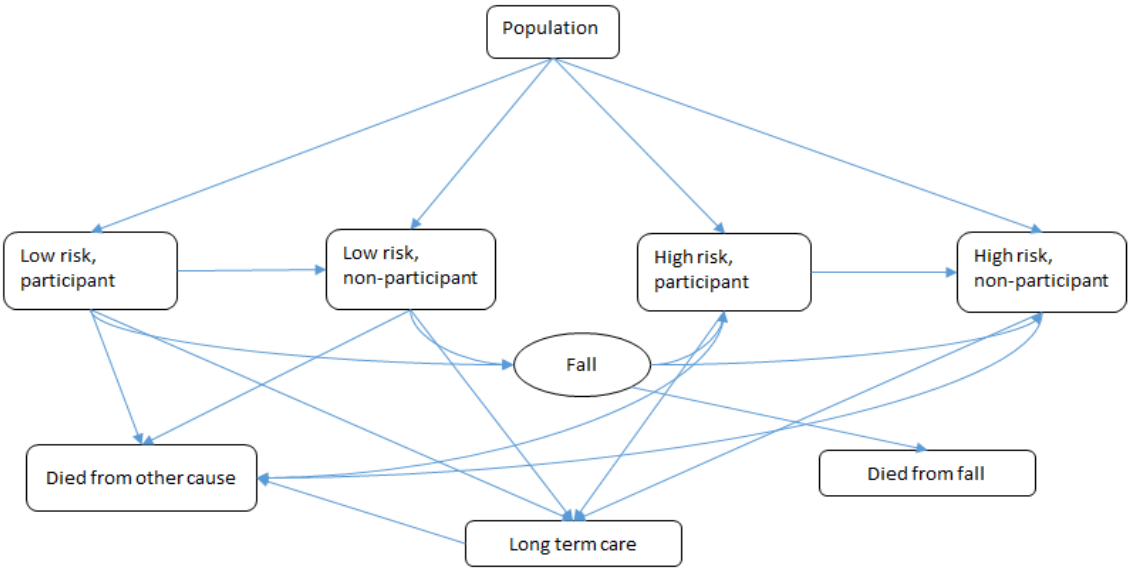
Online Supplementary Appendix

Additional methods

Figure A1: States in the fall prevention model (with the high-risk group having had an injurious fall in the previous five years)



Health gain measure

The QALY metric is a composite measure capturing both years of life lost from premature mortality and quality of life lost from morbidity. The morbidity component of this measure (i.e., an injurious fall), used health status valuations extracted from the Global Burden of Disease (GBD) Study (pair-wise comparison methodology), and adjusted for New Zealand[1 2] (see further details of the GBD below). The model was parameterised with the underlying population mortality and morbidity using life-tables, with average prevalent years of life lived in disability (YLD) for each of the cohort subpopulations extracted from the New Zealand Burden of Disease Study.[3] QALYs were cumulatively tallied until death, transition to residential care or 90 years of age for the modelled cohort.

The disability weights from the GBD Study can be considered theoretically interchangeable with utility weights (e.g., from a source such as the EuroQol). Also the value of using GBD values is particularly enhanced by the following points:

- It is by far the largest such survey of weights ever conducted and it continues to expand in sample size. The first study[4] had 13,902 participants in the household surveys (4 developing countries and the USA – which had the largest number of participants) and the 16,328 participants in the web survey. The later included respondents from 167 countries – including New Zealand, Australia, Canada, and various European and Scandinavian countries. Since the first study a second GBD study[5] expanded the sample from the first surveys (30,230 respondents) with an additional 30,660 from new European surveys (Hungary, Italy, the Netherlands, and Sweden).

- From a methods point of view, strengths of the GBD work include the analysis of paired comparison responses with probit regression analysis on all 220 unique states in the study.[4] Also the results were anchored on the necessary scale (from zero to one) by the respondents being asked additional questions to compare the health benefits of different life-saving or disease-prevention programmes. Such anchoring should help make the GBD results of reasonable equivalence to previous work estimating utilities using time trade-off methods.

The key utility value used for a fall injury was a disability weight (DW) of 0.10 with an uncertainty range of 0.06 to 0.15, which was based on GBD Study data.[2] It was assumed that each injurious fall accrued a disability weight for a fracture of 0.3 (neck of femur), applied for a four-month period. This is equivalent to an annual disability weighting of 0.1. We acknowledge this is a simplifying assumption that does not capture the heterogeneity of different injuries that occur (e.g., with DWs from the GBD ranging from: a sprain [0.009]; hand fracture [0.025], clavicle/scapula/humerus fracture [0.053], neck of femur fracture [0.308], and for a fractured pelvis [0.39]. We note the wide UI (0.06 to 0.15) captures this. But we did not include accounting for long-term (post one-year) disability – even though this may be notable in some cases (e.g., 0.194 for fractured pelvis). We also did not consider anxiety associated with fear of falling (which appears to be modified by some exercise interventions[6]).

Heterogeneity and equity analyses

To assess heterogeneity, analyses by demographic group were conducted to determine differential health gains, net costs and cost-effectiveness for Māori and non-Māori ethnic groups, as well as for men and women. As per standard BODE[3] approaches, equity analyses were conducted (Māori versus non-Māori ethnicity and by men and women, by setting the ethnic- and sex-specific background and disease parameters for Māori (higher background mortality and morbidity) to those of non-Māori and for men (higher background mortality and morbidity) to those of women.[7]

Transition probabilities and rates

Fall rates and probability of death from injurious falling for the target population, and those who had sustained a previous injurious fall, were obtained from official hospitalisation data (HealthTracker).[8] The probability of receiving primary health care (including physiotherapy) after an injurious fall was extracted from the official accident compensation claims register (held by the Accident Compensation Corporation [ACC]). The probability of death from other causes was extracted from projected life-tables for New Zealand.[9] Census data were used to determine the probability of moving into residential aged care facilities. As allowing uncertainty around each of the 20 age-group/sex/ethnicity parameters individually was not feasible, a scalar was used for each model parameter across population characteristics. The scaler was modelled with a normal distribution ranging from 0.5 – 1.5.

