Support Services for the Management and Utilization of Monitoring and Assessment of the EIP - MAFEIP Tool

Physical exercise program for reducing the risk of falling among older adults

Authors:

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Executive summary

Description of the intervention

Risk of falling has been revealed as one of the most important conditions causing dependency among older people (Beswick et al., 2010[1]). One in three people over 65 fall at least once a year worldwide. In Spain, between 15% and 32% people over 65 suffered a fall in the last year, representing a cost of more than 2 billion €. Older adults taking physical activity regularly can benefit of a proper maintenance of muscle strength and mass, which helps to retain function and independence, and to prevent falls and other injuries (El-Khoury, Charles, & Dargent-Molina, 2013[2]). Concretely, the effectiveness of balance and strength training programs on the reduction of falls has been sufficiently proved (Sherrington et al., 2011[3]).

A physical exercise program composed by balance and strength training was designed with the aim of reducing the prevalence of falls and its related cost. From a total of 60 exercises conforming the program, 34 are based on the OTAGO program, with largely proven effectiveness, and 26 were designed in the frame of this research by a physiotherapist, who was responsible for the program implementation. The 60 exercises comprise a total of ten 45-minute exercises routines including 6 exercises each one, which were implemented twice a week during 9 months.

The physical exercise program was addressed at 65+ community-dwelling older adults suffering from risk of falling. Patients from 2 healthcare centres in Valencia (Spain) participated in the study. A total of 55 participants attended the physical exercise program and a total of 136 participants conformed the comparison group. Participants were assessed at baseline and after 9 months (final evaluation). Risk of falling was assessed through two different criteria: 1) Falls history (NICE, 2013[4]); and 2) Fear of falling (Curcio & Gómez, 2012[5]) along with walking difficulties and/or balance problems (Tilburg Frailty Index; Gobbens et al., 2010[6]).

[1] Beswick, A.D., Gooberman-Hill, R., Smith, A., Wylde, V., & Ebrahim, S. (2010). Maintaining independence in older people. *Rev Clin Gerontol*, 20, 128–153.
[2] El-Khoury, B., Charles, M.A., & Dargent-Molina P. (2013). The effect of fall prevention exercise programmes on fall induced injuries in community dwelling older adults: systematic review and meta-analysis of randomised controlled trials. *BMJ*, 347, f6234.
[3] Sherrington, C., Tiedemann, A., Fairhall, N., Close, J.C.T., & Lord, S.R. (2011). Exercise to prevent falls in older adults: an updated meta-analysis and best practice recommendations. *New South Wales Public Health Bulletin*, 22, 78-83.
[4] NICE. (2013). Falls: assessment and prevention of falls in older people. (Clinical guideline; no. 161). London (UK): National Institute for Health and Care Excellence (NICE).
[5] Curcio, C.L., & Gómez, F. (2012). Temor a caer en ancianos: controversias en torno a un concepto y a su medición. *Hacia la Promoción de la Salud*, 17(2), 186 – 204.
[6] Gobbens, R.J., van Assen M.A. Luijkx, K.G., Wijnen-Sponselee, M.T., Schols, J.M. (2010). The Tilburg Frailty Indicator: psychometric properties. *Journal of the American Medical Directors Association*, 11(5), 344-355.

Model input

Defining the health states and the transition probabilities

The health states are defined according to the change in the risk of falling state after 9 months since the initial evaluation. Baseline health includes those participants who show an improvement in the risk of falls and deteriorated health includes those participants showing a worsening in the risk of falling or those that show no progression. Initially, 50 participants (90.9%) from the intervention group and 86 participants (63.2%) form the comparison group presented risk of falling. After the intervention, 30 intervention group participants (54.5%) showed an improvement in the risk of falling (went from deteriorated health to baseline health) and 25 participants from the intervention group (45.5%) showed no progression. Over the same time period, only 19 comparison group participants (13.97%) presented an improvement in the risk of falling, while 117 (86%) suffered a worsening or showed no progression. Thus, these are the values used as an input for the recovery and incidence rates of the intervention group and comparison groups (Table 1).

The risk for mortality of those with risk of falling is, according to the scientific literature, higher than for those not at risk. In line with this, a relative risk (RR) of 1.373 is used for the deteriorated state (both for the comparison and the intervention groups).

