

A Digital Gaming Intervention to Strengthen the Social Networks of Dutch Older Adults: Process Evaluation of a Randomized Controlled Trial

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Submitted to: JMIR Formative Research
on: December 19, 2022

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Table of Contents

Original Manuscript	5
Supplementary Files	32
Figures	33
Figure 1.....	34
Figure 2.....	35
Figure 3.....	36
Multimedia Appendixes	37
Multimedia Appendix 1.....	38
Multimedia Appendix 2.....	38
Multimedia Appendix 3.....	38
TOC/Feature image for homepages	39
TOC/Feature image for homepage 0.....	40

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Abstract

Background: Digital loneliness interventions for older adults are promising, yet conclusive evidence is lacking due to few randomized controlled trials (RCTs) and difficulties with recruitment. Process evaluation of performed RCTs is essential to inform future interventions but is rarely carried out, resulting in an overly optimistic view of the impact of eHealth interventions on loneliness in older adults and options to conduct such research fully remotely.

Objective: This paper describes a mixed methods process evaluation of a digitally conducted RCT assessing the effectiveness of a mobile social gaming application to facilitate meaningful social interactions in older adults.

Methods: To evaluate recruitment and onboarding, intervention adherence, and intervention acceptability, we quantitatively analyzed the questionnaire and game data of the RCT participants and conducted post-RCT evaluation interviews and a focus group with 4 RCT participants and 5 welfare organizations that aided RCT recruitment.

Results: In total, 371 people signed up for the RCT, of which 20% (76/371) installed the app and signed informed consent, showing a large drop-out during onboarding. The baseline questionnaires were completed by 36% (27/76), rapidly declining during follow-up. The high number of questions was a relevant barrier for participants. Both questionnaire and gameplay adherence was low. Participants indicated that the games elicited contact and a feeling of togetherness and proposed challenging and competitive games with increasing difficulty levels. They suggested focusing on enjoying the games rather than administering questionnaires.

Conclusions: Conducting a remote digital trial of a social gaming intervention for older adults is a great challenge. Remote recruitment and informed consent acquisition may often not result in sufficient participation. Personal engagement with fellow participants and researchers might be essential for adherence and enjoyment. Future digital gaming interventions should start with small-scale studies with in-person contact, repeated instructions, and fewer questionnaires.

(JMIR Preprints 19/12/2022:45173)

DOI: <https://doi.org/10.2196/preprints.45173>

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Original Manuscript



A Digital Gaming Intervention to Strengthen the Social Networks of Dutch Older Adults: Process Evaluation of a Randomized Controlled Trial

Original Paper

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JJ, PdH, and GP designed the evaluation. JJ, BC, RT, MD, RC, GP, and MOR conceptualized the trial. JJ, BC, and PdH collected and analyzed the data. JJ wrote the manuscript, to which all authors gave critical feedback. All authors approved the final draft of the manuscript.

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Abstract

Background: Digital loneliness interventions for older adults are promising, yet conclusive evidence is lacking due to few randomized controlled trials (RCTs) and difficulties with recruitment. Process evaluation of performed RCTs is essential to inform future interventions. Still, it is rarely carried out, resulting in an overly optimistic view of the impact of eHealth interventions on loneliness in older adults and options to conduct such research fully remotely.

Objectives: This paper describes a mixed methods process evaluation of a digitally conducted RCT assessing the effectiveness of a mobile social gaming application to facilitate meaningful social interactions in older adults.

Methods: The RCT included a main group of older adults (aged 65+) and a side group (aged 18-64). The side group allowed a network to play with the older adults. We analyzed the questionnaire and game data of the main and side groups to evaluate recruitment and onboarding, intervention adherence, and intervention acceptability. We furthermore conducted 6 post-RCT evaluation interviews and 1 focus group with a total of 4 RCT participants and 5 welfare organization representatives that aided in RCT recruitment.

Results: In total, 371 people aged 18+ signed up for the RCT, of which 64% (238/371) were 65+. Of the total sample, 20% (76/371) installed the app and signed informed consent, showing a large drop-out during onboarding. The high number of questions was a relevant barrier for participants. Both questionnaire and gameplay adherence were low. Participants indicated that the games elicited contact and a feeling of togetherness and proposed challenging and competitive games with increasing difficulty levels. They suggested focusing on enjoying the games rather than administering questionnaires.

Conclusions: Conducting a remote digital trial of a social gaming intervention for older adults is a great challenge. Remote recruitment and informed consent acquisition may often not result in sufficient participation. Personal engagement with fellow participants and researchers might be essential for adherence and enjoyment. Future digital gaming interventions should start with small-scale studies with in-person contact, repeated instructions, and fewer questionnaires.

Keywords: Loneliness; Serious Games; Qualitative Research; Mixed Methods

Introduction

Loneliness is a complex issue in older adults [1, 2], and many digital interventions have previously tried to address it. However, concluding evidence is still lacking [3-5] due to two major challenges. First, loneliness is highly personalized and subjective [6, 7], requiring solutions that are engaging and tailored to the individual's needs [5, 8]. We propose that digital games, both enjoyable and adaptable, might be a solution to this problem. Second, methodological issues such as the lack of randomized controlled trials (RCTs) and low participation and retention rates impede the quality of the evidence [3, 9]. We argue that thorough process evaluation of existing RCTs is more important than merely conducting more RCTs, especially in the new field of remotely conducted RCTs. This way, we can identify effective intervention and recruitment elements essential to advance in this research field [10, 11].

Regarding tailorable interventions, a suitable candidate could be digital games. They allow valuable social interactions [12-14], and older adults enjoy playing social gaming apps [15, 16]. Recent reviews reveal the underutilization of social games for social connection [4, 17] and, in the context of loneliness reduction, tend to focus on exercise games [18-20]. Exercise games are often not feasible for older adults due to functional and cognitive limitations [21, 22]. Therefore, research into more asynchronous, independent at-home games is needed.

The methodological issues shown in previous interventions [3, 4] are common in research with older adults. Digital recruitment of older adults, in general, is challenging [23, 24], and selection bias often causes an underrepresentation of lonely older adults in the included samples [16, 21]. Best practices are lacking, as many studies do not report on and evaluate recruitment and participant flow [25]. Furthermore, attrition rates are relatively high [3]. For example, in the online friendship course by Bouwman et al. [9], 76% of the included participants did not finish the intervention. These drop-out rates reveal the need to evaluate recruitment and retention rates to inform future interventions.

This paper describes the mixed methods process evaluation of a digitally conducted RCT that evaluated the effectiveness of a purposefully designed, text-based, mobile social gaming application to decrease loneliness in older adults (Textbox 1). The intervention was planned to last from April 2021 to April 2023, but inclusion was terminated in September 2021 due to far lower participant rates than expected. Terminated studies are underrepresented due to publication bias [26, 27], while their evaluation can reveal pitfalls avoidable in the future. We structure the process evaluation guidelines around the guidelines posed by the Medical Research Council [10], subsequently tailored to complex geriatric interventions [28, 29]. We report on the recruitment of participants and the intervention's adherence and acceptability using evaluative interviews, focus group data, and quantitative backend game data.

Methods

Randomized controlled trial

This preplanned process evaluation is part of an RCT for which the methodological details are presented in Multimedia Appendix 1. In short, it assessed the effectiveness of a purposefully designed mobile recruitment and data collection process linked to the interventional gaming app (Textbox 1). It was developed to decrease the loneliness of older adults (65+) by facilitating

valuable playful interaction moments. The app conducted monthly questionnaires for 12 months on, for example, loneliness, mobility, and well-being. Sign-up, onboarding, and the intervention were done entirely digitally. Using three different app versions, we compared 3 conditions: (1) games eliciting interaction about participants' personal life, (2) games eliciting sharing generic stories, and (3) no games at all. With this design, we simultaneously aimed to assess the effectiveness of a gaming app and the effectiveness of the personalized aspect of the games. The study focused on adults aged 65+ (the main group), but to allow a network of people to play with, all younger adults (18-64 years) were allowed to sign-up, play, and invite others as well (the side group). The side group received a brief questionnaire to obtain information on whom the main group played with.

Process evaluation

In the mixed methods process evaluation, we used quantitative data collected during the RCT. Furthermore, we conducted post-intervention interviews and focus groups with RCT participants and welfare organization representatives to collect their experiences with the RCT and the app.

Backend data collection

Regarding the onboarding process of the RCT, we assessed the number of people in the different steps of the onboarding process, that is, that signed up on the webpage, created an in-app profile, signed informed consent, and answered questionnaires. To assess intervention adherence, we assessed which game participants played for every session and the number of players in the group. We also saved the timestamp of the session creation. Lastly, we quantitatively evaluate the acceptability of the intervention by reviewing questionnaire adherence over time.

Post-intervention evaluation interviews

We sent an email to all 372 RCT participants who signed up on the RCT landing webpage and 39 organization representatives, inviting them for the qualitative evaluation. Participants had the opportunity to sign up for an individual, semi-structured interview or focus group discussion based on their preferences. Upon responding, participants received an email containing the study information. We made an appointment for a digital interview or focus group using Microsoft Teams, Zoom, or a phone call, depending on the participant's preference. All data were collected between November 2021 and February 2022.

The sessions were voice recorded and held by two researchers trained in qualitative research (JJ and PDH). At the start of the session, participants could ask questions regarding the participant information letter, after which they gave verbal, recorded consent. The questions followed an interview guide and focused on participants' experience with the app, the games, and the questionnaires and their suggestions for future design and implementation. We organized the focus group according to an equivalent procedure, with questions adapted slightly.

In total, we included 9 participants, of whom 8 females. We held 1 focus group (duration of 84 minutes) in which 3 representatives of 2 organizations participated. We furthermore held 6 individual, semi-structured interviews (average duration of 57 minutes) with 4 RCT participants and 2 representatives of 2 organizations. Given the homogeneity in interview responses, we assumed data saturation after the last interview.

Data analysis and integration

Two researchers (JJ and PDH) transcribed all audio recordings verbatim and open-coded the transcripts. The codes were subsequently grouped into categories and overarching themes.

Descriptive statistics of baseline scale scores described the RCT participant sample. We used qualitative and quantitative data to assess recruitment, adherence, and acceptability.