Health system costs

Costs of primary health care and hospitalisation following an injurious fall, and cohort-specific average population health care costs, were determined from the hospitalisation and accident claim registries referred to above. Both of these administrative sources cover all the key public health system costs, including costs of publicly-funded pharmaceuticals. The specific tabulated costs by age/sex group are shown in the Appendix of the previous study by Pega et al 2016.[10] Heterogeneity of these health system costs was determined by cohort (age, sex, and ethnicity) and uncertainty, using a range of 0.5 to 1.5. This uncertainty scalar was sampled from this range, which had a normal distribution with mean 1.0 and standard deviation of 0.26. The unit of currency for analysis was the New Zealand dollar, with all values adjusted to year 2011 values. However, we converted some of the NZ$ values to US$ for comparative purposes, using the Organisation for Economic Co-operation and Development 2011 benchmark purchasing power parity of 1.486.[11]

Intervention costs

Cost inputs were sourced from programmes that have been used in a New Zealand setting (see Table A2 for details). For peer-led group-exercise programme, the "Steady As You Go" (SAYGO) Programme, based on the Otago Exercise Programme (OEP), was used. This is a peer-run weekly exercise class for adults aged 65 years and over. Annual costs per participant were provided by the executive director of Age Concern Otago (Personal communication from Age Concern Otago). In addition, transport costs were calculated using Ministry of Health and New Zealand Transport Authority protocols.[12 13]

For the home-based exercise programme, the cost of the OEP was used. This is a physiotherapy-based exercise programme tailored to older adults by a nurse specialist. The programme has previously been promoted by ACC.[14-16] There are home visits at weeks 1, 2, 4 and 8, followed by another home visit at six months. Cost inputs were calculated from detailed costing provided in RCTs examining the OEP.[14 16 17]

Table A1: Parameter inputs for modelling exercise interventions for preventing falls in the New Zealand population aged 65 years and older

Parameter	Comment	Trend, uncertainty and any scenario analyses. (Standard BODE[3] methods apply, extra detail is included in the BODE[3] Study Protocol[1])
Demographic characteristics		
Population	Statistics New Zealand (SNZ) estimates for 2011 by sex, age-group and ethnicity.	Nil
All-cause mortality rates	SNZ mortality rates by age, sex and ethnicity	Annual declines of 2.25% and 1.75% were modelled for Māori and non-Māori all-cause mortality rates respectively (see BODE[3] Protocol and related work[18]). Trends were modelled out to 2026 with 0% per annum decline for both ethnic groupings thereafter. *Uncertainty:* nil.
Total morbidity per capita in 2011	The per capita rate of years of life lived with disability (YLD) from the NZ Burden of Disease Study[19] by age, sex and ethnicity.	No trend (i.e., assumed constant into the future).
Transition to residential aged care facilities	Those participants who transition to residential aged care facilities were treated as having exited the programme. For extra details see the Appendix in Pega et al 2016.[10]	No trend (i.e., assumed constant into the future).
Injury epidemiology characteristics		
Annual probability of injurious fall	ACC claims registry data provided to BODE[3]. In those with no previous injurious falls (in the past five years), the annual probability ranged from 5% (Māori men aged 65-69 years), to 36% in non-Māori women (aged 85+). In those with a past history of falls the annual probability was 65% to 70% for all age/ethnic groups.	*Uncertainty:* Log-normal with scalar (ranging from 0.5 to 1.5 of the point estimate). For extra details see the Appendix in Pega et al 2016.[10]
Probability of hospitalisation after an injurious fall	ACC claims registry data provided to BODE[3]. The probability ranged from 5% (non-Māori men aged 65-69 years), to 17% in Māori men (aged 85+).	As above.
Probability of death after an injurious fall	ACC claims registry data provided to BODE[3]. Range: 0% to 5% (highest in Māori men aged 65-69 years).	As above.
Morbidity from falls (disability	Disability weight for a fracture = 0.10 (annualised), based on Global Burden of Disease data.[4]	*Uncertainty interval (95%):* 0.06 to 0.15. We assumed that each injurious fall accrued the disability weight

