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Promoting the implementation of a computer-tailored physical activity intervention: development and feasibility testing of an implementation intervention

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Abstract

Background Although there are many proven effective physical activity (PA) interventions for older adults, implementation in a real world setting is often limited. This study describes the systematic development of a multifaceted implementation intervention targeting the implementation of an evidence-based computer-tailored PA intervention and evaluates its use and feasibility.

Methods The implementation intervention was developed following the Intervention Mapping (IM) protocol, supplemented with insights from implementation science literature. The implementation intervention targets the municipal healthcare policy advisors, as an important implementation stakeholder in Dutch healthcare system. The feasibility of the implementation intervention was studied among these stakeholders using a pretest–posttest design within 8 municipal healthcare settings. Quantitative questionnaires were used to assess task performance (i.e. achievement of performance objectives), and utilization of implementation strategies (as part of the intervention). Furthermore, changes in implementation determinants were studied by gathering quantitative data before, during and after applying the implementation intervention within a one-year period. Additionally, semi-structured interviews with stakeholders assessed their considerations regarding the feasibility of the implementation intervention.

Results A multi-faceted implementation intervention was developed in which implementation strategies (e.g. funding, educational materials, meetings, building a coalition) were selected to target the most relevant identified implementation determinants. Most implementation strategies were used as intended. Execution of performance objectives for adoption and implementation was relatively high (75–100%). Maintenance objectives were executed to a lesser degree (13–63%). No positive changes in implementation determinants were found. None of the stakeholders decided to continue implementation of the PA intervention further, mainly due to the unforeseen amount of labour and the disappointing reach of end-users.

Conclusion The current study highlights the importance of a thorough feasibility study in addition to the use of IM. Although feasibility results may have demonstrated that stakeholders broadly accepted the implementation intervention, implementation determinants did not change favorably, and stakeholders had no plans to continue the PA intervention. Yet, choices made during the development of the implementation intervention (i.e. the operationalization

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of Implementation Mapping) might not have been optimal. The current study describes important lessons learned when developing an implementation intervention, and provides recommendations for developers of future implementation interventions.

Keywords Intervention implementation, Ehealth, Computer-tailored intervention, Intervention characteristics, Organisational characteristics, Socio-political characteristics, Intermediary characteristics, Physical activity, Prevention

Contributions to the literature

- This study contributes to recognized gaps in the literature by providing insight in (1) a systematically developed multifaceted implementation intervention, following relevant guidelines for reporting implementation strategies, (2) changes in implementation determinants over time, use of implementation strategies and implementation outcomes, (3) the importance of a thorough feasibility study, (4) the importance of combining quantitative data to provide information on how implementation varied with qualitative data about why it varied, and (5) the importance of an iterative approach when developing and evaluating an implementation intervention.
- This feasibility study reflects important lessons learned that can help others in the development of their implementation plan.

Introduction

As societies are rapidly ageing worldwide, healthcare services face vast challenges that will increase in the years to come [1]. A large body of evidence has demonstrated the effectiveness of physical activity (PA) interventions to stimulate the health of older adults, and thereby to lower the impact of the ageing population on healthcare utilisation [2–7]. This evidence mostly comes from controlled trial settings. As the ultimate impact of these interventions not only depends on their effectiveness but also on their actual reach and use in practice, implementation studies are important. Several reports have noted a substantial gap between scientific knowledge and public health practice with regard to implementing PA interventions [8–12]. Furthermore, implementation studies so far mainly focused on the level of the individual end-user (i.e. target population of the intervention), whereas studies on implementation requiring an organizational or system-level adoption are sparse [13]. However, when implementing PA interventions, important stakeholders (i.e. intermediary organizations or implementation actors) are often needed. These stakeholders are the vital link between the intervention developer and the actual end-user, and influence the exposure of the intervention to the target population. Those stakeholders therefore

have a crucial role in the implementation process [14], and stimulating the organizational adoption of PA interventions by engaging those stakeholders is thus highly needed.

In the Netherlands, municipalities are responsible to promote the health and wellbeing of their inhabitants and as such they receive yearly grants of the government. Municipalities were therefore identified as important stakeholders and key intermediaries for implementing preventive health interventions [15]. In each municipality, policy advisors are responsible for putting preventive health policies into action. These healthcare policy advisors are therefore considered to be the most relevant stakeholders when implementing PA interventions to promote the health of older adults in the Netherlands, and are considered the ‘agents of implementation’ in this project.

To increase the public impact of PA interventions, we systematically developed and evaluated an implementation intervention (targeting the municipal healthcare policy advisors) to implement the evidence-based Active Plus PA intervention. Active Plus is a computer-tailored, theory-driven and evidence-based eHealth intervention, designed to stimulate or maintain PA levels among adults aged over fifty by targeting psycho-social determinants like awareness, motivation, self-efficacy and coping planning [16–18]. The intervention can be provided in a Web- or print-based format, and optionally includes information about existing local PA opportunities [17–19]. Participants receive automated computer-tailored advice at three time points within a four month period [16, 17]. The intervention showed significant effects on PA, decreased incidence numbers for PA-related diseases, and has been included in national databases for proven effective interventions [20–23].

To adequately implement evidence-based interventions, a systematic process is needed to develop an effective implementation intervention that considers determinants, mechanisms, and strategies for effecting change [24]. Using a systematic approach following the Intervention Mapping protocol [25] combined with literature and theory on implementation (i.e. Rogers’ Theory of Innovations [26], the framework of determinants of innovation processes described by Paulussen et al. [27], and the Consolidated Framework for Implementation

Research (CFIR [28]), we build upon previously identified potentially relevant stakeholders (i.e. the municipal healthcare policy advisor) and implementation determinants for Active Plus [15] to develop an implementation intervention. The current study aims to describe the systematic development and feasibility study of a multifaceted implementation intervention to guide healthcare policy advisors in the implementation of the Active Plus intervention within the municipality. Reflecting on the choices made during the development of the current implementation intervention the current study describes important lessons learned, and provides recommendations for future implementation intervention developers.

Methods

Study design

A multifaceted implementation intervention was developed according to the principles of the Intervention Mapping protocol [25], supplemented with relevant insights from then available implementation science literature [26–29]. Subsequently, a pre-test post-test feasibility study was performed within 8 municipal healthcare settings. As recommended by Fernandez et al. (2019), the products of the five tasks

of Implementation Mapping are presented in a model (presented in the result section), that illustrates the logic of how the strategies will affect implementation outcomes. The design of the current feasibility study is in line with this model and evaluates all different levels of the logic model considering the evaluation of (1) the use of the implementation strategies, (2) changes in implementation determinants, (3) achievement of performance objectives, and (4) the implementation output.