Computing the costs

The summary of the costs directly related to the intervention, which are costs that affect only the group that attended the physical exercise program, are shown in Table 1. The intervention costs per person per year was established in 104€. This cost was calculated based on: [physiotherapist cost per hour * total hours)/ participants per session].

Table 1 also summarises the healthcare costs in each situation, usual care and intervention and for both health states. Healthcare costs refer to resource use within the healthcare system. These were calculated based on the average doctor's visits and hospitalization for participants that were in remission (baseline state) and for those that were not (deteriorated state).

Utility

MAFEIP recommends using the EQ-5D to calculate utility, but our study did not use this questionnaire, instead we used the SF-12 Health Survey (Ware, Kosinsiki & Keller, 1996[7]). However, SF-12 scores were converted into EQ-5D scores using an algorithm developed by Gray, Rivero-Arias & Clarke (2006)[8]. From these results, utility was calculated for baseline health and for those with deteriorated health. Table 1 shows the utility values used in the model.

[7] Ware, J. E., Kosinsiki, M., & Keller, S. D. (1996). A 12-item short-form health survey: Construction of scales and preliminary tests of reliability and validity. *Medical Care*, 34(3), 220-233.
[8] Gray, A., Rivero-Arias, O., & Clarke, P. (2006). Estimating the association between SF-12 responses and EQ-5D utility values by response mapping. *Medical Decision Making*, 26(1), 18-29

Table 1. Input data used to populate the MAFEIP model

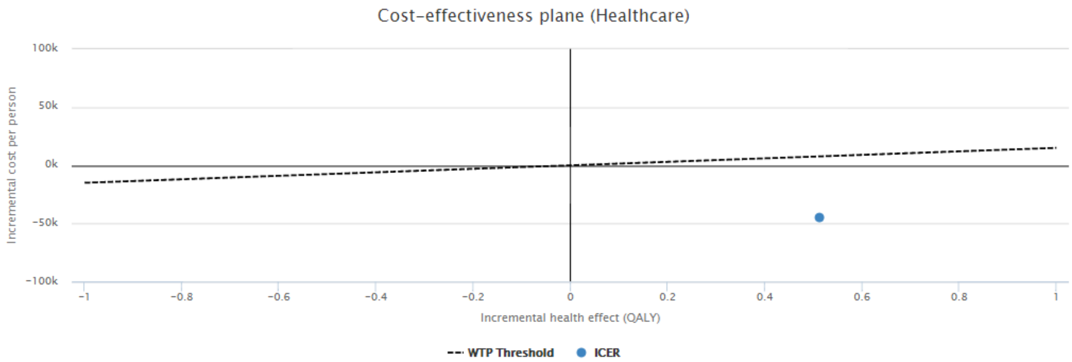
	Comparison Group	Intervention Group
Transition Probabilities		
Incidence	86 %	45.5 %
Recovery	14 %	54.5 %
Relative Risk		
Baseline State	1.00	1.00
Deteriorated State	1.373	1.373
Costs		
Recurring cost per patient/year (intervention)	-	104€
Healthcare cost – Baseline	1,630.22€	1,615.02€
Healthcare cost – Deteriorated	9,030.13€	3,130.96€
Utility		
Baseline State	0.81	0.81
Deteriorated State	0.75	0.75

Model output

The overall impact of the intervention on the costs and effects of the whole target population is shown in Figure 1. The incremental cost-effectiveness ratio (ICER) is calculated as: incremental cost divided by incremental effects. When this ratio is located in the lower-right quadrant means that the incremental cost is negative, thus the intervention provides cost savings compared with the standard care scenario. Moreover, incremental effects are positive, meaning that our intervention provides a gain in the health outcomes, thus is more effective than the standard care scenario.

Figure 1. Cost-effectiveness

Incremental cost and HRQoL effects	
Incremental cost (Healthcare)	-44832.92
Incremental effects	0.513
Incremental cost-effectiveness ratio (Healthcare)	Dominant



WTP Threshold: ◉ €15K/QALY ○ €20K/QALY ○ €30K/QALY ○ €50K/QALY ○ €80K/QALY

1. Description of the intervention

The intervention analyses using the MAFEIP tool is a physical exercise program aimed at reducing the risk of falling in 65+ community-dwelling older adults suffering from this condition. This program was designed and developed by Polibienestar Research Institute - University of Valencia (Spain) in the frame of a research project entitled *Urban Health Centre (UHCE): Integrated health and social care pathways, early detection of frailty, management of polypharmacy and prevention of falls for active and healthy ageing in European cities*[9].