Parameter	Comment	Trend, uncertainty and any scenario analyses. (Standard BODE[3] methods apply, extra detail is included in the BODE[3] Study Protocol[1])
weights)		for a fracture of 0.30 which was applied for a four-month period over the one year cycle.
Group exercise programme intervention		
Effectiveness of peer-led group-based exercise programmes	Data for effectiveness of group-based exercise programmes for falls prevention, were taken from the Cochrane meta-analysis by Gillespie et al.[20] **Effect size for reduction in falls rate: RR = 0.71,95%CI: 0.63 to 0.82. (As used in the modelling.)** For comparison, the effect size for reduction in falls risk was: RR = 0.85, 95%CI: 0.76 to 0.96 **Explanation:** The falls rate and risk refer to total falls, not injurious falls. The falls rate ratio was calculated from the rates of total number of falls per unit of person-time, in the intervention and control groups, over the time period that falls were monitored. The falls rate therefore indicates that those in a group-based exercise programme fell 29% less frequently than those in control groups. The falls risk, in comparison, is a binary outcome, calculated from the number of people who fell once or more – a group deemed 'fallers' by the Cochrane researchers – in the intervention and control groups. The falls risk therefore indicates that group-based exercise programmes reduce the risk of becoming a 'faller' by 15%. Given that the Cochrane effect sizes are for falls in general, and the model considers injurious falls by different intervention, the assumption that the rates are the same is covered in the *Discussion Section*.	The modelling assumed that the programme runs for a 25-year period without any changes to its effectiveness or cost. We assumed that the modelled cohort could potentially participate until either reaching the age of 90 years or dying. The uncertainties included in the 95%CI for the effect size from the Cochrane meta-analysis were included.
Starting participation	**Level of starting participation: 52% of eligible population** **Explanation:** A meta-analysis reports median participation in exercise programmes to prevent falls of 70.7%.[21] An evaluation of the SAYGO programme in NZ reported 52% participation.[22] The main analysis in this study assumed 52% eligible participation, given the NZ relevance.	Uncertainty of SD +/- 10% was added around this point estimate. Scenario analysis examining at which level of participation the intervention becomes cost-ineffective.
Decline in participation	**Decline in participation (at 12 months): 19.45%** **Explanation:** The initial withdrawal rate for group-exercise was based on two NZ studies that examined SAYGO. These studies had 12-month duration. Withdrawal rates were 15.9%[23] and 23%[22] at 12-months, which gives an average of 19.45%. The Cochrane review by Nyman and Victor reported a	Following the initial year, we assumed there was an exponential decay in subsequent participation, to a plateau point where at 10 years post initiation, 10% of the original cohort remain active participants.

Parameter	Comment	Trend, uncertainty and any scenario analyses. (Standard BODE[3] methods apply, extra detail is included in the BODE[3] Study Protocol[1])
	median annual attrition rate from community exercise programmes to prevent falls of 10%.[21] The average withdrawal rates from the NZ studies were used in the modelling.	
Commercial delivery of the group-based exercise programmes	For this intervention only the costing differed from the peer-led group intervention. That is, it was assumed that a fully commercial programme had the same effect on falls, participation and withdrawal rate as the peer-led one.	As per the peer-led one above.
Home-based exercise programme		
Home-based exercise programme for falls prevention	Data for effectiveness of a home-based exercise programme for falls prevention, as well as uncertainty parameters, were taken from the Cochrane meta-analysis by Gillespie et al. The same principles, described earlier, apply to the calculation of falls rate and risk.[20] **Effect size in reducing the falls rate: RR = 0.68, 95%CI: 0.58 to 0.80**	Uncertainties as per the 95% confidence interval from the Cochrane meta-analysis were included for the effect size.
Home-based exercise programme participation and withdrawal rates	**Reduction in participation by 12 months: 23.7%** **Explanation:** Initial withdrawal rates were also calculated from NZ-specific studies examining the OEP, from the intervention arm. Over 12-months, withdrawal rates were 17.4%[16] and 30%.[14] In another RCT, the withdrawal rate was not clear, but researchers had anticipated a 20% rate in their power calculation.[17] Averaging these first two rates gives 23.7%. An initial participation rate of 52% was again assumed for a home-based programme, with uncertainty of SD +/- 10% around this point estimate.	Following the initial year, there was an exponential decay on participation, to a point where at five years post initiation, 10% of the original cohort remain active participants. This lower figure (compared to the base-case) was chosen to reflect the likely importance of group dynamics for continued participation.

Table A2: Cost inputs for modelling exercise interventions for preventing falls in the New Zealand population aged 65 years and older

Parameter	Comment	Trends, uncertainty and any scenario analyses. (Standard BODE[3] methods apply, extra detail is included in the BODE[3] Study protocol[1])
Costs of non-hospital health care after falling (i.e., in primary health care)	ACC claims registry data provided to BODE[3].	*Uncertainty:* Log-normal with scalar (ranging from 0.5 to 1.5 of the point estimate).
Costs of hospitalisation after falling	ACC claims registry data provided to BODE[3].	*Uncertainty:* Log-normal with scalar (ranging from 0.5 to 1.5 of the point estimate).
Annual average population health system costs by age-group and sex	We used national health cost data from HealthTracker.[8] These data had to be scaled (by 1.21) to account for residual limitations with the comprehensiveness of national data. Proximity to death was accounted for (i.e., costs in the last six months of life) with these being scaled by 1.1 to 1.3 depending on age-group (to account for national data not containing certain end-of-life costs).	*Uncertainty:* Log-normal with scalar (ranging from 0.5 to 1.5 of the point estimate). *Heterogeneity:* Only by age and sex.
Group-based interventions		
Peer-led group-based exercise programme	**Total average cost per participant per annum in NZ 2011 dollars: $205.33** **Explanation:** Programme costs were based on the NZ SAYGO Programme.[23-25] This modification of the OEP involves 10 weeks of weekly exercise classes led by trained coordinators, after which time a group member is trained as a peer leader. The class then continues to be led by the group member. SAYGO is coordinated by Age Concern Otago, and based in Dunedin. Age Concern Otago provided detailed costings for the programme, which in 2011 NZ$ amount to **$64.93** per person per year. Additional out-of-pocket costs were calculated. Weekly hall hire is covered by gold coin donation, for which **NZ$2** was used in the model. An assumption was made that 50% of participants would drive to the exercise classes, with an average trip distance of 5km. Transport costs were estimated through using the reimbursement rate for private vehicles used by the Ministry of health (NZ$0.28/km in 2011 NZ$).[12] This leads to an average transport cost of **$1.40**, for 50% of participants. The final assumption for out-of-pocket costs was calculated:	*Uncertainty:* SD = -10% to +10% of the point estimate, gamma distribution.