Onboarding and participant flow

We graphically described the participant flow from onboarding, randomization, allocation, and drop-out. We related this flow to interview questions on recruitment and onboarding. We subsequently compared the acquired sample size with the sample size goal.

Intervention adherence and acceptability

We described the gameplay behavior, preferred games, and the number of players per session. We also used interview questions on gameplay and app enjoyment to describe participants' thoughts about the games. To assess acceptability, we used questionnaire adherence data and interview questions on questionnaires experience to support these results.

Ethics

The RCT with process evaluation was reviewed by the research ethics committee of the Radboud university medical center (file 2020-6884). It did not fall within the remit of the Dutch Medical Research Involving Human Subjects Act (WMO). The ethics committee approved the study based on the Dutch Code of Conduct for health research, the Dutch Code of Conduct for responsible use, the Dutch Personal Data Protection Act, and the Medical Treatment Agreement Act. The RCT is registered on Clinicaltrials.gov (NCT04733898).

For the RCT, participants gave informed consent in-app prior to data collection. For the process evaluation, participants received the information letter containing study details by email prior to the interview. They gave verbal informed consent at the start of the interview or focus group.

Textbox 1. Description of the *Playing Together*-app

The intervention evaluated in the RCT is the 'Playing Together' gaming application (in Dutch: *SamenSpelen*), designed and developed by Games for Health based on previous research [30, 31]. We created separate apps for each RCT condition to avoid contamination between the conditions. The apps were freely available on the App Store and Google Play Store. After randomization, participants received a download link to the app corresponding to their condition.

The app comprised 26 text- or photo-based games, combining digital adaptations of familiar games (like 'Hangman') and newly developed games (like 'PhotoSnake' or 'What is it?'). A game is a group chat in which one or more players play that specific game. A chatbot explains the rules through text messages, after which players can play at their own pace and with their own rules. Players can send text messages (including emoticons) and photos by taking one from their camera or selecting one from their photo library. Specific prompts are available for most games, serving as a conversation starter.

An example game is *PhotoSnake*: the (bot) facilitator explains to players that this game is about sending a photo of something that starts with the last letter of the item on the previous photo. Players can then take or upload a picture, after which they can respond, interact, and share related memories.

The goal of the app was to stimulate intergenerational contact. The app was suitable for this, as younger children can help and teach older adults who like to share memories and interact with younger generations. Thus, game and interface choices had to appeal to multiple generations.

Results

Onboarding feasibility

Participant flow

The onboarding process of the RCT consisted of four steps, all conducted on a website or in-app, without the interference of a researcher. Figure 1 shows the participant flow in the different steps. In total, 371 adults aged 18+ signed up on the project's website, after which they were randomly allocated to one of the three conditions. Participants received an email with a download link, after which 48% (177/371) downloaded the app and created an in-app profile. A chatbot provided the study information and asked for informed consent, which 43% (76/177) provided. Of the 76 final study participants, 43% (33/76) were 65+ and allocated to the main group, and 57% (43/76) were aged 18-64 and thus allocated to the side group. In conclusion, of the 238 older adults that signed up, we included 14% (33/238) in the study's main group. These 33 older adults had a median age of 69 (interquartile range (IQR) = 8) and a median loneliness score of 6 out of 11 (IQR = 5.5), indicating moderate loneliness.

The complex steps in the onboarding process were primarily caused by the apps' research aim, requiring randomization and informed consent. Multiple steps involving agreement and study explanation were necessary. These steps might partly explain the large sample size drop in the download and onboarding steps.

Onboarding and recruitment: barriers and facilitators

Interview results (see Multimedia Appendix 3 for a list of accompanying quotes) show that organizations praised the initiative and the project's goal and indicated that older adults showed enthusiasm toward the app after a workshop or presentation. However, they revealed concerns about the web-based recruitment approach and suggested letting welfare organizations serve as intermediaries in recruitment. Participants stressed the importance of in-person, personal, approachable, and repetitive instruction in small-scale settings. For technology adoption, they suggest "taking them by the hand" and letting them experience the games' added value and fun aspects before exposing them to many questionnaires. The focus should be on the enjoyment of the games rather than the research and its questionnaires. They also suggested focusing on younger people, who can enthuse older adults.

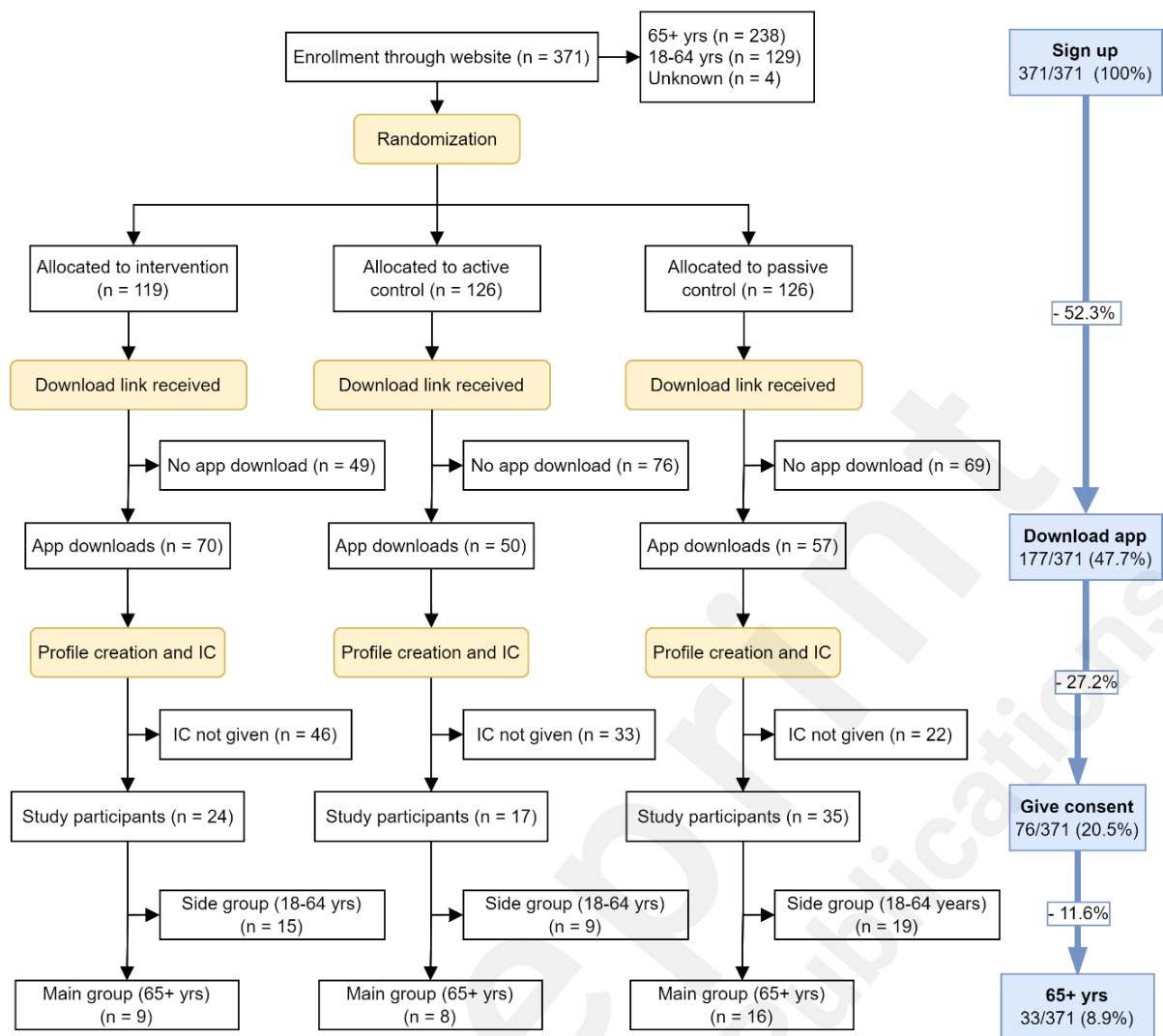


Figure 1. Enrollment, allocation, and onboarding flow of participants (N = 371) in the RCT. The yellow squares indicate steps in the onboarding process, and the blue column indicates the percentage of the total losses during the different steps.

Intervention adherence

Gameplay activity

To assess adherence to the intervention, we review players' in-app activity and their views on the games. Figure 2 shows the number of sent messages over time from inclusion (Time = 0). The number of sent messages is higher in the intervention group (2415) than in the active control group (363). Sent messages decrease rapidly over time, both within the first day (Figure 3a) and over more extended periods (Figure 3b).

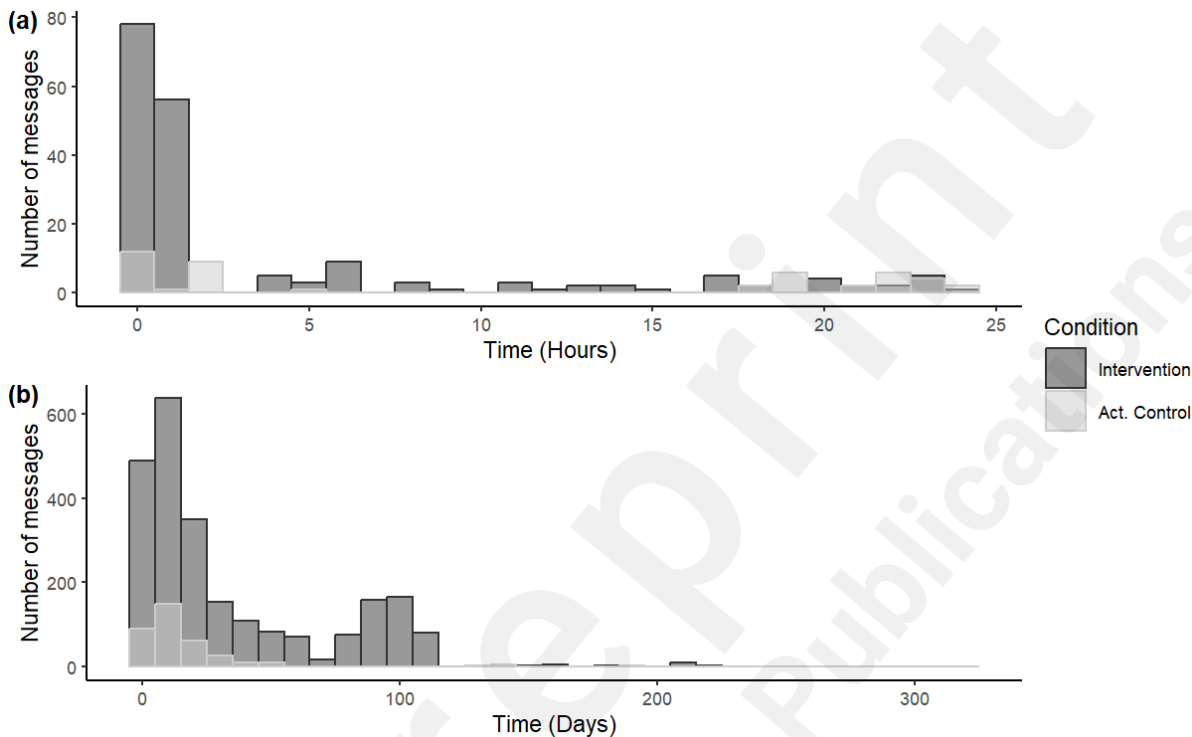


Figure 2. (a) the number of messages sent in the first 24 hours after sign-up per game condition by the total sample ($N = 76$); (b) the number of messages sent in days after sign-up per game condition by the total sample ($N = 76$).

