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Research Article

Unveiling Digital Pathways to Active Aging: An Exploratory Mixed Methods Study of Older Adults' Experiences and the Impact of Person-Level Factors on mHealth Intervention Engagement

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Background. Mobile health (mHealth) interventions hold promise in assisting older adults to meet physical activity (PA) guidelines. Yet, little is known about how older adults perceive using smartphones to enhance their PA. This study explored older adults' experiences with the "My Health Plan" mHealth intervention and examined which person-level factors were associated with adherence. *Methods*. Forty older adults (52.5% female, mean age: 72.6 years) were instructed to use the My Health Plan application, which provided up to six stretch- and strengthening exercises per day and to wear a Fitbit Charge activity monitor for seven consecutive days. Person-level factors (e.g., gender and age) and psychosocial factors (e.g., intention and motivation) were assessed using a questionnaire. Afterwards, semistructured interviews were conducted to gather participants' experiences with the application and Fitbit. Deductive thematic analysis (qualitative data) and regression analyses (quantitative data) were conducted. *Results*. Key themes emerging from the interviews were (1) smartphone notifications (including timing and number) and carrying the smartphone throughout the day, (2) suggested stretch- and strengthening exercises, (3) providing feedback, (4) experiences with Fitbit, and (5) overall suggestions for improving the application and mHealth interventions. Overall, participants reported positive experiences with the application and Fitbit. Being male, having higher baseline PA, lower anxiety, and greater ability to participate in social roles and activities were related to increased engagement with the proposed exercises. *Conclusions*. This study provides valuable insights to optimize future mHealth interventions tailored to older adults' specific needs, aligning with their perceptions of the digital transformation in health promotion.

1. Introduction

Regular physical activity (PA) is essential for healthy aging [1], yet many older adults worldwide are increasingly physically inactive [2, 3], putting them at risk of chronic diseases, functional and cognitive declines, and premature mortality [4–12]. The PA guidelines for older adults recommend at least 150 to 300 minutes of moderate-to-vigorous physical activity (MVPA) per week, including balance, coordination, and muscle strengthening exercises at least three days per week [13]. However, adherence to these guidelines, especially regarding multicomponent PA, is often lacking among older adults [14]. Encouraging PA among older adults is however crucial for healthy aging, with behavior change interventions playing a significant role in this effort [15, 16].

mHealth interventions, using smartphones [17], offer widespread accessibility, real-time engagement, and potential for personalization (i.e., tailored to individuals' needs). Their cost-effectiveness and ability to continuously monitor behavior contribute to their efficacy in promoting behavior change. Therefore, mHealth has emerged as an impactful tool for health promotion, offering advantages over traditional interventions that often struggle to achieve behavior change. Moreover, the potential to collect real-time data during mHealth interventions helps overcoming traditional challenges, such as recall bias, by utilizing objective measures (e.g., Fitbit) instead of relying on participants' memory-based self-reports [18–20]. Previous research demonstrated that using smartphones and wearable activity trackers in mHealth interventions can increase PA in older adults [21]. With the expanding use of digital technologies among older adults worldwide, including in Flanders (Belgium) [22, 23], there is a growing potential for integrating digital tools for PA promotion in older populations. Moreover, previous research has confirmed the effectiveness of mHealth interventions in older adults, although these effects are often short-term [24–26]. Extending the use of mHealth interventions beyond the intervention period could potentially sustain these health effects over time. Tailoring mHealth interventions to the specific needs and preferences of older adults can facilitate their continued use as they return to their regular routines. While previous research has explored the features older adults prefer in mHealth interventions and provided recommendations for development [27], it remains unclear how older adults perceive such interventions. Understanding their experiences with digitalization in the context of their daily lives and their willingness to use smartphones to enhance their PA is essential. Addressing this gap can significantly improve the development of mHealth interventions that meet older adults' needs and align with their perception of the ongoing digital transformation in health promotion.

