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ORIGINAL ARTICLE

Screening and Intervention to Prevent Falls and Fractures in Older People

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ABSTRACT

BACKGROUND

Community screening and therapeutic prevention strategies may reduce the incidence of falls in older people. The effects of these measures on the incidence of fractures, the use of health resources, and health-related quality of life are unknown.

METHODS

In a pragmatic, three-group, cluster-randomized, controlled trial, we estimated the effect of advice sent by mail, risk screening for falls, and targeted interventions (multifactorial fall prevention or exercise for people at increased risk for falls) as compared with advice by mail only. The primary outcome was the rate of fractures per 100 person-years over 18 months. Secondary outcomes were falls, health-related quality of life, frailty, and a parallel economic evaluation.

RESULTS

We randomly selected 9803 persons 70 years of age or older from 63 general practices across England: 3223 were assigned to advice by mail alone, 3279 to falls-risk screening and targeted exercise in addition to advice by mail, and 3301 to falls-risk screening and targeted multifactorial fall prevention in addition to advice by mail. A falls-risk screening questionnaire was sent to persons assigned to the exercise and multifactorial fall-prevention groups. Completed screening questionnaires were returned by 2925 of the 3279 participants (89%) in the exercise group and by 2854 of the 3301 participants (87%) in the multifactorial fall-prevention group. Of the 5779 participants from both these groups who returned questionnaires, 2153 (37%) were considered to be at increased risk for falls and were invited to receive the intervention. Fracture data were available for 9802 of the 9803 participants. Screening and targeted intervention did not result in lower fracture rates; the rate ratio for fracture with exercise as compared with advice by mail was 1.20 (95% confidence interval [CI], 0.91 to 1.59), and the rate ratio with multifactorial fall prevention as compared with advice by mail was 1.30 (95% CI, 0.99 to 1.71). The exercise strategy was associated with small gains in health-related quality of life and the lowest overall costs. There were three adverse events (one episode of angina, one fall during a multifactorial fall-prevention assessment, and one hip fracture) during the trial period.

CONCLUSIONS

Advice by mail, screening for fall risk, and a targeted exercise or multifactorial intervention to prevent falls did not result in fewer fractures than advice by mail alone. (Funded by the National Institute of Health Research; ISRCTN number, ISRCTN71002650.)

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Clinical guidelines suggest that preventing falls should reduce the incidence of fractures among older people and recommend strategies to prevent falls.[1,2] Many clinical services follow these guidelines, screening older persons and targeting interventions to those who are at increased risk for falling.[3] In general, targeted interventions include supervised strength and balance training or multifactorial approaches that assess several risk factors for falls and match preventive interventions to them. Randomized, controlled trials of sufficient size to show reduction in the incidence of fracture are lacking.[4,5] The comparative effectiveness of various strategies is not known.[6]

We assessed the clinical effectiveness and cost-effectiveness of a brief falls-risk screening questionnaire, sent by mail, followed by an exercise program or a multifactorial intervention targeted to persons at increased risk for falls, as compared with no screening in community-dwelling older people. All participants received advice by mail.

METHODS

TRIAL DESIGN, PARTICIPANTS, AND OVERSIGHT

The protocol, including the statistical analysis plan (available with the full text of this article at NEJM.org), has been published previously along with details of the intervention.[7-9] This was a three-group, pragmatic, cluster-randomized, controlled trial with parallel economic evaluation that included 63 general practices in seven rural and urban regions in England. Drawing from their patient registries, general practices contacted community-dwelling persons 70 years of age or older who were living in their own homes. Residents of assisted living facilities (with or without nursing care) and persons with terminal illnesses or life expectancy of less than 6 months were excluded.

The National Research Ethics Service approved the trial, which was overseen by a trial steering committee and a data and safety monitoring committee. All the authors were involved in the design, collection, and interpretation of data. Four of the authors analyzed the data and vouch for the accuracy and completeness of the data and for the fidelity of the trial to the protocol. The first author wrote the manuscript.