Of the 805 sessions started in-game, 82% (660/805) were occupied by a single person, and 27% (215/805) were chatbot sessions administering questionnaires. As all questionnaire chats are single-person, we can conclude that of the remaining 590 game sessions, $660 - 215 = 445$ (75%, $445/590$) are single-player. Furthermore, 46% ($233/590$) and 12% ($62/590$) were created for the games *Hangman* and *PhotoSnake*, respectively, indicating that these two games were the most popular. However, *Hangman* starts automatically upon first opening the app to get acquainted with the games, partly explaining the high number of sessions.

Gameplay and game design: barriers and facilitators

Qualitative results (also see Multimedia Appendix 3) indicated that, according to the participants, the games elicit social contact and create a feeling of togetherness and curiosity. Some found the games easy to use, and others wanted a greater challenge. Participants suggested gradually increasing the difficulty level to align with personalized preferences and (digital) skill levels. Furthermore, future designs should reduce the number of games to avoid

information overload and have more focus in-app.

Multimedia Appendix 2 shows screenshots of the app's interface. Some participants found the app interface appealing, while others reviewed it as crowded and childish, given the cartoons and colored background in the chat window. Participants suggested some interface improvements, e.g., deleting chats, increasing the textbox size when typing in a bigger font, adding voice message compatibility, and different colors of messages sent by different people. Some participants considered finding the right buttons to start a game and inviting others to play a game difficult.

Due to the games being targeted at multiple groups and aiming at intergenerational play, it was challenging to find the appropriate difficulty level. The RCT design did not allow for iterative development. These iterations are common in game design, and the lack thereof caused a mismatch between the app and the target group.

Intervention acceptability

Questionnaire adherence

Finally, we evaluated the acceptability of the intervention design. Regarding questionnaire adherence, Figure 3 shows that the number of answered monthly questionnaires decreased greatly after baseline, taking loneliness as an example. Almost everyone (96%, 73/76) answered the baseline questionnaire, which dropped to 24% (18/76) after one month. The drop is the largest in the passive control condition.

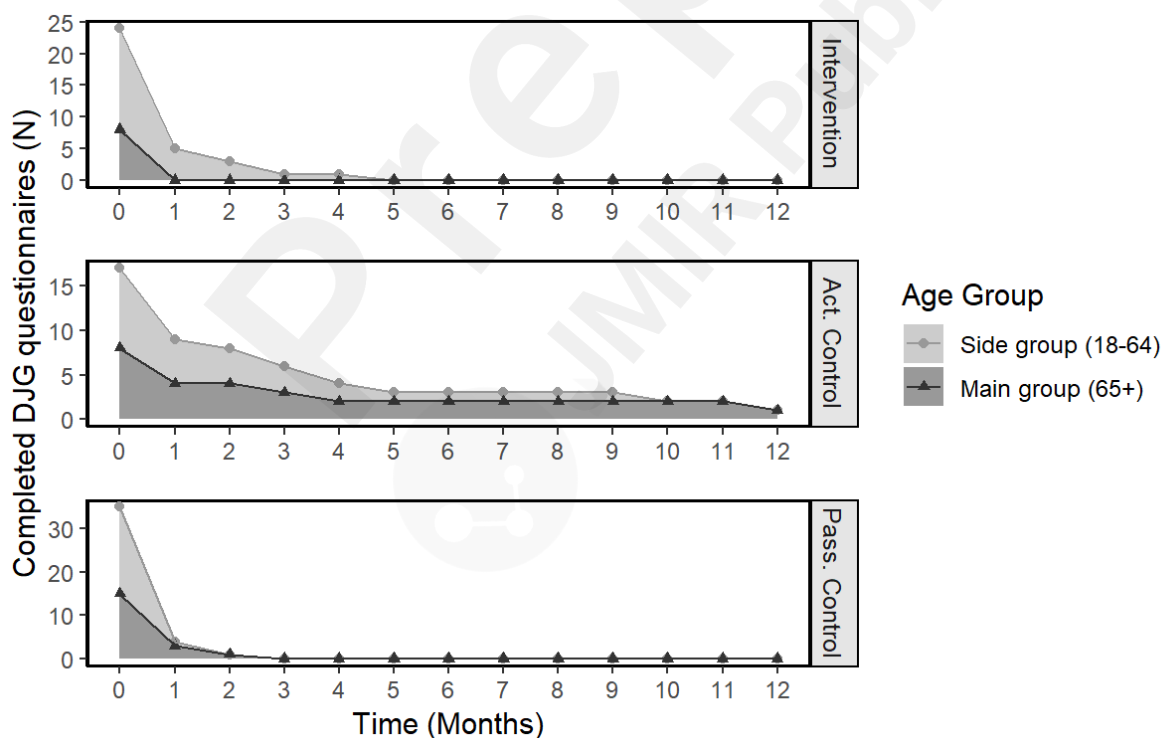


Figure 3. Percentage of people per condition, per age group, that completed the monthly Loneliness (DJG) questionnaire. Each graph represents an RCT condition.

Digital intervention: barriers and facilitators

Regarding the questionnaires, interview participants mentioned questionnaire length as a relevant barrier. Many found the number of questions and the required time investment too large. Representatives from welfare organizations mentioned that completing questionnaires was "not a priority" for older adults and that they dislike it when obliged to do something. For future design, participants suggested minimizing the number of questions and starting with small-scale studies. The question's wording should match the target group as closely as possible. Administering digital questionnaires was acceptable for some participants. In contrast, others preferred having them asked face-to-face, as it is too easy to skip or ignore when done digitally.

Regarding a digital intervention, participants mentioned an advantage of mobile games for people without day-to-day interaction but stressed that it could not replace in-person contact. They also mentioned that the advantage would be highest for digitally skilled older adults. On the other hand, participants indicated the app's potential for improving digital skills, as current training opportunities do not appeal to many older adults.

RCT design could partly explain a lack of questionnaire adherence. Due to multiple measurements with fixed intervals, it did not allow for spreading out the questionnaires, which participants advised, and which could have increased the number of completed questionnaires.

Discussion

This study described the mixed methods process evaluation of an entirely remotely conducted gerontological RCT assessing a newly developed digital gaming application for strengthening the social network of older adults. The evaluation showed that it is difficult to keep participants engaged for longer periods when conducting a digital trial in older adults without in-person contact. Remote recruitment and only informed consent acquisition started by social media, newsletters, and mailing lists of welfare organizations were insufficient to reach the desired study population. It resulted in low sample sizes, low questionnaire adherence, and little gameplay, consistent with recruitment and attrition challenges in previous studies [3, 9, 32].

Onboarding feasibility

The results reveal several difficulties encountered in this study and digital interventions for older adults in general [33, 34]. Less than half of the people signing IC were aged 65+ and eligible for our main sample, and we only managed to reach 1.5% (33/2220) of our sample size goal. Moreover, we lost more than half of the sample in the app download step and another half during chatbot interaction and signing IC. It indicates that a completely digital onboarding process, with relatively many steps, results in a very low inclusion rate. A previous feasibility study to this app [31] already showed the enormous loss of people during digital recruitment, which, combined with this study, indicates that a completely digital onboarding process for older adults might not be feasible.

The literature stresses the importance of cultivating a relationship with local organizations and face-to-face contact with participants [33, 35, 36], all of which, in our study, were complicated by social restrictions and online recruitment in general. Although many local and national aging, welfare, and volunteer organizations shared study information via their newsletters, mailing lists, or website, building a substantive relationship with organizations and potential participants was challenging. Social media recruitment seems promising [37], yet it still requires a precise target group definition and an extensive initial reach to have sufficient

participants. Retention also poses an issue due to needing to build a relationship with participants [23, 24].

Intervention adherence

In our RCT, 96% (73/76) of the participants answered the baseline questionnaire, declining to 24% (18/76) after just one month. This reveals a difficulty in keeping participants engaged online, which is in line with previous research [9, 31, 42]. A recent qualitative evaluation of adherence in a depression intervention showed that intrinsic motivation, time availability, and the relative value of the intervention were predictive of greater adherence [43]. Furthermore, an online friendship course against loneliness in older adults revealed that intervention drop-out decreased with engagement [9], which the authors defined as using the intervention as instructed. These findings suggest that engagement and intrinsic motivation are important predictors of adherence and effectiveness in socializing interventions [44]. It might have been the case that participants in the RCT did not feel intrinsically motivated, possibly due to the low availability of people to play games within the app or not feeling the games were "for them," as they did not feel lonely [30]. A possible disconnection between the app's goal and the players' sentiments might have influenced the game and questionnaire adherence.