Implementation process questionnaires were used to assess both the use of the implementation strategies (i.e. level 1 of the logic model) as well as the achievement of performance objectives (i.e. level 3 of the logic model). Those assessments took place at 2 months after the start of the implementation intervention (after the first educational meeting and implementation activities), at 4 months (after the second educational meeting and implementation activities), and at 8–11 months (after the final educational meeting and implementation activities) (see Timeline in Fig. 1). In addition to those questionnaires, semi-structured telephone interviews were performed with stakeholders sharing their views and

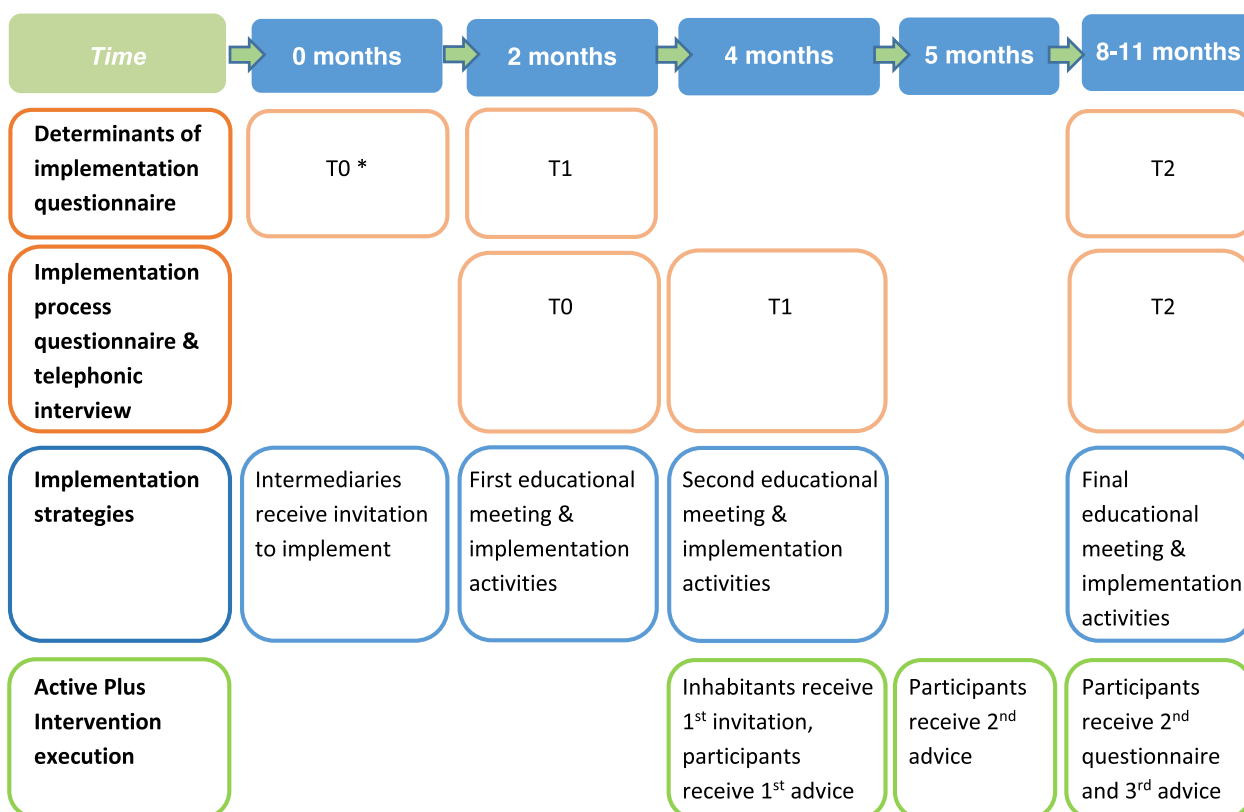


Fig. 1 Timeline of the study. *The T0 questionnaire assessing the implementation determinants was filled in by both implementers and non-implementers. All other assessments included only implementers

experiences regarding the feasibility of the implementation intervention.

Quantitative data on implementation determinants (i.e. level 2 of the logic model) was gathered before (T0), during (T1, after 2 months) and after applying the implementation intervention (T2, after 8 to 11 months) (see timeline in Fig. 1). Questionnaires were filled in by the local municipal healthcare policy advisor who was identified as the implementation actor. At baseline, data on implementation determinants was also gathered among healthcare policy advisors not receiving the implementation intervention nor implementing the Active Plus intervention.

Furthermore, implementation output (level 4 of the logic model) was assessed as the adoption rate (i.e. amount of municipalities willing to adopt the intervention divided by the number invited to adopt the intervention), the reach of the end-user (i.e. number of people using the intervention divided by the number invited to use the intervention), intervention continuation (attrition) among the end-user (number of people dropping out divided by the number that adopted the intervention) and implementation continuation among the healthcare policy advisors (i.e. number deciding to continue implementation divided by the number that started the implementation). Data was collected from August 2017 to October 2018. Effects of implementation on healthcare use were no subject of the current study, as intervention effects on PA and health have been investigated in previous studies [20, 23, 30].

Study Population and procedure

For the current study, the healthcare policy advisor of each municipality ($N=33$) in Limburg (i.e. a Dutch region with a large increase in the portion of older adults) received an email in which they were invited to implement Active Plus. This invitation was accompanied with the first questionnaire and an information leaflet about Active Plus. All invitations were directed to the healthcare policy advisors. Since the organization of policy advisors can differ between municipalities, some healthcare policy advisors appointed a colleague for participation in this project, as they might focus on an overlapping policy topic, like sports or elderly. Therefore, the implementation intervention is not aimed exclusively at the healthcare policy advisor, but at the policy advisor in general, who best meets the performance objectives as specified in the next sections.

Within each participating municipality, the policy advisor was allowed to invite a maximum of 1,000 inhabitants aged over 65 to participate in the Active Plus intervention, whereby the policy advisor could apply more specific selection criteria for participants (e.g. the policy

advisor was allowed to include only participants aged over 75 years if this was more compatible with the policy of the municipality). This age-group was chosen in this study since the amount of people that are sufficiently physically active decreases significantly from this age onwards in the Netherlands [31]. This study was approved by the Research Ethics Committee of the Open University of the Netherlands (reference number U2016/0237373/HVM). The Active Plus intervention itself was registered at the Dutch Trial Register (NTR2297). All participants gave their informed consent before participation.

Development of the implementation intervention

The implementation intervention was developed according to the principles of the Intervention Mapping protocol, supplemented with relevant insights from at the time available implementation science literature. This proved to be largely compatible with the later introduced Implementation Mapping, whose terminology we will use below [24].

The first task of Implementation Mapping (IM), i.e. conducting a needs assessment and identify intervention adopters and implementers, was already performed in a previous study [15], in which municipalities were identified as one of the optimal organization to implement Active Plus. Regional Health Counselors referred to the healthcare policy advisor within the municipality as the most important implementation agent.

Regarding IM-task 2, implementation determinants were also identified in a previous study [15], in which the potential implementers filled in questionnaires about implementation determinants, based on Rogers' Theory of Innovations [26] and the framework of determinants of innovation processes described by Paulussen et al. [27]. For the development of the current implementation intervention, the identified determinants were classified into three main domains of the Consolidated Framework for Implementation Research (CFIR [28]). In the CFIR domain Intervention characteristics, the determinants relative advantage of the intervention, outcome expectancy, and complexity were identified [15]. In the CFIR domain Inner setting, the determinants perceived task responsibility, compatibility available resources, self-efficacy and relative priority were identified. Within the CFIR domain Outer setting the determinants subjective norm and social support were identified. These determinants form the basis for the selection of implementation strategies.

Furthermore, within IM-task 2, performance objectives for implementers (i.e. the municipal policy advisors) were specified by the intervention owners (i.e. the

research team of the Open University who developed the implementation intervention). Performance objectives are essentially the tasks required to adopt, implement, or maintain a program. Three researchers (JB, BB and DP) discussed what sub-behaviours had to be performed in order to adequately implement the Active Plus intervention in practice. These performance objectives were based on previous experience with evaluations of intervention implementation [15, 32, 33], and were needed based on practical limitations (e.g., there was budget to finance participation of 1.000 inhabitants per municipality).