PROCEDURES

We recruited general medical practices, enlisting them in blocks of three practices from the same local health district. Each participating practice randomly selected up to 400 persons from their patient registries, informed them by mail that the practice was participating in research about treatments to improve the health of older people, and recruited them to complete an 18-month series of surveys about aging. (In protocol changes, we broadened the criteria for eligible fractures before finalizing the statistical analysis plan and increased sampling from 150 to 200 participants per practice to 300 to 400 participants per practice during the trial.) The mailed recruitment invitation included a baseline survey, consent form, and an advice booklet on preventing falls, "Age U.K. Staying Steady."[10] Practices sent one reminder letter to persons who did not respond to the invitation. Once 150 to 250 participants from each practice returned the survey and a signed consent form, we closed enrollment. With computer-generated randomization administered by an independent programmer, we randomly assigned the three practices in each local health district to the three interventions, one practice to each intervention. Practices assigned to the multifactorial fall-prevention strategy and the exercise strategy sent participants an additional brief screening questionnaire about the risk of falls, with a prepaid return envelope (details are provided in Section S1.1 in the Supplementary Appendix, available at NEJM.org). For participants whose responses to the questionnaire indicated that they were at increased risk for falls, multifactorial fall prevention or exercise, according to the random assignment, was arranged through the participants' usual National Health Service (NHS) provider. The falls-risk screening questionnaire was a validated algorithm[11] that was based on guidelines of the American Geriatrics Society and British Geriatrics Society, with small adaptations to enhance sensitivity and to suit administration by mail.[12]

EXERCISE INTERVENTION

We used the Otago Exercise Program, which includes progressive home exercises for strength and balance performed at least twice a week and a recreational walking program.[13] We trained physical therapists to deliver a minimum of seven sessions over 6 months. At least four sessions, including the initial session, were required to be in person, and the remainder could be conducted by telephone. Therapists used behavioral interventions to encourage adherence and provided participants with ankle weights to use during exercises.[14,15]

MULTIFACTORIAL INTERVENTION

Nurses, general practitioners, and consultant geriatricians assessed falls and medical history, gait and balance, fear of falling, postural hypotension, arrhythmia, medications, visual acuity, and feet and footwear status and conducted a home environment interview.[16] Linked treatments included a medication review, exercise (the same as that used in the exercise strategy), home modifications, and referral to opticians, medical specialists, and podiatrists. Gait and balance assessment included timed tests.[17] All medications, including over-the-counter medications, were screened. If medications that confer a predisposition to a fall were identified, a medical practitioner conducted a face-to-face review (Section S1.2). The multifactorial intervention was provided in general practices or hospital clinics. Trained assessors observed at least one session and provided feedback to the practitioners carrying out the intervention.

OUTCOMES

The primary outcome was the rate of fractures per 100 person-years over the 18-month period after randomization. We ascertained cases of fracture by searching NHS Digital Hospital Episode Statistics for fracture diagnoses at hospital admission and emergency department and clinic visits.[18] We searched practice records for consultations for fracture, radiography reports, and hospital correspondence detailing fractures. Two clinical members of the trial team independently confirmed all events by reviewing all records, from which group assignment and personal and practice details were redacted. A third trial member was available in case of disagreements, but there were none. We counted fractures included in the Prevention of Falls Network Europe consensus,[19] as well as rib, sternum, skull, and facial fractures because of emerging epidemiologic trends.[20] We used *International Classification of Diseases, 10th Revision* (ICD-10), codes assigned in Hospital Episode Statistics. If ICD-10 codes were missing, we used data from emergency department, fracture clinic, or practice records to derive a code. We used the hospital admission date as the date of the fracture unless other more-accurate data were in the general practice record. A fracture episode was counted as the sum of all fractures occurring in a person in a 24-hour period; all fractures were reported, and we prespecified separate reporting of wrist and hip fractures.

The baseline survey included demographic data, fall and medical history, balance problems, activities of daily living, Strawbridge Frailty Index,[21] and a clock-drawing test (a test in which participants were asked to draw a clock face showing a specific time).[22] We recorded the socioeconomic statuses of the practice areas.[23]

Secondary outcomes were falls, the use of health and social care resources (as assessed by participant recall over each survey period), and the results of the 12-Item Short-Form General Health Survey, version 2 (SF-12),[24] and the EuroQoL Group 5-Dimension 3-Level questionnaire (EQ-5D-3L).[25] The follow-up surveys were conducted every 4 months for the first year, and the final survey was conducted 6 months later. We repeated the Strawbridge Frailty Index at 18 months after randomization. Participants completed a daily falls diary in one randomly selected 4-month survey period. We used an internationally agreed-on definition of falls.[19] All data-management staff were unaware of the treatment assignments.