Another important aspect in improving game adherence is self-efficacy. Enjoying easy-to-use games positively affects self-efficacy and social interactions [45, 46]. Providing older adults with learning opportunities that show them the added benefit of technology to their social connections is an important predictor of motivation and skill [46, 47], which in turn is associated with health improvement benefits [48]. Furthermore, (social media) self-efficacy is associated with lower levels of loneliness [49, 50]. Following this, Chen and Gao [50] suggest providing older adults with offline ICT learning to strengthen their perception of connectedness and digital skill. This aligns with the findings of our process evaluation and emphasizes the importance of repeated practice sessions for effective digital gaming adaptation. Primarily due to Covid lockdown restrictions, our study did not include such practice sessions. However, we recognize the crucial role they may play in ensuring the long-term engagement of older adults in digital interventions.

Intervention acceptability

In terms of the games, we found that participants enjoyed the games for a while, but felt that they lacked challenge in the long term. Older adults increasingly participate in digital technology and games [51]. They play games for various reasons, e.g., social interaction, competition, challenge, arousal, relaxation, and passing the time [52-55]. Qualitative literature suggests that social games for older adults might be most effective when players are matched with the right, balanced team of partners, share high scores, and incorporate vicarious play [56]. Competition aspects were deliberately not added to our app, as they might have shifted the attention away from social interaction. However, this might have created a discrepancy between the players' expectations and the app's goal, decreasing motivation to play. Furthermore, the games needed more challenge for more digitally skilled individuals, as indicated in the interviews, while simultaneously being too difficult for others, equating to an unfitting amount of challenge for most participants.

The app's initial goal was to encourage intergenerational contact. Game design for different generations is possible but has specific co-design requirements [57-59]. One can best achieve intergenerational contact by building on the shared ideas of both generations, using the skills of both younger and older adults (e.g., by letting children assist older adults), and allowing both

generations to spend time together [57]. Our app incorporated games known to older adults, an interface resembling apps familiar to older and younger generations, and used language believed to appeal to both. These design decisions might have worked if older adults had played with younger children. However, in this study, older people played in a child-friendly environment that might have felt childish.

Strengths and limitations

This process evaluation suggests development, usability, recruitment, gameplay improvements, remote recruitment, and data acquisition. Given the difficulty in reaching older adults and the limited effectiveness of loneliness interventions, process evaluation is vital to inform future interventions. We minimize the use of valuable resources by allowing future interventions to apply our lessons learned.

The low response rate for the process evaluation may be a limitation. It proved difficult to recruit respondents, even after multiple contact attempts. The responses were homogeneous, indicating data saturation. However, we cannot confidently conclude this, as we failed to represent the complete sample of RCT participants and organizations in our qualitative evaluation. Participants who declined indicated they quit RCT participation long ago, were uninterested, or felt they were not of added value due to limited playtime. Furthermore, our sample's relatively high number of organization representatives could have slightly biased our results. These representatives are generally more knowledgeable about recruiting older adults than their actual game experience.

Game design and evaluation is a multistage iterative process in which small-scale feedback rounds continuously enhance the product. On the other hand, a large trial demands that the interventional product remains the same throughout the study period, meaning that we could not update the app once inclusion started, apart from necessary bug fixes. Furthermore, using the app as a scientific intervention allowed for rich and systematic data collection to evaluate gaming behavior but also required aspects not usually included in a game, like questionnaires and informed consent procedures. Therefore, it asks for a pre-trial design process to obtain good feedback on design choices while thoroughly assessing whether the trial intervention is suitable for large-scale research through feasibility and pilot testing.

Conclusions and Future Perspectives

This study showed that both older adults and organizations are optimistic about the concept of a gaming app for social connectedness. However, merely relying on online recruitment is insufficient to reach lonely older adults. Furthermore, a digital intervention and onboarding process creates challenges in participants' understanding, engagement, and motivation.

The app should be accessible, easy to use, understandable, have various difficulty levels, and have minimal functionality to make it accessible for a digitally low-skilled population. Future study designs should start on a small scale, with few questionnaires and no follow-up measurements, and subsequently build up to more complex designs, thereby avoiding wasting time and resources. Process analysis should always be preplanned as it is crucial to improving e-health applications and evaluations. In conclusion, social health games may assist in strengthening social connectedness and natural age-related decline in the social network of vulnerable populations. However, a scientifically sound evaluation is still needed, and the most effective set-up of such interventions remains to be developed in collaboration with the stakeholders.

Acknowledgments

We thank the participants for generously sharing their experiences with us. The research is part of the Social Health Games project in collaboration with Games for Health and Cooperation Dela.

Funding details

This work was supported by the Netherlands Organisation for Scientific Research (NWO) under Grant 645.003.002.

Author contributions

JJ, PdH, and GP designed the evaluation. JJ, BC, RT, MD, RC, GP, and MOR conceptualized the trial. JJ, BC, and PdH collected and analyzed the data. JJ wrote the manuscript, to which all authors gave critical feedback. All authors approved the final draft of the manuscript.

Conflicts of Interest

Games for Health was both a research partner and a commercial partner. Research-wise, they performed design research to explore and validate how to design for social interaction and quality contact to reduce loneliness. Commercial-wise, they investigated if and how a feasible business model could be created about this scope.

Abbreviations

IC: informed consent

RCT: Randomized controlled trial

SD: Standard Deviation

NWO: Netherlands Organisation for Scientific Research

WMO: Medical Research Involving Human Subjects Act

DJG: De Jong Gierveld Loneliness Scale

SPF-IL: Social Production Function scale

NDIS: Network Domain Identification and Significance scale

TOPICS: The Older Persons and Informal Caregivers Survey

LSA: Life Space Assessment

ANOVA: Analysis of Variance

ICT: Information and Communication Technology

Covid-19: Coronavirus Disease 2019

Multimedia Appendix 1. RCT protocol details

Study design

The study consisted of a three-arm, parallel-group, participant-blinded, randomized, and controlled clinical trial. Participants were randomly allocated to either the intervention (personal games), active control (non-personal games), or passive control group (no games) (1:1:1). The three groups' design allowed assessment of whether playing games improve social connectedness (by comparing intervention and passive control) and whether the personal aspect of the game is needed to achieve this (by comparing intervention and active control).

Objectives

Primary objective

To investigate whether playing social games is effective in decreasing subjective loneliness in older adults aged 65 and older, compared to playing non-personal games and not playing games.

Secondary Objective

(1) to investigate whether mobile games are effective in increasing the size of the social network and in improving the social well-being of older adults aged 50 and older, compared to playing non-personal games and not playing games; (2) to validate whether social interaction can be measured using game data; (3) to investigate whether we can model social network dynamics to generate micro-interventions to increase network strength; (4) to conduct a process evaluation, e.g., in gaming behavior, subjective evaluation of the games, and points of improvement.

Study population

Study participants included older adults aged 65 and older (main group). In addition, people aged 18 and over can use the app; they will form a pool of people that the participants can play with (side group). This pool will be tracked within the gaming portal and posed questions regarding their fellow players and their experienced loneliness. We will not collect data from players younger than 18.

Inclusion criteria

- Being aged 65 years or older (main group) or 18 to 64 years (side group)
- Have access to a smartphone or tablet with an internet connection

Exclusion criteria

Participants could not participate if one of the following criteria holds:

- Visual or cognitive impairments that limit independent use of a mobile phone
- Not being fluent in the Dutch language
-

The chatbot will evaluate the exclusion criteria during profile creation with the question: 'Do you have a smartphone that you can use without help from others?'

Power calculation

Given a primary endpoint after three months (and thus four measurements), three groups, a within-person correlation of .80, a power of .80, and a small effect (Cohen's $d = .28$) based on

previous research [60], the required sample size per group was 74, with a total sample size of 222. Assuming a drop-out of 90% (ie, 90% will not actively participate in gameplay during three months) gives a total sample size of 2.220.

Recruitment

Participants were recruited through advertisements on the project's social media pages, in newsletters, on social media pages of organizations concerned with the digitalization and well-being of older adults, and through workshops and meetings with these organizations.

Intervention

The investigational intervention is a mobile gaming application purposely designed by Games for Health. The prototype is freely available to download in the App Store or Google Play Store. Like other chat applications, the app has a chat-like environment where players can interact, play games, and answer questionnaires. We created a different app for every condition to avoid contamination between the conditions.

Intervention group

Participants in the intervention group had access to a purposely designed app with around 25 text and photo-based games that are either adaptations of well-known games such as Hangman or newly developed games. Each game was a group chat with the people invited to play that specific game. Upon start, the chatbot presented the instructions, after which players could start playing. Participants could play with their network of family and friends and with other people allocated to the intervention group. Participants were asked to play games at least twice a week but might play as often as they liked. The intervention group's game design aimed to trigger personal interaction perceived as valuable by the participants. Therefore, we formulated the instructions such that they nudged toward sharing personal memories and pictures of the home environment, all aimed at starting a meaningful conversation.

Active control group

Participants in the active control group had access to a purposely designed app that offers 'non-personal games.' The app contained a subset of the games included in the app for the intervention group, adapted for non-personal play. This means that all aspects that made the interaction personal, as described above, were removed. Participants could play the remaining games with others (family/friends and others in the same condition), but the instructions did not nudge toward sharing personal information. Participants were asked to play the games at least twice a week but might play as often as they liked.

Passive control group

The passive control group had access to an app where participants could not play games. Like the other groups, using different games, (gaming) apps, or social media platforms was allowed in this group. The only restriction was that participants would not have access to the games offered in the social games and active control groups.

Measures

Participants answered questionnaires measuring the following constructs:

- *Loneliness* was measured indirectly with the 11-item De Jong Gierveld Loneliness scale (DJG; higher scores indicate higher loneliness) and directly measured with a single-item Likert scale
- *Well-being* was measured with the Social Production Function scale (SPF-IL) [61] (higher scores indicate higher levels of well-being). This scale measures the domains of

affection, behavioral confirmation, status, comfort, and stimulation.

- The Network Domain Identification and Significance (NDIS) [62] measured social network size and composition. This scale uses name-generator questions to identify network members in seven domains (household members, children and their partners, other relatives, neighbors, colleagues from work or school, members of organizations, and others).
- Quality of life, morbidity, activities of daily living, demographics, and frailty index were measured with The Older Persons and Informal Caregivers Survey (TOPICS) [63, 64]. A single question measures quality of life where a higher score indicates a higher quality of life. The frailty index comprises different aspects of the TOPICS (see [64] for a detailed description).
- *Life space* was measured with the Life Space Assessment (LSA) [65, 66], indicating how much an individual has been outside their home and personal environment. A higher score indicates a larger life space.