The UHCE project started in January 2014 and finished three years after. It was co-funded by the European Commission under the 2nd Health Programme. Within the project 5 pilots were conducted in 5 different European countries including Croatia, Greece, Spain, The Netherlands, and United Kingdom. The objective of these pilots was to develop and implement strategies aimed at tackling the risk of falling, frailty and loneliness among 65+ community-dwelling older adults. Each pilot site developed different context-adapted strategies to meet this objective. In Spain, Polibienestar –who was responsible for the pilot– designed and implemented a multidimensional intervention including the physical exercise program, which is analysed in this case by means of the MAFEIP tool.

Risk of falling represents an important and complex health problem because of its high prevalence among older adults and its consequences at physical, psychological and social level (Ong, Uchino, & Wethington, 2016[10]). One in three people over 65 falls at least once a year worldwide. In Spain, between 15% and 32% people over 65 suffered a fall in the last year, representing a cost of more than 2 billion €. Among the consequences of falls are: pain, fractures, hospitalization, institutionalization, limitations in activities of daily living (ADLs), disability, mortality, social isolation, decreased quality of life, and increases in health expenditure (Kannus et al., 2005[11]). Therefore, the high prevalence and the consequences on health of the risk of falling among older people highlight the need to develop and to implement strategies that effectively address these conditions among this population.

In this regard, the practise of physical activity regularly has proved to maintain muscle strength and mass, which helps to retain function and independence, and to prevent falls and other injuries (El-Khoury, Charles, Dargent-Molina, 2013[12]). Concretely, balance and strength training programs appear to be the most effective interventions to reduce the risk of falling (Sherrington et al., 2011[13]). Therefore, our physical exercise program was composed by balance and strength

[9] https://www.uhce.eu/
[10] Ong, A.D., Uchino, B.N., & Wethington, E. (2016). Loneliness and Health in Older Adults: A Mini-Review and Synthesis. *Gerontology*, 62(4), 443-449.
[11] Kannus, P., Sievanen, H., Palvanen, M., Järvinen, T., & Parkkari, J. (2005). Prevention of falls and consequent injuries in elderly people. *Lancet*, 366, 1885–1893.
[12] El-Khoury, B., Charles, M.A., & Dargent-Molina P. (2013). The effect of fall prevention exercise programmes on fall induced injuries in community dwelling older adults: systematic review and meta-analysis of randomised controlled trials. *BMJ*, 347, f6234.
[13] Sherrington, C., Tiedemann, A., Fairhall, N., Close, J.C.T., & Lord, S.R. (2011). Exercise to prevent falls in older adults: an updated meta-analysis and best practice recommendations. *New South Wales Public Health Bulletin*, 22, 78-83.

training. A total of 60 exercises conform the program, from which 34 are based on the OTAGO program and 26 were designed in the frame of the UHCE-Spanish pilot by a physiotherapist, who was also responsible for the program implementation. The 60 exercises comprise a total of ten 45-minute exercises routines including 6 exercises each one.

The physical exercise program was addressed at 65+ community-dwelling older adults suffering from risk of falling. Patients from 2 healthcare centres in Valencia (Spain) participated in the study. A total of 55 participants attended the physical exercise program twice a week during 9 months, and a total of 136 participants conformed the comparison group. Participants were assessed at baseline and after 9 months (final evaluation). Risk of falling was assessed through two different criteria: 1) Falls history (NICE, 2013[14]); and 2) Fear of falling (Curcio & Gómez, 2012[15]) along with walking difficulties and/or balance problems (Tilburg Frailty Index –TFI–; Gobbens, 2010).

The age of the participants in the UHCE-Spanish pilot ranged from 65 to 92 years old and it included both females (63%) and males (37%). The evaluation used a prospective longitudinal study. Concretely, a quasi-experimental pretest-posttest non-equivalent control group study design.

2. Model input

2.1. Defining the health states and the transition probabilities

In our study, the presence of the risk of falling was measured through the abovementioned criteria from which participants were classified as having or not having falls risk.