We collected details on exercises prescribed in the multifactorial fall-prevention and exercise groups. We measured balance and strength at the first and last exercise sessions.[8] For the multifactorial fall-prevention group, we documented the risk-factor assessment and the intended interventions. We tracked prescriptions for psychotropic and psychotropic-related medication, bisphosphonates, and mineral supplementation over the trial period (Section S1.2).[9]

HEALTH ECONOMIC ANALYSIS

We constructed a within-trial cost-utility analysis expressed as the incremental cost per quality-adjusted life-year (QALY), incremental net health benefit, and incremental net monetary benefit (Section S1.4).[26,27] We used multiple imputation for the base-case analysis. We assessed uncertainty using a probabilistic sensitivity analysis and complete case analysis.

STATISTICAL ANALYSIS

In calculating the sample size, we used historical data of fracture rates in England.[28] We calcu-

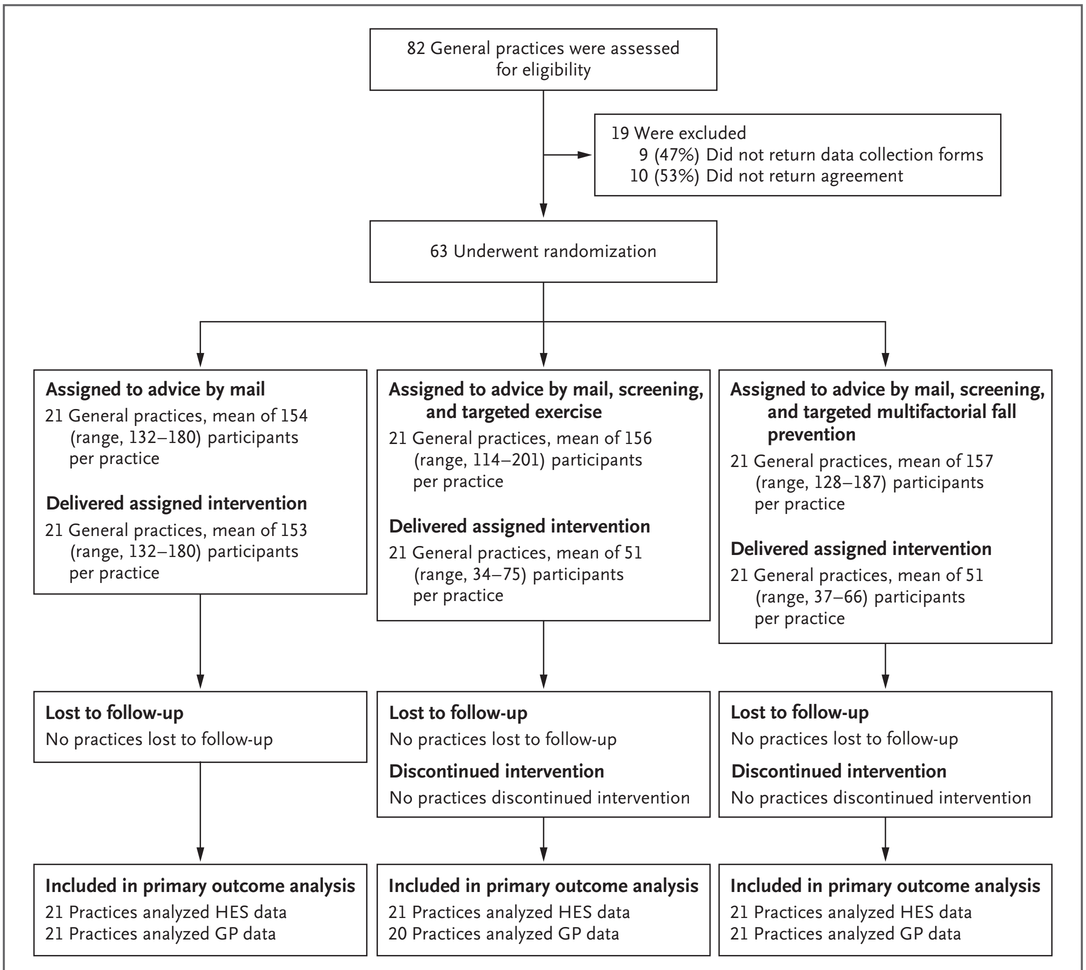

Figure 1. Screening, Randomization, and Follow-up of General Practices.
GP denotes general practices, and HES National Health Service Digital Hospital Episode Statistics.

lated that 1872 participants in each group (5616 in total) would be needed for the trial to have 80% power to detect a difference of 2 percentage points between the advice-by-mail group (6%) and the two intervention groups (4%) in the proportion of people having at least one fracture over 18 months, at a significance level of 0.05. We inflated for clustering (intraclass correlation coefficient, 0.00226; target cluster size, 150 participants), variation in cluster size of 0.56, and 10% loss to follow-up, including because of death, resulting in a minimum sample size of 9006 participants and 60 general practices.