We also continuously collected game and session data (ie, group composition, playtime, game type) and asked participants to answer questions about a fellow player if they had never played with them. See Table 1 for an overview of the frequency of administering the various questionnaires.

A chatbot called "Onderzoeker Bas" administered the questionnaires in a separate chat, which is always present at the top of the chat window. Questions can be multiple-choice (allowing the participant to click on an option) or open-ended (by sending a text message). Questionnaires could be paused when needed, and notifications reminded participants they had uncompleted questionnaires after a pre-defined number of days/weeks.

Table A1. The frequency of the different measures administered during the RCT, for both the main (65+ yrs) and the side (18-64 yrs) group.

Construct	Main group (65+ yrs)	Side group (18-64 yrs)
Demographics	0, 6, 12 months	0, 6, 12 months
Well-being (SPF-IL ^a)	0, 6, 12 months	-
Demographics, quality of life, frailty index (TOPICS ^b)	0, 6, 12 months	-
Life Space (LSA ^c)	0, 6, 12 months	-
Loneliness (Likert)	Monthly	Monthly
Loneliness (DJG ^d)	Monthly	Monthly
Social network (NDIS ^e)	0, 6, 12 months	-
Anonymous game data	Continuously	Continuously
Relationship assessment	After first interaction with player	After first interaction with player

^aSPF-IL = Social Production Function Scale.

^bTOPICS = The Older Person and Informal Caregiver Survey.

^cLSA = Life Space Assessment.

^dDJG = De Jong Gierveld Loneliness Scale.

^eNDIS = Network Domain Identification and Significance.

Endpoints

The primary endpoint is loneliness after 3 months. The secondary endpoints are (1) loneliness after 12 months; (2) well-being, social network, and life space after 12 months; (3) gaming behavior.

Study procedure

Randomization

We randomly allocated participants (main group and side group) to the intervention, active control, or passive control condition (1:1:1) upon signing up on the website based on a pre-defined randomization scheme.

Onboarding

After randomization, participants received an email with a link to download the app corresponding to their condition and instructions. After downloading and creating a profile, the chatbot explained the study and asked them to agree with the study conditions and the informed consent form. When participants digitally agreed to informed consent, they received the baseline questionnaire. After this, they could freely navigate the app, play games, and invite others.

Every participant received a unique code word in the invitation email, which they had to forward to people they invited in the app, ensuring that the invited players ended up in the same

group as the participant. This person entered this word in the app, after which they could play the games.

Data analysis

Primary endpoint

We summarized the loneliness item scores in a single scale score. The difference in loneliness between baseline and three months, between conditions, is analyzed with a linear mixed model, as it can handle (not completely random) missing values, clustered measurements, and unstructured data.

Secondary endpoints

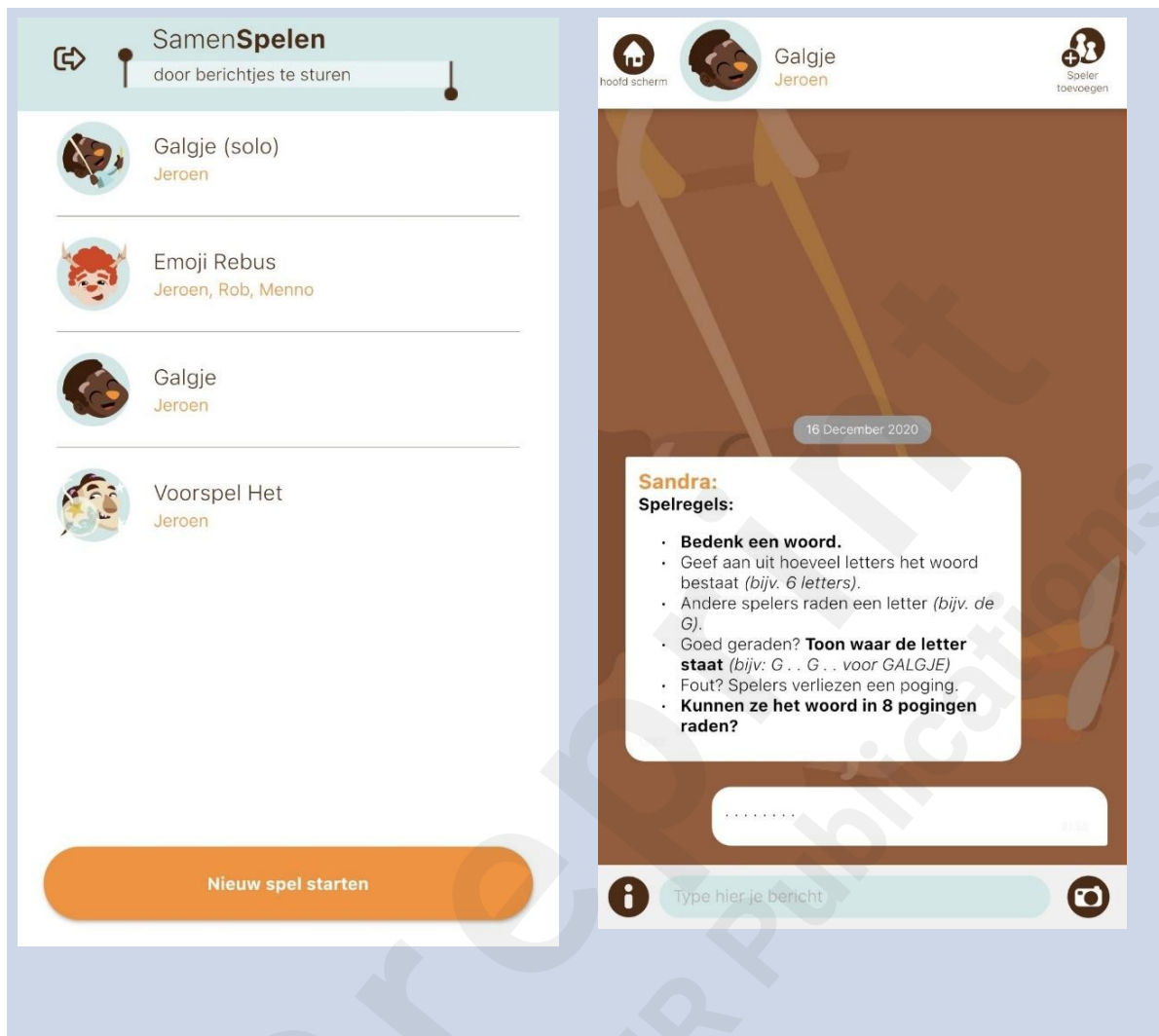
Equal to the primary endpoint analysis, we also analyzed the difference in well-being, social network size, and loneliness after 12 months.

Ethics

The RCT was reviewed by the research ethics committee of the Radboud university medical center (file 2020-6884). It did not fall within the remit of the Dutch Medical Research Involving Human Subjects Act (WMO). The ethics committee approved the study based on the Dutch Code of Conduct for health research, the Dutch Code of Conduct for responsible use, the Dutch Personal Data Protection Act, and the Medical Treatment Agreement Act.

All participants gave digital informed consent in-app prior to data collection. Before starting the study, we registered the RCT on Clinicaltrials.gov (NCT04733898, <https://clinicaltrials.gov/ct2/show/NCT04733898>).

Multimedia Appendix 2. Screenshots of the Playing Together app



Multimedia Appendix 3. Selected quotes from the process evaluation interviews

Table C1. List of quotes from participants in the process evaluation interviews and focus group.

Participant recruitment	
	"The accent should be on the games, on having fun. You can explain why it is very important why you do the research but it has to be very short, as it is not of direct importance for those people."
	"My age group does not necessarily like 'having to do' something. Most of them are retired, and the word 'to have', especially filling in so many things, they do not want to do that. They all found that difficult, and I do not know whether they actually did".
	"Eventually [older adults] should become curious. How do you do that? By almost literally taking their hand, let them experience a fun and pleasant afternoon. You have to invest in them. If you do that well, [...] and let them experience that, they might be convinced. And then, when there are still questions, there is a very easy back-up for them to [ask questions]."
	"I think that, with this app and its possibilities, you have to go to the people."
Intervention adherence	
	"Playing a game, whether it is in-person or digitally, elicits social contact between people. That is also what you take out of this app."
	"Then someone starts to post a picture of a vase. Someone else then says, 'What a beautiful vase,' after which the sender says, 'Yes, my grandmother gave it to me .' [...] that is how it starts."
	"I invited one friend. Why only one? I have more friends I play games with, but I thought the quality was not good enough to invite them. I just did not like it enough, so to say."
	"I felt, I got the feeling [...] that it was not the intention that, when [someone] sends a picture, I ask 'where did you take that picture?'. I felt like I was not supposed to share any form of personal information. On the one hand, I missed that"

	"If the app is mostly intended for older adults, I think the images are childish."
Intervention acceptability	
	"I received feedback [from participants] that people thought it was a big time investment, and they had to fill in many lists. Many of them dropped out there already. I understand all that information is important; otherwise, you cannot do research. But for the participants, it was a bridge too far".
	"You can split them up in smaller pieces. If at the beginning you hear that there are only five questions, you think, 'Oh, I can do that.' Then I would be inclined to do it more quickly".
	"In a study like this, you want to ask for much information. But later, when the app is in use, I want to say, be very critical, and leave out a lot of things."
	"My experience is that older adults are more inclined to play games behind their computer."
	"In the future, make the study as small-scale as possible, and formulate the questions as close as possible to the target group."