In the frame of MAFEIP, the health states are defined according to the change in risk of falling state among participants at the final evaluation (after 9 months since the initial evaluation). **Baseline health** includes those participants who show an improvement in the risk of falls and **deteriorated health** includes those participants showing a worsening in the risk of falling or those that show no progression.

Initially, 50 participants (90.9%) from the intervention group and 86 participants (63.2%) from the comparison group presented risk of falling. After the intervention, 30 participants from the intervention group showed an improvement in the risk of falling (went from deteriorated health to baseline health). This is a 54.5% of the sample, and it is the value that it is used as an input for the **recovery rate of the intervention group**; while, 19 participants from the comparison group presented an improvement in the risk of falling, establishing the **recovery rate of the comparison group** in 13.97%.

[14] NICE. (2013). Falls: assessment and prevention of falls in older people. (Clinical guideline; no. 161). London (UK): National Institute for Health and Care Excellence (NICE).
[15] Curcio, C.L., & Gómez, F. (2012). Temor a caer en ancianos: controversias en torno a un concepto y a su medición. *Hacia la Promoción de la Salud*, 17(2), 186 – 204.

On the other hand, 25 participants from the intervention group showed no progression after the intervention; and over the same time period, 117 suffered a worsening or showed no progression. Thus, the **incidence rate** of the intervention group was established in 45.5% and for the comparison group in 86%.

The **risk for mortality,** according to the scientific literature, should be a bit higher among the older adults at risk of falling than for those not at risk. For instance, falls are the second leading cause of accidental or unintentional injury deaths worldwide, and older people have the highest risk of death from falls. Moreover, this risk increases with age. In line with this, a relative risk (RR) of 1.373 is used for the deteriorated state, which was used in both comparison and intervention groups.

Tabla 2. Transition probabilities

	Initial evaluation	Final evaluation		Transition probabilities	
		Improves	Worsens/Remain the same	Recovery rate	Incidence rate
Intervention group	50	30	25	54.5%	45.5%
Comparison group	86	19	117	13.97%	86%

2.2. Computing the costs

The main costs to implement our physical exercise program was the physiotherapist cost. The physiotherapist was responsible for the program implementation and supervision. In this regard, intervention costs affect only the intervention group. This cost was calculated using the following equation: [physiotherapist cost per hour * total hours)/ participants per session]. The cost per hour of a physiotherapist was estimated in 20€, a total of 78 hours a year were calculated (1.5hours/week * 52weeks) and approximately a total of 15 participants attended each session. The results of this equation showed an intervention cost of 104€ per person per year. No other direct cost were associated with the physical exercise program implementation.

Healthcare costs refer to resource use within the healthcare system in each situation, usual care and intervention. In our study, we collected data on the number of doctor's visits and the number of hospitalisations in both intervention and comparison groups.

Doctor's visits have an estimated costs per hour of 29.23€ (calculated from the average income for one full-time employee with employer contributions to social security) and the estimation of cost per bed-day is 733.56 € (obtained by dividing the Expenditure for Inpatient curative care in hospitals by Hospital bed-days in services of curative care; both variables are available in Eurostat[16]). These data allowed us to calculate the cost of the average number of doctor's visits and hospitalization per group and for both states, baseline and deteriorated (Table 3).

[16] Eurostat hlth_sha11_hc and hlth_co_dischls

Healthcare costs for patients in remission (baseline state) were estimated to be 1,615.02€ for the intervention group and 1,630.22€ for the comparison group; while for those not in remission (deteriorated state) 3,130.96€ for intervention group and 9,030.13€ for the comparison group.

Table 2. Healthcare Costs (per patient and year in €)

Intervention Group baseline health	1,615.02€
Intervention Group deteriorated health	3,130.96€
Comparison Group baseline health	1,630.22€
Comparison Group deteriorated health	9,030.13€

No societal costs were calculated for this case.

Utility

MAFEIP recommends using EQ-5D to calculate utility, but UHCE project did not use this questionnaire. However, it used the SF-12 Health Survey which also is a health-related quality of life measure. SF-12 scores were converted into EQ-5D scores using the algorithm developed by Gray, Rivero-Arias, & Clarke (2006)[17]. From these results, utility was calculated for baseline health and for those with deteriorated health, as it is shown in Table 4.