Our primary analyses included all participants enrolled from practices that underwent randomization (9803 participants), according to the intention-to-treat principle (Section S1.3). We performed a nested analysis that included only the participants who were at an increased risk for falls. We compared fracture and fall prevalence using negative binomial regression.[29] We performed a complier average causal effect analysis,[30] defining adherence as attendance at the first session of each active intervention. In all primary analyses, we adjusted for age, sex, log of falls at baseline,[31] general practice deprivation score, and general practice as a random effect. There was a prespecified hierarchy for comparisons between groups. We performed unadjusted analyses of subgroups defined according to age (<80 years of age vs. ≥80 years), sex, and risk of falling. For secondary outcomes, analyses have not been adjusted for multiplicity and hence confidence intervals cannot be used to infer effects. We calculated receiver operating characteristic curves for the falls-risk screening tool

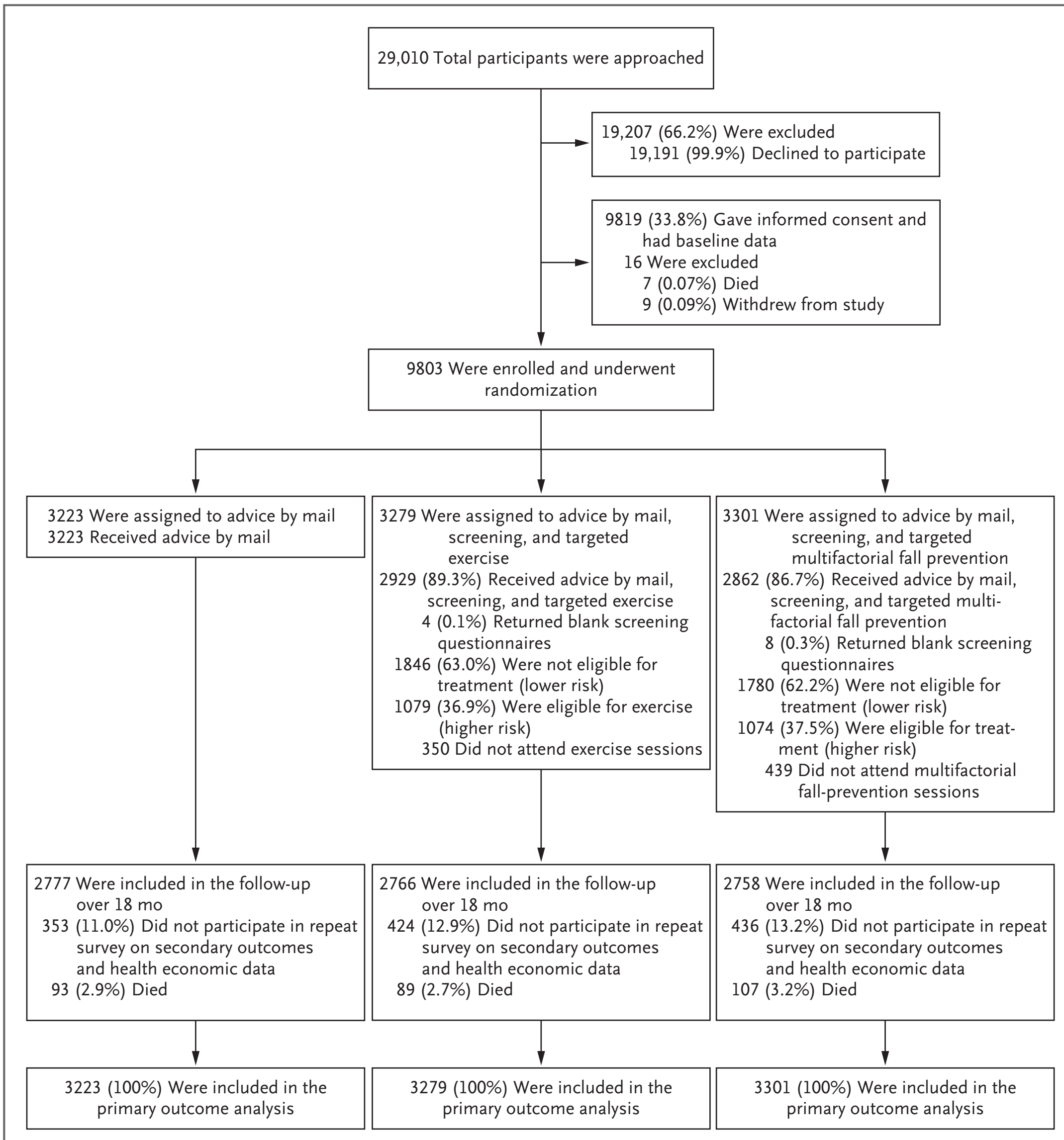

Figure 2. Screening, Randomization, and Follow-up of Participants.

(Section S1.1).[32] We excluded time periods with missing data on falls. We removed data with extreme outlying points for falls (>30 falls) and used multiple imputation in a sensitivity analysis for all analyses with missing values.[33]

RESULTS

GENERAL PRACTICES AND PARTICIPANTS

We enrolled 63 participating general practices during the period from September 2010 through June 2014, recruited 9803 participants, and obtained data on fractures from the NHS Digital Hospital Episode Statistics for 9802 of the 9803 participants. We had general practice records for 9644 participants (98%); one exercise practice refused access to records after randomization (Figs. 1 and 2). Over the course of 18 months, 289 participants (3%) died and 1213 (12%) did not complete the surveys, with no differences between trial groups.

The mean age of participants was 78 years;

Table 1. Baseline Characteristics of General Practices and Participants.*

Characteristic	Advice by Mail	Exercise	Multifactorial Fall Prevention
Practice data			
No. of practices	21	21	21
Median deprivation score (IQR)†	6 (4–8)	7 (4–9)	6 (4–9)
Participant data			
