

Development and implementation of bidirectional online-frailty prevention system for community-dwelling older adults

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Abstract

Frailty is an age-related condition characterized by a decline in physical capacity with an increased vulnerability to stressors. During the COVID-19 pandemic, there was considerable progression in frailty in older adults. Therefore, an online frailty check (FC) is required for continuous screening, especially acceptable to older adults. We aimed to co-design/co-develop an online FC application with FC supporters who were facilitators in a pre-existing onsite FC program in the community. It consisted of a self-assessment of sarcopenia and an 11-item questionnaire assessing dietary, physical, and social behaviors. Opinions obtained from FC supporters (median 74.0 years) were categorized and implemented. The usability was assessed using the system usability scale (SUS). For both FC supporters and participants ($n = 43$), the mean score was 70.2 ± 10.3 points, which implied a “marginally high” acceptability and a “good” adjective range. Multiple regression analysis showed that the SUS score was significantly correlated with onsite–online reliability, even after adjusting for age, sex, education level, and ICT proficiency ($\beta = 0.400$, 95% CI: 0.243–1.951, $p = 0.013$). We also validated the online FC score, which showed a significant association between onsite and online FC scores ($R = 0.670$, $p = 0.001$). In conclusion, the online FC application is an acceptable and reliable tool to check frailty for community-dwelling older adults.

1. Aim of Research

1-1 Development of Frailty checkup application

For older adults, to be acceptable based on the established onsite FC program, we co-designed/co-developed an online FC application with FC supporters through participatory action research (PAR).

1-2 Relevance of online Frailty checkup program

Using the developed frailty checkup application, we examined the usability of online FC focusing on ① reliability, defined as the consistency of pre-existing onsite FC, and ② online communication. We also validated the online FC scores with those of onsite FC.

2. Method of Research & Progression

2-1 Study Design: Participatory Action Research

To co-design the application, focus group interviews and mock tests were conducted with FC supporters, and self-efficacy questionnaires were assessed before and after the mock test. After online FC implementation, we conducted surveys on the onsite–online reliability, online communication, and usability of the user interface.

2-2 Online Frailty Check Application: Device and Contents

The online FC was conducted via the FC application using a tablet device by joining a video conference room with six seats (FC supporter: participants = 1~2:1~5). This ratio was intended to enable FC supporters to adequately attend to the participants.

The online FC program consisted of three sections: basic information (age, sex, body weight, and height); the Yubi-wakka test (a sarcopenia test with video instruction) and an 11-item FC questionnaire (yes/no, validated questionnaires

including questions on nutrition, oral and physical function, and social activity). Inputted data were summarized at the end, which the participants could confirm prior to submission. This design was also used in the onsite FC program.

To facilitate the smooth execution of the experiment and the collection of authentic and reliable data, the process was divided into two main parts. To collect primary data, we began by conducting online FC briefing sessions and conducted several meetings for user experience sharing. The primary data were extracted from focus group interviews, discussions, and observations.

User experience meetings for the prototype application were held over 2 days, and a total of 32 FC supporters participated. Subsequently, we improved the application based on the opinions and feedback received.

2-3 Verification

For both the FC supporters and participants, we evaluated the user interface of the online FC application using relevant questionnaires. To assess the onsite–online reliability (3 items) and interaction quality (4 items), we utilized modified questionnaires on telehealth usability. For quantitative data, we scored the system usability scale (SUS). The SUS has been extensively used in previous user research studies and demonstrated good psychometric properties. Better usability was indicated by higher SUS scores, ranging from 0 to 100. A SUS score of 68 is the center of the Sauro–Lewis curved grading scale, which is one of analyzing points of usability. The SUS consists of 10 items, each with five steps anchored with “strongly disagree” and “strongly agree”. It is a mixed-tone questionnaire in which the odd-numbered items have a positive tone, and the even-numbered items have a negative tone.

3. Results of Research

3-1 Development of Frailty checkup Application

Through focus group interview, fifty-five detailed opinions were obtained and classified into five categories based on keywords such as reliability, social interaction, and user-friendliness. The largest number of opinions were related to reliability such as blue/red stickers.

For example, to improve familiarity with the online questionnaire format, the onsite format of the 11-item self-reported questionnaire was adapted and modified to display one question at a time on a single page. In addition, a confirmation page was added so each participant could reconfirm all the responses. Furthermore, FC supporters expressed difficulties in online communication, such as identifying the speaker and capturing their reaction.

To enhance and encourage communication, we implemented several measures, including spotlighting the person speaking, providing an explanation of the system, and removing the daily topic section before the check.

Furthermore, several opinions on user-friendliness were collected, and improvements based on this feedback were implemented: ① using a stylus, ② enlargement of font size, and ③ introducing a button-pressing simulator.

In particular, we found that including a stylus significantly improved usability by solving dry fingers and touch sensitivity issues, especially for older adults. We also received suggestions on font size enlargement and improving readability. A button-pressing simulator was also included for participants new to tablets, bridging the gap between physical interfaces and touch-based interaction for a smoother transition. Our study involved 52 participants, ensuring a diverse sample size to capture various perspectives and usability issues.