Parameter	Comment	Trends, uncertainty and any scenario analyses. (Standard BODE[3] methods apply, extra detail is included in the BODE[3] Study protocol[1])
	Average out-of-pocket cost = (Non-driver cost + driver cost)/2 = ((Donation) + (Donation + travel cost))/2 = (2 + (2+1.40))/2 = **$2.70 per week** **= $140.4 per participant per annum** Thus the overall cost per participant was: $64.93 + $140.4 **= $205.33 per participant per annum**	
Commercial delivery of the group-based exercise programmes	This intervention assumed that participants enrolled in a class at a commercial gym, at an average out-of-pocket cost of **$736.84 per participant per annum.** ***Explanation:*** Costs for this option were obtained by contacting two nationally available gym chains. Group-exercise classes are offered with a focus on balance and strength, but not specifically designed for older adults as with SAYGO: **Fitness chain A:** A balance-focused class combining elements of yoga, Pilates and Tai Chi is available. A 12-month senior membership, for those aged 65 and over costs $16.50 per week (**$15.34** in 2011 NZ$). This also includes two personal trainer assessments, and assistance to modify the group routine if elements were found to be too excessive or strenuous for the participant. **Fitness chain B:** A balance-focused class combining elements of Tai Chi and yoga is available. A yearly membership which allows attendance of this class is $13.99 per week (**$13.00** in 2011 NZ$). Average weekly cost for 50% of participants: **$14.17,** which equates to annual per participant cost of **$736.84.**	As per the peer-led group intervention.
Home-based intervention		
Home-based exercise programmes for falls prevention	**Total cost per participant for first year in 2011 NZ$: $480** **Cost per participant for each subsequent year: $62** **Explanation:** Costs for a home-based programme were averaged from the results of three NZ-based RCTs implementing the OEP.[14 16 17] The three studies used to calculate an average cost included data accounting for all incremental costs. These included programme	Uncertainty of SD = +/- 10% of the point estimate, gamma distribution, and assuming that the programme runs for a 25-year period.

Parameter	Comment	Trends, uncertainty and any scenario analyses. (Standard BODE[3] methods apply, extra detail is included in the BODE[3] Study protocol[1])
	recruitment, consumables and equipment, supervision costs and overheads (35%; 21.85% and 21.85% of total costs respectively). These costs were converted to 2011 NZ$ as per the BODE[3] protocol.[1] The average cost for the first year of a home-based programme in 2011 NZ$ was **NZ$480 per person.** Only one of the studies examined costs in the second year,[17] so this ratio of year 1: year 2 was used to calculate an average cost for each ongoing year, of **$62 per participant.**	Uncertainties as per the 95%CI from the Cochrane meta-analysis were included for the effect size.

Additional results

Population group and equity analyses

This study used equity analyses as per the established BODE[3] protocols. The underlying rationale is that because certain groups (men compared to women; Māori compared to non-Māori) have higher base-case mortality and morbidity, a long-term model may result in 'penalising' these groups by not reflecting actual potential health gains resulting from the intervention.[7] As calculation of QALYs takes into account years of life lost and years of life lived with disability, shorter life expectancy will translate into lower QALYs gained despite a similar or even better outcome. An equity analysis was carried out by applying the lower mortality and morbidity rates of women and non-Māori to men and Māori respectively.

Table A3: Analyses by ethnicity and sex for the peer-led group-exercise intervention: QALYs gained, incremental costs and ICERs (for the lifetime of the modelled cohort, 95% UI in brackets)

Intervention	QALYs gained	Net cost (NZ$ m)	ICER (NZ$)
All (as per Table 1 in the main manuscript)	42,000 (21,800 to 65,600)	535 (311 to 730)	14,100 (5900 to 30,700)
Māori	1570 (726 to 2500)	28.2 (19.4 to 36.1)	20,200 (9460 to 43,200)
Māori (equity analysis)[1]	2540 (1200 to 4000)	36.7 (26.5 to 45.8)	16,000 (8300 to 33,000)
Non-Māori	40,700 (21,100 to 63,000)	507 (292 to 695)	14,000 (5700 to 30,300)
Men	18,800 (9230 to 29,500)	252 (164 to 328)	15,000 (6850 to 32,100)
Men (equity analysis)[2]	23,600 (11,700 to 36,700)	304 (206 to 389)	14,300 (7000 to 29,500)
Women	23,500 (12,600 to 36,400)	283 (142 to 406)	13,500 (5000 to 29,800)

Notes:

[1] As Māori have higher background mortality rates and higher morbidity, this essentially 'penalises' health gain for Māori in the standard analyses. So we present an equity analysis with non-Māori morbidity and mortality rates applied to Māori (i.e., expanding the envelope of potential health gain for Māori).

[2] As men have higher background mortality rates, this essentially 'penalises' health gain for men in the analyses. So we present an equity analysis with women's morbidity and mortality rates applied to men.

Uncertainty analyses

Uncertainty analyses were carried out for key model parameters for net incremental costs, health gain and ICERs for the peer-led group-exercise programme. Tornado plots for these uncertainty analyses are presented Figures A3, A4 and A5.

For incremental costs, the parameter contributing the most uncertainty was the scaler for the probability of death from falling, followed by uncertainty around the intervention cost and the scaler for the costs of injurious falls not resulting in hospitalisation. For QALYs gained, the intervention effect size contributed the most uncertainty, followed by the scaler for the probability of death from falling and the scaler for the base-case fall rate among the lower risk population who had not sustained a prior injurious fall. The uncertainty analysis for ICERs showed that the peer-led group intervention remained cost-effective in all scenarios. That said, the parameter contributing the most to uncertainty was again the intervention effect size, followed by disability weightings for injurious falls and the scaler for the base-case falls rate among people who have previously sustained an injurious fall.

