Randomized controlled feasibility study of FindMyApps: first evaluation of a tablet-based intervention to promote self-management and meaningful activities in people with mild dementia

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ORIGINAL RESEARCH

Randomized controlled feasibility study of FindMyApps: first evaluation of a tablet-based intervention to promote self-management and meaningful activities in people with mild dementia

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ABSTRACT

Objectives: We tested the feasibility, implementation strategy and mechanism of impact of FindMyApps. FindMyApps is a tablet intervention consisting of a selection tool to help people with dementia find usable apps for self-management and meaningful activities, including training to support informal carers in employing errorless learning principles to help people with dementia learn tablet and tool usage.

Methods: We conducted an exploratory, pilot randomized controlled trial with a mixed-methods design. Twenty persons with mild dementia and carer dyads were randomly assigned to the FindMyApps group ($n = 10$), receiving either the FindMyApps training and selection tool, or a control condition ($n = 10$), receiving only a short tablet training. Pre- and post-test measurements at a three month follow-up, consisted of questionnaires and post-test semi-structured interviews.

Results: The FindMyApps tool was mostly perceived as useful and easy to use. Persons with dementia were generally able to learn how to use the tool, though they regularly needed support from informal carers. Persons with dementia found apps through the tool, which they used regularly. Persons with dementia and informal carers were positive about the training and support they received. No significant differences were found on outcome measures of persons with dementia, but based on effect sizes FindMyApps is a promising intervention.

Conclusions: Qualitative results indicate that the FindMyApps intervention has the potential to positively influence the self-management abilities and engagement in meaningful activities of people with dementia. Remarks are made to improve the intervention and recommendations are given for future effectiveness studies.

➤ **IMPLICATIONS FOR REHABILITATION**
- The person-centred tablet intervention FindMyApps has the potential to positively influence the self-management and engagement in meaningful activities in people with dementia.
- Based on the input of persons with dementia and informal carers, the FindMyApps intervention and study procedure will be further improved and evaluated in terms of effectiveness in an RCT.

Introduction

Dementia is a syndrome that describes various chronical neurodegenerative conditions with cognitive impairment in areas such as memory, thinking, judgement, orientation, language and comprehension [1]. Dementia has a major impact on individuals and their social environment. Research shows that 70% of people with dementia stop engaging in activities due to a lack of confidence, 50% avoid their neighbourhood due to their limitations, and 40% hardly leave their home [2]. Informal carers of people with dementia often feel burdened [3]. The high burden on carers frequently results in the person with dementia being admitted to a long-term care facility [4]. The current policy in Western countries though, is to enable people with dementia to live in their own home for as long as possible [5].

Community-dwelling people with dementia and their informal carers report a lack of meaningful activities [6–9] and a lack of support to successfully self-manage their condition, especially in the early stages [10]. Hand-held touch-screen devices such as tablets have the potential to support people with dementia in managing their life and in engaging in meaningful activities [11,12]. In the last decade, many applications (apps) for tablets have been developed to support people in managing their daily lives and health, staying in touch with their social network, and engaging in activities [13]. There is growing evidence that apps also have the potential to support people with mild dementia in these areas [14–26]. However, people with dementia need support to learn how to use touch screen devices [16,19,20,23–25,27]. It can also be hard to find apps that match one's own personal needs,

wishes and abilities. Support in the selection of apps is required, as just a small number of existing apps are usable for individuals with mild dementia [16,24,28–30].

A person-centred, tailored tablet intervention, called FindMyApps, was developed in co-creation with end users, to support community-dwelling people with mild dementia in the use of apps [31]. The intervention consists of the FindMyApps training in tablet use and the FindMyApps selection tool to help users find apps for self-management and meaningful activities that fit their needs, wishes and abilities [32].

In the FindMyApps training, informal carers are trained to use the FindMyApps tool and tablet, so that they in turn can support the person with dementia in using it. The FindMyApps training is based on the errorless learning (EL) method [33,34]. EL refers to a learning condition involving the elimination of errors during the learning process [35,36]. The rationale behind this method is that people with dementia can be taught new skills by repetition and by using their implicit memory that is a part of the long-term memory, which is relatively spared in the early and middle stages of dementia. This memory function helps people perform procedural tasks, such as cycling and washing hands, which are acquired through fixed routines and are conducted automatically [37]. This method has been successfully applied to (re)teach people with mild to moderate dementia how to use everyday technologies [36], for example, a voice mail or answering machine [38], a mobile phone [39] and a digital organizer [40].

The FindMyApps selection tool consists of a library of dementia-friendly apps, which can be matched to the user's individual needs, wishes and abilities based on their input of personal preferences. The tool is intended for use by people with dementia with the support of their informal carers [32]. The tool was developed using needs studies to identify user requirements for desired activities in the context of self-management and meaningful activities, and by identifying the needs, wishes and abilities related to app features [41]. Subsequently, the tool was developed in a user-participatory design process to ensure that it would meet the needs of people with dementia and informal carers [32].

We followed the recommendations of the Medical Research Council (MRC) framework [42,43] for the evaluation of complex interventions, and accordingly conducted an exploratory feasibility study to test the FindMyApps intervention, the implementation and the research design for a future effectiveness study (RCT). Understanding the context, e.g., the implementation process, and the mechanism of impact is crucial in interpreting the outcomes of a complex intervention [44]. Therefore, we first explored the implementation strategy of the FindMyApps training and the mechanism of impact regarding the usability, i.e., the usefulness, user-friendliness, learnability, and adoption of the FindMyApps tool. The research questions addressed in this study were:

1. Is the implementation strategy for the FindMyApps training feasible?
2. Which mechanism of impact plays a role in implementing the FindMyApps tool?
3. What is the potential impact of FindMyApps on self-management and engagement in meaningful activities?
4. How feasible is the current research design and which adaptations are recommended for a future effect study?

Methods

Research design

A mixed methods design, including qualitative and quantitative research methods, was used. This feasibility study was conducted as an exploratory pilot randomized controlled trial (RCT) in order to assess the potential impact of FindMyApps and to inform the design of future studies. Participants were randomly assigned to either the FindMyApps group, receiving the FindMyApps training and tool, or the control group, receiving an introductory tablet training and links to websites that recommend apps for people with dementia in general. Randomization was done manually by a researcher who was not involved in the eligibility screening. This was first stratified for co-habiting with informal carers, after which participants were randomized in block sizes of four with a 1:1 allocation. Assessments consisting of standardized questionnaires were performed at baseline and again after three months, to test the potential impact of FindMyApps on self-management and engagement in meaningful activities. Additional qualitative evaluation using semi-structured interviews was conducted to explore the feasibility of the implementation strategy and the mechanism of impact of the FindMyApps intervention as well as the feasibility of the research design, methods and procedures. Participants and assessors who conducted the baseline and post-test measurements with questionnaires, were blinded to treatment allocation.

Ethical approval was granted by the Medical Ethics Committee of the VU University Medical Centre in Amsterdam (no. 2016.030) and the Ethics Committee of the Faculty of Behavioural, Management and Social Sciences of the University of Twente (no. 17784). The trial was registered at clinicaltrials.gov (identifier NCT04026061).

Participants and procedure

From June to November 2017, dyads (people with Mild Cognitive Impairment (MCI) or dementia and informal carers) were recruited through the Dutch Alzheimer's Association, Meeting Centres for people with dementia and carers, Alzheimer's Cafés, a day care centre for people with dementia, a case manager and a care organization, all located in the eastern part of The Netherlands. Eligible dyads had to be community dwelling. People with dementia had MCI or mild dementia with a score of 3–4 on the Global Deterioration Scale (GDS; [45]), with or without a confirmed diagnosis, and the availability of an informal carer or volunteer to provide support. Exclusion criteria were participation in another intervention trial and severe visual and/or physical impairment. Since this was a pilot study, we expected to require approximately 20–24 dyads to gain insight into all relevant feasibility factors. This number was not based on power calculation.