mHealth interventions offer a practical and accessible way to encourage and guide older adults in reaching the PA guidelines. By integrating PA suggestions (i.e., stretch- and strengthening exercises) into mHealth applications, potential barriers related to traditional interventions can be addressed, making it easier for older adults to incorporate PA into their daily lives. Furthermore, exploring person-level (i.e., gender and age) and psychosocial factors (i.e., intention and motivation) can potentially influence individuals' reactions and perceptions towards these PA suggestions and provide valuable insights into how older adults perceive PA suggestions in mHealth interventions. Tailoring digital health applications to the unique needs of older adults based on these factors supports a more personalized approach to increasing PA and addresses potential barriers related to mHealth interventions in this population.

The aim of the current exploratory mixed methods study is twofold. The first aim is to gain insight into older adults' experiences towards mHealth interventions, using the My Health Plan mHealth application as a case study. The second aim is to examine whether specific person-level and psychosocial factors of older adults are linked to performing the PA suggestions.

2. Materials and Methods

2.1. Participants. Between February and June 2021, older adults (65+) were recruited through convenience sampling (e.g., flyers and social media) and snowball sampling. Exclusion criteria were (a) impaired cognition (i.e., diagnosed with dementia or other cognitive diseases), (b) severe impairment of vision and/or hearing, (c) impaired physical health (i.e., not able to walk 100 m), (d) impaired fine motor skills hindering smartphone usage, (e) insufficient knowledge of the Dutch language, (f) not living independently, and (g) fear of going outside due to COVID-19 circumstances.

2.2. Procedures. Participants were visited twice at home (Supplementary file 1). During the first visit, participants provided informed consent, completed an intake questionnaire, and received instructions for the seven-day measurement period. The following day, the measurement period started, during which participants received notifications on their smartphone through a smartphone application (i.e., My Health Plan) including short stretch- and strengthening exercises, with a maximum of six notifications/day. Participants without a compatible smartphone (Android 7.0 or lower) were provided with a Motorola One Macro smartphone (Android 9.0). Additionally, participants wore a Fitbit Charge 2 activity monitor throughout the measurement period to measure their daily steps.

During the second visit, measurement materials were reassembled, and participants underwent a semistructured interview to share their experiences with the My Health Plan application and Fitbit. Ethical approval was obtained from the Ghent University Hospital Ethics Committee (BC-08803).

2.3. Measures

2.3.1. Intake Questionnaire. The intake questionnaire included four parts. The first part gathered information on gender, age, BMI, educational level, main occupation before retirement, marital status, and familiarity with smartphone use. The second part included the International Physical Activity Questionnaire, short form (IPAQ-SF) [28], to assess baseline PA levels. The third part assessed psychosocial determinants of PA (Supplementary file 2), including intention (1 item), self-efficacy (5 items), motivation (6 items), outcome expectancies (5 items), risk perception (5 items), and the degree of PA self-monitoring in daily life (3 items). This part consisted of 25 items in total, each assessed on a 5-point Likert scale (except intention), validated by an expert panel [29]. The fourth part included the PROMIS-29 Profile v2.0 (Dutch-Flemish v2.01), assessing physical function, anxiety, depression, fatigue, sleep disturbance, ability to participate in social roles and activities, pain interference, and pain intensity [30].