Figure A2: Cost-effectiveness acceptability curves for the three exercise programme interventions

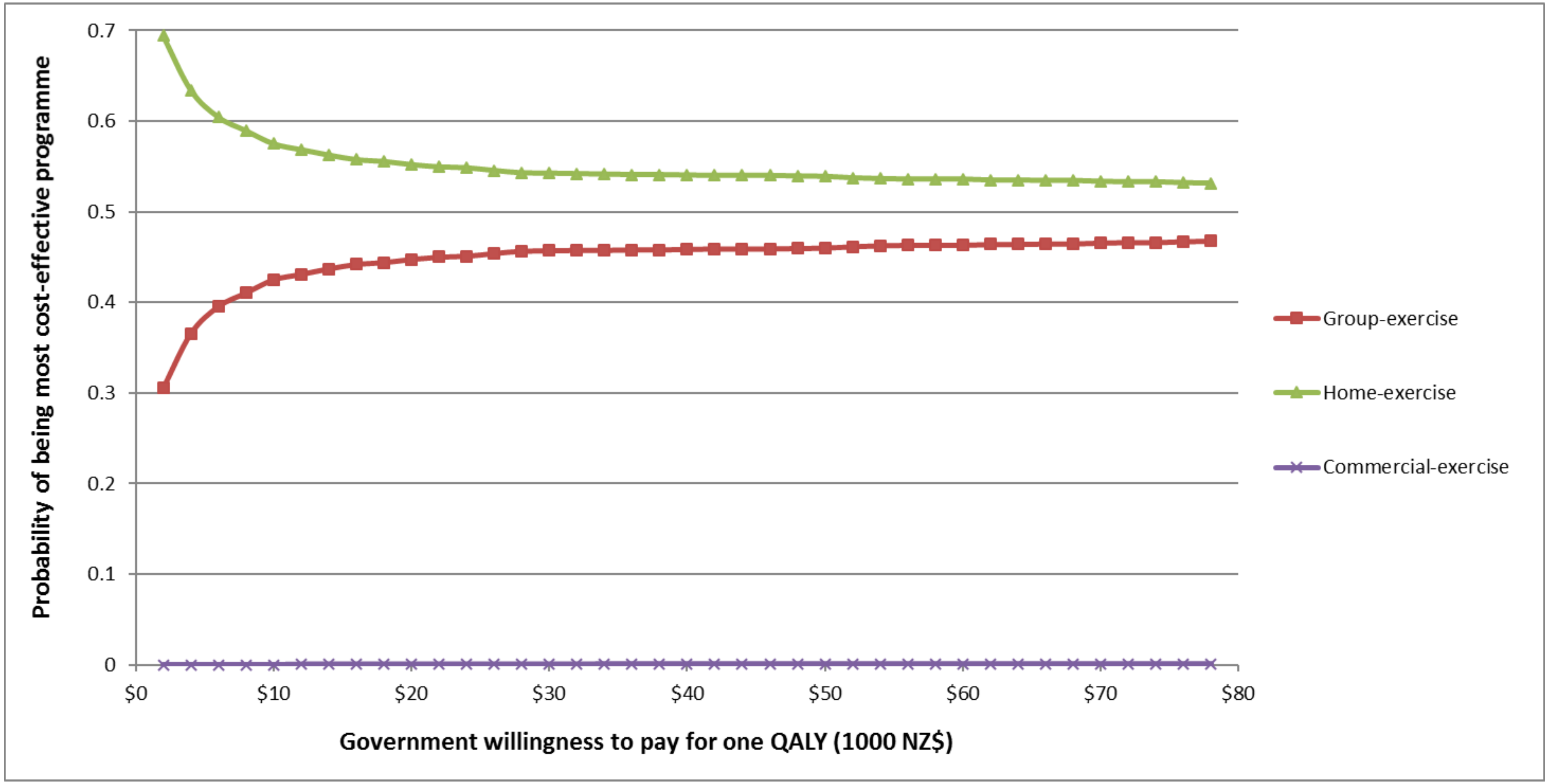
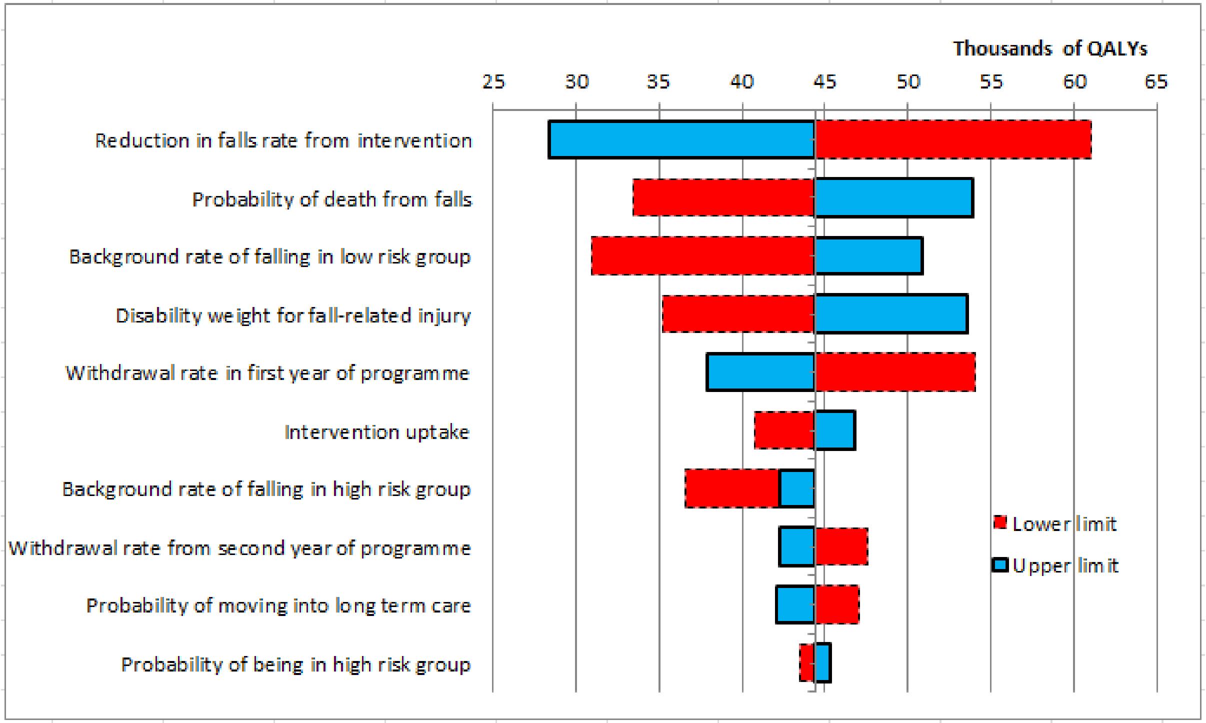


