Establishment of an appropriate fall prevention program: A community-based study

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Aim: To identify an appropriate community-based fall prevention program

Methods: We introduced two programs to 24 senior centers, “community salons,” in a Japanese city, and carried out a prospective controlled trial between 2004 and 2005. Eight salons (185 participants aged 72.0 ± 7.1 years) received a single-visit program consisting of one multidisciplinary team visit that included fall risk assessment with feedback and a fall prevention lecture. A total of 16 salons (418 participants aged 73.6 ± 7.4 years) received a year-round comprehensive program, with visits carried out every 3 months. We compared the fall rates for 1 year between the two programs. Based on the results, we implemented a modified program until 2014 and examined the long-term consequences.

Results: In the prospective controlled trial, fall rates did not differ significantly between programs (P = 0.449). Instead, fall rates for both programs decreased significantly by 0.89 (95% CI 0.84–0.94) times each month. Therefore, we implemented a modified version of the single-visit program. By March 2014, the programs had been delivered to 1863 individuals, and the total number of attendees was 6622. The average attendance frequency per participant was 0.62 times per year. Overall, the rate of falling (fall rates in the preceding year) decreased significantly as the number of program attendances increased (incident rate ratio = 0.89, 95% CI 0.85–0.92) irrespective of initial program types.

Conclusions: The programs including fall risk assessment with feedback and a fall prevention lecture reduced falls when embedded into the community, and they were accepted well over the course of 10 years. Geriatr Gerontol Int 2017; 17: 1081–1089.

Keywords: aging, delivery of healthcare, frail elderly, preventive health service, rehabilitation.

Introduction

Falls among older people are a serious public concern due to the presence of aging populations worldwide. Approximately one-third of community-dwelling older people fall annually.1,2 The incidence of fall-related injuries and death increase with age,3,4 and falls are the leading cause of fatal and non-fatal injuries in older people.5 Fall-related injuries, such as hip fractures, are associated with mortality and morbidity3,6 and result in substantial economic burden.7

A systematic review based on randomized controlled trials showed that some interventions, such as exercise and multifactorial interventions with individualized risk assessments, reduce the incidence of falls effectively.8 However, issues regarding randomized controlled trials design, such as settings and participant selection, potentially limit the generalizability of results.9 In fact, just 10–30% of recruited older people participated in previously reported fall prevention trials.10–12 A gap exists between “what is efficacious in a designed trial” and “what is effective in the real world.”13 An appropriate community-based program should not only be effective in a well-designed short-term trial, but also delivered successfully to those to whom it is beneficial, well accepted and feasible in a real community in the long term. Some population-based trials showed that implementation of multiple interventions could potentially prevent fall-related injuries within entire communities.14,15 However, these trials were subject to “the black box,” and often revealed inadequate information as to how program components

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achieved their effects. Therefore, clarification regarding the types of programs appropriate for community-based fall prevention is required.

The aims of the present long-term community-based study of more than 10 years were to identify an appropriate fall prevention program in a Japanese community, and to propose a model of community-based fall prevention.

Methods

Settings and study outline

The study was carried out at small seniors centers (named “community salons”) in Tatebayashi City, located approximately 60 km north of Tokyo, Japan. In 2004, the city’s population was 79,597, with 18.5% of the population aged 65 years or older. Each salon included approximately 10–30 older people who could walk independently with or without an assistive device; joined voluntarily or with persuasion; and undertook weekly leisure activities, such as Karaoke, to maintain their independence. Salon activities were supported by middle-aged welfare volunteers (Minseiin) commissioned by the Minister for Health and Welfare to provide private voluntary welfare services, including support, for older people.

We carried out a prospective controlled trial between February 2004 and August 2005 to identify an effective program for the target population. We then implemented a modified program based on the results of the trial until March 2014. All staff members involved in the study worked at a community orthopedic hospital in the city.

A local institutional review board approved the protocols for the prospective controlled trial and the retrospective analyses in the entire study individually. In the prospective controlled trial, only those who provided written informed consent participated in the trial, but we provided fall prevention programs regardless of study participation.