2.3.2. My Health Plan Application. The My Health Plan application (Supplementary file 3) was initially developed at the Department of Information Technology at Ghent University. For this study, S.C. modified the application to better suit older adults, including a simple and uncomplicated design with minimal interfaces. Large font styles and clear colors were incorporated to enhance visibility and accessibility. The main screen displayed participants' daily step count, while another interface contained participants' personal information (e.g., name and gender) and various settings allowing customization of notification time window (i.e., participants could customize the start and end time of the notifications, ensuring a minimum of ten hours between both). Notifications (i.e., PA suggestions), containing stretch- and strengthening exercises, were sent throughout the day, offering 8 stretching exercises (i.e., calves, back and side, back of thighs, hip, front of thighs, shoulders and neck, back, and chest) and 6 muscle-strengthening exercises (i.e., shoulder, back, arm and shoulder, abs, thigh, and calf muscles) alternately. These exercises were triggered based on participants' current number of steps, with a preestablished daily step goal of 8000 steps set for each participant [31]. Participants' step count was evaluated every hour by the My Health Plan application, and if they were not on track to meet the daily step goal, the application prompted a PA suggestion (i.e., stretching or strengthening exercise). In cases where participants had injuries or physical complaints (e.g., shoulder pain), this could be specified in the settings to prevent the suggestion of exercises targeting that area. The exercises included step-by-step instructions and images [32, 33]. When receiving a notification, participants could choose to perform or skip the suggested exercise. If they chose not to perform the exercise, they were asked to provide feedback by answering three questions: (1) "Why did you choose not to perform the exercise?" with 11 predefined reasons (Supplementary file 4), (2) a rating (1 to 5 stars) for the timing of the suggestion, and (3) a rating (1 to 5 stars) for the suggested activity.

2.3.3. Fitbit Charge 2. To capture participants' daily steps, the Fitbit Charge 2 was worn at the nondominant wrist. The validity of the Fitbit Charge 2 in assessing steps in free-living conditions in older adults has been established [34]. Participants were instructed to wear the Fitbit throughout the entire measurement period, excluding water-based activities. The Fitbit was connected to Google Fit, which transferred Fitbit data (e.g., step count) to the My Health Plan application, triggering notifications based on participants' step count and progress towards the daily step goal.

2.3.4. Semistructured Interviews. Semistructured face-to-face interviews were conducted with all participants to explore their overall impressions of the My Health Plan application and the use of the Fitbit Charge 2. All interview questions can be found in Supplementary file 5. The interviews, conducted by three trained researchers, involved one researcher paired with one participant. Interviews were audio recorded (mean duration: 8.18 minutes, SD: 3.29) and transcribed verbatim, resulting in a 74-page document using Calibri font, size 11.

2.4. Analyses. Descriptive statistics were used to describe participants' baseline characteristics and the extent of usage of the My Health Plan application. To examine the first research question, qualitative data were thematically analyzed using NVivo 12 software package (QSR International). All interviews were analyzed by one researcher (I.M.), with results discussed with two other researchers (D.V.D. and J.L.) in case of uncertainties. Initially, interview transcriptions were read twice to become familiar with the data, and a coding tree was developed before the coding process. The coding involved a deductive, line-by-line approach, with adjustments made to the initial coding tree if needed. To examine the second research question, SPSS Statistics for Windows version 29 (IBM Corp) was used. Univariate logistic regressions were performed using generalized estimating equations, accounting for the nested structure of notifications within days and within subjects. The dependent variable was the performance of the exercises (1 = performed exercise; 0 = nonperformed exercise, including notifications responded with nonperformance of the exercises or ignored), with personal characteristics (age, gender, BMI, familiarity with smartphone-use, educational level, and baseline PA) and psychosocial factors (intention, motivation, self-efficacy, outcome expectancies, risk perception, self-monitoring, and all PROMIS items) as predictors. Second, univariate linear regressions were performed with the percentage of performed exercises as the dependent variable and the personal characteristics and psychosocial factors as predictors. The percentage of performed exercises was calculated by dividing the total number of performed exercises by the number of received notifications. $P < 0.05$ was considered as statistically significant and 95% confidence intervals were also reported.

3. Results

3.1. Descriptive Statistics. Forty older adults completed the seven-day measurement period. Descriptive statistics can be found in Table 1.