Table 4. Utility

	Control	Intervention
Baseline	0.81	0.81
Deteriorated	0.75	0.75

3. Model output

The figure below shows the incremental costs by age, which are negative. This means that the usual care is more expensive than the intervention. Moreover, the graphic presents an upward trend meaning the older the participant the less savings (Figure 2). The incremental effects by age are also positive, due to the fact that our physical exercise program increased participants' satisfaction with life and health outcomes (Figure 3). In this case, the graphic shows a downward trend meaning that the improvement is less noticeable as the age increases.

In consequence, the incremental cost-effectiveness ratio (ICER)[18] is placed in the lower-right quadrant (Figure 4). Thus, indicating that our intervention is cost-effective (more effective and less expensive than the standard alternative).

[17] Gray, A., Rivero-Arias, O., & Clarke, P. (2006). Estimating the association between SF-12 responses and EQ-5D utility values by response mapping. *Medical Decision Making*, 26(1), 18-29

[18] This is the ratio between incremental costs and incremental effects.

Figure 2. Incremental cost by age

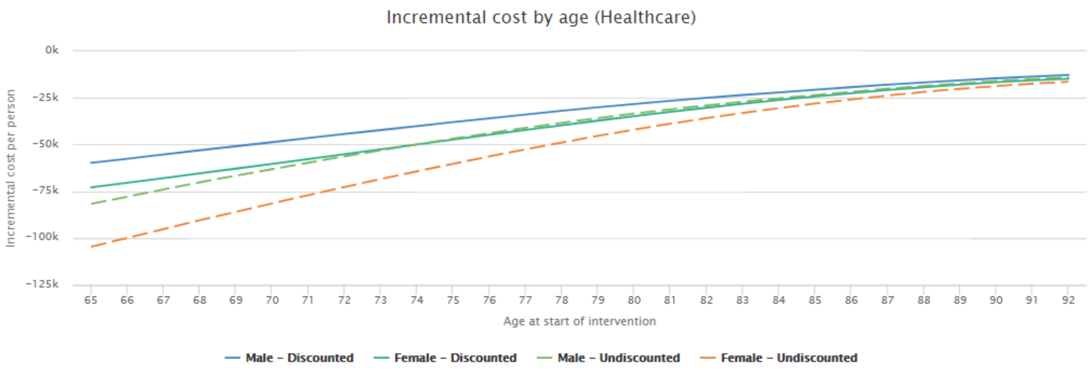


Figure 3. Incremental effects by age

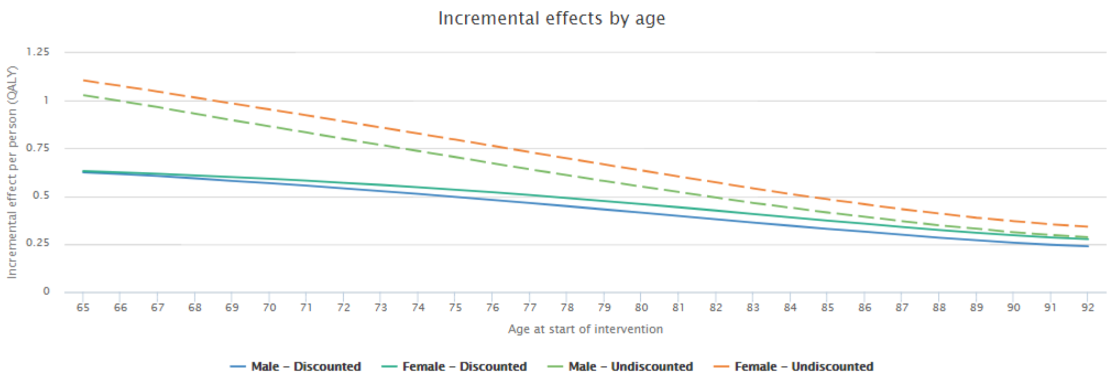
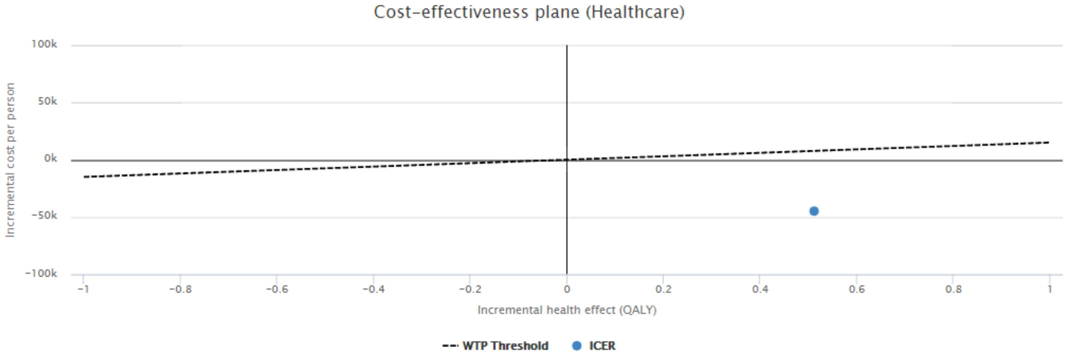