Prospective controlled trial (2004–2005)

In 2004, we carried out a prospective non-randomized controlled trial involving 24 salons. Participants included older people who gathered at the salons. After obtaining salon representatives’ permission to implement the programs for research purposes, we proposed two programs that would not disrupt salon activities: a single-visit program and a year-round program (Table 1). Both programs were delivered by a multidisciplinary team, and involved a core component consisting of comprehensive fall risk assessment with feedback and a fall prevention lecture. The year-round program was more comprehensive than the single-visit program (details are described in Appendix SI). We asked the representatives whether the salons would like to receive one of the programs. If they expressed an interest in participation, we asked them to choose a program according to the salon’s annual schedule. As a result, eight and 16 salons chose the single-visit and year-round programs, respectively. We implemented the chosen programs as salon activities.

The number of falls that occurred during the 1-year trial period was the primary outcome measure. The definition of fall was as follows: “unintentionally coming to rest on the ground, floor or other lower level; excludes coming to rest against furniture, a wall or another structure.” Participants’ falls were monitored by monthly fall calendars. Participants provided daily records of falls on prepaid postcards printed on fall calendars, which were posted to the researchers each month. If the calendar was not returned, a trial assistant contacted the participant by telephone within 10 days. When a fall was reported, the participant was contacted to confirm the fall and obtain details regarding precise circumstances and injuries.

Among the measures in the comprehensive risk assessment (Table 1), musculoskeletal pain, the Frenchay Activities Index, the Mini-Mental State Examination, fear of falling, the Geriatric Depression Scale – Short Form, body mass index, grip strength, the Timed Up & Go Test, the functional reach test, the one-leg standing test and the calcaneal speed of sound were reassessed as secondary outcomes at post-intervention evaluation (Appendix SI). Sample size estimation for the trial is presented in Appendix SII.

Implementation of a modified program (2005–2014)

The year-round program failed to show definite superiority over the single-visit program in reducing falls. Surprisingly, fall rates decreased over time regardless of program type. We obtained these findings using traditional statistics and selected the single-visit program as the basis of a new intervention, because it showed superior feasibility. We added the home-based exercise menu used in the year-round program to the new program, as there is considerable evidence of positive outcomes with exercise, and the prospective controlled trial results favored the year-round program, which involved exercise. We also added rhythm exercises to increase exercise intensity and enjoyment. We then implemented a third program, the modified single-visit program (Table 1), in salons on demand from 2005 to 2014.

Regarding outcomes, we did not collect prospective fall data during the implementation phase. Instead, we asked participants how many times they had fallen in the preceding year, as an index of fall risk for each class attendance.

Analysis

In the prospective trial, a negative binomial regression analysis was carried out to identify differences in fall reduction effects between programs. In addition to program type, the following covariates were selected based on widely known risk factors: age, sex, fall history in the preceding year, number of medications, mobility (use of a walking aid), musculoskeletal pain, cognitive function (Mini-Mental State Examination), depression (Geriatric Depression Scale – Short Form), body mass index and...
Table 1 Fall prevention programs in the study

| Core components of the programs |  
| Multidisciplinary team | A physiatrist, physical therapists, an occupational therapist, physical trainers, a nurse, a dietitian and assistants  
| Fall risk assessment | Basic health measures  
• Medical history  
• No. falls in the preceding year  
• Medications  
• Use of assistive devices  
• Exercise habits  
• Musculoskeletal pain†  
• Frenchay Activities Index†  
*Cognitive and psychological measures*  
• Mini-Mental State Examination†  
• Fear of falling†  
• Geriatric Depression Scale – Short Form†  
*Physical measures*  
• Body mass index†  
• Grip strength†  
• Timed Up & Go Test†  
• Functional reach test†  
• One-leg standing test†  
• Calcaneal quantitative ultrasound†  
(Several items were optional in the modified single-visit program)  
| Feedback | Written individualized feedback was provided for each participant.  
| Fall prevention education | Lecture on fall risk factors and their modification. The meaning of each assessment in the program was also presented.  