3.2. My Health Plan Application: Notifications. During the study, a total of 429 notifications were sent. Among these, 142 notifications (33.1%) remained unanswered, providing no further information, while 287 (66.9%) were responded by the participants. From these responses, participants reported engaging in the suggested exercises 273 times (95.1%). Only 14 times (4.9%) participants indicated that the exercise was not performed, with feedback provided 13 times (92.9%) (Supplementary file 4). Reasons for not performing the exercise included "*I don't have time to do the recommended activity*" (5/13), "I *was doing something else at the moment of recommendation*" (5/13), "*I chose another activity*" (1/13), "*I don't feel mentally well enough to perform the recommended activity*" (1/13), and "*I already planned to do something else (which is not a PA)*" (1/13).

Nine participants did not receive any notifications and were excluded from the quantitative analyses. The majority of these participants were male (7/9, 78%), 70 years or older (6/9, 67%), married or living together (8/9, 89%), highly educated (5/9, 56%), and familiar with a smartphone (6/9, 67%), and their mean daily step counts per day was lower than 8000 (5/9, 44%).

Table 1: Descriptive statistics of the study sample.

Characteristics	Values ($n = 40$)
Female, n (%)	21 (52.5)
Age in years, mean (SD), range	72.6 (5.6), 65–83
BMI, mean (SD), range	26.6 (3.7), 19.8–35.3
Nontertiary education, n (%)	28 (70.0)
Main occupation before retirement	
Household, n (%)	3 (7.5)
Blue collar worker[a], n (%)	10 (25.0)
White collar worker[b], n (%)	25 (62.5)
Other[c], n (%)	2 (5.0)
Marital status	
Single, n (%)	2 (5.0)
Married or living together, n (%)	29 (72.5)
Divorced, n (%)	3 (7.5)
Widow/widower, n (%)	6 (15.0)
Familiar with smartphone use, n (%)	25 (62.5)
Using their own smartphone, n (%)	12 (30)
Steps per day, mean (SD)	8317.9 (3518.8)

[a]Self-employed and workers. [b]Employee, education, executives, free professions, and officer. [c]Unemployed, disabled, and other.

Two participants never reacted on their received notifications. Both participants were male, aged 67 and 71 years old, married or living together, and lower educated, and one of them was familiar with using a smartphone, while the other was not, and both of them were quite active (i.e., an average of more than 9000 steps per day).

Three participants had no Fitbit data, but the My Health Plan application used the smartphone's accelerometer data when Fitbit data were missing. So, these participants still received notifications.

3.3. Semistructured Interviews. The main themes that emerged from the semistructured interviews were (1) smartphone notifications, (2) suggested exercises, (3) providing feedback, (4) experiences with Fitbit Charge 2, and (5) overall suggestions for improvement of the My Health Plan application and mHealth interventions in general.

3.3.1. Smartphone Notifications. Overall, participants were positive about receiving exercises through a smartphone application (Figure 1). Participants indicated that receiving notifications for being reminded to do some exercises was good ($n = 22$), and that it was easy ($n = 2$), educational ($n = 2$), and convenient that a smartphone provided the exercises ($n = 2$). Furthermore, it was mentioned that there probably was no other alternative method to provide the exercises ($n = 7$), and they had to get used to it ($n = 2$).

(a) *Timing of Notifications.* The majority of participants indicated they liked the randomness of the notifications ($n = 23$). It was also mentioned that the timing was good ($n = 17$). A few participants indicated it was not always feasible to answer the notifications ($n = 8$), and that there was a rapid succession of notifications ($n = 4$). Eight participants would like more personalization of the notifications' timing. Specific preferences included avoiding noon ($n = 6$) and favoring notifications in the morning ($n = 3$).

(b) *Number of Notifications.* Participants indicated that the quantity of notifications was good ($n = 16$), enough ($n = 4$), or not enough ($n = 4$) (Table 2). Most participants were positive about the number of notifications, and only one participant found it too high. Fifteen participants indicated they would like to personalize the number of notifications (i.e., different number/day depending on their calendar).

(c) *Keeping the Smartphone with You All Day.* Participants generally indicated it was feasible ($n = 23$) to keep the smartphone with them throughout the day. Some indicated that they did not always keep their smartphone near ($n = 8$), or found it challenging ($n = 8$).