Dyads interested in participating received an information flyer. Informal carers were then called by the researcher (YK) to receive additional information and to verify their eligibility. Subsequently, trained assessors visited eligible dyads before randomization to obtain written consent and perform baseline measurements.

After baseline assessments, randomization took place and informal carers received training from researchers (GK trained the control group and MV trained the FindMyApps group) in their home setting. They were then asked to start with the intervention. If participants did not own a tablet, they could borrow one. During the three-month intervention period, informal carers kept a diary of app usage by the person with dementia. Follow-up phone calls with informal carers took place every two weeks to address possible problems and to increase adherence. In addition, informal carers could consult a help desk if they had questions or needed support.

After three months, post-test measurements were performed by blinded, trained assessors, followed by individual semi-structured interviews (carried out by GK and MV) with the dyads in

their homes. All interviews were voice-recorded and transcribed verbatim. The trial ended in March 2018. All trial protocols are available from the authors on request, see also Kerkhof et al. [31].

The intervention

FindMyApps group
The FindMyApps training. In the training session, informal carers learned how to support persons with dementia in using a tablet and the FindMyApps tool in conformity with EL [34]. First, the method was explained at the start of the training, stating that a task has to be broken down into small steps, each step needs to be demonstrated, and then copied by the person with dementia. If that person makes a mistake, he or she should be corrected to prevent the error being consolidated in the memory. This needs to be done for all steps until the person with dementia has learned to carry out the complete task [34]. Second, informal carers were taught the tablet and the FindMyApps tool functions in accordance with EL (e.g., breaking each task down into steps). Using a tablet and the FindMyApps tool requires the use of different skills such as turning the power on/off, opening and closing apps or returning to the home screen. Explanation of these skills was done through the use of a step-by-step guide with accompanying screen shots. The skills were demonstrated by the researcher and then tried out by the informal carers. Third, informal carers downloaded an app from the FindMyApps tool that matched the person with dementia's interests. Finally, they received tips to help them support the persons with dementia,

such as using a stylus and giving positive feedback. The informal carers received a written manual with the information given in the training, as well as laminated explanation cards with the steps of the EL method and the FindMyApps tool.

The FindMyApps tool. The FindMyApps tool is the main part of the intervention. It is a web application installed on tablets consisting of a library containing 180 apps in the domains of self-management and meaningful activities which are assessed as dementia-friendly apps [32]. This was based on a set of important app criteria with regard to interaction, feedback, aesthetic design, app design, customization, obstacles and age appropriateness [29,46]. Usable apps are selected by matching personal preferences of persons with dementia (i.e., the user profile) with app features and by matching their needs and wishes with the different types of apps. The FindMyApps tool consists of six components, also called pages [32].

Figure 1 provides an overview of the FindMyApps tool flow. On the page *personal settings* (Figure 1(a)), a user profile for the person with dementia is created by answering six questions relating to personal preferences regarding apps by means of a yes/no button. This user profile is set by informal carers during the training. The preferences offered are: large font size; less text, many pictures; only in Dutch; real photos; simple to operate; and instructions offered. After this, the home page of the tool with the main *categories*, i.e., "in and around the house", "contacts" and "leisure" (Figure 1(b)), opens. From here, sub-categories (Figure 1(c)) can be chosen to find usable apps. When a sub-

Figure 1. Flow of the FindMyApps tool, including setting the user profile in the personal settings (a), division into main categories (b) and subcategories (c), overview of apps in a category (d), and description of an app (e).

category is selected, a page with an *overview of apps in each category* (Figure 1(d)) opens. Each app is presented with a brief information sentence, the costs, and an overall score is shown indicating the match of the app with personal preferences; a higher score indicates a better match. By clicking on the button "information & download", the page with the *app description* (Figure 1(e)) is opened. More specific app information and screenshots are presented and six scores show the match of the app with all six personal preferences. A button to access the Apple Store or Play Store to download the app is provided. The page "*My Apps*" provides an overview of all apps that someone has shown interest in, arranged in subcategories. Finally, all pages show the *explanation button*, which gives support on how to use that particular page.

Control group

Informal carers in the control group received a tablet training similar to the training of the FindMyApps group but without the use of the EL method, and they were also provided with a list of Dutch- and English-language websites containing potentially usable apps for people with dementia. The training started with an explanation and demonstration of the tablet functions. They were then asked to open one of the websites and download an app matching the interests of the person with dementia. Finally, informal carers received the same tips for tablet use as the FindMyApps group. After the training, the informal carers received a written manual containing the information from the training, as well as laminated explanation cards showing links to websites and tips.

Instruments

A variety of questionnaires and assessment procedures were used.

Baseline characteristics

The baseline characteristics of dyads that were assessed included age, gender, education and experience using a tablet. Additionally, the living situation (alone/with spouse or partner) of the person with dementia, as well as their relationship with the informal carer was collected. The type of dementia and the awareness of cognitive deficits of persons with dementia were determined, using the GDS [45] and the Guidelines for the Rating of Awareness Deficits [47], respectively. All baseline characteristics were acquired through informal carers.

Feasibility implementation strategy and mechanism of impact of FindMyApps intervention (research questions 1 and 2)

Individual semi-structured interviews with persons with dementia and informal carers were used to explore the feasibility of the implementation strategy and mechanism of impact of the FindMyApps intervention. To get insight into the implementation strategy of the intervention, the practicality of the FindMyApps training was explored in the interviews. Bowen et al. define practicality for feasibility studies as the extent to which the intervention can be delivered when resources, time, commitment or some combination thereof are constrained in some way [48].

To get insight into the mechanism of impact of the intervention, the usability of the FindMyApps tool was explored. The interview scheme was divided into four themes: usefulness, user-friendliness, learnability and adoption [20]. Usefulness refers to whether users believe a website or application fulfils specific needs or whether it helps them to be more effective and productive [49]. User-friendliness (i.e., ease of use) indicates whether users

believe that using a website or application will be easy and simple to use [49]. Learnability (i.e., ease of learning) refers to whether users believe that using a website or application is easily learned [49]. Adoption is defined as the decision, by an organization or individual, to utilize and implement a technology [50].

We also conducted individual semi-structured interviews with the control group to explore the feasibility of the tablet training and explore apps usage found on the suggested websites.

Participants' quotes were included to help provide an in-depth understanding of results. Confidentiality and privacy were ensured by coding participants' data using numbers and letters, which also identified them as a person with dementia (PwD), an informal carer (IC) or a volunteer (VT).

Interviews included the use of the Usefulness, Satisfaction, and Ease of Use (USE) questionnaire [49], consisting of 30 statements measuring four dimensions of usability (usefulness, ease of use, ease of learning, and satisfaction). The statements are rated on a seven-point scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*) with higher scores indicating better usability. Total scores were calculated by determining the mean score for each subscale.

Outcome measures (research question 3)

A number of measurements were used to evaluate the potential impact of the FindMyApps intervention.

Person with dementia outcomes. The primary outcomes were self-management abilities and participation in daily and social activities. *Self-management abilities* were measured using the revised 30-item Self-Management Ability Scale (SMAS-30) [51]. In a population of independently living elderly people without dementia, the revised SMAS-30 was found to have good internal consistency with Cronbach's alpha of .90 [51]. *Participation in daily and social activities* was measured using two instruments: a short version of the Pleasant Activities List (PAL) [52] consisting of 31 items on a five-point scale for frequency and enjoyability, and one item of the Adult Social Care Outcomes Toolkit (ASCOT) [53]. Both the original PAL and the ASCOT show good psychometric properties [52,54].