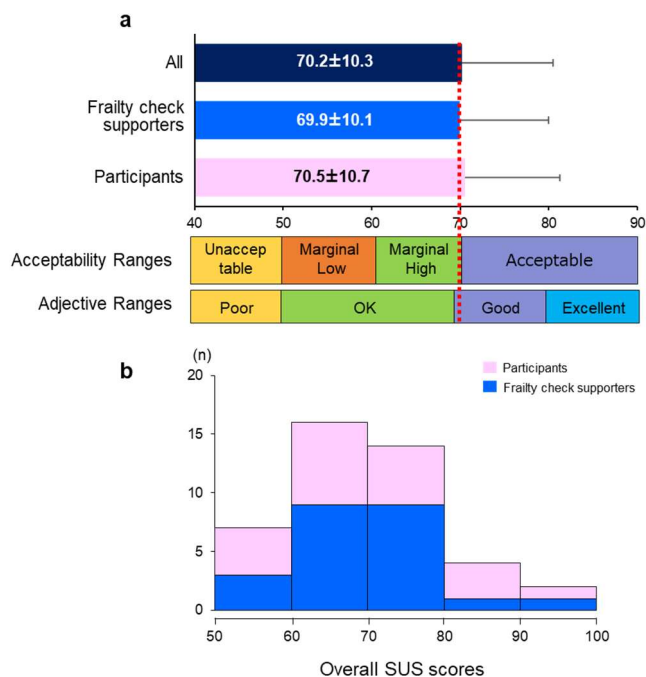
3-2 Self-efficacy of Frailty Check Supporters

A slight but not significant increase in the total GSES score was observed after the mock test (before: 12.0 vs. after: 13.0). However, among the three GSES categories, we noticed a trend of improvement in the non-anxiety of failure category, as the proportion who answered “no” regarding (Q5) “I am more concerned about small failures than others all the time”, tended to increase after the mock test (before: 63.0% vs. after: 77.8%, $p = 0.094$). Additionally, in the category of the social positioning of ability, the proportion of “yes” responses to (Q3) “there are areas where I have better knowledge than friends,” significantly increased ($p = 0.031$) in comparison to results from before the mock test. Similarly, the proportion of “yes” responses to (Q1) “I have better ability than friends,” also increased ($p = 0.063$).

3-3 Usability Evaluation

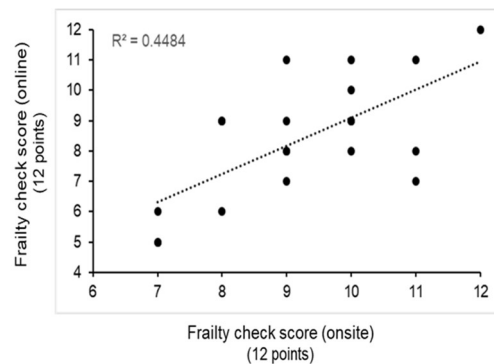
The overall system usability of the online FC application was evaluated using the SUS, a widely used questionnaire with an acceptability and adjective range scale. We found that the average SUS scores of both FC supporters and participants were similar and in the “marginally high” section of the acceptability range. Additionally, the scores were above the average (68 points) of the adjective ranges, which implies that the developed FC application is suitable for older adults.

Next, we examined the overall SUS score and factors that affect the user interface. As shown in Table 4, we found that age, education level, subjective ICT proficiency, reliability, and interaction quality were significantly associated with the SUS score ($p < 0.05$). Furthermore, when we assessed the multiple (linear) regression analyses, we observed a significant correlation between the SUS score and the reliability of the online FC application after adjusting for covariates, including age, sex, education duration, and ICT proficiency. On the other hand, the interaction quality did not display a significant association with the SUS score.



3-4 Validation of online Frailty checkup application

We validated the results of the online FC program by comparing them against those of the onsite FC, which were conducted within 4 months of each other. Pearson’s correlation coefficient revealed a significant association between the onsite and online results ($p = 0.001$).



Collectively, in this study, we developed an online FC application for community-dwelling older adults delivered via video conferencing, during the COVID-19 pandemic. To enhance its acceptability in older adults through PAR, we co-designed/co-developed it with stakeholders named FC supporters who are older community-dwelling volunteers facilitating the pre-existing onsite FC. This study aimed to examine the usability and validity of the online FC application.

To the best of our knowledge, this is the first online application for frailty checks designed by older adults, for older adults. To achieve our purpose, we utilized a PAR approach, consisting of focus group interviews and a mock test.

In this study, we suggested the use of continuous and effective FC in the community using a hybrid system linking onsite (every 6 months) and online FC (e.g., once or twice between 6 months) by understanding benefits (e.g., no risks of falling going to the appointment) and disadvantages (e.g., not going to meet people in person, appointments give some people a reason to leave the house) of online FC.

4. Future Area to Take Note of, and Going Forward

Our study had several limitations. The primary focus was on developing the application and conducting a preliminary evaluation of its acceptability, reliability, and usability. This study was not designed to rigorously test the efficacy of the online FC assessment in improving frailty status. Additionally, the use of non-systematic recruitment methods may have introduced a bias toward participants who were more open to this type of intervention. Our design/development was limited to Japanese older adults. To build a generalizable system, an established protocol of PAR involving community stakeholders is needed.

Despite these limitations, our study has several important implications: (1) individual FC supporters and participants may benefit from

using the online FC application; and (2) a participatory design approach is a useful methodology for developing a relevant, useful, and acceptable tool for older adult users.

5. Means of Official Announcement of Research Results

We have published this research results at the journal of *Int J Environ Res Public Health* as follow: Son BK, Miura T, Yabu K, Sumikawa Y, Kim DY, Lyu W, Yang Y, Tanaka M, Tanaka T, Yoshizawa Y, Iijima K. The Co-Design/Co-Development and Evaluation of an Online Frailty Check Application for Older Adults: Participatory Action Research with Older Adults. *Int J Environ Res Public Health* 2023, 20(12), 6101; <https://doi.org/10.3390/ijerph20126101>