Within IM-task 3 and 4, implementation strategies were selected by the research team aimed to target the identified determinants. Although at present, guidance on how to select implementation strategies is available (for example in the CFIR-ERIC matching tool [34]), at the time of selecting the implementation strategies in the current project, literature regarding effective implementation strategies was limited. However the research team could draw on their broad experience within behavior change, by selecting behavior change techniques (BCTs, as already applied in the development of the Active Plus intervention itself [16–18]), as for example described within the Intervention Mapping protocol [25]. BCTs were selected from the tables within the Intervention Mapping protocol matching the previously described implementation determinants, and these BCTs were combined and translated to one of the discrete implementation strategies from the compilation of Powell et al. (2015). E.g. ‘Consciousness raising’ was selected as a method to increase awareness regarding the perceived advantages of the intervention which was integrated in the development of the educational materials and the educational meetings. ‘Arguments’ (also integrated in the development of the educational materials and the educational meetings) and ‘direct experience’ were selected as methods to increase positive outcome expectations. The ‘direct experience’ was incorporated in the implementation strategy ‘Audit and provide feedback’. ‘Mobilizing social support’ was selected as a method to stimulate social support while implementing the intervention, which was integrated in the implementation strategy ‘Build a coalition’ and ‘Conduct educational meetings’. Implementation strategies were specified in the result section of the manuscript, following the guidelines for reporting by Proctor et al. [35]. The intervention owner and the municipal policy advisors were specified as the actors of the implementation strategies. Further, no specific criteria regarding their expertise were specified for the included actors, besides working as a policy advisor in the municipality related to health, elderly, physical activity and/or prevention. IM step 4 requires planners

to create design documents, draft content, pretest and refine content, and produce final materials. Materials developed in the current project are considered as draft content, that can be refined based on the results of the current feasibility study.

IM-task 5 concerns the evaluation of the implementation using a combination of questionnaires, semi-structured telephone interviews, research notes and registration data. To evaluate the use of the implementation intervention and its effect on implementation determinants and implementation output, a feasibility study was performed as described below.

Measurement instrument

Municipal policy advisors received two types of questionnaires: (a) three questionnaires aiming to test the changes in implementation determinants after using the implementation intervention, and (b) three questionnaires assessing the feasibility of the implementation intervention (i.e. achievement of the performance objectives and utilization of implementation strategies).

Implementation determinants questionnaire

This questionnaire (see Appendix 1, in Dutch) was developed based on Rogers’ theory of Innovations [26], the CFIR [28], the implementation questionnaire used by Bessems et al. [36], and in-depth interviews in a previous study [15]. All determinants from IM-task 2 relevant for a specific time point were assessed with several items per construct (Table 1). Questionnaires were filled out at baseline (T0; the adoption phase), after 2 months (T1; within two weeks after the first implementation strategies have been performed) and after 8–11 months (T2; when Active Plus was completed and data on reach of the intervention and effects on PA were available). The policy advisor of municipal healthcare settings not implementing the intervention were only requested to fill in the baseline questionnaire assessing the adoption determinants.

Feasibility questionnaire

This questionnaire (see Appendix 2, in Dutch) evaluated the execution of the performance objectives and the use of implementation strategies as part of the implementation intervention. Policy advisors were requested to state whether they had performed the prescribed performance objectives by answering dichotomous statements (‘Yes’ vs. ‘No’). Additionally, open-ended questions were asked to state (concisely) the main reason for not performing a certain task or for making a certain decision. These questionnaires were sent after 2 months (the T0 measurement for this process; i.e. within two weeks after the first implementation strategies should have been performed), after 4 months (T1; i.e. within two weeks after the second stage of implementation strategies should have been

Table 1 Measurements of characteristics of the intervention, the inner setting and the outer setting of the implementing organization

CFIR Domain—Concept	Definition	Items (N)	Example Question/Statement	Reliability α
Intervention characteristics				
Relative advantage	Degree to which Active Plus is perceived as being superior to other PA interventions	18	Compared to other interventions, implementation costs for this intervention are low. <i>Totally disagree (1) to Totally agree (5)</i>	0.91
Outcome expectancy	Quality and validity of evidence supporting the belief that Active Plus will have desired outcomes and that effects are observable to others	13	By implementing this intervention, PA behaviour of people aged over 65 within our region will increase <i>Totally disagree (1) to Totally agree (5)</i>	0.95
Complexity	Degree to which Active Plus is perceived as difficult to understand and use	5	Implementing Active Plus is uncomplicated. <i>Totally disagree (1) to Totally agree (5)</i>	0.66
Inner setting				
Perceived task responsibility	Perception of the organization that he or she is responsible for intervention implementation	7	It is our organisation's responsibility to stimulate PA among people aged over 65. <i>Totally disagree (1) to Totally agree (5)</i>	0.83
Compatibility	Degree to which the intervention is perceived as being consistent with existing values, needs, and experiences of the implementing organization	7	The intervention corresponds with our targets <i>Totally disagree (1) to Totally agree (5)</i>	0.87
Available resources	Sufficiency of resources to implement the intervention	9	Our organisation has sufficient staff capacity to implement the intervention. <i>Totally disagree (1) to Totally agree (5)</i>	0.80
Self-efficacy	Belief in their own capabilities to execute courses of action to achieve implementation goals	4	I think our organisation is capable to implement the intervention. <i>Totally disagree (1) to Totally agree (5)</i>	0.77
Relative priority	Perception of the importance to implement the intervention	5	Our organisation thinks it is relevant that people aged over 65 are sufficiently physically active. <i>Totally disagree (1) to Totally agree (5)</i>	0.96
Outer setting				
Subjective norm	Expectation that other local or regional organizations think that the municipality should implement the intervention	8	Welfare organisations think it is— <i>Very unimportant (1) to Very important (5)</i> —that our organisation implements this intervention	0.93
Social support	Expectation that these other organizations will support the implementation	9	I expect to get support for intervention implementation from (other) MHC's. <i>Certainly not (1) to Yes, definitely (5)</i>	0.72
Intention to implement Active Plus				
		5	Within one year, our municipality would like to play a role in the implementation of Active Plus. <i>Certainly not (1) to Yes, definitely (5)</i>	0.87

α stands for the reliability of each scale calculated from baseline values in the current study. A reliability of 0.6–0.7 is considered acceptable. A reliability > 0.7 is considered good (Field, 2013)

performed) and after 8–11 months (T2; i.e. when Active Plus was finished).

Semi-structured telephone interview and research notes

Semi-structured telephone interviews were performed with policy advisors evaluating their considerations on how they performed the performance objectives and implementation strategies. When a task was not performed, they were asked to elaborate on the reason(s) and whether the task was scheduled for a later moment (see appendix 3, in Dutch). If the policy advisors did not yet fill in the implementation process questionnaire before the deadline, questions that were stated in this questionnaire were asked within the interview as well. These qualitative data were supplemented with data acquired during meetings within the implementation process. As the qualitative data were collected to enhance interpretation of the quantitative data but not for the purpose of an exhaustive qualitative analysis, they were not recorded or analyzed as such.

Analyses

Questionnaire data were analyzed using SPSS version 24. For the feasibility study, the dichotomously scored performance objectives were described for each municipal healthcare setting over time and as a percentage of all planned performance objectives. Execution of each performance objective over all municipal healthcare settings was expressed as a percentage. Qualitative data (i.e. notes taken during telephonic interviews) were matched with the relevant performance objectives, implementation strategies and determinants by a researcher not being the interviewer.