### Specific components of each program

| Name of the program | Single-visit program | Year-round program | Modified single-visit program |
|---|---|---|---|
| **Frequency of visits** | Once per year | Every 3 months | Once per year |
| Exercises | None | Stretching  
Half squats  
Figure 8 exercises  
One-leg stands  
Regular walking | Stretching  
Half squats  
Figure 8 exercises  
One-leg stands  
Regular walking |
| **Modification of environmental risks** | None | Lecture on environmental fall risks and their modification | None |
| **Nutritional improvements** | None | Lecture on appropriate nutrition for older people including vitamin D and calcium | None |
| **Other** | None | Each participant received a pedometer and a fall prevention diary, in which they could record one-sentence entries, exercise menus, and the number of steps taken daily. | None |

†Secondary outcome measures in the prospective controlled trial.
We included the Frenchay Activities Index as the covariate for activity level, as high activity could be associated with increased fall risk. We also analyzed changes in fall rates over time using monthly fall data through multilevel, mixed-effects, negative binomial regression models, with participants and salons treated as random effects. We added months and the interaction between programs and months to the model. Monthly mean temperature was also added to the model to exclude the effects of colder climate on fall occurrence, as the months during which the program began varied between salons. Baseline and secondary outcome measures were compared between programs, and pre-post comparisons for each program were analyzed. Pearson’s $\chi^2$-test and McNemar’s test were used to assess categorical variables; $t$-tests and paired $t$-tests, and Wilcoxon rank-sum and signed-rank tests were used to assess parametric and non-parametric variables, respectively.

In the entire study, the number of participants, average attendance frequency, number of attendants and number of salon requests throughout the study period were analyzed. To determine whether the number of falls in the preceding year decreased as the number of class attendances increased, we produced multilevel, mixed-effects, negative binomial regression models, with salons and participants treated as random effects. The covariates were age at each attendance, sex, initial program type (i.e. single-visit, year-round or modified single-visit program), number of attendances, and the interaction between initial program type and number of attendances.

**Results**

**Effectiveness of the programs in the prospective controlled trial**

Of the 625 community-dwelling older people who gathered at salons at the commencement of the study, 603 (approximately 4% of the city’s older population, mean age 73.1 ± 7.3 years) participated in the trial. Single-visit and year-round programs were delivered to 185 and 418 participants, respectively (Fig. 1). As for the baseline comparison shown in Table 2, fall rates and proportions of fallers in the preceding year did not differ significantly between programs, but year-round program participants were slightly older and had poorer balance (as shown by the Timed Up & Go test, functional reach test and one-leg standing) relative to those in the single-visit program.

There were 56 falls in 177.0 person years in the single-visit program and 116 falls in 398.7 person years in the year-round program. Detailed statistics for falls in each program are shown in Table S1. An adjusted negative binomial regression analysis showed no significant differences between programs (incident rate ratio = 0.84, 95% CI 0.54–1.32). After excluding the interaction term (program × month), as it was non-significant ($P = 0.507$), a multilevel, mixed-effects, negative binomial regression analysis of monthly fall data showed that fall rates did not differ significantly between programs ($P = 0.317$). Instead, fall rates for both programs decreased significantly by 0.89 (95% CI 0.84–0.94) times each month. This represents a 43.0% reduction in the mean fall rate over the trial period. Other significant covariates are shown in Table 3.

We assessed secondary outcome measures during post-intervention evaluations for 108 (58.4%) single-visit and 245 (58.6%) year-round program participants (Table 4). Interestingly, the number of participants with musculoskeletal pain and numerical rating-scale pain scores decreased significantly in both programs from baseline to post-intervention evaluation. Participants’ Mini-Mental State Examination scores, body mass index, grip strength, functional reach test scores and quantitative ultrasounds of the calcaneus differed significantly between programs at post-intervention evaluation and within programs in pre- and post-intervention comparisons. However, these differences were very small; therefore, their clinical meaning was inconclusive. Overall, physical and psychological indices were stable and well preserved throughout the trial for both programs.
Table 2  Comparison of participants’ baseline demographic characteristics between groups