No. of participants	3223	3279	3301
Age — yr	78±5.7	78±5.7	78±5.7
Female sex — no. (%)	1666 (52)	1724 (53)	1760 (53)
White race — no./total no. (%)‡	3166/3196 (99)	3225/3250 (99)	3239/3278 (99)
Married or cohabiting — no./total no. (%)	2050/3212 (64)	2035/3266 (62)	2085/3287 (63)
Living alone — no./total no. (%)	1048/3203 (33)	1104/3258 (34)	1065/3284 (32)
Median age at end of full-time education (IQR) — yr§	16 (15–17)	16 (15–17)	16 (15–17)
Three or more coexisting conditions — no. (%)	598 (19)	610 (19)	612 (19)
At increased risk for falls — no./total no. (%)	1382/3221 (43)	1422/3274 (43)	1487/3300 (45)
Had fallen in the previous year — no./total no. (%)	966/3145 (31)	986/3211 (31)	1054/3237 (33)
Reported fracture in the previous year — no. (%)	106 (3)	112 (3)	106 (3)
Median no. of falls in previous year (IQR)	0 (0–1)	0 (0–1)	0 (0–1)
Frail — no./total no. (%)¶	647/3182 (20)	625/3228 (19)	733/3261 (22)
SF-12 physical component summary score‖	50.3±10.2	50.5±10.3	50.0±10.5
SF-12 mental component summary score‖	50.2±9.3	50.3±8.9	50.1±9.3
Participant-reported osteoporosis — no. (%)	377 (12)	400 (12)	395 (12)
Possible cognitive impairment, as indicated by clock-drawing test — no./total no. (%)	294/3176 (9)	271/3223 (8)	305/3222 (9)
Body-mass index**	26.4±4.7	26.5±4.5	26.4±4.6

* Plus–minus values are means ±SD. IQR denotes interquartile range.
† The deprivation score, calculated at randomization, measures practice-level socioeconomic deprivation with the English Index of Multiple Deprivation. Scores range from 1 to 10, with higher scores indicating less deprivation.
‡ Race was determined by the participant.
§ Data were missing for 50 participants in the advice-by-mail group, 43 participants in the exercise group, and 62 participants in the multifactorial fall prevention group.
¶ Frailty was assessed with the Strawbridge Frailty Index.
‖ The 12-Item Short-Form General Health Survey (SF-12) physical composite score (PCS) and mental composite score MCS) range from 0 to 100, with higher scores indicating better physical or mental health. Data were missing for 320 participants in the advice-by-mail group, 326 participants in the exercise group, and 338 participants in the multifactorial fall prevention group.
** The body-mass index is the weight in kilograms divided by the square of the height in meters.