3.3.2. Suggested Exercises. Overall, the suggested exercises were perceived positively (Figure 2). The majority indicated that they were more active thanks to the exercises ($n = 26$), that the exercises were motivating ($n = 7$), and that they felt better after performing them ($n = 3$). Furthermore, participants indicated that the exercises were good ($n = 33$), relevant ($n = 19$), easy to perform ($n = 11$), clear ($n = 9$), fun ($n = 3$), and interesting ($n = 2$). Additionally, participants appreciated the variation in exercises ($n = 2$). However, there were also some negative experiences. Some participants found the exercises too easy ($n = 9$), and a few participants perceived them as unnecessary ($n = 2$). Lastly, many participants indicated they already engaged in enough PA ($n = 9$).

3.3.3. Providing Feedback. The majority of the participants indicated they did not use the feedback option ($n = 20$), mostly because they performed all suggested exercises. Furthermore, five participants mentioned they provided feedback only once. Several participants indicated it was clear how to provide feedback ($n = 8$). However, some were doubting what to indicate ($n = 3$).

3.3.4. Experiences with Fitbit Charge 2. Overall, participants mainly reported to experience wearing the Fitbit as positive (Figure 3). Almost all participants indicated that the visibility of their steps on the Fitbit was valuable ($n = 30$). Furthermore, nearly half of participants perceived wearing the Fitbit as motivating for PA ($n = 19$). However, several participants also reported wearing a Fitbit did not influence their PA level ($n = 17$).

Other positive experiences were perceiving wearing the Fitbit as good ($n = 23$), pleasant ($n = 5$), interesting ($n = 4$), easy ($n = 3$), and user-friendly ($n = 2$). Some participants indicated that the Fitbit did not count their steps correctly ($n = 7$).

3.3.5. Overall Suggestions for Improvement. Several participants provided valuable suggestions for improvement of the My Health Plan application and mHealth interventions in general: extending the visibility duration of exercises ($n = 4$), personal feedback on performance of the exercise ($n = 3$),