| Characteristics                                      | Overall (n = 603) | Single-visit program (n = 185) | Year-round program (n = 418) | P-value |
|------------------------------------------------------|-------------------|-------------------------------|----------------------------|---------|
| Age (years)‡                                         | 73.1 ± 7.3        | 72.0 ± 7.1                    | 73.6 ± 7.4                  | 0.013   |
| Sex, female/male (% female)‡                          | 502/101 (83.3)    | 171/14 (92.4)                 | 331/87 (79.2)               | <0.001  |
| Incidence rate for falls in the preceding year, person years (95% confidence interval)§§ | 0.61 (0.47–0.79)  | 0.56 (0.39–0.81)              | 0.63 (0.45–0.88)            | 0.666   |
| Fallers in the preceding year, n (%)§§               | 153 (25.4)        | 49 (26.5)                     | 104 (24.9)                  | 0.676   |
| Multiple fallers in the preceding year, n (%)§§      | 80 (13.3)         | 26 (14.1)                     | 54 (13.0)                   | 0.705   |
| Past fall-related fractures, n (%)§§                 | 98 (16.3)         | 31 (16.8)                     | 67 (16.0)                   | 0.823   |
| No. medications†                                     | 2 (0–3)##         | 1 (0–3)                       | 2 (0–4)##                   | 0.059   |
| Use of osteoporosis medication, n (%)§§              | 52 (8.7)##        | 17 (9.2)                      | 35 (8.4)##                  | 0.761   |
| Use of a walking aid, n (%)§§                        | 30 (5.0)          | 7 (3.8)                       | 23 (5.5)                    | 0.371   |
| Regular exercise ≥1 week (%§§                        | 325 (54.2)##      | 102 (55.1)                    | 223 (53.7)##                | 0.751   |
| Musculoskeletal pain, n (%)§§                        | 278 (46.3)##      | 98 (53.0)                     | 180 (43.4)##                | 0.029   |
| Numeric rating scale for pain (range 0–10)¶¶         | 0 (0–4)##         | 2 (0–4)                       | 0 (0–4)¶¶                   | 0.041   |
| Frenchay Activities Index (range 0–45)¶¶            | 30 (24–34)##      | 30 (24–34)##                  | 30 (24–33)§§§              | 0.706   |
| Mini-Mental State Examination (range 0–30)¶¶         | 25 (24–28)##      | 26 (24–27)##                  | 25 (23–28)##††              | 0.564   |
| Fear of falling, n (%)¶††                            | 353 (58.7)††      | 112 (60.5)                    | 241 (57.9)††                | 0.549   |
| Geriatric Depression Scale – Short Form (range 0–15)¶| 4 (2–6)¶          | 4 (2–6)¶                      | 4 (2–6)§§§                  | 0.731   |
| Body mass index (kg/m²)†                              | 23.7 ± 3.3        | 23.8 ± 3.5                    | 23.6 ± 3.2                  | 0.335   |
| Grip strength, average of right and left (kg)†       | 21.4 ± 6.8        | 21.3 ± 5.9                    | 21.4 ± 7.2                  | 0.848   |
| Timed Up & Go Test (s)†                               | 9.6 ± 2.5         | 9.0 ± 2.2                     | 9.9 ± 2.5                   | <0.001  |
| Functional reach test, average of right and left (cm)†§ | 29.9 ± 7.5§§      | 31.0 ± 6.9‡‡                   | 29.4 ± 7.7‡‡                | 0.015   |
| One-leg standing (s), average of right and left (range 0–180)¶ | 14.5 (4.7–42.3)‡† | 20.0 (6.0–55.9)               | 13.2 (4.3–39.3)‡†           | 0.040   |
| Calcaneal ultrasound bone densitometry, speed of sound (m/s)† | 1483.9 ± 22.4 | 1479.5 ± 21.2 | 1485.8 ± 22.7 | 0.002 |

Parametric test results are presented as mean ± SD. Non-parametric test results are presented as medians (interquartile range). Categorical data are presented as counts of participants (proportions). ‡Unpaired t-test; ‡χ²-test; §estimated from negative binomial regression with dispersion as mean, using robust estimators of variance; ¶Wilcoxon rank–sum test. Observations missing for #1, ††2, ‡‡3, §§4, †¶5, ‡¶6, ‡‡¶7, ††¶8, ‡‡¶9, ††¶10, ‡‡¶11, §§¶13, †¶16 and aaaa20.

In the year-round program, 180 participants (43.1%) attended all of the classes, and each participant attended 2.9 classes on average. Exercise compliance was monitored through participants’ diaries for over 70.6% of the total trial period. On surveyed days, over 81.6% of diaries were completed, and participants exercised for 2.7 days per week on average. No intervention-related adverse events were reported.