Univariate one-way analyses of variance (ANOVA) were used to examine differences in baseline scores on implementation determinants between municipal healthcare advisors that implemented the intervention and those that did not. Friedman non-parametric tests assessed changes in implementation determinant scores over time. Furthermore, the adoption rate of municipalities was assessed by dividing the number of implementers, by the number of municipalities invited to implement the intervention. The reach of the end-user was calculated by dividing the number of Active Plus participants per municipality, by the number of inhabitants that were invited to participate per municipality. Attrition was calculated by dividing the number of participants that completed the second Active Plus questionnaire, by the number of participants that completed the baseline questionnaire.

Results

Within this section, firstly the results of applying the Intervention Mapping protocol are presented, resulting in a multifaceted implementation intervention, followed by the results of the feasibility study.

A multifaceted implementation intervention

Building upon the results of a previous study (i.e. identification of relevant adopters and implementers and identification of implementation determinants, IM-task 2 resulted in the formulation of relevant performance objectives to be achieved during intervention implementation. An overview of these performance objectives is presented in Table 2.

As a result from IM-task 3 and 4, Table 3 provides an overview of the implementation strategies selected, following the guidelines for reporting by Proctor et al. (29).

The results of following all tasks of IM are summarized in a comprehensive logic model (see Fig. 2), illustrating how the selected implementation strategies (visualized at the left part of the logic model) can influence the determinants of implementation behaviors, and consequently the performance objectives for adoption, implementation, and maintenance, which in turn influence implementation outcomes.

Results of the feasibility study

In line with the different levels of the logic model, the feasibility study provided insight in the use of the implementation strategies, achievement of performance objectives, changes in implementation determinants and implementation output.

Use of implementation strategies

The use of the implementation strategies is discussed below, in order of appearance in Table 3.

Access new funding: All policy advisors employed the funding that was made available to invite 1000 participants. Within two municipal healthcare settings both the Web- and print-based format was implemented: as the additional labour, material and postage costs were not covered by the funding, they arranged additional funding within their own municipal healthcare settings.

Develop and distribute educational materials: The intervention owner developed and distributed the materials as stated in Table 3. The interviews showed that within municipal healthcare settings Active Plus was actively promoted by announcements in their local newspapers or on social media. One policy advisor organized a kick-off meeting for the target population; other policy advisors found this impossible to organize because of time constraints, and one policy advisor decided against such a meeting out of fear that older adults who were not

Table 2 Performance objectives per implementation stage

Stage of Implementation process	Performance objectives
The municipal policy advisor decides to adopt Active Plus	<ol style="list-style-type: none"> 1. Choose whether to adopt the online version of Active Plus, the print-delivered version or both 2. Choose who (selection of 1.000 inhabitants) will be invited to participate
The municipal policy advisor implements Active Plus as described in the implementation manual	<ol style="list-style-type: none"> 1. Inquire information at the regional health counselor about the possibility to integrate Active Plus with other initiatives in the region 2. Inform other relevant stakeholders (like welfare organizations and local interest groups for older adults) about Active Plus, involve them and keep them updated 3. Gather information about local sport options and social initiatives for older adults, and integrate this information within the Active Plus website 4. Explore the strategies to recruit the target population with network partners 5. Invite 1.000 inhabitants aged over 65 to participate in Active Plus 6. Make sure that someone is available to answer potential questions of participants
The municipal policy advisor plans for Active Plus to be part of their policy and implementation will be maintained long-term after initial funding	<ol style="list-style-type: none"> 1. Inquire information at the regional health counselor about the possibility to integrate Active Plus within the existing policies of your municipality 2. Make a plan about the prolonged continuation of Active Plus within your municipal healthcare setting, based on experiences

invited for the intervention would feel left out. Stakeholders were provided with leaflets and recruitment letters that they could provide to the target population. About one third of the policy advisors did not distributed the recruitment letters among the target population at T0 because of time constraints. At T1, all policy advisor but two expressed that they did not perform any additional recruitment activities after sending the recruitment letter; time constraints were mentioned as main cause.

Develop and distribute an implementation manual: the manual was developed and distributed among the policy advisors by the intervention developer. Additionally, a step-by-step checklist was provided and during the educational meeting the essential implementation strategies were discussed. At T0, five policy advisor expressed that they used either the manual, the checklist or both. At T1, all policy advisor expressed that they did not use the manual anymore but either found enough guidance in the meetings or in the checklist.

Build a coalition: At T0, all policy advisors reported that they approached or intended to approach their regular contacts among stakeholders; no policy advisor tried or intended to establish new collaborations. At T1, the majority of policy advisors declared that they performed this task mostly as planned. If not, it was due to time constraints. All policy advisors expressed to be content with the coalition that was formed. In the implementation manual, the Regional Health Service (RHS) and the Senior Citizen Organisations (SCO) were explicitly mentioned as potential coalition partners. Policy advisors had divergent ideas on the usefulness of the RHS: half found the RHS of no additional value and therefore did not contact them, the other half approached them

actively for advice on what target population to choose. The majority of policy advisors expressed that SCOs have other goals than being included in an intervention implementation effort and therefore did not contact them.

Conduct educational meetings: These were organized by the intervention owner on T0, T1 and T2, on which respectively seven, six and six policy advisors were present. The meetings lasted about three hours and at all meetings, representatives of the RHS and SCO were present.

Capturing and sharing local knowledge: All policy advisors actively participated in the interactive educational meetings. During the interviews the policy advisors declared that they did not organise any collaboration sessions with the partners in their coalition: stakeholders were contacted individually. Again, time constraints were mentioned as a reason.

Centralize technical assistance: The intervention owner arranged technical assistance for each municipal healthcare setting which was available both by telephone and email. Policy advisors also arranged this for the participants and three also arranged personal assistance to fill in the questionnaires.

Promote adaptability: All policy advisor added their logo to their homepage and information on local PA opportunities such as hiking clubs or opening hours of swimming pools. Furthermore, six policy advisor adapted the recruitment letter to optimize it to the needs of older adults in their municipal healthcare setting.

Audit and provide feedback: During the course of the intervention, the policy advisor could access real-time data via their personal website on reach, demographic features of the participants and their PA behaviour. These

Table 3 Overview of implementation strategies

Implementation strategies	Actors	Actions	Targets	Temporality	Dose	Implementation output or determinant affected
Access new funding	Intervention owner	<p>Costs for implementation were covered by a research grant received by the intervention owner. Costs were covered regarding:</p> <ul style="list-style-type: none"> • Intervention participation of 1,000 citizens aged over 65 • Printing, postage and labour costs for the municipality to recruit participants • Additional labour, material and postage costs for the printed version were not covered by the funding and had to be funded by the municipality 	Municipal policy advisor	<ul style="list-style-type: none"> • Start of implementation 	Once	<ul style="list-style-type: none"> - Reach of end-user - Perceived relative advantage

Table 3 (continued)