The secondary outcomes were perceived self-efficacy, perceived autonomy, and quality of life. *Perceived self-efficacy* was measured using the Dutch version of the 10-item General Self-Efficacy Scale (D-GSE scale) [55]. Previous studies have confirmed high reliability, stability and construct validity of the original GSE scale [56,57], as well as good internal consistency with Cronbach's alpha of .85 for the D-GSE. *Perceived autonomy* was measured using the 12-item Experienced Autonomy List (EAL) [58], a scale consisting of relevant items from the Mastery scale [59] and the WHOQOL-100 [60]. Both the Mastery Scale and the WHOQOL-100 have shown good validity and reliability in Dutch populations [61,62], though the psychometric properties of the EAL have not been investigated yet [63]. *Quality of life* was measured with the Dementia Quality of Life scale (DQoL) [64], which has shown good internal consistency and construct validity in a population of people with dementia [64,65].

Informal carer outcomes. The primary outcome was a *feeling of competence*, which was measured using the Short Sense of Competence Scale (SSCQ) [66]. The scale shows good internal consistency with Cronbach's Alpha of .76 and a good construct validity was found in a population of community-dwelling people with dementia [66].

The secondary outcomes were positive care experience and quality of life. *Positive care experiences* were measured using the

Positive Experience Scale (PES) [67], a scale with good reliability with Cronbach's alpha of .74 and validated for large groups of informal carers, as carers for people with dementia [67]. *Quality of life* was measured using the EQ-5D-5L [68]. The EQ-5D-5L has been used in a multitude of health conditions [69], has good test–retest reliability, and has been validated for many diseases [70]. Additionally, the quality of life topic was measured using the TOPICS-MDS [71], which was found to have good construct validity in different study settings [72].

Feasibility of research design (research question 4)

Recruitment feasibility was evaluated based on inclusion and dropout rates. Research assessment procedures were evaluated based on persons with dementias' and informal carers' feedback on clarity and perceived burden of measurements at baseline and post-test, which was logged by assessors. The duration of the visits, adherence to the assessment protocol, and other irregularities were also logged. Questions relating to the feasibility of the research design were asked during the semi-structured interviews, such as informal carers' experiences with keeping a diary of app usage and follow-up phone calls every two weeks.

Data analysis

The interviews were transcribed verbatim. The transcripts were then read multiple times to get familiar with the data. They were initially analysed using a deductive approach, meaning that relevant fragments were coded into predefined categories [73]. These fragments consisted of meaningful words, phrases and quotes. The following categories were used: *feasibility of the* FindMyApps *training* and *usefulness, user-friendliness, learnability* and *adoption* of the FindMyApps tool. Two sub-categories were used to make a distinction within the categories: *positive* and *negative*. Three researchers (GK, MV and YK) individually identified those categories and sub-categories within the first two transcripts and marked relevant fragments with separate colours. The researchers met to discuss the first coding scheme. Any disagreements in coding were discussed until consensus was reached and the coding scheme was revised accordingly. The remaining transcripts were then analysed by two researchers (GK and MV) in the same manner. Inter-rater reliability, assessed as percentage agreement, was 70%. The final coding scheme was checked by the third researcher (YK) and any further disagreements were discussed between the three researchers until consensus was reached. Afterwards, inductive analysis – meaning that codes derived from the narrative instead of predefined categories [73] – was used. Coding each fragment was done by GK for the persons with dementia, and by MV for the informal carers. After the codes had been established, they were reviewed by YK and some codes were adjusted or merged. The codes and relevant quotes were then summarized in the categories and sub-categories. Subsequently, for each code, the number of persons with dementia and the informal carers who had been given that code were counted.

Descriptive statistics were used to summarize background characteristics of participants. Full cases analysis was carried out. No imputation techniques were used for missing data. Baseline differences between both groups were assessed with nonparametric tests due to the small sample size and non-normal distribution of the data [74]. Mann–Whitney's U test was used for ordinal and continuous variables, and Pearson chi-square test was used for nominal variables. If the assumptions of the Pearson chi-square test were not met, Fisher's exact test or likelihood ratio test was used instead [75]. Descriptive statistics were computed for all measures. Analysis of covariance (ANCOVA) was conducted to determine differences in outcome data between the groups, with treatment condition (FindMyApps group or control group) as the independent variable, post-test data as the dependent variable, and pre-test values as the covariate. Given the small sample size involved in this pilot study, we also calculated effect sizes, i.e., partial eta squared (η_p^2), to interpret the meaningfulness of the data. An effect size of .01 was considered to be small, .06 was medium and .14 was large [76]. A value of *alpha* smaller or equal to 0.05 was taken to denote significant differences. All statistical analyses were performed with SPSS 24.0 (SPSS Inc., Chicago, IL).

Results

Out of the 28 screened dyads, 20 dementia-informal carer dyads (71.4%; $n = 10$ in the FindMyApps group; $n = 10$ in the control group) were eligible and willing to participate in this exploratory pilot RCT (Figure 2). Study attrition rate was 37.5%, with six dyads dropping out during the three-month intervention period, mainly due to lack of interest using the tablet for the participants with dementia, and the additional burden for informal carers in supporting their relatives with dementia in using the tablets. In the control group, three additional participants with dementia dropped out due to lack of interest in using the tablet, institutionalization and death. As this happened at the end of the intervention period, it was decided to keep the informal carers of these participants in the study.

Participants' characteristics at baseline are presented in Table 1. There were no significant differences between both groups regarding these characteristics. A Mann–Whitney U test showed that there was a significant difference ($U = 16.0$, $p = .03$) in the age of informal carers who completed the study ($M = 61.9$) compared to informal carers who dropped out ($M = 72.7$).

Feasibility implementation strategy and mechanism of impact of FindMyApps (research questions 1 and 2)

Individual semi-structured interviews took place with four persons with dementia in the control group and six of the seven persons with dementia in the FindMyApps group, since one person with dementia had not used the FindMyApps tool. Furthermore, semi-structured interviews took place with seven informal carers in the FindMyApps group and six of the seven informal carers in the control group, as one informal carer had provided less support. The interviews also took place with two volunteers, because one person with dementia in each group was trained by a volunteer. It was not possible to include all data from the interviews in this article, therefore. the focus of this result section is on the feasibility of the implementation strategy of the FindMyApps training and the mechanism of impact: the usability (usefulness, user-friendliness, learnability and adoption) of the FindMyApps tool. We only mention the control group when relevant.