Long-term effectiveness of the programs

Including those in the prospective controlled trial, the program was offered to 1863 individuals (392 men, 1471 women; mean age at the first attendance 72.6 ± 7.4 years). After excluding the interaction term (initial program type × number of attendances), as it was non-significant (P = 0.220), a multilevel, mixed-effects, negative binomial regression model showed that the fall rates in the preceding year decreased significantly as the number of class attendances increased (incident rate ratio = 0.89, 95% CI 0.85–0.92; P < 0.001). Fall rates did not differ significantly between initial program types (year-round and single-visit programs, P = 0.738; modified single-visit and single-visit programs, P = 0.144).

Long-term acceptability

Average attendance frequency, or total number of attendances divided by the time between initial participation and the end of March 2014 (6.5 ± 3.2 years on average), was 0.62 per year (joining several year-round program classes was counted as one attendance). The number of attendants who joined each year remained almost unchanged throughout the study, with 6622 attendants, including those in the year-round program, as at March 2014. The number of salons in the city had increased to 37 in 2014. On average, 85.3% (30.2) of salons requested the program annually.
Table 3  Incident rate ratios for fall rates for each covariate in a negative binomial regression model and a multilevel, mixed-effects, negative binomial regression model

| Covariates                                      | Negative binomial regression† | Multilevel, mixed-effects, negative binomial regression‡ |
|-------------------------------------------------|------------------------------|--------------------------------------------------------|
|                                                  | IRR  95% CI P-value          | IRR  95% CI P-value                                     |
| Year-round program (over single-visit program)  | 0.84 0.54–1.32 0.449         | 0.82 0.51–1.32 0.404                                   |
| Age                                             | 1.01 0.98–1.04 0.474         | 1.01 0.97–1.05 0.634                                   |
| Female (over male)                              | 0.99 0.54–1.80 0.965        | 0.92 0.48–1.77 0.806                                  |
| History of a fall(s) in the preceding year      | 2.92 2.14–3.97 <0.001        | 3.22 2.06–5.03 <0.001                                 |
| No. medications                                 | 1.14 1.01–1.28 0.033        | 1.16 1.04–1.30 0.007                                  |
| Use of a walking aid                            | 3.00 1.27–7.06 0.012        | 2.81 1.12–7.01 0.027                                  |
| Musculoskeletal pain                            | 1.48 0.83–2.65 0.183        | 1.48 0.95–2.31 0.086                                  |
| Frenchay Activities Index (/10 points)          | 1.37 1.08–1.74 0.010        | 1.40 0.95–2.07 0.090                                  |
| Mini-Mental State Examination                    | 1.04 0.97–1.11 0.268        | 1.05 0.96–1.14 0.281                                  |
| Geriatric Depression Scale – Short Form         | 1.04 0.94–1.15 0.439        | 1.04 0.95–1.13 0.375                                  |
| Body mass index                                 | 2.16 0.89–5.28 0.090        | 1.81 0.71–4.61 0.211                                  |
| Underweight (<18.5)                             | 1.22 0.69–2.15 0.491        | 1.12 0.67–1.85 0.667                                  |
| Overweight (≥25)                                | 0.89 0.44–1.79 0.736        | 0.99 0.36–2.70 0.983                                  |
| Obese (≥30)                                     | 0.97 0.87–1.08 0.557        | 0.98 0.88–1.10 0.748                                  |
| Timed Up & Go Test (s)                          | 0.89 0.84–0.94 <0.001       | 1.26 1.00–1.59 0.048                                  |
| Trend of fall rate over a month                 |                              |                                                        |
| Temperature (/10 °C decrease)                   |                              |                                                        |

†Model with dispersion as a function of the expected mean. Clustered according to the salons and adjusted according to observation period for each participant. ‡Salons and participants treated as random effects; model with dispersion as a function of the expected mean. §Mean monthly temperatures ranged from 3.6 to 28.2 °C during the trial period. CI, confidence interval; IRR, incident rate ratio.

Discussion

Three programs including fall risk assessment with feedback and a fall prevention lecture as the core components were proven to be effective on reducing falls in the present study. The 43% reduction in the fall rate within a year observed in the prospective trial is comparable with the outcomes of intensive interventions. For example, in a randomized controlled trial involving a similar analytical method to that used in the present study, Taylor et al. found that exercises, such as Tai Chi, reduced fall rates by 58% over 18 months. A systematic review showed that even modest interventions, consisting predominantly of assessment and referral or information provision, could reduce fall rates. Furthermore, some reports have shown that health-related screening alone could prevent falls. Considering these reports, it is unsurprising that the fall prevention lecture might have enhanced the intervention’s effects.