5150 (53%) were female. Characteristics were well balanced across the groups (Table 1). Completed falls-risk screening questionnaires were returned by 2925 of 3279 (89%) persons randomly assigned to the exercise strategy, of whom 1079 were at increased risk for falls and were sent an invitation to participate in the exercise intervention. Among persons assigned to the multifactorial fall-prevention strategy, 2854 of 3301 (87%) returned a falls-risk screening questionnaire; of those who returned the questionnaire, 1074 (28%) were sent an invitation to participate in the multifactorial fall-prevention assessment. There was a greater percentage of frail persons (as assessed by the Strawbridge Frailty Index) among those who did not respond to the falls-risk screening questionnaires than among those who did respond (26% [212 of 801]

Table 2. Fracture, Fall, Health Utility, and Incremental Net Benefits of Screening and Treatment Pathways over 18 Months.

Variable	Advice by Mail	Exercise	Multifactorial Fall Prevention	Adjusted Rate Ratio (95% CI)	
				Exercise vs. Advice by Mail	Multifactorial Fall Prevention vs. Advice by Mail
No. of participants (person-yr of data)	3223 (4869)	3279 (4981)	3301 (4985)	—	—
No. of fractures	133	152	173	—	—
No. of fractures/100 person-yr	2.76	3.06	3.50	1.20 (0.91 to 1.59)	1.30 (0.99 to 1.71)
One or more fracture episodes*	110	126	143	—	—
No. of fracture episodes*	118	131	153	—	—
Fracture episodes/100 person-yr*	2.44	2.66	3.08	1.10 (0.85 to 1.43)	1.26 (0.98 to 1.62)
No. of hip fractures	33	26	28		
No. of wrist fractures	20	23	34		
Median time to first fracture (IQR) — mo	9 (3.9 to 14.5)	10 (5.1 to 14.1)	9 (4.6 to 12.9)		
No. of falls†	4309	4277	4842		
No. of participants who had falls	1276	1277	1301		
No. of falls per 100 person-years over 18 months	105.6	104.4	127.2	0.99 (0.86 to 1.14)	1.13 (0.98 to 1.30)
0–4 months	118.8	134.4	152.4	1.12 (0.87 to 1.45)	1.19 (0.92 to 1.53)
4–8 months	136.8	106.8	164.4	0.79 (0.64 to 0.96)	1.13 (0.93 to 1.37)
8–12 months	110.4	115.2	116.4	1.04 (0.91 to 1.20)	0.97 (0.84 to 1.12)
12–18 months	97.2	108.0	116.4	1.10 (0.91 to 1.34)	1.13 (0.93 to 1.38)
Total costs					
GBP (95% CI)‡	3,373.42 (3,447.64 to 4,028.34)	3,720.44 (3,456.80 to 3,456.78)	3,940.92 (3,456.78 to 4,430.70)		
USD	4,351.71 (4,447.41 to 5,196.56	4,799.37 (4,459.27 to 4,459.25)	4,825.79 (4,459.25 to 5,715.60		
Mean expected QALY (95% CI)‡	1.1137 (1.0918 to 1.1354)	1.1195 (1.0954 to 1.1431)	1.1064 (1.0825 to 1.1301)		

				Difference (95% CI)	
Incremental net monetary benefit§					
GBP				135.39 (−358.88 to 625.22)	−352.89 (−839.86 to 147.16)
USD				174.65 (−462.96 to 806.53)	−455.23 (−1,083.42 to 189.84)
Incremental net health benefit§				0.0068 (−0.0179 to 0.0310)	−0.0176 (−0.0419 to 0.0074)
No. of adverse events¶	0	2	1		

* A fracture episode was counted as the sum of all fractures occurring in a person in a 24-hour period.
† Data were missing for 183 participants in the advice-by-mail group, 189 participants in the exercise group, and 194 participants in the multifactorial fall prevention group.
‡ Costs are net present values, converted to U.S. dollars (£1 equivalent to U.S. $1.29 as of September 10, 2020). GBP denotes British pound sterling, and USD U.S. dollar.
§ Incremental net monetary benefit and incremental net health benefit 95% confidence intervals were based on the total number of participants (9803) and an assumption of £20,000 per quality-adjusted life-year (QALY).
¶ One participant in the exercise group had an angina attack while exercising at home (treated with glyceryl trinitrate) and one fell during a multifactorial assessment. There was one serious adverse event — a participant in the exercise group had a hip fracture that occurred while mailing back a questionnaire.

vs. 20% [1146 of 5779]); otherwise there were no differences between those who responded to the questionnaires and those who did not. The area under the curve of the falls-risk screening questionnaire was 0.72 (95% confidence interval [CI], 0.69 to 0.74) for repeat falls, 0.66 (95% CI, 0.64 to 0.68) for a single fall, and 0.60 (95% CI, 0.55 to 0.64) for a fracture.