Feasibility of the FindMyApps training

All informal carers in the FindMyApps group were positive about the training they received. Most frequently mentioned positive remarks were: (1) clear and useful explanation of all parts of the training. (2) EL method was useful. *"For me, it was a revelation that people with mild dementia could learn new things, I thought this was not possible anymore. So, I taught her the FindMyApps tool and tablet in accordance with this method and I hope this will also work out for the long term"* (IC14). (3) Laminated explanation cards
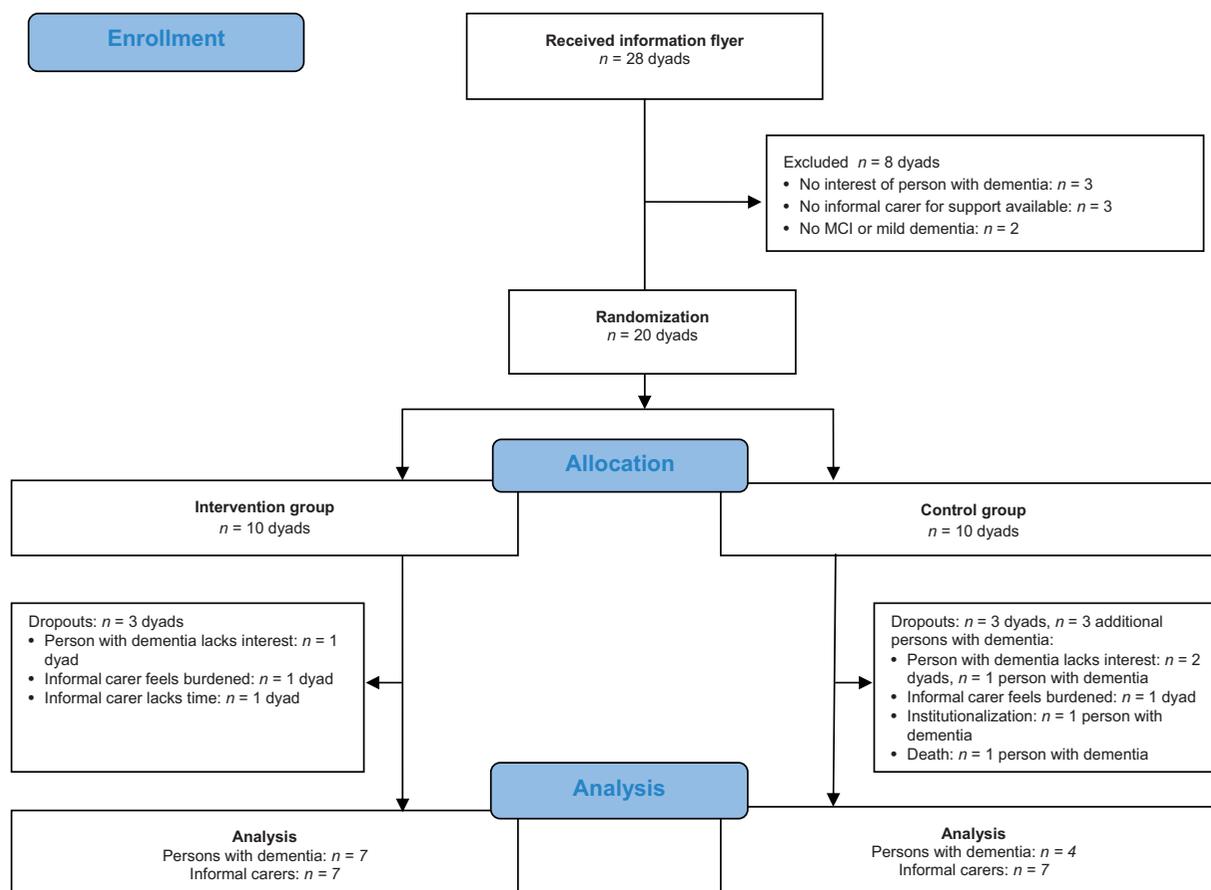
Figure 2. Recruitment and participant flow of exploratory pilot RCT.

were supportive. *"The instruction cards are helpful, you can easily see what you have to do"* IC19. The most frequently mentioned critical remark was that the training should be given in the presence of the person with dementia. *"It might be supportive if the training was given in the presence of my mother. The mother-child relationship could have hindered her from learning from me. If a stranger emphasises that an open attitude towards me [carer] is important, that might be helpful"* (IC14). Other critical remarks were that the training was not sufficient for someone with no tablet experience and that the training took too long.

Overall, persons with dementia in the FindMyApps group were satisfied with the support they received from informal carers. They also thought that the support was sufficient. However, five informal carers suggested that this kind of support should be provided by someone other than the informal carer due the amount of time it took and the difficult relationship patterns between dyads that make giving and receiving support difficult at times. *"Yes, this was immediately obvious. My husband is always jumping from one subject to another and I thought VT17 would interrupt him, but he didn't, and maybe this is the right thing to do. I have less patience and that's why me supporting him is not a good idea"* (IC17, Pwd17 received support by VT17). Also, supporting persons with dementia in small groups was mentioned as a possibility by informal carers.

Furthermore, most informal carers in the control group were positive about the training they received. Frequently made positive remarks were: (1) clear explanations; (2) useful for supporting tablet use by persons with dementia; (3) manual and laminated explanation cards were useful. One informal carer found just one

training session insufficient and needed more face-to-face support. Three informal carers mentioned that the persons with dementia showed less interest in learning to use this, for them, new device during the intervention period, and this was frustrating or an extra burden for informal carers. Persons with dementia in the control group were satisfied with the support they received from their informal carers. Some of them already had experience with touch screen devices. Support was needed for downloading apps and operating apps which showed pop-up ads.

Usefulness of the FindMyApps tool

Five persons with dementia and seven informal carers found the FindMyApps tool useful for several reasons: (1) apps match their personal needs and interests. *"There are [apps] in there that are very useful, you know, in my case with dementia"* (PwD13). (2) It enables tablet learning. (3) It stimulates tablet use. (4) It helps finding apps. *"I think [it's useful] to a certain extent. Because, you know, it's a good starting point to find something"* (PwD17). (5) It enables exploration of what kind of apps are being offered and it gives new ideas. *"You notice that the initiative of the person with dementia decreases and it's very useful and nice that FindMyApps gives new ideas for spending spare time"* (IC13). (6) It supports self-management and engaging in meaningful activities. *"The reason we participated in this study was to try and stimulate my husband's brain. This is because he is showing less initiative and prefers to watch television all the time. So, it would be good to activate his brain more to slow down the dementia process. And it worked"* (IC17). One person with dementia and the informal carer stated that the tool was less useful because the apps did not match the

Table 1. Baseline characteristics of persons with dementia and informal carers, by group.

Characteristic	FindMyApps group (n = 7)	Control group (n = 4)	p
Persons with dementia			
Gender, n (%)			.49
Female	1 (14)	2 (50)	
Male	6 (86)	2 (50)	
Age, M (SD), [min–max]	68.9 (14.0), [50–87]	76.0 (4.2), [72–81]	.45
Type of diagnosis, n (%)			.34
Alzheimer's disease	3 (43)	1 (25)	
Vascular dementia	2 (29)	–	
Other	1 (14)	1 (25)	
Not diagnosed	1 (14)	2 (50)	
GDS stage, M (SD), [min–max]	2.8 (.3), [2.5–3.4]	3.0 (.4), [2.5–3.4]	.29
GRAD score, n (%)			.75
Intact	4 (57)	2 (50)	
Mildly impaired	2 (29)	1 (25)	
Moderately impaired	1 (14)	1 (25)	
Living situation, n (%)			1.00
Alone	1 (14)	1 (25)	
With spouse or partner	6 (86)	3 (75)	
Education level, n (%)			.23
Lower education	1 (14)	2 (50)	
Secondary education	2 (29)	1 (25)	
Higher education	4 (57)	1 (25)	
Use of tablet, n (%)			.67
Every day	4 (57)	2 (50)	
Once before	1 (14)	–	
No experience	2 (29)	2 (50)	
Characteristic	FindMyApps group (n = 7)	Control group (n = 7)	p
Informal carers			
Gender, n (%)			1.00
Female	7 (100)	6 (86)	
Male	–	1 (14)	
Age, M (SD), [min–max]	63.0 (11.8), [47–79]	61.0 (11.7), [40–71]	.81
Relationship with PwD, n (%)			.56
Spouse or partner	6 (86)	4 (57)	
Child	1 (14)	3 (43)	
Education level, n (%)			.54
Lower education	1 (14)	1 (14)	
Secondary education	1 (14)	3 (43)	
Higher education	5 (71)	3 (43)	
Use of tablet, n (%)			.62
Every day	5 (71)	4 (57)	
Once a week	1 (14)	–	
Once or twice a month	–	1 (14)	
Once before	–	1 (14)	
No experience	1 (14)	1 (14)	

GDS: Global Deterioration Scale; GRAD: Guidelines Rating of Awareness in Dementia.
Differences between groups were tested using a Pearson chi-square test for categorical variables, and Mann–Whitney's *U* test for ordinal and continuous variables.

personal interests of younger people with dementia. *"I took a quick look at 'reminiscence', but that wasn't a good match I thought"* (PwD19).