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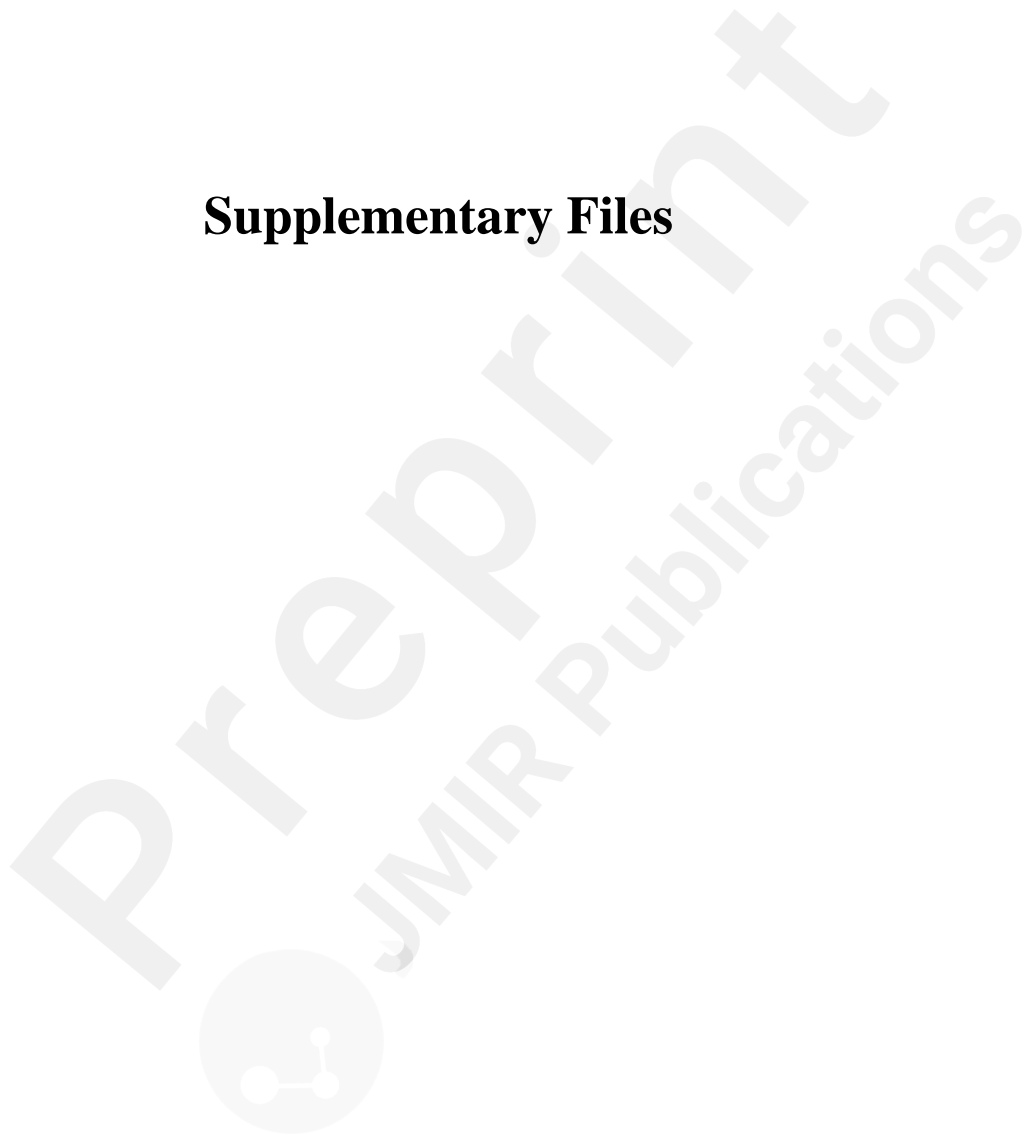
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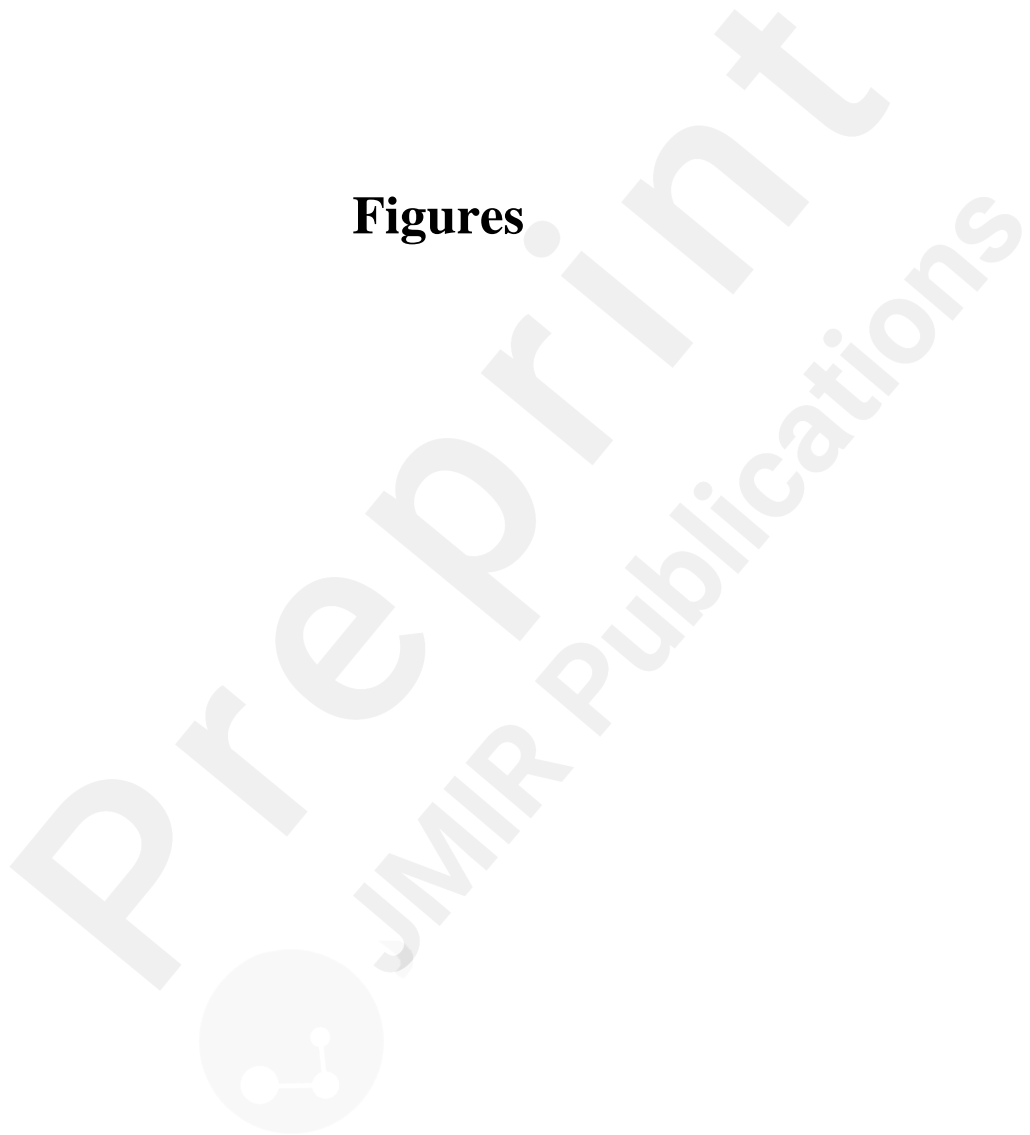
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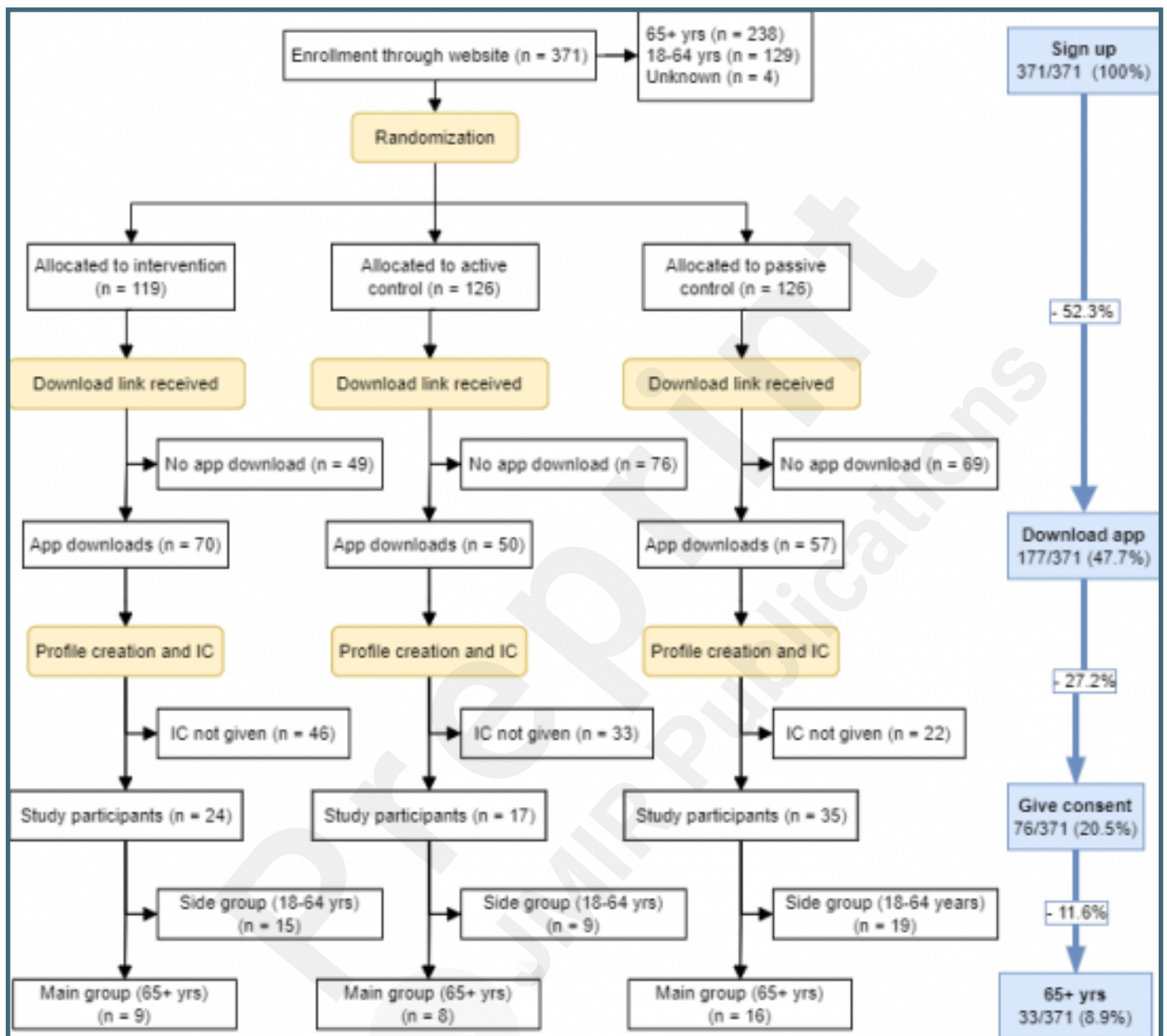
Supplementary Files