Figure 4. Cost-effectiveness plane (healthcare costs)

Incremental cost and HRQoL effects	
Incremental cost (Healthcare)	-44832.92
Incremental effects	0.513
Incremental cost-effectiveness ratio (Healthcare)	Dominant



WTP Threshold: ◉ €15K/QALY ○ €20K/QALY ○ €30K/QALY ○ €50K/QALY ○ €80K/QALY

The following figures show the cumulative costs and effects. The population is 7117261, the estimation of the number of people assigned to the intervention who suffer from risk of falling. Looking at the discounted values, we observe that the lines become practically flat around the year 20 after the start of the intervention, implying that the intervention would not produce further costs neither effects from that time on.

Figure 5. Cumulative incremental costs

Population-level impact	Population: 7117261 Reset
Population-level impact on incremental cost (Healthcare)	-319087584300.98
Population-level impact on incremental HRQoL	3650710.06

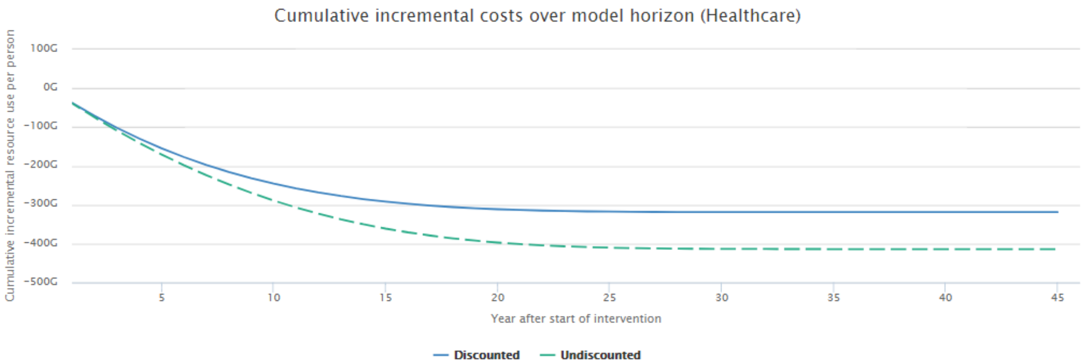
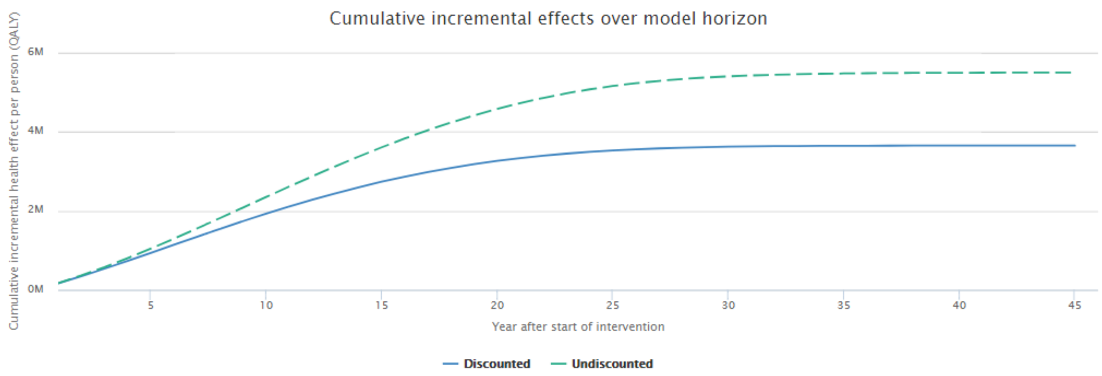