Implementation strategies	Actors	Actions	Targets	Temporality	Dose	Implementation output or determinant affected
Develop and distribute educational materials	Intervention owner	<p>The following educational materials were developed and distributed:</p> <ul style="list-style-type: none"> • a letter providing information on the timeline of implementation and brief information about the performance objectives for municipalities; • a flyer explaining the content of the intervention, its timeline and the effectiveness; • a manual for working with Active Plus, in coherence with GDPR guidelines; • a manual for implementing Active Plus • recruitment letters as a template on how municipalities could invite the end-user • pre-structured plan that guides the municipal policy advisor in translating their implementation experiences into an implementation continuation plan (e.g. involvement of stakeholders, financing the intervention, determining a target population etc.) 	Municipal policy advisor	<ul style="list-style-type: none"> • Start of implementation: the information letter and the information flyer were distributed • After 2 months (during first educational meeting): both manuals and example recruitment letters were distributed 	Once	<ul style="list-style-type: none"> - Reach of end-user - Perceived relative advantage - Outcome expectancy - Complexity - Compatibility
	Municipal policy advisor	<p>The example recruitment letters, and information flyers were distributed among other relevant stakeholders to inform them about Active Plus and to instruct them how to promote participation of the end-user to the intervention</p>	Other stakeholders (like Senior Citizen Organizations and regional Municipal Health Services)	<ul style="list-style-type: none"> • After the first educational meeting 	Once	<ul style="list-style-type: none"> - Subjective norm - Social support - Available resources

Table 3 (continued)

Implementation strategies	Actors	Actions	Targets	Temporality	Dose	Implementation output or determinant affected
	Municipal policy advisor	Recruitment letters were distributed to the end-user (i.e. target population) in coherence with GDPR regulations	End-user	<ul style="list-style-type: none"> • After the second educational meeting 	Once	<ul style="list-style-type: none"> - Reach of end-user
Develop and distribute an implementation manual	Intervention owner	A implementation manual was developed and distributed describing: <ul style="list-style-type: none"> • the features of the intervention • which actions have to be performed to get it running, • suggestions for relevant stakeholders to be involved in promoting the interventions 	Municipal policy advisor	<ul style="list-style-type: none"> • Presented and distributed during the first educational meeting 	Once	<ul style="list-style-type: none"> - Reach of end-user - Perceived relative advantage - Outcome expectancy - Complexity - Compatibility
Build a coalition	Municipal policy advisor	Municipalities were stimulated to recruit and cultivate relationships other with stakeholders and instructed to build a coalition	Other stakeholders	<ul style="list-style-type: none"> • During the first educational meeting 	Continuously	<ul style="list-style-type: none"> - Subjective norm - Social support - Available resources

Table 3 (continued)

Implementation strategies	Actors	Actions	Targets	Temporality	Dose	Implementation output or determinant affected
Conduct educational meetings	Intervention owner	<p>Three interactive collaboration sessions were organised</p> <ul style="list-style-type: none"> • Meeting 1: Regarding Active Plus, municipalities were informed about: <ul style="list-style-type: none"> - its necessity and its proven effectiveness, - how it matches the targets of the municipalities (e.g. improving health, loneliness and independence of their inhabitants) - its ease of implementing, and other advantages - the performance objectives during implementation <p>Information was visually presented and used to stimulate discussion</p> <ul style="list-style-type: none"> • Meeting 2: This meeting focusses on: <ul style="list-style-type: none"> - collaboration with relevant stakeholders (see 'Build a coalition' and 'Capture and share local knowledge') - How to use Active Plus: Municipalities received the educational materials and had the opportunity to practice with the different functionalities on the Active Plus website - Local adaptability of the intervention was promoted (see 'Promote adaptability') • Meeting 3: This meeting aimed to: <ul style="list-style-type: none"> - Evaluate the intervention (see 'Audit and provide feedback') - Share local knowledge and best practices (see 'Capture and share local knowledge') 	Municipal policy advisor	<ul style="list-style-type: none"> • 2 months after deciding to implement the intervention, • 4 months after deciding to implement the intervention, • at the end of the first implementation round 	3 times	<ul style="list-style-type: none"> - Reach of end-user - Perceived relative advantage - Outcome expectancy - Complexity - Compatibility - Subjective norm - Social support - Perceived tasked responsibility

Table 3 (continued)

Implementation strategies	Actors	Actions	Targets	Temporality	Dose	Implementation output or determinant affected
Capture and share local knowledge	Intervention owner Municipalities	Municipal policy advisors were stimulated to invite other relevant stakeholders to join the 2nd meeting as well. During this meeting, all attendees were stimulated to discuss: <ul style="list-style-type: none"> • their local considerations regarding which inhabitants to invite for participation, • their plans on how to invite these inhabitants, • whether they preferred to implement the printed or the online version of the intervention • which other organizations they would involve during implementation Municipal policy advisors were stimulated to organize comparable meetings themselves	Municipal policy advisor	<ul style="list-style-type: none"> • During second and third educational meeting 	3 times	<ul style="list-style-type: none"> - Reach of end-user - Compatibility - Complexity - Subjective norm - Social support - Available resources
Centralize technical assistance	Intervention owner	Technical assistance for the municipalities was provided by the intervention owner by mail and telephone to assist with implementation issues	Municipal policy advisor		Continuously during implementation	<ul style="list-style-type: none"> - Complexity
	Municipalities	Technical assistance was provided by the municipality to the end-user by mail and telephone to assist with questions about Active Plus	End-user		Continuously during participation	<ul style="list-style-type: none"> - Reach of end-user

Table 3 (continued)

Implementation strategies	Actors	Actions	Targets	Temporality	Dose	Implementation output or determinant affected
Promote adaptability	Intervention owner	<p>It was explained how municipalities were able to adapt the intervention to their local situation. Potential adaptations were:</p> <ul style="list-style-type: none"> • free choice of delivery mode of the intervention (i.e. online, print-delivered or a combination), • adding their logo to the intervention materials (using their personal page on the intervention website) • adding information on local PA initiatives 	Municipal policy advisor	<ul style="list-style-type: none"> • During the second educational meeting • In the educational materials • In implementation manual 	Continuously during implementation	- Perceived relative advantage
Audit and provide feedback	Intervention owner	<p>Information regarding the reach, demographic features of the participants and their PA behaviour was gathered and reported to the municipal policy advisors on a personal webpage and during the final educational meeting. Furthermore, these findings were discussed during the third educational meeting</p>	Municipal policy advisors, End-user	<ul style="list-style-type: none"> • At the start of Active Plus • After 2 months • After 12 months 	3 times	<ul style="list-style-type: none"> - Perceived relative advantage - Outcome expectancy