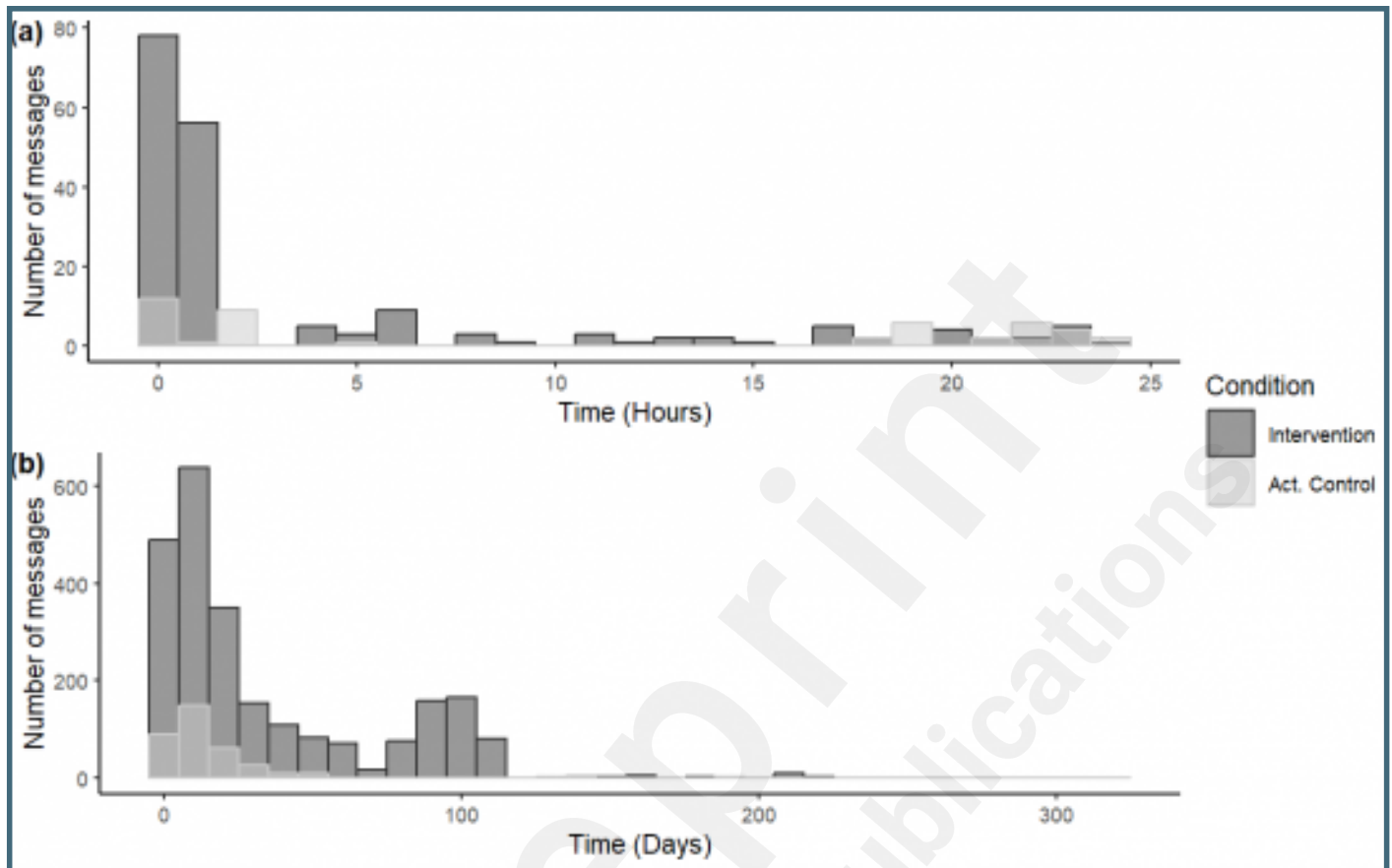
Figures



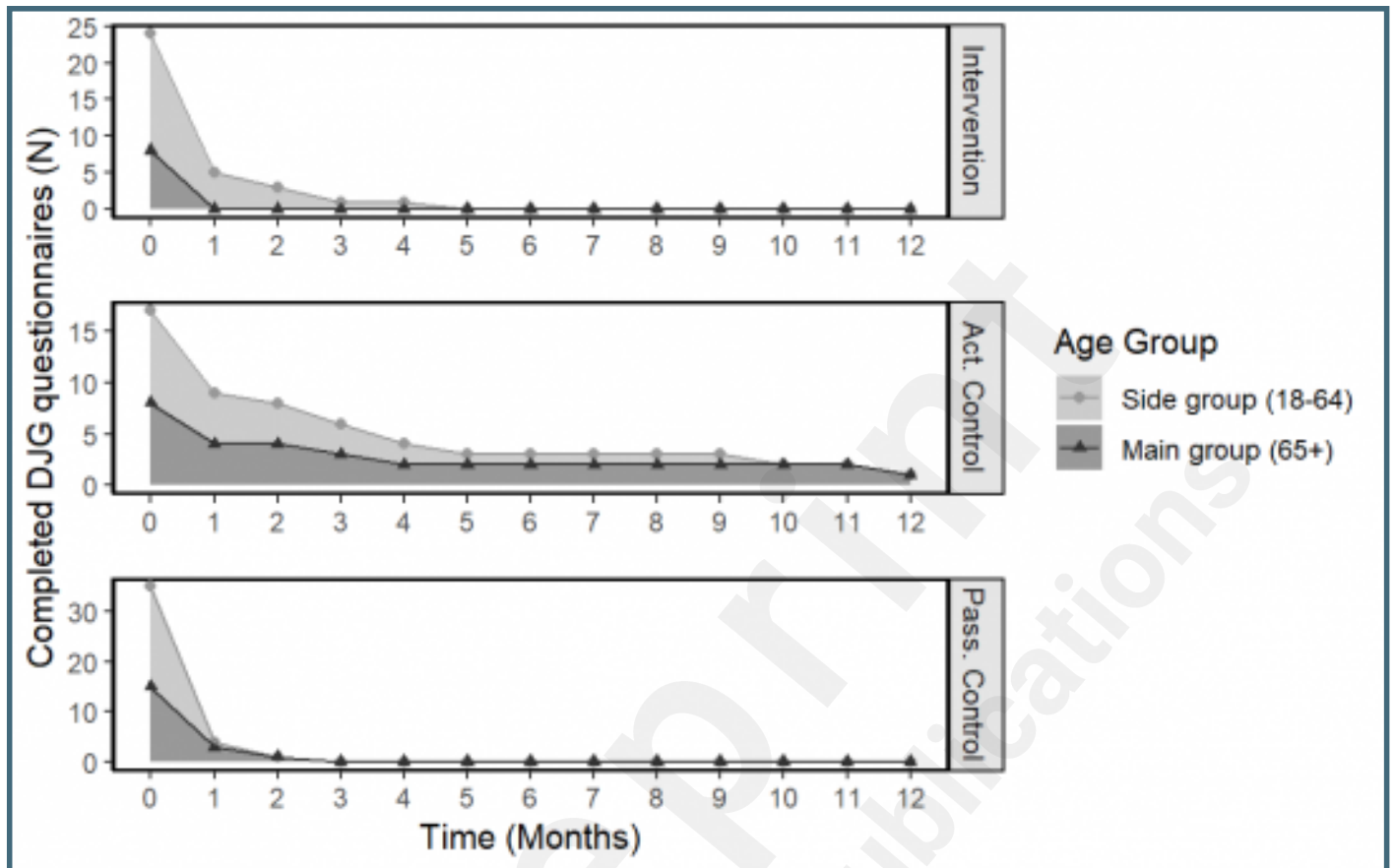
Enrollment, allocation, and onboarding flow of participants (N = 371) in the RCT. The yellow squares indicate steps in the onboarding process, and the blue column indicates the percentage of the total losses during the different steps.