There were differences in both content and frequency between the programs besides the core components (Table 1). In particular, the year-round program interventions were more comprehensive relative to that of the single-visit program. The results favored the year-round program, even though the participants in the year-round program were slightly older and had poorer balance than those in the single-visit program, and thus would have had a higher risk for falls. However, the between-program difference in fall reduction did not reach statistical significance, even after adjusting various covariates including age and balance. There are two possible reasons for this finding. First, the increased frequency and intensity of interventions in the year-round program could have been insufficient to produce a significant additive effect on fall reduction. The observation of only subtle differences between the programs in secondary outcome measures supports this explanation. Second, it is possible that the trial was underpowered. In the sample size estimation (Appendix SII), we hypothesized that the effect of the 3-day program would be very subtle. Therefore, the difference between the programs was smaller than expected. Thus, we could not draw a conclusion as to whether interventions other than those involving the core components exerted favorable effects on fall reduction.

In addition to program content, setting is a very important determinant of an intervention’s success. Social support is particularly important in community interventions. Perceived peer support, described as social support from individuals of a similar age and background, is known to exert a major influence on physical activity participation.
Table 4  Pre- and post-intervention comparisons of secondary outcomes within and between programs

| Characteristics                  | Overall (n = 353) | Single-visit program (n = 108) | Year-round program (n = 245) | Between programs | Within program (pre vs. post) | P-value |
|----------------------------------|-------------------|--------------------------------|-------------------------------|------------------|------------------------------|---------|
| Musculoskeletal pain, n (%)†‡   | 172 (48.9)        | 62 (57.4)                      | 110 (45.1)                    |                  |                              | <0.001  |
| Numeric rating scale for pain (range 0–10)#, †† | Pre: 0 (0–4)§§ | 2 (0–4.5)                       | 0 (0–4)§§                     |                  |                              | <0.001  |
| Frenchay Activities Index (range 0–45)#, †† | Pre: 30 (25–34)§§ | 30 (25–34)§§                   | 30.5 (25–34)§§                |                  |                              | <0.001  |
| Mini-Mental State Examination (range 0–30)#, †† | Pre: 26 (24–28)‡‡ | 26 (24–28)‡‡                    | 25.2 (24–28)§§                |                  |                              | 0.033   |
| Fear of falling, n (%)†‡         | 207 (58.6)        | 63 (58.9)                      | 144 (58.8)                    |                  |                              | 0.938   |
| Geriatric Depression Scale–Short Form (range 0–15)#, †† | Pre: 4 (2–6)‰‰ | 4 (2–6)‰‰                      | 4 (2–6)‰‰                     |                  |                              | 0.842   |
| Body mass index (kg/m²)§, ¶ | Pre: 23.8 ± 3.2  | 24.2 ± 3.4                      | 23.6 ± 3.2                    |                  |                              | 0.118   |
| Grip strength, average of right and left (kg)§, ¶ | Pre: 21.9 ± 6.5 | 21.5 ± 5.5                      | 22.1 ± 6.9                    |                  |                              | 0.123   |
| Timed Up & Go Test (s)# | Pre: 9.3 ± 2.3 | 9.0 ± 2.5                       | 9.5 ± 2.3                     |                  |                              | 0.032   |
| One-leg standing (s), average of right and left (range 0–180)§ | Pre: 12.5 ± 15.6 | 15.8 ± 15.7                      | 14.3 ± 15.6                   |                  |                              | 0.058   |
| Calcareous bone density (speed of sound m/s)§ | Pre: 1491 ± 236 | 1484 ± 232                      | 1492.7 ± 233                  |                  |                              | 0.022   |

Parametric variables are presented as mean ± SD. Non-parametric variables are presented as medians (interquartile range). Categorical data are presented as numbers of participants (proportions). The χ²-test; McNemar’s test; unpaired t-test; paired t-test; Wilcoxon signed-rank test. Observations missing for †‡1, §§2, ¶¶3, ##4, †††5, ‡‡‡6, §§§7. 

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This was one of the strengths of our intervention, because the programs were introduced and embedded within existing social structure, and as salon members, participants were already connected socially. Furthermore, welfare volunteers could play an important role in encouraging participants, enhancing group social cohesion, and bridging the gap between staff and older participants. In the year-round program, we ascertained that participants were able to maintain the habit of keeping a diary over a substantial period. This somewhat surprising finding might not be observed with only a few professional visits. This behavioral modification, which could play a key role in fall reduction, was led mainly by community support.