The persons with dementia and their informal carers, including the volunteer, were also asked how useful they found the different pages of the FindMyApps tool. Most pages were perceived as useful. The page *"My Apps"* was perceived as less useful by the informal carers because it was not functional. The opinions about the *"explanation button"* differed among persons with dementia and informal carers, as some found it useful and some found it unnecessary. *"To be honest, it is a bit redundant, because at the home page you automatically click on the main categories"* (IC13).

Finally, persons with dementia and informal carers rated the FindMyApps tool by means of the USE questionnaire as useful, with a mean score of 5.0 (SD = 1.0; range 2–7) for persons with dementia and a mean score of 4.6 (SD = 1.5; range 1–7) for informal carers. All persons with dementia and the informal carers agreed with the statement "FindMyApps is useful" and they generally agreed that "FindMyApps gives me (my relative) more

control over activities in my (his/her) life". Persons with dementia were less positive about the statement: "FindMyApps helps me to be more productive" and informal carers were less positive about the statement: "It saves my relative time when he/she uses it".

User-friendliness (ease of use) of the FindMyApps tool

Four persons with dementia and four informal carers were positive about the user-friendliness of the FindMyApps tool. Most frequently mentioned positive remarks were: (1) easy to use. *"It is very user-friendly. It is not difficult at all. I am not at all technical with computers and tablets, but even I understand this"* (IC5). (2) Recognizable and clear icons. *"Icons are fine. They are recognisable"* (PwD5). (3) Colours are clear. (4) Clarity of the design. *"Sometimes I make a mistake if I click on something. I think that happens to most people, but then I just go back"* (PwD13). Most frequently mentioned critical remarks or suggestions to improve the user-friendliness of FindMyApps were: (1) activating touchscreen is difficult. (2) Icon of the main category "leisure" is not recognizable. *"That clock doesn't make me think about leisure*

time. It's about time, but leisure time is more about things that you do rather than time itself" (PwD19). (3) Apps on page "My Apps" are not touchable. "In FindMyApps a list with searched apps becomes available. But I noticed that my husband tried to click on them, that is something he got used to and it seems logical" (IC13). (4) Too many categories and apps made it unclear. "There are a lot of categories, you can easily get lost in FindMyApps. That is a bit unclear" (VT17). Two persons with dementia suggested it should be made clearer which subcategories are behind a main category and suggested adding a table of contents. "Maybe you should first show a table of the apps that are being offered and which app belongs to which [category]. For example [the category] 'diary', which [apps] are in there and what you can do with them" (PwD13). (5) Downloading apps is difficult. (6) Buttons "Information & Download" and "Download Appstore/Play Store" are unclear due to their colour. (7) Colour variation. "The app is very calm and clear and you have to keep it that way, but a bit more colour diversity within the (sub)categories makes it less boring and stimulating" (MZ14). (8) Enlarge the screenshots in the app description.

The persons with dementia and informal carers, including the volunteer, were asked how user-friendly they found the different pages of the FindMyApps tool. Most pages were perceived as user-friendly by the people with dementia. Informal carers found the pages "choosing main and subcategories", "overview of apps in each category" and "description of an app", a bit difficult to operate for persons with dementia. "He cannot manage to make choices in these pages, making choices is also very difficult for him in daily life. This is a major struggle for him, also with regards to the tablet" (IC7).

Persons with dementia and informal carers also rated the FindMyApps tool by means of the USE questionnaire as user-friendly, with a mean score of 5.4 ($SD = .6$, range 2–6) for persons with dementia and a mean score of 4.9 ($SD = .8$; range 1–7) for informal carers. All persons with dementia and all informal carers agreed with the statement "FindMyApps is user friendly" and they generally agreed that "FindMyApps is easy to use" and "FindMyApps is simple to use". Persons with dementia were less positive about the statement "I can quickly and easily correct mistakes I've made in FindMyApps". Informal carers were less positive about the statement "my relative can use FindMyApps successfully every time" and "my relative can use FindMyApps without written instructions".

Learnability (ease of learning) of the FindMyApps tool

The answers persons with dementia gave suggested that they did not always differentiate between the learnability of the FindMyApps tool and the learnability of the tablet. According to persons with dementia and informal carers, "doing it often" was the most important facilitating factor in learning how to use the FindMyApps tool. "It's a matter of establishing a routine. If that routine is gone, you have to relearn it bit by bit" (PwD19). Second, persons with dementia mentioned "perseverance" as a factor that facilitated learnability. "I just keep on [working] with it until I succeed" (PwD7). According to the informal carers, other facilitating factors were: (1) use of the EL method. "I am very consistent in using this method and I also use it to train other skills. Through repetition, providing verbal prompts, and using small steps, and I hope it will remain" (IC14). (2) Patience and listening carefully to the needs of persons with dementia. (3) Previous experience of persons with dementia with a computer/tablet. "I think he managed very well, of course we practise on a regular basis, but he was already very experienced using a computer and a tablet" (IC5). (4) Stimulation of persons with dementia to learn something new.

Persons with dementia stated that support is most needed when "they don't know how things work". Informal carers made this more specific by mentioning that persons with dementia needed support with the FindMyApps tool for: (1) downloading apps. "Downloading apps was difficult, we did this mostly together, he never did it alone" (IC5). (2) Operating the overview of apps in each subcategory. (3) Navigating through (sub)categories. "I helped him with that, certainly to start with" (IC13).

Persons with dementia were also asked to indicate: (1) the difficulty in learning how to use the FindMyApps tool and the tablet and (2) the difficulty of using the FindMyApps tool and tablet independently. Overall, persons with dementia found learning to use the FindMyApps tool and using it independently more difficult compared to the tablet. Most needed support when using the FindMyApps tool. "I couldn't do it by myself, someone had to be around" (PwD7).

Finally, persons with dementia and informal carers were positive about the ease of learning of the FindMyApps tool rated by the USE questionnaire, with a mean score of 5.4 ($SD = .5$; range 4–6) for persons with dementia and a mean score of 4.4 ($SD = 1.2$; range 1–7) for informal carers. All persons with dementia agreed with the statement "I easily remember how to use FindMyApps", whereas informal carers were most negative about this statement for their relative.

Adoption of the FindMyApps tool

Persons with dementia in both groups reported the number of apps downloaded, the source, the frequency and the type of support those apps had provided (see Table 2). In the FindMyApps group, most apps were found in the FindMyApps tool: five persons with dementia found more than three apps in the FindMyApps tool. One person with dementia stated that he did not download any apps from the FindMyApps tool. In the control group, three persons with dementia found apps only on the suggested websites and three found apps elsewhere as well as on the suggested websites.

In the FindMyApps group, the persons with dementia used apps found in the FindMyApps tool more often than apps found elsewhere. In the control group, persons with dementia used apps that were found elsewhere a little more frequently than apps found on the suggested websites. In the FindMyApps group, all of the persons with dementia stated that the apps found in the FindMyApps tool supported them in pursuing meaningful activities and four reported the apps supported them in self-management.