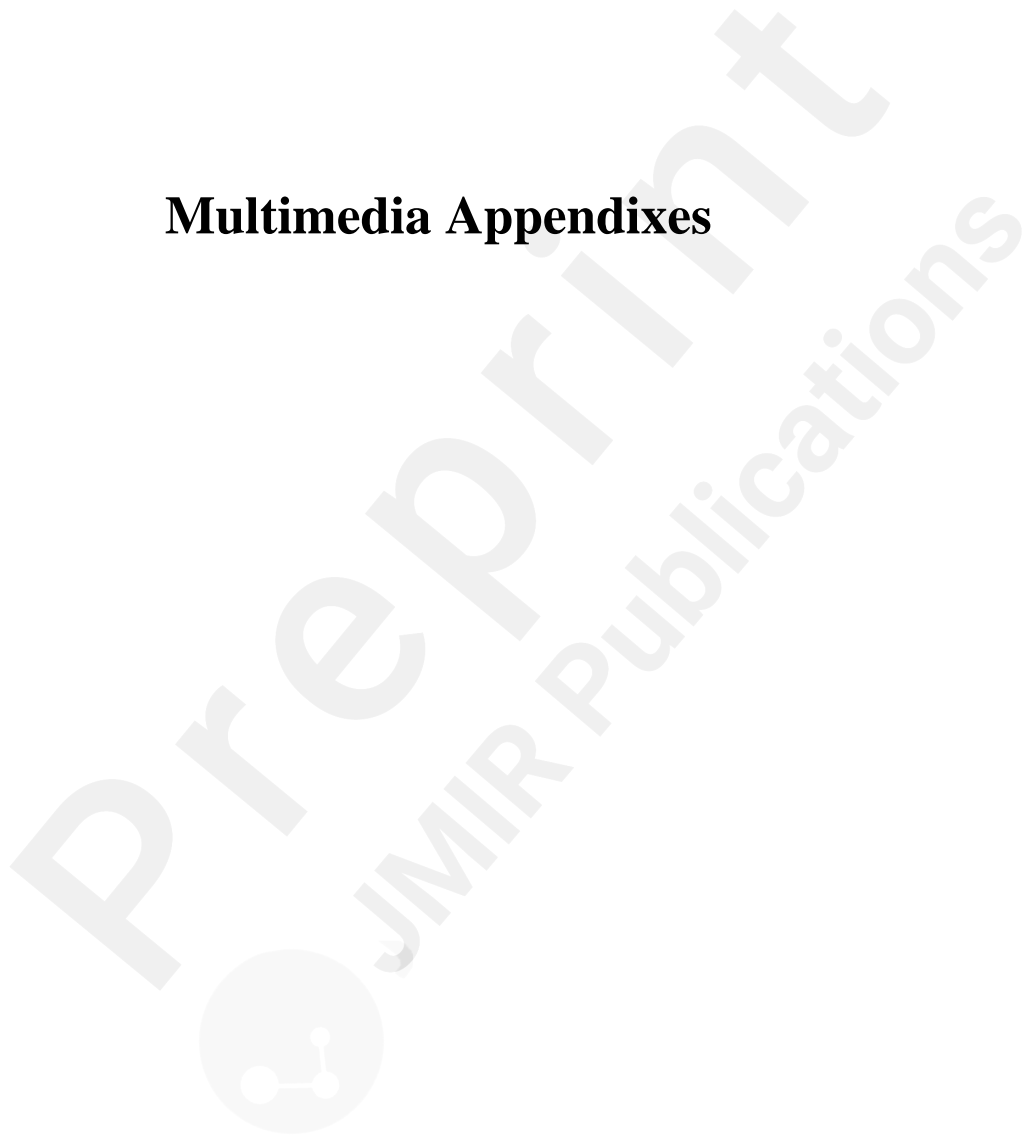
(a) Number of messages sent in the first 24 hours after sign-up, per game condition; (b) Number of messages sent in days after sign-up, per game condition.



Percentage of people per condition, per age group, that completed the monthly Loneliness (DJG) questionnaire. Each graph represents an RCT condition.



Multimedia Appendixes



RCT Protocol Details.

URL: <http://asset.jmir.pub/assets/95d135461a159c73fb194b059f6544cb.docx>

Screenshots of the Playing Together app.

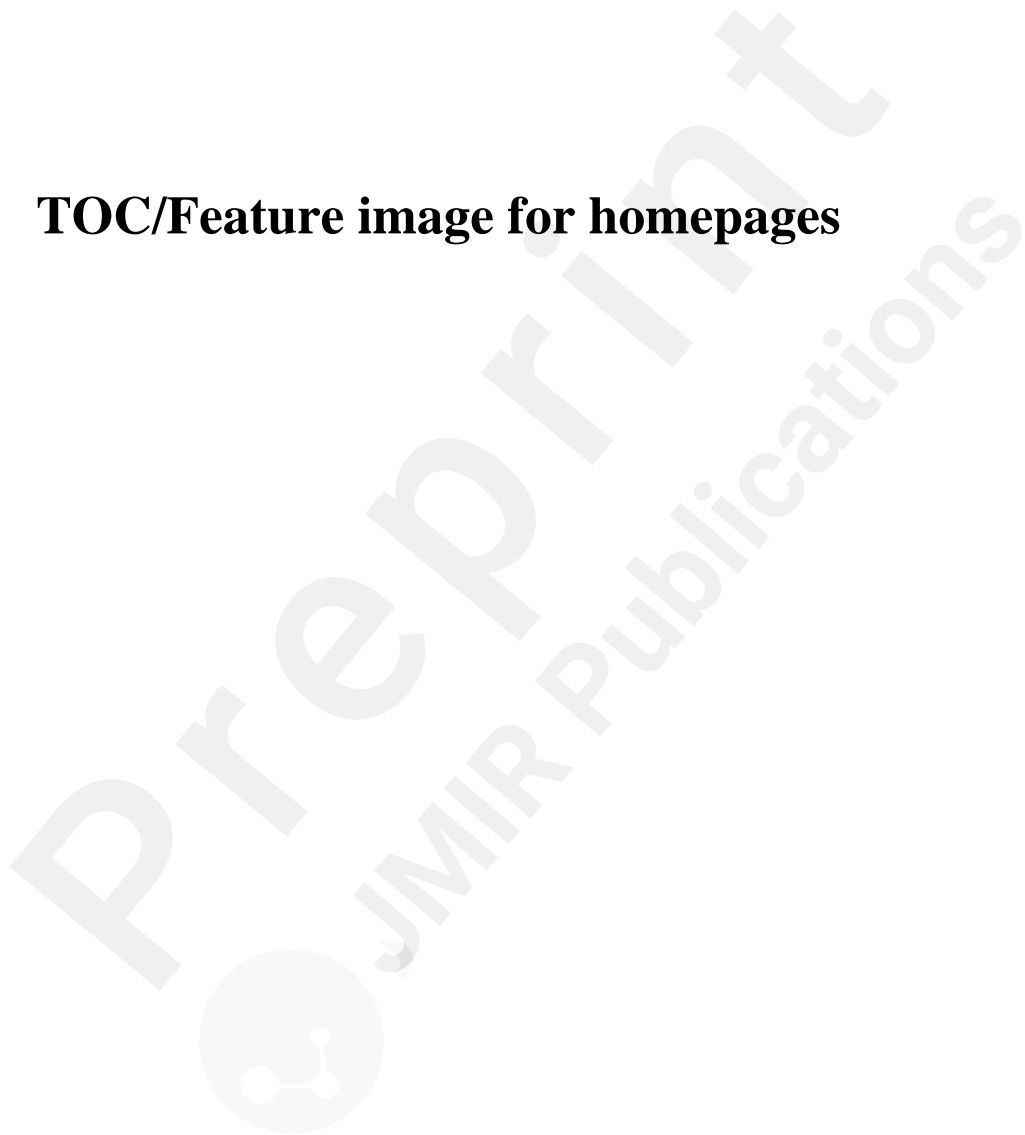
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Selected quotes from the process evaluation.

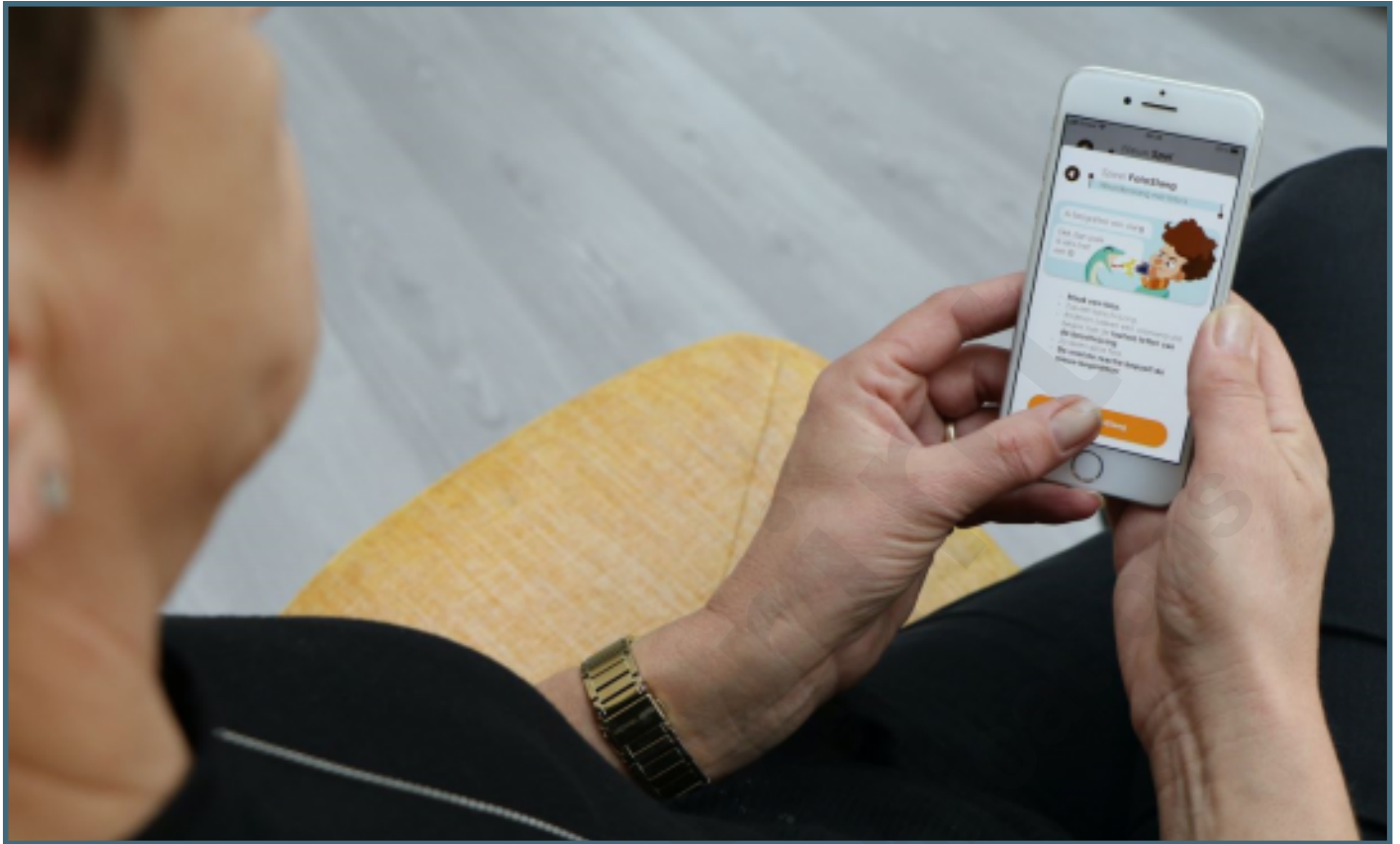
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TOC/Feature image for homepages



A person holding a smartphone showing the Playing Together app.



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