detected at follow-up.

322 **RESULTS**

323 Overall, 1,215 persons were included in the intervention group and 1,110 persons in the control
324 group at baseline (Figure 1). At the 12-month follow-up, 986 persons in the intervention group
325 (81.2%) completed the questionnaire and 858 persons in the control group (77.3%) completed
326 the questionnaire (Figure 1). Reasons for drop-out at follow-up were unwillingness to
327 participate, feeling too ill to participate, mortality and relocation. Persons who dropped out of
328 the intervention group after baseline were older ($P<0.001$), lower educated ($P<0.001$) and had a
329 lower level of independence (GARS, $P<0.001$) than persons included in the intervention group
330 at follow-up. Persons who dropped out of the control group only had a lower level of
331 independence (GARS, $P=0.003$) than persons included in the control group at follow-up. Of the
332 986 persons in the intervention group, information of 15 persons on enrolment in care-
333 pathways was missing or could not be linked to study data. Of those with information, 520
334 (53.6%) enrolled in any care-pathway during the UHCE study, this differed by city (Figure 1).
335 At baseline, the average age of persons in this study was 79.5 years ($SD=5.6$), 60.8% of the
336 sample consisted of women, 38.1% were living alone and 51.1% had a lower education level
337 (Table 2). The fear of falling score measured with the short FES-I and loss of independence
338 score were lower and mental health-related quality of life and mental well-being were higher
339 among persons in the intervention group compared to the control group ($P<0.05$). All other
340 characteristics were similar between the groups at baseline. Characteristics by city are
341 presented in Table S1.

342

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.

343

344 At follow-up, persons in the intervention group had significantly less recurrent falls compared
 345 to persons in the control group (10.5% vs. 14.8%; OR= 0.65, 95% CI = 0.48-0.88; Table 3). Frailty
 346 was lower among persons in the intervention group compared to persons in the control group
 347 (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
 348 health-related quality of life was significantly better among persons in the intervention group

349 compared to persons in the control group (mean=41.8, SD=12.1 vs 40.4, SD=11.5, B=0.95; 95%
350 CI= 0.14-1.76; Table 3). Finally, mental well-being was significantly better among persons in the
351 intervention group compared to persons in the control group (mean=74.9, SD=20.5 vs
352 mean=71.8, SD=21.3, B=1.50; 95% CI=0.15-2.84; Table 3). No other effects of the UHCE
353 approach on lifestyle, health or quality of life were found. Results by city are presented in Table
354 S2 and S3. In Rijeka, significant positive effects were found for nine outcomes. In Valencia,
355 significant positive effects were found for three outcomes and in Rotterdam for one outcome.
356 In Manchester, significant positive effects were found for one outcome and negative effects for
357 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.

358

359 When comparing persons who enrolled in any type of care-pathway with all persons in the
360 control group (Table 4), adjusted significant effects were stronger compared to the whole
361 intervention group for recurrent falls (OR=0.58, 95% CI=0.40-0.85), frailty (B=-0.44, 95% CI=-
362 0.71- -0.17) and physical health-related quality of life (B=1.22, 95% CI=0.24-2.21). Additionally
363 there was a positive effect on loneliness (B=-0.18, 95% CI=-0.35- -0.02). The positive effect on
364 mental well-being was no longer significant.

365 For persons in the falls, loneliness and frailty/medical care-pathways, significant positive effects
 366 were found on frailty and physical health-related quality of life (Table S4). For persons in the
 367 falls care-pathway, additional positive effects were found on recurrent falls and loneliness. For
 368 persons in the loneliness care-pathway additional positive effects were found on fear of falling
 369 measured as single item and recurrent falls. For persons in the frailty/medical care-pathway,
 370 additional positive effects were found on fear of falling measured as single item and loneliness.
 371 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.

372

373 Regarding care use, the number of hours per week needing household help due to health

374 problems was reduced among persons in the intervention group compared to persons in the

375 control group (Table S5). There were no effects on the use of doctor visits, hospital admissions

376 and help in self-care.

377

378 **DISCUSSION**

379 **Principal findings**

380 Using a pre-post controlled design, we explored the effects of the UHCE approach on multiple
381 outcomes of the lifestyle, health and quality of life among older persons in five European cities.

382 The UHCE approach showed minor positive effects in tackling recurrent falls and frailty and
383 promoting physical health-related quality of life and mental well-being compared to care as
384 usual. Effects were stronger in the subgroup of persons who enrolled in care-pathways.

385 **Interpretation**

386 It is promising that we found positive effects of the UHCE approach on tackling recurrent falls
387 and frailty and promoting physical health-related quality of life and mental well-being.

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

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

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

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

426 In our study, not using additional inclusion criteria such as frailty or multi-morbidity might also
427 have impacted on enrolment in care-pathways as participants could have been too healthy to
428 need care. However, frail persons might in turn not be fit and willing enough to engage in
429 preventive care. Evidence on effective intervention components of coordinated care
430 interventions and target populations has been mixed(16, 19). In a meta-analysis, Beswick et al.
431 found reductions in nursing home admissions for populations with increased death rates and
432 no benefits for any specific type of intervention among multifactorial interventions(19).

433 Though, Stuck et al. found that only interventions with a multidimensional geriatric assessment,
434 regular follow-up visits and targeted at persons at lower risk for death were effective in
435 reducing functional decline(16). More research is needed to uncover the effective elements and
436 target groups of complex coordinated preventive care interventions for older persons. In order
437 to identify these elements, reporting of the development and evaluation of these complex
438 interventions should be streamlined(22, 53). It could also be possible that structured and
439 preventive monitoring and promotion of the health of older persons could result in stronger
440 health benefits within a longer time span, as our study only measured effects in one year.

441 Future studies should investigate the long-term effects of a coordinated preventive care
442 approach for older persons.

443 **Strengths and Limitations**

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

463 **Conclusions**

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

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

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477 **Author contributions**

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

484 **Conflict of interest**

485 The authors declare that they have no competing interests

486 **Availability of data**

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

489 **Consent for publication**

490 Not applicable.

491 **Sponsor's role**

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494 **Ethical approval and consent to participate**

495 Ethical committee procedures have been followed in all cities and institutions involved, and
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497 Manchester, United Kingdom: NRES Committee West Midlands - Coventry & Warwickshire; 06-
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499 Pallini, Greece: The Ethics and Scientific board - Latriko Palaiou Falirou Hospital; 04/03/2015;
500 20150304-01; Rijeka, Croatia: The Ethical Committee - Faculty of Medicine University of Rijeka;
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504 CICHGUV-2015-01-29. Written consent is obtained from all participants.

505

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679 **CAPTIONS**

680 **Figure 1.** Flowchart of participants through trial

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682 **Supporting information**

683 **Supplementary Text S1.** CREDICI II criteria

684 **Supplementary Text S2.** Details of measurement of measures

685 **Table S1.** Socio-demographic, lifestyle and health characteristics by intervention and control
686 group of each city among persons in the UHCE study at baseline (N=1844).

687 **Table S2.** Lifestyle and health outcomes by intervention and control group of each city among
688 persons in the UHCE study at follow-up (N=1844).

689 **Table S3.** Effect of the UHCE approach on outcomes for each city separately.

690 **Table S4.** Effect of each UHCE care-pathway on outcomes for at-risk persons in the intervention
691 group who enrolled in a specific care-pathway compared to at-risk persons in the control group.

692 **Table S5.** Mean social and health care use in past 12 months at follow-up and effects of the
693 UHCE approach with the control group as reference (N=1844).