Figure A3: Impact of uncertainty around incremental QALY gains associated with the peer-led group-exercise programme intervention*



* For all these tornado plots there are small differences between the expected value in the vertical line and the values in Table 1 in the main manuscript. This is because the results in Table 1 are overall mean values of all the of all the simulated values based on probabilistic sensitivity analysis, while the tornado plots are based on the mean values, or expected values, of each input value.

Figure A4: Impact of uncertainty around net incremental costs associated with the peer-led group-exercise programme intervention

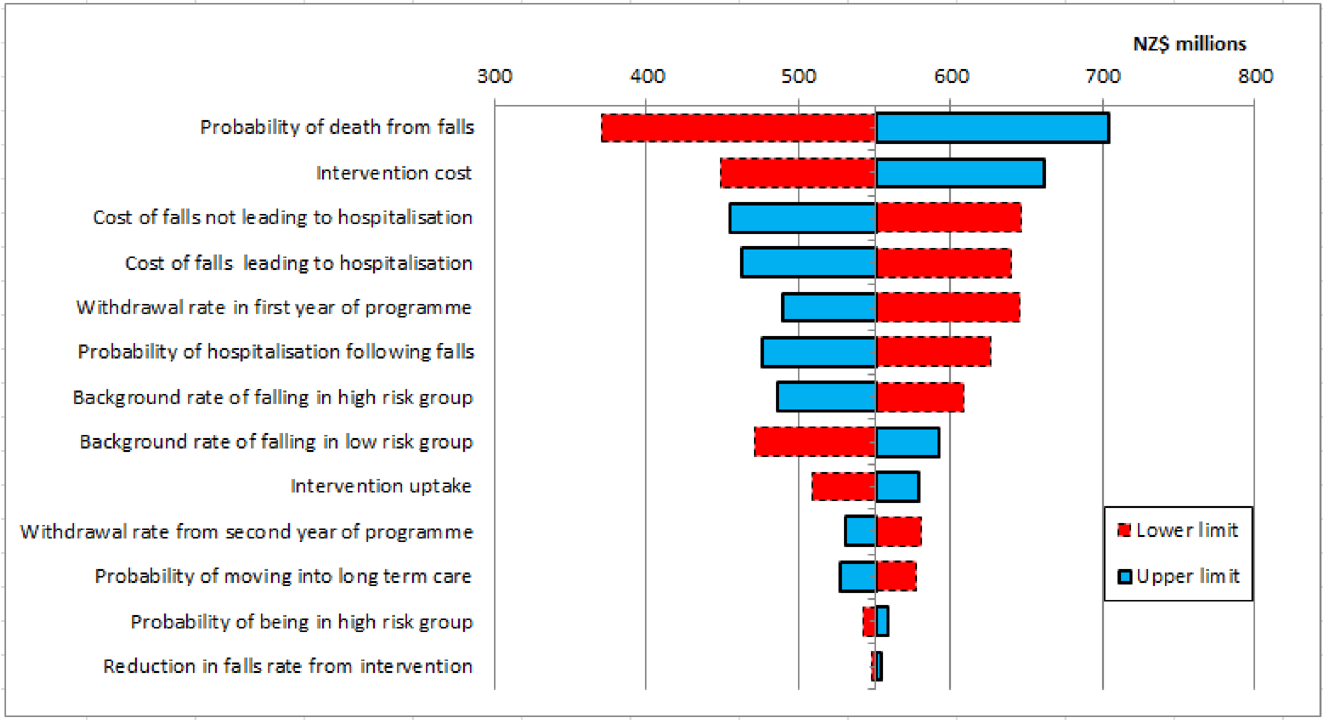
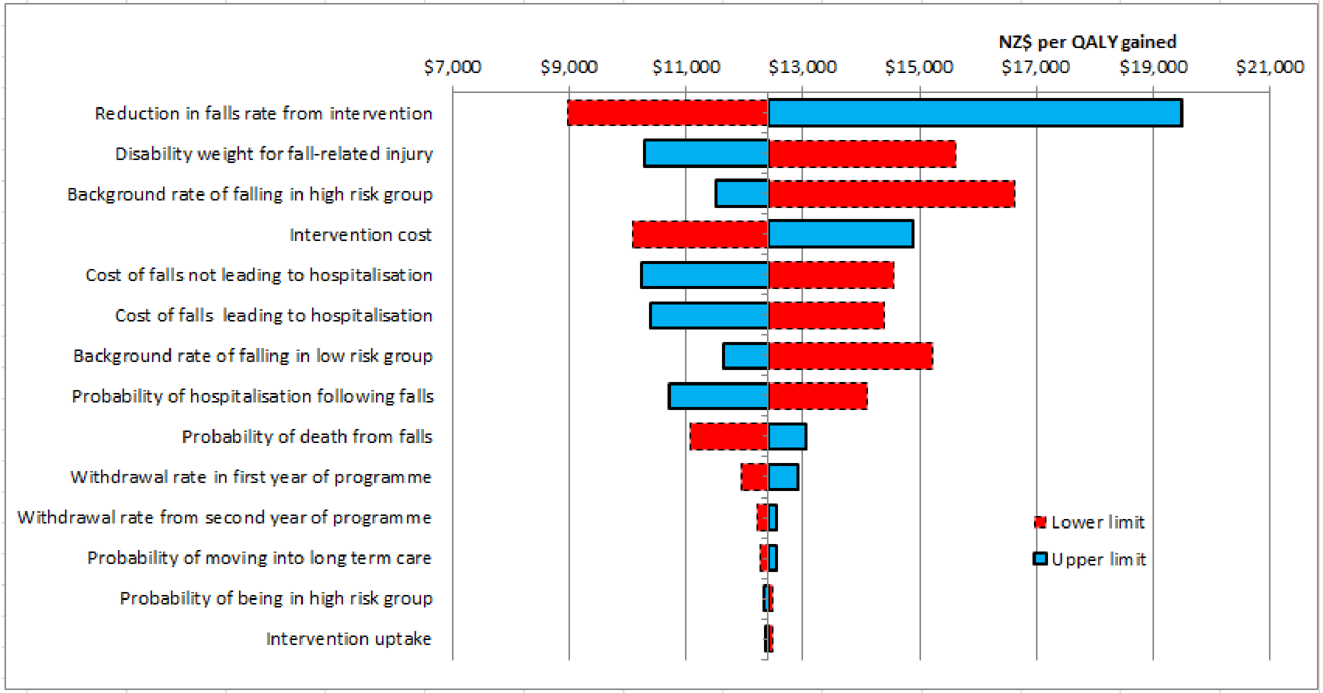