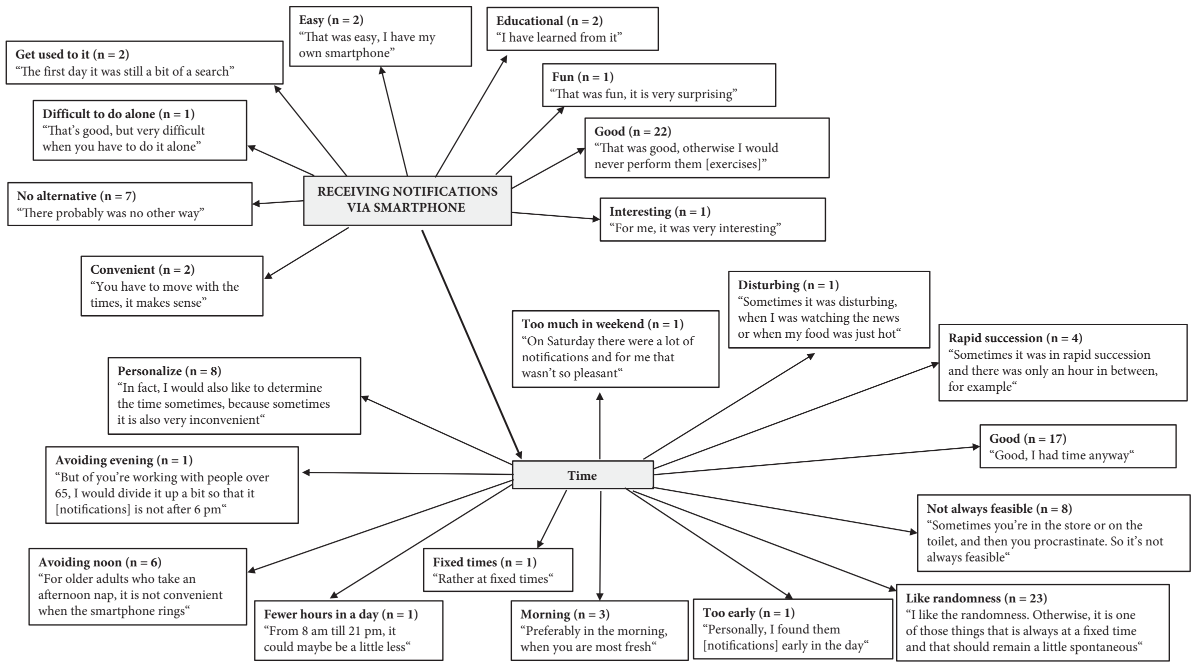

Figure 1: Pen profile: receiving notifications via smartphone.

Table 2: Number of received notifications for each participant that categorized the number of notifications as either good, enough, not enough, or too high (i.e., 25 of the 40 participants).

Indicated	Number of received notifications per participant																Mean	SD
Good	0	0	3	4	5	6	7	10	12	13	18	27	29	37	38	39	16.5	14.0
Enough	0	6	8	10													6.0	4.3
Not enough	0	3	3	7													4.3	2.9
Too high	4																	

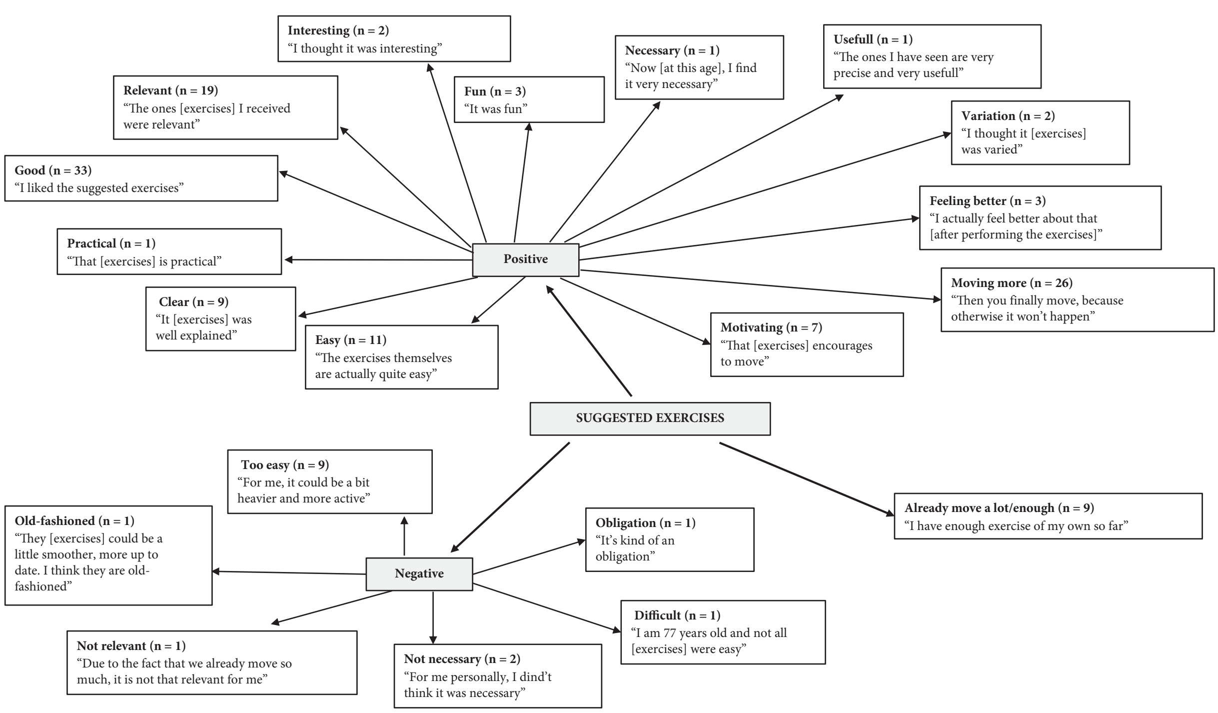

Figure 2: Pen profile: suggested exercises.