In addition, persons with dementia and informal carers made remarks regarding the impact that using the FindMyApps tool and the tablet had on their daily lives. Most frequently mentioned remarks were: (1) increased use of tablets. "Not every day, but a few times per week" (PwD7). (2) Increased interest in tablet devices. "It definitely stimulated his interest, he said 'I want a tablet of my own. Because when I am sitting outside, I enjoy using it.' So, we bought a tablet" (MZ7). (3) Becoming more digital. "Well, I have become more digital. Before, I would have used a paper file" (PwD13). (4) Keeping up with the times. "You know, I grew up with pen and paper. But you can live without it nowadays" (PwD17). (5) The world has become bigger. "Yes, I think [that my life has changed]. It hasn't changed a lot, but I do think that it changes you. You know more, you hear more, and you see more, and your social environment is different. When I look at my sister, well, her world is very small. And a tablet can make it bigger" (PwD14). Informal carers mentioned a lack of time as an important reason that impeded the adoption of FindMyApps in daily life. "I can get it off the ground, my husband was always against

Table 2. Overview of number and usage of apps, and type of support the apps provided for persons with dementia (PwD) in FindMyApps and control group ($N = 10$) during three-month intervention period based on diary of app usage.

	FindMyApps group ($n = 6$)		Control group ($n = 4$)	
Variables	FindMyApps tool n (%)	Elsewhere n (%)	Websites n (%)	Elsewhere n (%)
Number of apps				
0	1 (17)	1 (17)	1 (25)	1 (25)
1–2	–	3 (50)	–	1 (25)
3–4	2 (33)	–	2 (50)	1 (25)
>5	3 (50)	2 (33)	1 (25)	1 (25)
Usage[a]				
Several times per day	2 (40)	2 (33)	–	–
One time per day	–	–	1 (33)	2 (50)
A few times per week	3 (60)	1 (17)	1 (33)	1 (25)
A few times per month	–	1 (17)	1 (33)	–
Type of support[b]				
Self-management	4	3	2	2
Meaningful activities	5	4	2	3
Other	2	–	1	–

PwD who did not download any apps were not included in the description of "usage" and "type of support".
[a]One missing value in FindMyApps group for apps found elsewhere.
[b]PwD could name more than one type of support, therefore, the numbers do not add always up to the number of PwD.

using laptops and computers. At the moment I have to deal with all kinds of family issues and in combination with my energy level necessary to take care of my husband, this makes it impossible. It is just a matter of lack of time" (MZ2).

Overall, persons with dementia and informal carers were satisfied with the FindMyApps tool as rated by the USE questionnaire, with a mean score of 5.0 ($SD = .6$; range 2–7) for persons with dementia and a mean score of 4.9 ($SD = 1.5$; range 1–7) for informal carers. All persons with dementia and informal carers agreed with the statement "FindMyApps is fun to use". Fewer persons with dementia thought that "FindMyApps works the way I want it to work" and informal carers were less positive about the statement "My relative would recommend FindMyApps to a friend".

Results: outcome measures (research question 3)

One person with dementia in the FindMyApps group was excluded from the analysis of outcome measures, because he did not complete the post-test measurement as he found it too stressful. Descriptive statistics of the outcomes, and results of the ANCOVAs including effect sizes are provided in Table 3.

Analysis of outcome measures for persons with dementia shows large effect sizes for *Investing*, i.e., investing in resources for long-term benefits ($\eta_p^2 = .16$), and *Multifunctionality*, i.e., gaining or maintaining resources or activities that serve multiple dimensions of well-being simultaneously ($\eta_p^2 = .42$) of the primary outcome measure SMAS-30. Investing was more favoured in the control group and multifunctionality in the FindMyApps group. Additionally, a moderate effect size was found for *Variety*, i.e., achieving and maintaining various resources for each dimension of well-being ($\eta_p^2 = .12$), in favour of the FindMyApps group. We also found large effect sizes for both frequency and enjoyability of the social and domestic activities scale of the PAL, with η_p^2 ranging between .15 and .38, in favour of the FindMyApps group, though scores suggest some decline in both groups. Effect sizes of the secondary outcome measures D-GSE and EAL showed relative changes in the expected direction that favoured the FindMyApps group, with an η_p^2 of .34 and .24, respectively, while the scores on the EAL also improved for the control group.

For informal carers, a large effect size was found for the primary outcome measure *feeling of competence* measured with the SSCQ

($\eta_p^2 = .18$), in favour of the control group, though this declined for both groups at the post-test.

The ANCOVAs showed only one significant difference in the primary and secondary outcome measures between the FindMyApps group and the control group: scores of the PES, with pre-test scores included as covariate, showed that informal carers in the FindMyApps group reported significantly fewer positive care experiences at post-test than informal carers in the control group, $F(1, 11) = 5.17$, $p = .04$, $\eta_p^2 = .32$. This was a large effect in favour of the control group.

Input future research design: methods and procedures (research question 4)

Of the 28 dyads that were approached or showed interest in participating, 20 took part, giving an inclusion percentage of 71.4%. Dropout rate was 37.5% ($n = 15$) for individual participants. Most dropouts were in the control group. Although it was not the main reason for dropping out, two informal carers in the control group and one in the FindMyApps group mentioned that the tablet training was not sufficient enough for persons with no experience in using a tablet.

Informal carers were positive about the phone call at the start of the study, as it provided them with sufficient information about the research to give their consent. However, some noticed that the call took too long. Persons with dementia and informal carers also mentioned that the measurements of primary and secondary outcomes of persons with dementia were too time consuming ($M = 58$ min, range = 40–100 min). Especially the PAL and SMAS were perceived as too long and confusing for persons with dementia to answer. Also, persons with dementia had problems with the D-GSE scale; in many cases they forgot what had been asked, due to the questions being too long. The test questions of the DQoL at baseline were confusing and it was therefore decided to skip them at post-test. Overall, the laminated response cards were helpful for people with dementia.

The measurements involving informal carers were less time consuming ($M = 20$ min, range = 10–30 min). Informal carers became sometimes emotional during the administration of the SSCQ or PES, as they found some questions to be confrontational. However, at the same time, they also felt relieved to be able to express their emotions for a moment. Informal carers differed in their experiences with the follow-up phone calls that took place every two weeks. Half of them felt this was positive, that the

Table 3. Descriptions of outcome measures and results of ANCOVA for persons with dementia (PwD) and informal carers (IC) in the FindMyApps (FMA) and control group.