Figure A5: Impact of uncertainty around the ICER associated with the peer-led group-exercise programme intervention



Additional Discussion

Limitations – further details

Given data limitations around the intensity of the exercise programmes, this study was unable to account for non-injury health gains arising from exercise. Regular exercise is associated with reduced incidence of cognitive decline (including among those with neurodegenerative disease),[26] stroke,[27-30] ischaemic heart disease and diabetes.[31] There is also epidemiological evidence suggesting that regular exercise is associated with decreased incidence of certain cancers, especially colon, breast and endometrial.[32-34] Furthermore, for older people there is an association between traditional Chinese exercise and reduced mortality rates.[35] Furthermore, our modelling study could not quantify the social benefits of group membership, which may reduce social isolation in older people.

The effect sizes provided by the Cochrane meta-analysis are from short-run trial data, and it was assumed that these would remain constant over the modelled period. It is possible that the intervention may become less – or more – effective with increased years of participation. Data from evaluations of SAYGO have found that longer-term participation (up to ten years) was associated with reduced falls incidence.[23]

The effect sizes reported by the Cochrane meta-analysis for group and home-exercise refer to *all* falls, as opposed to injurious falls in a general sense, or more specifically falls causing fracture. The model used New Zealand data on *injurious* falls (those requiring medical attention) to estimate the impact on health spending and QALYs. It is assumed that the effect sizes for all falls apply equally to injurious falls. The Cochrane reviewers did examine the impact of exercise on falls causing fractures. This, however, only included six studies, of which only two were exclusively group-based exercise programmes. The analysis reported that there was a significant reduction in fractures from participation in an exercise programme (RR = 0.34, 95%CI: 0.18 – 0.63).[20] A subsequent meta-analysis did consider injurious falls, finding that exercise programmes for falls prevention (14 of 17 studies were group-based) reduced injurious falls and falls requiring medical attention (RR = 0.63, 95%CI: 0.51 – 0.77, 10 trials; and RR = 0.70, 95%CI: 0.54 – 0.92, 8 trials respectively). However, results from this subsequent meta-analysis were not separated by home or group-delivery.[36] Furthermore, a recently published 12-month cohort study examining fall-related injuries in SAYGO participants reported that participation appeared to result in less severe injuries when falls do occur.[25]

It was beyond the scope of this study to assess the capacity of local community venues to accommodate a large number of exercise classes. It is recognised that this issue of capacity would probably need to be addressed in any jurisdiction opting for any national programme in which entry for participation is open and ongoing. Nevertheless, there are community halls, school buildings and churches throughout many developed countries that are potentially available for hire at minimal cost (e.g., in New Zealand community halls are usually owned by local government and church and school facilities are sometimes available for hire).

The cost data for the model was derived from the New Zealand based SAYGO Programme. This is a peer-led, group-based configuration which significantly reduces costs compared to use of paid professionals. Nevertheless, it reflects delivery in an urban setting and so costs in smaller towns might be higher (i.e., with fewer participants per trainer involved in starting up the programme and also greater travel costs for any rurally based participants). For such reasons, moderate uncertainty of SD = +/-10% was built into this cost parameter in the model. Similarly, the findings of the model with regard to cost-effectiveness will be less applicable to a professionally-led and therefore more expensive programme model. In this sense, the modelling for commercial provision of exercise programmes provides a proxy for a more expensive programme.