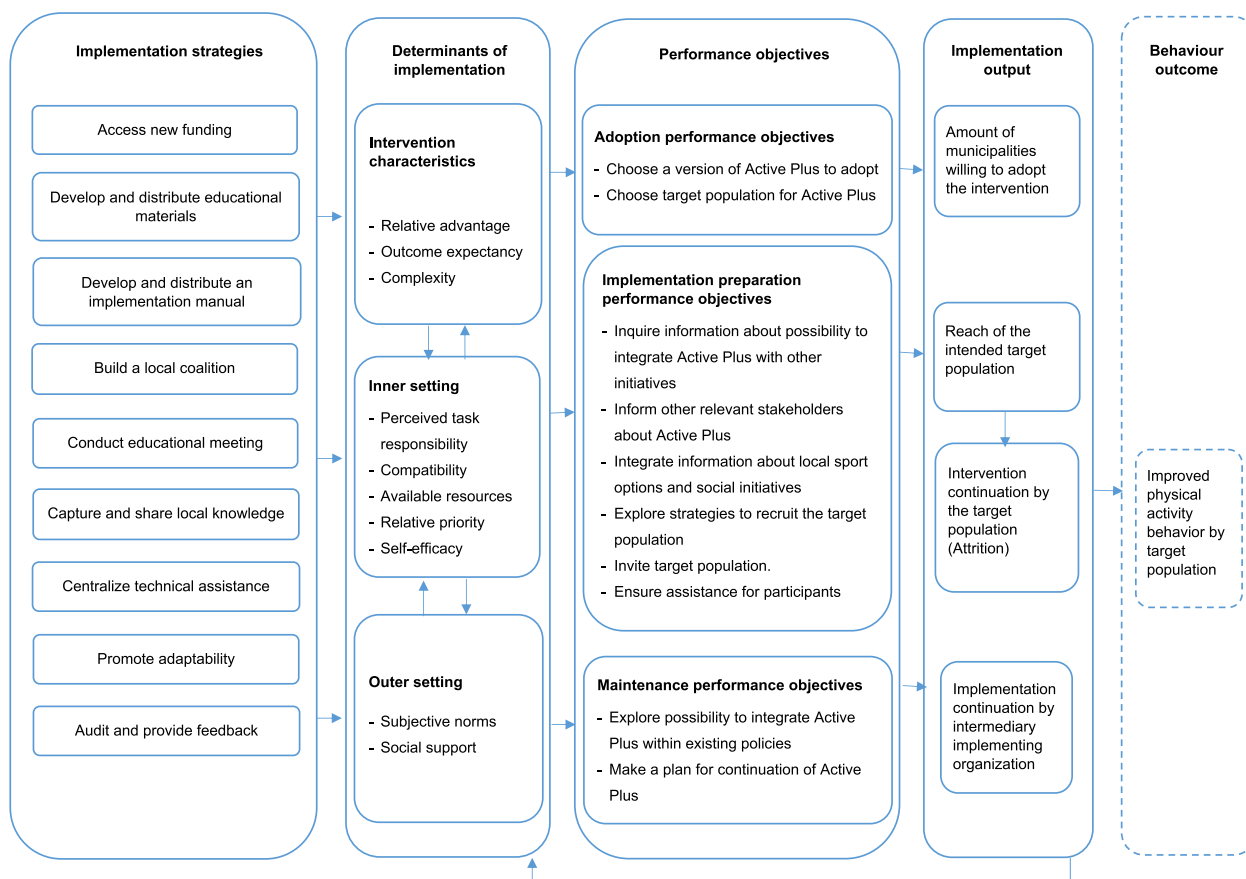


Fig. 2 Logic model of the study

data were also presented by the intervention owner during the final educational meeting.

Achievement of performance objectives

Overall, execution of the performance objectives for adoption and implementation was relatively high, ranging from 75 to 100% execution score per municipal healthcare setting (see Table 4). The two performance objectives for maintenance were executed to a lesser degree (12.5% and 62.5%). Regarding the decision to adopt Active Plus, within the first two months five policy advisors did not know yet whether they would choose to implement the online or the printed version. The decision which 1.000 inhabitants to invite was made within the first two months by all policy advisors. In the interviews, all policy advisors stated that they balanced between inviting a target population that could benefit most from the intervention (e.g. low Socio Economic status neighbourhoods, or inhabitants with sufficient digital skills for an online intervention) and a target population that was pragmatic to invite (e.g. the oldest 1000 inhabitants).

Six policy advisors indicated that they expected higher participation rates and effectiveness by offering Active Plus both web- and print-based; four decided to offer web-based only due to either difficulties in complying to the then newly implemented privacy protection regulations (i.e. the General Data Protection Regulation (GDPR)) (N=2), time investment and printing costs (N=3) or because the selected inhabitants were deemed to be sufficiently e-literate for a web-based version (N=1). During the telephone interviews, a large majority of policy advisors expressed that if there were no constraints regarding the number of invitations, different choices would have been made: most policy advisors would then prefer inviting either a larger group or to additionally offer a printed delivery mode.

Five policy advisors inquired information at the RHS about integration with other initiatives, but only after inviting the end-users. The other implementation performance objectives were executed by all policy advisors.

Overall, five policy advisors contacted the RHS about integration with local policies, and one municipality made a plan about continuation. Four policy advisors reported that they indeed considered continuation

Table 4 Execution of the performance per municipality at T0 and T2, and for the total intervention period (T0-T2)

POs	M1		M2		M3		M4		M5		M6		M7		M8		Execution by municipalities (%)							
	T0	T2	T0-T2	T0	T2	T0-T2	T0	T2	T0-T2	T0	T2	T0-T2	T0	T2	T0-T2	T0		T2	T0-T2					
	A1	Y	Y	Y	Y	N	N	N	Y	Y	Y	Y	N	N	N	Y		Y	N	Y	Y	75		
A2	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	100				
I1	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	N	N	N	88				
I2	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	100				
I3	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	100				
I4	Y	N	Y	N	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	N	Y	Y	100				
M1	Y	N	Y	N	N	Y	Y	Y	Y	Y	Y	N	N	N	N	N	N	N	N	63				
M2	N	N	N	N	N	N	N	N	N	N	N	Y	Y	Y	N	N	N	N	N	13				
Execution of POs (%)	86	63	88	43	88	88	43	75	75	71	63	88	100	88	88	29	75	75	43	75	75	57	63	63

M1-M8 = Code of municipal healthcare setting; Y = Performance objective executed; N = Performance objective not executed. PO = Performance objective; A1 = Choose whether to adopt the online version of Active Plus, the print-delivered version or both; A2. Choose who (selection of 1,000 inhabitants) will be invited to participate; I1. Inquire information at your regional health counselor about the possibility to integrate Active Plus with other initiatives in the region; I2. Inform other relevant stakeholders (like welfare organizations and local interest groups for older adults) about Active Plus, involve them and keep them updated; I3. Gather information about local sport options and social initiatives for older adults, and integrate this information within the Active Plus website; I4. Explore the strategies to recruit the target population with network partners; M1. Inquire information at your regional health counselor about the possibility to integrate Active Plus within the existing policies of your municipality; M2. Make a plan about the prolonged continuation of Active Plus within your municipality, based on experiences

Table 5 Scores on implementation determinants

	Determinant scores, Mean (SD)				Sign. difference			
	Baseline measurement (t0)		Interim measurement (t1)	Final measurement (t2)	Between implementers and non-implementers at t0		Within implementers over time (t0-t1-t2)	
	Non-implementers (n = 16)	Implementers (n = 8)	Implementers (n = 7)	Implementers (n = 8)	Mann-Whitney U	Exact Sig	Chi-Square	Asymp. Sig
Intervention characteristics								
Relative advantage	2.82 (0.35)	3.41 (0.54)	3.29 (0.24)	2.72 (0.43)	35.500	.083*	7.600	.022**
Outcome expectancy	3.18 (0.85)	3.58 (0.19)	4.01 (0.48)	3.32 (0.33)	30.500	.513	6.000	.050*
Complexity	3.26 (0.46)	3.50 (0.55)	3.91 (0.43)	3.53 (0.58)	42.500	.475	1.600	.449
Inner setting								
Perceived task responsibility	3.90 (0.65)	4.19 (0.23)	-	3.93 (0.55)	61.000	.130	2.667	.102
Compatibility	3.29 (0.46)	3.79 (0.09)	4.10 (0.30)	3.71 (0.20)	41.500	.040**	.316	.854
Available resources	3.10 (0.41)	3.19 (0.62)	3.48 (0.44)	3.14 (0.42)	32.000	1.000	1.500	.472
Relative priority	4.14 (1.03)	4.50 (0.33)	-	4.23 (0.47)	47.500	.659	1.800	.180
Self-efficacy	3.42 (0.73)	3.42 (0.49)	3.86 (0.38)	3.09 (0.61)	24.000	.776	10.182	.006**
Outer setting								
Subjective norm	3.26 (0.73)	3.69 (0.42)	-	2.76 (0.58)	30.000	.491	2.667	.102
Social support	3.17 (0.47)	3.42 (0.26)	-	2.45 (0.80)	31.000	.414	1.800	.180
Intention to implement Active Plus within the next year	2.62 (0.84)	3.40 (0.61)	3.57 (0.66)	2.30 (0.69)	58.000	.085*	7.524	.023**

* $p < .10$ ** $p < .05$

of Active Plus a task for municipal healthcare settings, because it fits their responsibility to care, be close to inhabitants and bring stakeholders together. The two policy advisors that did not feel the responsibility to continue Active Plus stated that implementation involved too much practical work that should be outsourced or would come with additional financial burden.