INTERVENTIONS

The median time between randomization and the start of exercise intervention was 14 weeks (interquartile range, 10 to 22), and the median time from randomization to the start of the multifactorial intervention was 16 weeks (interquartile range, 13 to 23). More than 95% of intervention sessions (5996 of 6280) were provided within the usual NHS provider network, and the remainder of contacts were through university clinical staff. Acceptance of the offer of intervention was higher in the multifactorial fall-prevention group (762 of 1074 [71%]) than in the exercise group (697 of 1079 [65%]). In total, there were 3842 intervention sessions for exercise and 2530 for multifactorial fall prevention. Assessments of patients in the multifactorial fall-prevention group identified 299 of 762 participants for referral to exercise (203 of the 299 attended exercise sessions), and 459 of 762 for face-to-face medication review (risk factors identified in multifactorial fall-prevention assessments are provided in Table S1). The mean (±SD) number of exercise sessions was 5.5±1.98, with no difference between groups in attendance or strength and balance outcomes. The majority of participants had improvement or remained at the upper level of strength (391 of 454 [86%]) as measured by the Otago Exercise Program strength scale. Evaluations for balance showed that 330 of 453 (72%) of participants had improvement or remained at the top level of balance as measured by the Otago balance scale. Over the course of the trial, only prescriptions for mineral supplementation changed, from 13.8% to 15.6%, with no difference between groups.

OUTCOMES

The greatest number of fractures occurred among persons assigned to the multifactorial fall-prevention strategy, and the fewest occurred in the group that received advice by mail only (Table 2, Figs. S1 and S2, and Table S3). There

Table 3. Fractures and Falls in Participants at Higher Risk for Falling.

Variable	Advice by Mail	Exercise	Multifactorial Fall Prevention	Adjusted Rate Ratio (95% CI)	
				Exercise vs. Advice	Multifactorial Fall Prevention vs. Advice
No. of participants (person-yr of data)	1382 (2073)	1422 (2153)	1487 (2229)		
No. of fractures	88	79	113		
Fractures/100 person-yr	4.28	3.70	5.12	0.94 (0.65–1.35)	1.26 (0.89–1.78)
Persons with ≥1 fracture episode	69	67	91		
No. of fracture episodes	75	71	97		
Fracture episodes/100 person-yr	3.62	3.33	4.35	0.94 (0.67–1.32)	1.21 (0.88–1.67)
No. of hip fractures	22	19	20		
No. of wrist fractures	13	10	22		
Median time to first fracture (IQR) — mo	8 (11.8)	10 (9.3)	10 (7.9)		
No. of falls — no./total no.*	3255/3349	3226/3329	3608/3721		
No. of persons who fell — no./total no.*	750/844	718/821	787/900		
Falls/100 person-yr over 18-month period	190.8	183.6	210.0	0.97 (0.80–1.18)	1.07 (0.88–1.29)
0–4 months	213.6	252.0	259.2	1.15 (0.85–1.55)	1.14 (0.84–1.53)
4–8 months	222.0	170.4	244.8	0.79 (0.62–1.08)	1.07 (0.84–1.37)
8–12 months	193.2	194.4	187.2	1.00 (0.82–1.23)	0.92 (0.75–1.14)
12–18 months	165.6	175.2	183.6	1.03 (0.80–1.34)	1.08 (0.83–1.39)

* Data were missing for 94 participants in the advice-by-mail group, 103 participants in the exercise group, and 113 participants in the multifactorial fall prevention group.

were no significant differences in fracture rates (number of fractures per 100 person-years) between the exercise group and the advice-by-mail group (adjusted rate ratio for fracture, 1.20; 95% CI, 0.91 to 1.59; P=0.19) or between the multifactorial fall-prevention group and the advice-by-mail group (adjusted rate ratio, 1.30; 95% CI, 0.99 to 1.71; P=0.06) (Table 2). Any differences in fall rates were not sustained over 18 months. There were no differences in the SF-12 or Strawbridge Frailty Index scores (Table S2) and no subgroup or adherence effects.