We also recognise that technological enhancements could potentially improve the cost-effectiveness of exercise interventions. For example, the use of videogames for exercise intervention delivery could reduce running costs. A 2014 systematic review of exergaming for falls prevention did not examine falls incidence, but reported improvements in balance indicators in 12 out of 19 studies.[37] A 2016 meta-analysis of 18 studies and 619 community-dwelling participants compared active video-gaming with both control and standard treatment. Balance and functional mobility indicators improved compared to control, but in contrast to the previous review, the review reported inferiority to standard treatment.[38] A RCT conducted in Hong Kong in 2015 specifically examined fall incidence as an outcome, in a study of video game use in 60 adults living in residential care who had had a previous injurious fall.[39] Compared to a control group of a standard balance class, use of an exergaming platform reduced falls (incidence rate ratio [IRR] = 0.35, 95%CI: 0.2 – 0.64), adjusted for age and sex. Robots have also been considered as a delivery method for exercise programmes, and particularly in Asia several models have been successfully trialled for feasibility and acceptance, often in residential care situations.[40-42]

Study populations in falls prevention interventions are predominantly women. In the Cochrane meta-analysis used for the measure of effectiveness in our model, 70% of participants were women, but a single relative risk was calculated for both sexes.[20] Study populations in two evaluations of the SAYGO Programme were also predominantly women (91% and 84% respectively), and data were not presented by sex.[23 24] RCTs examining the home-based OEP were exclusively women;[17] 67% women without data presentation by sex[16]; and 70% women but with equal effect for both sexes respectively.[14] It is also reassuring (in terms of the design of modelling presented here) that a meta-analysis of four trials from the research group that developed the OEP reported equal benefit for both sexes.[43] If future modelling work did also consider the cardiovascular disease (CVD) benefits of exercise programmes, the overall health benefit might become greater for men (owing to higher incidence and prevalence of CVD in men). This argument may also apply for ethnic populations with higher rates of CVD, as per Māori in New Zealand.

The model used for this study had previously been used to assess the impact of HSAM on falls sustained within the home. As the costs for injurious falls remained tied to data for in-home falls, this does require the assumption that falls in the home are as likely to cause injury as falls sustained in *any* location, and that the proportion of falls leading to death or fracture would also remain the same. Studies from Korea[44] and the US[45] suggest that injurious falls are approximately equally distributed between indoors and outdoors, while another US and a Dutch study finding approximately two-thirds occurred indoors.[46 47] It was consistently found that older and frailer individuals were more likely to sustain an injurious fall *indoor*s. A French cohort study used survival analysis and reported that women who fell inside had shortened survival times, and that inside falls were associated with a significantly increased risk of death.[48]

New Zealand data shows that of the falls involving an ACC claim, 50% occur in the home, but this is not necessarily an indicator that severity of injury is equally distributed.[49] In addition, if the exercise intervention did not reduce falls caused by remediable home hazards, the cost-effectiveness results presented in this study may be overly favourable.

Our previous HSAM modelling study identified the potential for double-counting of fallers, through use of both the hospitalisation register (Health Tracker) and the ACC claims register.[10] If a person had two falls in one year, being hospitalised for only one, they may be counted twice in the ACC register. In the previous study we assumed a small number of hospitalisation events were likely counted twice, and that health gains were therefore possibly 'slightly' overestimated.[10] This argument is therefore also likely to apply to the exercise intervention modelling presented here.

Table A4: Comparison of costs, health gain and cost-effectiveness between HSAM and exercise for falls prevention in adults aged 65 years and over

	Intervention		
Key variable	**HSAM (using the same model for NZ)[10]**	**Home-based exercise (this study)**	**Peer-led group-based exercise (this study)**
Net cost (NZ$m)	$111 (cost saving to $197)	$282 ($139 – $380)	$535 ($311 – $730)
QALYs gained	34,000 (5490 – 65,300)	47,100 (22,300 – 74,400)	42,000 (21,800 – 65,600)
ICER (NZ$)	$9000 (cost saving to $20,000) [US$6060]	$6900 ($2200 – $15,600) [US$4640]	$14,100 ($5900 – $30,700) [US$9490]

Table A5: Per capita health gain (QALYs per 1000 population) aged 65+ for home safety assessment and modification (HSAM) and peer-led group-exercise interventions by demographic group

Population group (all aged 65 years and over)	**Intervention**	
	HSAM (95%UI) (using the same model for NZ)[10]	**Peer-led group-based exercise (this study)**
All	58 (9 – 112)	75 (39 – 116)
Non-Māori	60 (9 – 115)	76 (39 – 118)
Māori	46 (7 – 91)	49 (22 –78)
Māori (equity analysis)	71 (11 – 140)	79 (37 – 125)
Women	59 (9 – 115)	77 (41 – 120)
Men	59 (9 – 115)	71 (35 – 112)
Men (equity analysis)	71 (11 – 138)	90 (44 – 140)

Commercially-provided exercise programme

This intervention was paid for by participants but it assumed that the Ministry of Health would only endorse such programmes if the key falls prevention elements such as balance improvements are included. To determine the likely cost, we contacted two commercial gym chains that have facilities throughout New Zealand. The cost per annum of a membership that would allow participation in a group-exercise class was obtained (personal communication with key informants from each company). These existing classes were not specifically targeted to falls prevention, but had a focus on balance and strength. This analysis, assumed the same effect sizes, participation and withdrawal parameters as the base-case analysis.

Adoption of commercially-provided exercise classes (assuming universal eligibility for ages 65+) over a 25-year period, cost participating citizens a total of $1970m in class fees (95% UI: 1450m to $2500m). Net incremental costs (costs to citizens plus health system costs) were $1950m (95% UI: $1370m to $2560m). Health gains were 42,300 QALYs (95% UI: 21,800 to 65,700) and the ICER was not so favourable at $51,200 per QALY gained (95% UI: $25,400 to $107,000). However, the uncertainty range includes values which we would regard as being cost-effective. In summary, commercially-provided group-exercise programmes appear to be less cost-effective and have significantly higher implementation costs (albeit paid for by citizens rather than health funders).

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