The programs were well accepted by the community. Almost all of the older people who gathered at salons participated in the program. Those who participated in the program once attended 0.62 times, on average, annually thereafter, and the majority of salons requested the program every year. Furthermore, the finding showing that approximately 4% of the older population of the city participated in the program annually was meaningful.

With respect to feasibility, the single-visit program and modified single-visit program were more feasible in frequency than the year-round program. At least, the modified single-visit program might be feasible as a community-based program, because it was provided for the long term without cessation, even though it was heavily dependent on the involvement of volunteers from the community hospital.

Considering the factors discussed above, we propose that an appropriate community-based fall prevention model should include annual risk assessment and feedback with a lecture on fall prevention, and should be embedded in the existing community structure. Components other than the core components, such as exercise, might be added and the frequency of program visits might be increased depending on the usable resources.

The study’s weaknesses were that the intervention’s effect on fall prevention was not examined in the entire community, and a cost-effectiveness analysis was not carried out. Despite these weaknesses, the effectiveness, feasibility and acceptability of the programs were confirmed in a real community structure over 10 years.

Other populations or communities might benefit from our program. Based on grip strengths, the present study population was frailer relative to the general population (mean grip strength in our trial sample was 21.4 kg, whereas that in women and men in the same age range were 23.1 kg and 36.1 kg, respectively in a national survey carried out during the same year); therefore, the program could be implemented for other independent but somewhat frail individuals. Also, in 2014, there was approximately one salon with 2.4 welfare volunteers per 304 older people in Gunma prefecture, in which Tatebayashi City is located. Our program could easily be extended by the regional healthcare providers to those salons or similar seniors centers in other regions and countries.

The study’s success implies that fall prevention programs established within existing community structures could be of substantial benefit because of the valuable support provided by the community. In turn, social cohesion within the community could be enhanced through the establishment of community-based programs. In the future, to reduce costs and to reach more people, the role of healthcare professionals should instead be to support older people and/or non-professional volunteers to establish fall prevention programs by and for the community.

In conclusion, fall risk assessment with feedback and a fall prevention lecture reduced falls when embedded into the community and was accepted well over the course of 10 years.

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Disclosure statement

The authors declare no conflict of interest.

References

1 Tinetti ME, Speechley M, Ginter SF. Risk factors for falls among elderly persons living in the community. N Engl J Med 1988; 319: 1701–1707.
2 Campbell AJ, Borrie MJ, Spears GF, Jackson SL, Brown JS, Fitzgerald JL. Circumstances and consequences of falls experienced by a community population 70 years and over during a prospective study. Age Ageing 1990; 19: 136–141.
3 Rubenstein LZ, Josephson KR. The epidemiology of falls and syncope. Clin Geriatr Med 2002; 18: 141–158.
4 Peel NM, Kassulke DJ, McClure RJ. Population based study of hospitalised fall related injuries in older people. Inj Prev 2002; 8: 280–283.
Community-based fall prevention program