Outcome measures, [range]	Pre-test, M (SD) FMA group (n = 6)	Con. group (n = 4)	Post-test, M (SD) FMA group (n = 6)	Con. group (n = 4)	M_{adj} FMA group	M_{adj} Con. group	F	p	η^2_p
Primary outcome measures PwD									
Self-management abilities									
SMAS-30, [0–100]									
Taking initiative	58.0 (17.0)	47.0 (17.1)	57.3 (9.4)	51.0 (21.8)	53.9	56.1	.15	.71	.02
Self-efficacy	75.0 (15.8)	78.8 (9.5)	79.2 (12.0)	82.5 (8.7)	80.2	81.0	.04	.84	.01
Investing	66.7 (11.2)	54.0 (18.0)	61.3 (9.0)	59.0 (12.4)	58.3	63.6	1.30	.29	.16
Positive perspective	71.3 (17.6)	62.5 (6.5)	67.5 (15.1)	62.5 (17.1)	66.0	64.8	.01	.91	.00
Multifunctionality	48.0 (12.9)	46.0 (23.7)	58.7 (9.4)	42.0 (21.0)	58.2	42.7	5.06	.06	.42
Variety	68.7 (4.7)	60.0 (18.8)	72.7 (12.0)	63.0 (6.8)	71.5	64.7	.93	.37	.12
Total	64.6 (10.5)	58.0 (11.7)	66.1 (8.4)	60.0 (9.5)	64.2	62.8	.23	.64	.03
PAL, [1–5]									
Social activities – Frequency	2.6 (.5)	2.4 (.6)	2.3 (.4)	1.9 (.4)	2.3	1.9	3.17	.12	.31
Social activities – Enjoyability	3.3 (.6)	3.4 (.6)	3.3 (.4)	3.1 (.3)	2.7	2.2	2.42	.16	.38
Domestic activities – Frequency	2.9 (.4)	2.7 (.8)	2.7 (.4)	2.1 (.7)	3.3	3.1	4.23	.08	.26
Domestic activities – Enjoyability	3.6 (.4)	3.0 (.6)	3.6 (.4)	2.9 (.4)	3.5	3.1	1.25	.30	.15
Participation in social activities									
ASCOT[a], [1–4]	1.7 (.8)	2.0 (1.2)	1.8 (.8)	2.0 (.8)	1.9	1.9	.00	1.00	.00
Secondary outcome measures PwD									
Perceived self-efficacy									
D-GSE, [10–40]	30.7 (3.6)	30.8 (12.0)	31.3 (6.4)	28.0 (8.0)	31.4	28.0	1.07	.34	.34
Perceived autonomy									
EAL, [12–60]	36.0 (5.1)	38.3 (7.5)	36.5 (4.2)	40.3 (1.3)	36.5	40.2	2.25	.18	.24
Quality of life									
DQoL, [1–5]									
Self-esteem	3.8 (.7)	3.9 (.6)	3.8 (.4)	3.8 (.4)	3.8	3.8	.02	.90	.00
Positive affect	3.9 (.9)	4.0 (.6)	3.8 (.4)	3.8 (.5)	3.8	3.8	.03	.88	.00
Negative affect	2.2 (.6)	2.3 (.2)	2.0 (.5)	2.0 (.1)	2.1	2.0	.32	.59	.04
Feeling of belonging	3.8 (.6)	3.6 (.5)	3.6 (.6)	3.3 (.7)	3.5	3.4	.60	.46	.08
Sense of Aesthetics	3.5 (.7)	4.0 (.8)	3.5 (.6)	3.8 (.3)	3.5	3.6	.09	.77	.01
General quality of life	3.2 (.8)	3.3 (.5)	3.5 (.5)	3.3 (1.0)	3.5	3.2	.26	.63	.04
	FMA group (n = 7)	Con. group (n = 7)	FMA group (n = 7)	Con. group (n = 7)					
Primary outcome measures IC									
Feeling of competence									
SSCQ, [7–35]	26.9 (6.1)	22.9 (3.9)	24.6 (7.7)	21.6 (6.6)	22.0	24.9	2.35	.15	.18
Secondary outcome measures IC									
Positive Care Experiences									
PES [0–8]	5.0 (2.0)	3.6 (2.1)	4.4 (1.7)	4.4 (2.6)	3.7	5.1	5.17	**.04**	.32
Quality of life									
EQ-5D-5L[a], [1–5]	1.5 (.3)	1.4 (.7)	1.4 (.3)	1.4 (.7)	1.3	1.5	.88	.37	.07
EQ-VAS, [0–100]	77.1 (12.5)	72.9 (17.0)	76.4 (11.8)	77.9 (18.7)	75.9	78.4	.09	.77	.01
TOPICS-MDS									
General[a], [1–5]	3.0 (.6)	3.1 (.7)	2.9 (.9)	3.0 (.6)	2.9	2.9	.01	.94	.00
General[a] – compared to one year ago, [1–5]	3.3 (.8)	2.9 (1.1)	3.1 (.9)	3.3 (.8)	3.1	3.3	.09	.77	.01
Rate, [0–10]	7.0 (.8)	6.8 (1.3)	7.0 (.6)	7.0 (.8)	7.0	7.0	.05	.83	.01

SMAS-30: Self-Management Ability Scale-30; PAL: Pleasant Activities List; ASCOT: Adult Social Care Outcomes Toolkit; D-GSE: Dutch General Self-Efficacy Scale; EAL: Experienced Autonomy List; DQoL: Dementia Quality of Life; SSCQ: Short Sense of Competence Scale; PES: Positive Experience Scale.
η^2_p: 0.01 small effect size, 0.06 medium effect size and 0.14 large effect *size. p:* < 0.05 is statistically significant.
aLower scores are better, for other measures higher scores are better.

phone calls worked as a reminder or that they were able to ask questions about problems they had encountered. Others experienced it as a burden when nothing had changed since the last phone call. Keeping a diary of app usage was difficult for informal carers, because some found it too time consuming and others did not have the discipline to do it or continue with it.

Most participants that contacted the helpdesk had questions about the research procedure or needed support with tablet use. At the start of the intervention period researchers accidently discovered that FindMyApps was not working due to technical problems of the software provider. After it was agreed with software provider, researchers were to check the functionality of the FindMyApps tool on a daily basis.

Other irregularities encountered were that measurements involving persons with dementia were not always conducted in a separate room, i.e., in absence of the informal carer, because of the living situation of participants. In some cases, informal carers appeared annoyed that answers given by the person with dementia were not in line with the carer's perception. In addition, because of informal carers' preferences, some semi-structured interviews with persons with dementia and informal carers were planned directly after the post-test measurements or on the same day. Most people with dementia experienced this as exhausting.

Discussion

Overall results

FindMyApps is a newly developed intervention that helps persons with dementia to select and use apps for self-management and

meaningful activities. This feasibility study explored the implementation strategy of the FindMyApps training and the impact of the FindMyApps tool on self-management and engagement in meaningful activities. We tested the potential effect of the intervention on persons with dementia and their informal carers. Overall, the results suggest that the FindMyApps intervention is a feasible intervention for people with dementia and informal carers and that, based on the calculation of effect sizes, it has the potential to positively influence the self-management and engagement in meaningful activities in people with dementia. In this small sample, however, no significant differences between the FindMyApps group and control group regarding the outcome measures for persons with dementia were found. For informal carers, we found a significant difference between both groups regarding the positive care experiences in favour of the control group.

The FindMyApps training was generally well-received by informal carers. The explanations were clear, and the training based on the EL method [35,36] proved helpful for informal carers in supporting persons with dementia in using the FindMyApps tool and tablet. Persons with dementia learned to use the FindMyApps tool and tablet through this method, which supports earlier findings that persons with dementia can learn how to use everyday technology like mobile phones [39,40]. Despite this positive result, it was remarked by some carers in both groups that one face-to-face training session given by a trainer was not sufficient to fully support both the person with dementia and carer in the independent use of the tablet and FindMyApps tool.

This study also investigated the mechanism of impact of the FindMyApps tool. The research indicates that the FindMyApps tool was useful and user-friendly. Persons with dementia and informal carers in this study reported that the tool was helpful in finding apps and that most apps were interesting and in line with the personal needs of the person with dementia. Given the results of prior studies emphasizing that apps need to match the needs and wishes of persons with dementia [16,26], this is a positive outcome. Individuals also reported that using the FindMyApps tool had helped them become more familiar with the use of a tablet. In this pilot study, persons with dementia stated that using the tablet was an enjoyable activity in itself, which is in line with previous studies [16,24,26].

Nevertheless, there were also some critical remarks regarding the usability and user-friendliness of the FindMyApps tool. Using the touchscreen of the FindMyApps tool was at times difficult for the participants. This confirms previous research showing that persons with dementia can have difficulties with movements such as swiping and tapping on a touchscreen [16]. Also, the FindMyApps tool was developed as a web application and at times a slow internet connection or a slow host server might have caused some of the problems. Another important criticism was that the page "My Apps" in the FindMyApps tool was not as useful as expected, because apps presented in that list could not be directly opened from that page. Furthermore, there were too many categories and sub-categories, and buttons were not always recognizable as such due to a lack of colour contrast.