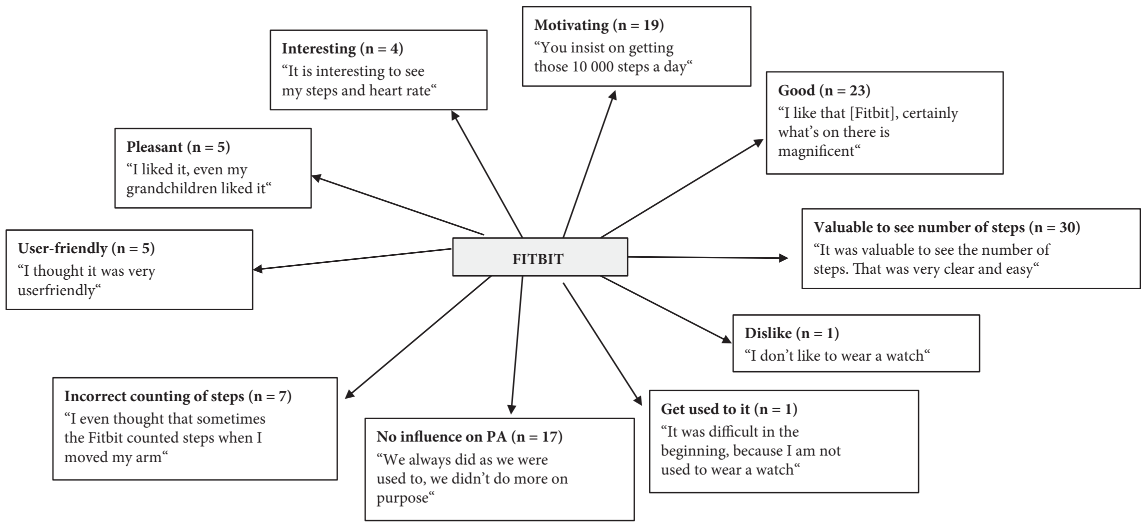

Figure 3: Pen profile: Fitbit Charge 2.

adding more exercises or increasing the variation ($n = 3$), enabling personalization of activity level or type ($n = 3$), introducing more challenging exercises ($n = 2$), providing an option to redo missed notifications/exercises ($n = 2$), presenting notifications and exercises on the watch instead of the smartphone ($n = 1$), incorporating more visual support ($n = 1$), presenting an end-of-day overview of performed and missed exercises, personal progress, step count, etc. ($n = 1$), assigning unique sounds to different types of notifications ($n = 1$), personalizing exercises based on age ($n = 1$), and allowing users to provide personal feedback for why an exercise was not done ($n = 1$).

3.4. Associations with Person-Level and Psychosocial Factors

3.4.1. Predictors for Performance of the Exercises. For the univariate logistic regressions, the performance of the exercises was used as the dependent variable resulting in 273 performed exercises and 156 nonperformed exercises (including notifications responded with nonperformance and ignored notifications). All outcomes are presented in Table 3.

Gender ($P = 0.02$), baseline PA ($P = 0.005$), anxiety ($P = 0.04$), and ability to participate in social roles and activities ($P = 0.01$) were significant predictors for performance of the suggested exercises. The odds to perform the suggested exercise were 4.04 times higher for males than females. One hour increase in baseline PA was associated with 1.06 higher odds of performing the suggested exercise. One unit decrease in anxiety and one unit increase in ability to participate in social roles/activities were associated with, respectively, 1.07 and 1.10 higher odds to perform the suggested exercise.

3.4.2. Predictors for Percentage of Executed Exercises. For the univariate linear regressions, the percentage of performed exercises was used as the dependent variable. All outcomes are presented in Table 3, but no significant associations were found.