Figure 6. Cumulative incremental effects



Regarding the expected transition between states for one specific person (in this case a 75 years old female), the following figures show that participants in the deteriorated state in the intervention have less probability to stay in this state that participants in deteriorated state who not receive the intervention. On the other hand, participants in baseline state who attend the intervention have higher probability of staying in the baseline state, since the recovery rate is larger. Therefore, participants in the intervention have more probability to be in the baseline states because the recovery rate is higher and the incidence rate is lower than current care scenario.

Figure 7. Patient flow through model states (Alive states)

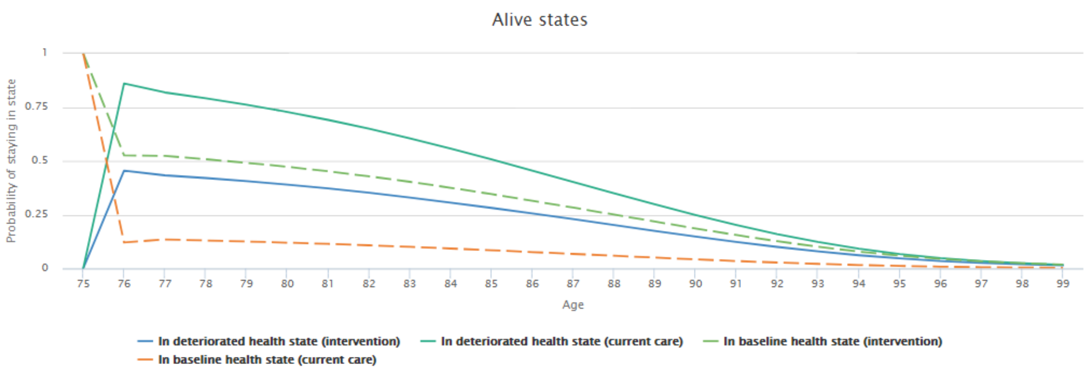
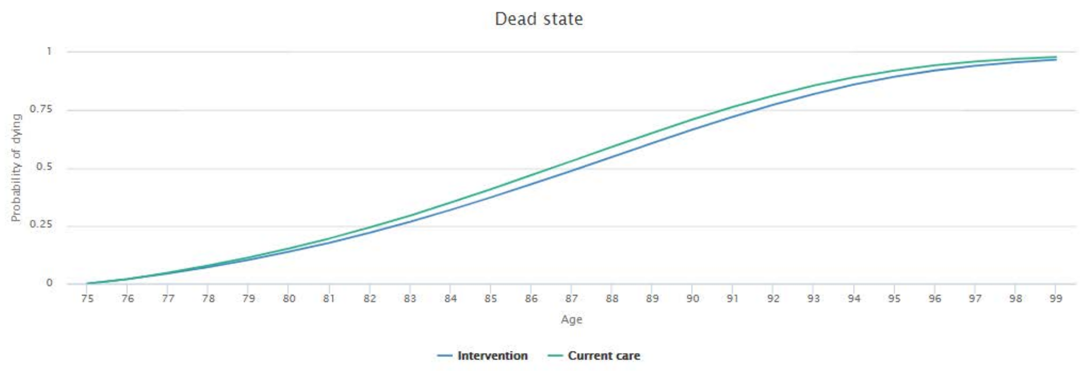


Figure 8. Patient flow through model states (Dead state)



4. Lessons learned

This section summarises the main difficulties we have encountered in adapting the physical exercise program to the Markov model used in MAFEIP. These difficulties are detailed below:

- In the intervention most of the participants started with the health condition (risk of falling). However, in the current version of the tool, all the population starts the simulation by default in the baseline health state.

- In our study societal cost were not calculated. Therefore, the section on intervention costs does not include societal costs. Moreover, intervention costs were only calculated for the intervention group participants, who receive the intervention.

- It would be useful to have more guidelines on how to convert different variables to utility, since not all projects use the EQ-5D. For example, in this case we used the SF-12 Health Survey, which was converted into the 0-1 range using an algorithm.

These lessons learned can be applied for the further development of the MAFEIP tool.