Persons with dementia were generally able to learn how to use the FindMyApps tool by using it regularly and through perseverance. For informal carers, it was important to be patient when training the person with dementia. Previous experience using a tablet made the training easier for persons with dementia. Downloading apps was difficult for persons with dementia, and many needed support in navigating categories on the FindMyApps tool. Though the persons with dementia stated that they had generally learned how to use the tool, almost all of them needed support from their informal carers in using specific parts of FindMyApps, which was expected [32,41].

Most persons with dementia in the FindMyApps group found more than three apps in the FindMyApps tool, which they used on a daily or weekly basis. Persons with dementia in the control group also found useful apps on websites, though they used them less often than participants in the FindMyApps group. All participants reported that the apps stimulated either their self-management abilities, their engagement in meaningful activities or both. These findings confirm previous studies that show that persons with dementia can still enjoy engaging in activities and that a tablet with apps can be both an interface to do this as well as offering daily support [15–17,19,21,24,26]. For example, Cutler et al. [15] and Groenewoud et al. [16] found that playing games on a tablet can be a meaningful activity for persons with dementia.

We did not find any statistical significant effects in the FindMyApps group on the primary or secondary outcomes in persons with dementia. Hence, there was no clear indication that the FindMyApps group had more support in tablet use than those in the control group. We did find some moderate to large effect sizes for variables of the primary and secondary outcomes for people with dementia, which are generally slightly in favour of the FindMyApps group. For example, we found a large effect size for the D-GSE with scores showing an improvement for persons with dementia in the FindMyApps group. Persons with dementia in the FindMyApps group possibly felt more optimistic that they were able to cope with their condition, because they had access to the specific intervention. Informal carers in the FindMyApps group reported significantly fewer positive care experiences than participants in the control group. A possible explanation could be that informal carers in the FindMyApps group experienced the support for their relative with dementia as too time-consuming, which was also acknowledged in the semi-structured interviews. A future RCT with a larger sample will enable us to have enough power to draw conclusions that are supported by statistical analyses.

Strengths and limitations

Strength of this study is that we used a mixed-methods design comprising qualitative and quantitative measures, which helped us gain in-depth information on the experiences and opinions of the participants. We took the time to build relationships with the participants. By building a relationship and meeting the participants in person – an important aspect of dementia-related research to maximize responses of persons with dementia [77] – we were able to find the intended amount of dyads to start this pilot study.

There are some limitations to be noted. Although we did find some moderate to large between-group effect sizes, statistical power was low due to the small sample, and we must therefore be cautious in drawing conclusions about the potential impact of FindMyApps. Next, selection bias could have influenced the results. In our sample, the majority of persons with dementia and informal carers had a high level of education and the majority of persons with dementia were male, while the majority of informal carers were female. However, research shows that Internet use is a male-dominated activity among the older population [78], which may clarify why we had more men than women with dementia in our sample. In addition, due to the high level of study attrition, it may be that the opinions of persons with

dementia and informal carers who completed the study differed from those who dropped out. This has to be considered when reviewing our findings.

Recommendations for a future effectiveness study

As this study was an exploratory pilot RCT in preparation for an upcoming effectiveness study, some recommendations can be made. First, due to the high number of persons with dementia who dropped out due to a limited interest in using a tablet, we recommend that researchers check the level of motivation regarding tablet use not only with informal carers, but also with potential persons with dementia in order to reduce study attrition. This seems to be particularly important for people who have no prior experience in using a tablet. Second, we noticed that data collection using questionnaires was difficult and at times stressful for some persons with dementia due to the number of questionnaires and their length. We therefore recommend using shorter questionnaires. Examples are the SMAS-S [79], a shortened version of the SMAS-30 with 18 items, the Maastricht Social Participation Profile [80], an alternative to the PAL that measures social participation in older adults with 26 items, and a shortened version of the USE questionnaire consisting of 17 items as described by Lund [49]. This would make data collection from persons with dementia more feasible and decrease the likelihood of missing values. Third, several informal carers reported that keeping a diary of app usage took up too much time and a lot of diaries were not completed. We think that using a diary for app usage will not be necessary in a future RCT, as data analytics tools for tracking app usage in the back-end of the FindMyApps tool, supported with the page "My Apps" in the FindMyApps tool and the interviews, will provide enough information on app usage by persons with dementia. Fourth, we recommend checking the status of dementia in participants and also repeating this post-test. The results of these outcomes could then be connected to the results of the outcome measures to get a clearer view on a possible relationship between a decline in the outcomes and the stage of dementia. Fifth, based on the data of this pilot study and the medium to large effect sizes found for some of the primary and secondary outcome measures, an *a priori* power calculation was performed with G*Power version 3.1 [81] to allow for a recommendation regarding the sample size for the upcoming RCT. The calculation indicates that in an ANCOVA model with a power of 80% and a significance level of 0.05 a total sample size of 128 participants would be needed to detect a medium effect and 52 participants to detect a large effect. Allowing for a dropout rate of 37.5%, an overall sample of 176 participants, 88 participants in the experimental group and 88 in the control group, or 72 participants, 36 participants in the experimental group and 36 in the control group, will be required, respectively.

Recommendations for the FindMyApps training and tool

The results of the qualitative analyses provided valuable insights into how the FindMyApps training and tool can be improved. Based on the remark made by informal carers that one training is not sufficient enough to support persons with dementia, we suggest adding demonstrational videos, an approach that has effectively been used to help people acquire new skills [82]. These videos could provide general instruction on the functions of the tablet for both groups, as well as instructions on how to use the tool in the FindMyApps group. Informal carers and persons with dementia could watch the videos any time they needed

assistance. Hopefully, this would also contribute towards less time investment by informal carers in training their relatives with dementia. Second, qualitative analysis showed that several participants did not find the page "My Apps" useful, because it was not possible to open apps directly from this page. The reason for this is that we built the FindMyApps tool as a responsive website instead of a native app, so that it could be easily updated and developed further, which was more feasible for our study purposes. We recommend that clicking on an app on the page "My Apps" opens the App Store respectively Play Store, which would enable participants to open the specific preferred app. This would be an interim solution, as directly opening an app through the page "My Apps" is not yet possible due to its development as a responsive website. Third, participants reported that it was not always clear to them what kind of apps a main or subcategory entailed based on the symbols used. We therefore suggest adding a short description sentence to each category. Furthermore, the icon of the main category "leisure" should be made more recognizable, and some buttons, like the download button, must offer more contrast in colour.

Scientific and practical relevance

To our knowledge, this is the first intervention for people with dementia designed to help them find usable apps for self-management and meaningful activities that are tailored to their needs, wishes and abilities. Our findings are contributing towards the growing field of eHealth interventions for people with dementia, especially regarding the potential use of tablets and apps. In dementia-related research, the opinions and experiences of persons with dementia are often neglected [77]. Our findings suggest that they can still provide valuable information and contribute to research, if the study procedure is fitted to suit their abilities, e.g., making use of trained assessors and interviewers and shorter questionnaires. A shift from doing research *on* people with dementia to doing research *with* people with dementia would be a fruitful direction for the development of effective interventions for people with dementia.

Conclusions

Based on the qualitative results and the effect sizes on the outcomes measured in this study, we consider that the FindMyApps intervention has the potential to positively influence the self-management and engagement in meaningful activities in people with dementia. Future studies with a larger sample should better indicate whether this expectation can be confirmed. The intervention will be further improved and tested in a larger pilot-RCT study and its effectiveness subsequently evaluated in a definite RCT.

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