Changes in determinants of implementation

At baseline, mean scores on implementation determinants (scaled from 1–5) varied from 2.82 to 4.14 among non-implementing municipal healthcare settings and from 3.19 to 4.50 among implementing municipal healthcare settings (see Table 5). Highest scores were seen in relative priority, among both non-implementers and implementers. The score on perceived relative advantage was lower among non-implementers compared to implementers (2.82 versus 3.41; $p = 0.083$). The perceived compatibility was significantly higher among implementers

compared to non-implementers (3.79 versus 3.29; $p = 0.040$).

Over time, several changes in implementation determinant scores were identified among the policy advisors who implemented the intervention. These changes were supported by the findings from interviews with the policy advisors, which are reported below per cluster of implementation determinants.

Perceived intervention characteristics

A decrease was observed in the perceived relative advantage of the intervention, starting with a score of 3.41 at baseline and ending with a score of 2.72 ($p = 0.022$). Around half of the policy advisors expressed that the online delivery mode of the intervention, and specifically the few administrative tasks associated with it, were considered a relative advantage compared to other interventions. However, policy advisors found the other implementation strategies, such as getting stakeholders involved, more time-consuming than expected, which

is in line with the found decrease in perceived relative advantage. Outcome expectancies significantly varied over time with an average score of 3.58 at baseline, 4.01 at interim and 3.32 at the end of the period ($p=0.050$). In the interviews, five policy advisors expressed from baseline on that the intervention would only be sustained after the research period if outcomes were satisfactory. Regarding outcome expectancy, policy advisors mainly referred to the number of participants and the attrition over time, and much less so to the effectiveness of the intervention. Six of the policy advisors were not satisfied with both participation and attrition, which is in line with the decrease in outcome expectancy.

Inner setting

Self-efficacy significantly varied over time with an average score of 3.42 at baseline, 3.86 at interim and 3.09 at the end of the period ($p=0.006$). Half of the policy advisors stated that they used the implementation intervention only at the start of the intervention and expressed that it gave them the guidance needed at that point in time. Later on, six policy advisors stated that they did not use the implementation intervention anymore. In combination with the extra labour that was needed to reach sufficient end-users and collaborating stakeholders, implementation was found more challenging, possibly accounting for the decrease in self-efficacy.

Outer setting

No significant changes were observed in outer setting determinants.

Intention to implement within the next year

The intention varied significantly over time with an average score of 3.40 at baseline, 3.57 at interim and 2.30 at the end of the period ($p=0.023$). In the interviews, all policy advisors stated that the participation degree of elderly in the intervention was the main reason for their lack of intention to continue the implementation. Also, budgetary reasons, was frequently stated as reason. Three policy advisors stated that the decision to implement would also depend on policies being developed in the upcoming years.

Implementation output

The implementation output was reflected in an adoption rate of 24%; 8 of the 33 invited municipal health-care setting were willing to implement Active Plus. Among the end-users, a reach of 8% (range 4 to 11%) was achieved, i.e. 624 older adults participated in Active Plus. The second questionnaire of the intervention was completed by 124 end-users, implying an attrition of 80.1% in three months.

None of the municipal policy advisors decided to continue implementation of the PA intervention. In the telephone interviews at T0, all but one policy advisor stated that they intended to continue implementation if results were satisfactory and if sufficient budget was available. Regarding the budget, policy advisors also mentioned that obtaining sufficient budget could be problematic as financial means were already allocated for the next year. At T2, 75% of the policy advisors mentioned the disappointing participation rate of older adults as the main reason to discontinue implementation: only 25% mentioned financial limitations as reason.

Discussion

The current study describes the systematically developed multifaceted implementation intervention to support implementation of the evidence-based Active Plus intervention and the results of its feasibility-test.

Following the principles of the Intervention Mapping protocol, supplemented with relevant insights from then available implementation science literature, a multi-faceted implementation intervention was developed in which implementation strategies (e.g. funding, educational materials, meetings, building a coalition) were selected to target the most relevant identified implementation determinants. Results of the feasibility study showed that most implementation strategies were performed adequately and that execution of the performance objectives for adoption and implementation was relatively high. This may demonstrate that implementers broadly accepted the presented strategies and performance objectives and recognized them as being useful. Despite this, no positive changes in implementation determinants were observed over time: remarkably, a decrease was observed in the perceived relative advantage of the intervention and after an initial increase, scores on outcome expectancies, self-efficacy and intention to implement the intervention decreased. Eventually, none of the implementers decided to continue intervention implementation. As the most important reason not to continue the implementation, implementers declared that the unforeseen amount of labour required to promote the intervention among stakeholders and end-user (due to the disappointing reach and attrition) made the implementation more time-consuming than expected.

In addition to the above, the fact that no positive changes in implementation determinants were found may have several explanations. First of all, it might be explained by the depth in which we assessed determinants of implementation in our previous study, which forms the base for the developed implementation intervention. Secondly, the selection of implementation strategies used in the current study might have not

been optimal. These two explanations will be elaborated on below.

With regard to implementation determinants, the study identifying these determinants [15] was targeted to only one person within each municipal healthcare setting, which might have resulted in a lack of insight in potential barriers and facilitators of implementation perceived by other relevant implementation actors. As stated by Fernandez et al. [24] in their Implementation Mapping protocol, which was published after the design of our implementation intervention, implementation outcomes and performance objectives should be stated specific for each adopter and implementer. If adoption and implementation involve multiple actors such as administrators, policy advisors and policy makers, each may have their own performance objectives. In line with this recommendation of Fernandez et al., it can be recommended to gain insight in the perceived determinants by all these different adopters and implementers as well, and not only by one stakeholder per municipal healthcare setting. In addition, more in-depth insight to some implementation determinants might be useful. For example, whereas outcome expectancy and visibility of the intervention effects were previously [15] identified as important implementation determinants, the current study showed that the reach and attrition of participants seemed a more important outcome measure than the effectiveness of the intervention on PA for the decision to discontinue the implementation of Active Plus. It would therefore be advisable to explicitly ask the implementing organisations at which outcomes they would consider the intervention to be successful.

Insight in determinants related to the CFIR-domain 'implementation process' were lacking in our previous study [15], as that study focused on municipalities who had not yet implemented the intervention. The current study showed that within the implementation process, hindering aspects mainly related to the CFIR constructs 'engaging' (e.g. the difficulties perceived to get other external stakeholders involved in the implementation, and in recruitment of intervention participants) and the construct 'planning' (e.g. the mentioned time constraints which affected timelines of task completion). Identifying determinants associated with the implementation process can be challenging among potential implementation actors who have no prior experience with the intervention. This underscores the significance of conducting a feasibility study during the development of an implementation intervention, as it has the potential to yield fresh insights into the determinants linked to the implementation process itself.