Among the participants in the nested analysis group, who were at increased risk for falls (4192 of 9803 participants), the fracture rate was 3.70 per 100 person-years in the exercise group (adjusted rate ratio in the comparison with advice-by-mail group, 0.94; 95% CI, 0.65 to 1.35), 5.12 per 100 person-years in the multifactorial fall-prevention group (adjusted rate ratio in the comparison with advice-by-mail group, 1.26; 95% CI, 0.89 to 1.78), and 4.28 per 100 person-years in the advice-by-mail group (Table 3).

COST AND QALY ANALYSIS

By providing the highest expected QALY outcome at the lowest expected cost, the exercise strategy dominated both advice by mail alone and multifactorial fall prevention (Tables S4 through S7). The differences in costs and QALYs were marginal and driven largely by a higher QALY gain for exercise, particularly as compared with multifactorial fall prevention (Fig. S4). The probability that exercise is cost-effective at a £20,000 (US$25,800) threshold is 70%.

DISCUSSION

In this cluster-randomized, controlled trial involving participants drawn from general medical practices, screening for increased risk for falls with the targeted offer of an exercise or multifactorial intervention added to advice by mail did not prevent fractures. Some possible benefits were associated with screening and a targeted offer of exercise, including small enhancements of quality of life and reduced health care costs.

Our trial had certain strengths. We used a common, evidence-based pathway for the program that was consistent with guidelines of the American Geriatrics Society and British Geriatrics Society and other clinical guidelines.[1,2] Nearly all residents of England are registered with a local general practice, which provided an obvious point from which to initiate a population-based approach to screening and treating patients. We were able to separate the clinical approach to participants from the research procedures in the trial, and the trial population was representative of persons 70 years of age and older in England.[34] The majority of interventions were provided within the participants' usual NHS provider network.

The trial had certain limitations. The main method of measuring falls was retrospective reporting over survey intervals. This method may underestimate the incidence of falls as compared with reporting from diaries, but we believe that this did not affect the estimates of intervention effect, since underreporting of falls was consistent across groups.[35] We used the standard-of-care method for fracture ascertainment in England, and these data were available for all but one participant. We searched general practice records as a safeguard, particularly for fractures that may not have resulted in admission to the hospital. One general practice in the exercise group refused access to their practice records, and we may have underestimated minor fractures by one or two events in that group.

We did not collect data on minor injuries, since these are poorly recorded in England.[19] We noted small improvements in health-related quality of life that can possibly be attributed to lessening of pain and improvement in mobility, and possibly to fewer minor injuries. The proportion of participants in whom a fracture occurred was lower than we anticipated when we calculated the sample size, but for the estimation of effect, we used a between-group comparison of rate (number of fractures per 100 person-years), which provided more power in the analysis than a comparison of proportion of participants[36] and exceeded our recruitment target. The observed number of fractures was consistent with contemporary estimates.[37]

Pragmatic trials estimate effectiveness in everyday settings. The percentage of persons who responded to falls-risk screening by mail was high. The accuracy of the screening was similar to that of other population tools for predicting risk of falls.[38,39] We did not recontact persons who did not respond to the falls-risk screening mail and hence missed a small number of people at increased risk. Including detailed performance tests that require in-person administration may improve the accuracy of falls-risk screening[38] and might contribute to improvements in the future. We used the Otago Exercise Program in a manner consistent with common practice in the United Kingdom.[3] An exercise intervention that is more prolonged or more intense, or both, may have a more sustained effect on falls but would cost more. Future studies should include interventions with better long-term adherence among persons at greatest risk for a fracture.

In England, bone health and fall prevention pathways are often separated. In order to isolate the effect of falls prevention on the incidence of fracture, we did not provide medication to improve bone resilience. The SCOOP (Screening in the Community to Reduce Fractures in Older Women) trial used very similar methods to test a population strategy for bone health and suggested modest benefits from fracture-risk screening and pharmacologic osteoporosis management.[37]

Our findings are consistent with the broader evidence base, including a recent trial of multifactorial fall prevention in women.[40] A recent Cochrane review reported limited and variable effects of multifactorial interventions on falls and included no reliable evidence about fractures.[5] In our trial, exercise had less effect on falls than was reported in some other published studies,[4] but we used a longer-term follow-up than most. When applied in pragmatic settings, screening by mail followed by a targeted exercise intervention or multifactorial approach for prevention of falls did not result in a lower rate of fractures than advice by mail alone.

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