5 Center for Disease Control and Prevention. Web-based Injury Statistics Query and Reporting System (WISQARS) [Cited 19 Nov 2015] Available from: http://www.cdc.gov/injury/wisqars.
6 Keene GS, Parker MJ, Pryor GA. Mortality and morbidity after hip fractures. *BMJ* 1993; **307**:1248–1250.
7 Stevens JA, Corso PS, Finkelstein EA, Miller TR. The costs of fatal and non-fatal falls among older adults. *Inj Prev* 2006; **12**:290–295.
8 Gillespie LD, Robertson MC, Gillespie WJ *et al*. Interventions for preventing falls in older people living in the community. *Cochrane Database Syst Rev* 2012; **9** CD007146.
9 Rothwell PM. External validity of randomised controlled trials: “to whom do the results of this trial apply?”. *Lancet* 2005; **365**:82–93.
10 Wagner EH, LaCroix AZ, Grothaus L *et al*. Preventing disability and falls in older adults: a population-based randomized trial. *Am J Public Health* 1994; **84**:1800–1806.
11 Hornbrook MC, Stevens VJ, Wingfield DJ, Hollis JF, Greenlick MR, Ory MG. Preventing falls among community-dwelling older persons: results from a randomized trial. *Gerontologist* 1994; **34**:16–23.
12 Day L, Fildes B, Gordon I, Fitzharris M, Flamer H, Lord S. Randomised factorial trial of falls prevention among older people living in their own homes. *BMJ* 2002; **325**:128.
13 Glasgow RE, Lichtenstein E, Marcus AC. Why don’t we see more translation of health promotion research to practice? Rethinking the efficacy-to-effectiveness transition. *Am J Public Health* 2003; **93**:1261–1267.
14 Tinetti ME, Baker DI, King M *et al*. Effect of dissemination of evidence in reducing injuries from falls. *N Engl J Med* 2008; **359**:252–261.
15 McClure R, Turner C, Peel N, Spinks A, Eakin E, Hughes K. Population-based interventions for the prevention of fall-related injuries in older people. *Cochrane Database Syst Rev* 2005 CD004441.
16 Schooler C, Farquhar JW, Fortmann SP, June A, Flora JA. Synthesis of findings and issues from community prevention trials. *Ann Epidemio* 1997; **75**:S54–658.
17 Buchner DM, Hornbrook MC, Kutsner NG *et al*. Development of the common data base for the FICSIT trials. *J Am Geriatr Soc* 1993; **41**:297–308.
18 Guideline for the prevention of falls in older persons. American Geriatrics Society, British Geriatrics Society, and American Academy of Orthopaedic Surgeons Panel on Falls Prevention. *J Am Geriatr Soc* 2001; **49**:664–672.
19 Nevitt MC, Cummings SR, Kidd S, Black D. Risk factors for recurrent nonsyncopal falls: a prospective study. *JAMA* 1989; **261**:2663–2668.
20 Tinetti ME, Kumar C. The patient who falls: “It’s always a trade-off.”. *JAMA* 2010; **303**:258–266.
21 Rubenstein LZ, Josephson KR. Interventions to reduce the multifactorial risks for falling. In: Masdeu JC, Sudarsky L, Wolfson L, eds. *Gait Disorders of Aging Falls and Therapeutic Strategies*. Philadelphia: Lippincott-Raven, 1997; 309–326.
22 Rubenstein LZ, Josephson KR, Trueblood PR *et al*. Effects of a group exercise program on strength, mobility, and falls among fall-prone elderly men. *J Gerontol A Biol Sci Med Sci* 2000; **55**:M317–M321.
23 Campbell AJ, Spears GF, Borrie MJ, Fitzgerald JL. Falls, elderly women and the cold. *Gerontology* 1988; **34**:205–208.
24 Stevens JA, Thomas KE, Sogolow ED. Seasonal patterns of fatal and nonfatal falls among older adults in the U.S. *Accid Anal Prev* 2007; **39**:1239–1244.
25 Taylor D, Hale L, Schluter P *et al*. Effectiveness of tai chi as a community-based falls prevention intervention: a randomized controlled trial. *J Am Geriatr Soc* 2012; **60**:841–848.
26 Carpenter GL, Demopoulos GR. Screening the elderly in the community: controlled trial of dependency surveillance using a questionnaire administered by volunteers. *BMJ* 1990; **300**:1253–1256.
27 Barr RJ, Stewart A, Torgerson DJ, Seymour DG, Reid DM. Screening elderly women for risk of future fractures--participation rates and impact on incidence of falls and fractures. *Calcif Tissue Int* 2005; **76**:243–248.
28 Rhodes RE, Martin AD, Taunton JE, Rhodes EC, Donnelly M, Elliot J. Factors associated with exercise adherence among older adults: an individual perspective. *Sports Med* 1999; **28**:397–411.
29 e-Stat. Portal Site of Official Statistics of Japan. [Cited 19 Nov 2015] Available from: http://www.e-stat.go.jp.
30 GunmaCouncilSocialWelfare. Gunma Council Social Welfare. [Cited 19 Nov 2015] Available from: http://www.g-shakyo.or.jp (in Japanese).

**Supporting information**

Additional supporting information may be found in the online version of this article at the publisher’s web site.

**Appendix SI**. Details of the programs

**Appendix SII**. Sample size estimation for the prospective controlled trial

**Table S1**. Falls and fall-related injuries for each program during the prospective controlled trial