Determinants related to the 'outer setting' domain (i.e. contextual influences like policy and local agenda

settings) changed over time. The identification of determinants and the actual implementation of the intervention were three years apart, so determinants related to the outer-setting might have changed, as well as the prioritization of the determinants, which might both have consequences for the adequateness of the selected implementation strategies. Changes in context or policy might influence the role that municipalities play in intervention implementation. This was supported by our qualitative data: three municipalities expressed that changes in policy influence if and which interventions to stimulate PA would be implemented. Anticipating on changes in context and policy (and thus regularly assessing the related determinants) is highly recommended.

The second explanation on why no positive changes in implementations determinants were found might lay in not selecting the most optimal implementation strategies. As there is still no consensus in literature on how to best select implementation strategies, the current implementation intervention was based on a pragmatic selection of most suitable strategies targeting the identified implementation determinants. A useful tool to make a first selection of implementation strategies is the 'CFIR-ERIC strategy matching tool'. However, this tool was not yet available during the development of the implementation intervention described in the current study. The CFIR-ERIC matching tool can help to select strategies to address barriers that were identified using the CFIR. This tool is based on the work of Powell et al. [29] and the work of Waltz et al. [34]. The selection of strategies could further have been optimized by including stakeholders in the selection and development of these implementation strategies as well (i.e. user-centered development). Previous studies have shown that a user-centered design also results in better program sustainability [10, 37, 38]. This user-centered development should not only involve the implementing organizations, but also to the target population (i.e. the end-user). The policy advisors stated that they were not content with the participation and attrition rates. Adding implementation strategies like 'increase demand' (attempting to influence the market for Active Plus) and 'intervene with consumers to enhance uptake and adherence' [29] might positively affect the participation and attrition of the target population. This could demonstrate the need for active involvement of the target population in the development of implementation strategies.

Furthermore, although formulating a plan for sustainability of implementation was one of the intended outcomes, implementation strategies to facilitate continuation were not sufficiently included in the current implementation intervention. Since we provided funding

for the intervention cost as part of the evaluation, implementers may have regarded the implementation as a test without any obligation or may have not sufficiently considered financial support for continuing the intervention. Furthermore, the current implementation intervention mainly aimed to target determinants related to the intervention characteristics and the inner setting, and to a much lesser degree the implementation determinants related implementation process and the outer setting. Based on the current insights, recommendations can be provided for (additional) more suitable implementation strategies affecting determinants relating to the implementation process itself and the outer setting, e.g., implementation strategies like conducting local consensus discussions, inform local opinion leaders, promote network weaving, and obtain formal commitments might positively influence the engagement [29]. Furthermore, as the use of local opinion leaders has been identified as one of the most effective implementation strategies [39], implementation of Active Plus could benefit from including this strategy within its implementation intervention as well.

To our knowledge, this is the first study providing insight over a longer implementation period in the use and effects of a systematically developed implementation intervention aiming to target the implementation of an evidence-based eHealth PA intervention for older adults. One of the strengths of the current study is that it provides insight into the use of the implementation strategies, as well as in the changes in determinant scores regarding implementation over time and consequently the results of the implementation intervention (i.e. the implementation output). Furthermore, the mixed method design, i.e. the use of both quantitative and qualitative methods of evaluating the implementation can be considered a strength of our study. While the quantitative data has provided us with statistical information on how the implementation of an intervention varies, the qualitative data has provided insights on why it varies, and integrating these data generates a better insight in factors that determine intervention implementation [40].

Although this study provides relevant insight, some limitations should be noted. First, no ad-verbatim transcripts were made of the qualitative data. Hence, the qualitative data should be interpreted with care. However, it has been argued that the benefits of combining quantitative data with qualitative data outweighs the strict use of guidelines: instead, a pragmatic approach to interpreting qualitative data has been advocated, especially in a study like ours which leans on existing theoretical frameworks [41]. The interviews provide useful insights into the complexity of the choices made by the implementers. As the interviews were analysed

by another researcher than the one that performed the interviews, a sufficient level of objectivity was accounted for. Furthermore, the current study aimed to evaluate the feasibility within municipalities in a region of the Netherlands counting 33 municipalities in total. Reaching a sample size of 8 municipalities (i.e. an adoption rate of 24%) was therefore evaluated as a reasonable sample size considering these sample size limitations. However, guidelines for designing and evaluating feasibility studies recommended sample sizes about 30 to establish feasibility [42, 43]. The quantitative results of the current study should therefore be interpreted with caution.

Another limitation of the current study is that causal pathways cannot be confirmed due to the lack of a control group implementing Active Plus not receiving the current implementation intervention. Nonetheless, the lessons learned and systematic description of the implementation of a PA intervention by intermediaries are relevant to all organizations developing and implementing public health interventions in real-life.

Furthermore, a practical limitation of the current project is that the intervention owners (i.e., the authors) were heavily engaged in driving the implementation process. To increase the sense of shared ownership, a more bottom-up approach may be recommended in which the needs and actions of policy advisors and other stakeholders drive the implementation process.

Conclusion

Several explanations can be found for the lack of effect of our implementation intervention, that can all be reflected in the choices made during its systematic development. Although both the Intervention Mapping protocol and the Implementation Mapping protocol are very useful protocols, the guidance on 'how to' gain the insights that are needed to inform the different steps of these protocols are limited. Our feasibility study therefore resulted in several important lessons that could help other implementation intervention developers. In line with the Implementation Mapping protocol, we would like to highlight the importance of including the perceptions of different implementation actors when identifying implementation determinants, stating implementation outcomes and performance objectives specific for each adopter and implementer, and to select implementation strategies matching the perceptions of the different implementation actors (no one size fits all implementation plan).

Most important lessons learned from our feasibility study:

- Use a mixed-method approach when identifying the implementation determinants and when evalu-

ating the feasibility of your implementation plan, as in-depth insights are very meaningful.

- Include a pre-test post-test design within your feasibility study to monitor whether the implementation intervention positively effects the implementation determinants.
- Ensure a broad perspective on implementation determinants (e.g. by using a framework like CFIR) as all domains seem to have relevant aspects when implementing an intervention.
- Use an iterative approach as relevant implementation actors, determinants and consequently the needed implementation strategies change over time, even within a year.

Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s43058-024-00622-8>.

- Supplementary Material 1.
- Supplementary Material 2.
- Supplementary Material 3.

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Authors' contributions

Authors DP, JB, LL, CB and BB were involved in the development and evaluation of the Active Plus intervention. DP and BB were involved in data collection and analyses of the quantitative implementation data. JB was responsible for analyzing the qualitative data and attributing these insights to the quantitative results. FvN was actively involved in writing the current manuscript after the data was already gathered. All authors were involved in the design of the current study, have approved the submitted version, and agreed to be personally accountable for their own contribution and ensure that questions related to the accuracy or integrity of any part of the work can be appropriately investigated.

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Availability of data and materials

The quantitative data described in the current study, can be requested at the corresponding author. Qualitative data cannot be made available as persons are identifiable with the combination of answers in this data, and therefore not in line with GDPR. The questionnaire used to assess determinants of implementation and the guideline for the semi-structured interview assessing the implementation process are made available in appendixes of the current manuscript.

Declarations

Ethics approval and consent to participate

This study was approved by the Research Ethics Committee of the Open University of the Netherlands (U202200520). All participants gave their informed consent before participation.

Consent for publication

Not applicable.

Competing interests

Although the Open University is the owner of the Active Plus intervention, and several authors were involved in the development and evaluation of the Active Plus Intervention, the Open University is a non-profit organisation and there are thus no financial competing interests.

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