4. Discussion

The global rise in the aging population highlights the importance of promoting PA among older adults for healthy aging. Despite the well-known benefits of PA, many older adults struggle to meet recommended guidelines, increasing their risk of health issues. mHealth interventions offer a promising solution, providing wide and convenient access to personalized guidance, real-time feedback, and tools that can enhance motivation and adherence to PA. The present study explored older adults' experiences with mHealth interventions, focusing on the My Health Plan application, and examined who (based on person-level factors) was more likely to perform the suggested stretch- and strengthening exercises. This study provides useful insights to tailor future mHealth interventions, optimizing their effectiveness in promoting PA among older adults and supporting healthy aging.

4.1. Experiences with My Health Plan mHealth Application and Fitbit Charge 2 Activity Monitor. Participants generally reported positive experiences with receiving notifications throughout the day via the My Health Plan app. Most older adults reported that the suggested stretch- and strengthening exercises increased their PA levels, motivation, and well-being. They appreciated the random timing of the notifications and considered smartphones a convenient platform for health interventions. Although keeping a smartphone nearby throughout the day posed some challenges, these findings highlight the feasibility of using smartphones in health interventions for older adults. A large-scale survey conducted annually in Flanders (Belgium) by Imec, an independent Flemish research center, supports these findings. The survey showed that half of the older adults (65+) expressed interest in digital technology, with the majority frequently using smartphones [23]. Moreover, almost one-third of older adults aged 65 to 74 years uses a health or sports application at least monthly [22], showing promise for mHealth interventions targeting PA.

Table 3: Outcomes of univariate logistic regressions and univariate linear regressions.

	Performance of the exercises: logistic regressions		Percentage of performed exercises: linear regressions	
	ExpB[a] (95% CI)	*P* value	Unstandardized beta (95% CI)	*P* value
Gender	4.04 (1.28–12.74)	0.02	0.19 (−0.50–0.42)	0.12
Age	1.00 (0.88–1.14)	0.98	−0.01 (−0.03–0.02)	0.63
BMI	0.97 (0.83–1.14)	0.72	0.02 (−0.01–0.05)	0.12
Familiar with smartphone-use	1.13 (0.64–2.00)	0.69	−0.02 (−0.11–0.07)	0.68
Education level	0.99 (0.59–1.67)	0.97	−0.02 (−0.15–0.11)	0.76
IPAQ (in hours)	1.06 (1.02–1.11)	0.005	0.00 (0.00–0.00)	0.29
Intention	1.42 (0.99–2.03)	0.06	−0.06 (−0.15–0.02)	0.13
Motivation	1.07 (0.40–2.90)	0.89	−0.05 (−0.31–0.21)	0.72
Self-efficacy	1.27 (0.49–3.24)	0.62	−0.20 (−0.02–0.01)	0.29
Outcome expectancies	0.55 (0.22–1.38)	0.20	0.11 (−0.20–0.41)	0.47
Risk perception	1.03 (0.58–1.84)	0.92	0.07 (−0.06–0.19)	0.29
Self-monitoring	1.10 (0.45–2.71)	0.84	0.04 (−0.11–0.19)	0.57
PROMIS				
Physical function	1.01 (0.95–1.09)	0.72	−0.01 (−0.02–0.01)	0.42
Anxiety	0.94 (0.88–1.00)	0.04	0.01 (0.00–0.02)	0.13
Depression	0.96 (0.89–1.04)	0.38	0.01 (−0.01–0.02)	0.44
Fatigue	0.97 (0.89–1.06)	0.46	0.02 (0.00–0.03)	0.07
Sleep disturbance	1.00 (0.90–1.10)	0.98	0.01 (−0.01–0.03)	0.54
Ability to participate in social roles and activities	1.10 (1.02–1.19)	0.01	−0.02 (−0.03–0.00)	0.07
Pain interference	0.96 (0.90–1.03)	0.30	0.01 (0.00–0.03)	0.08
Pain intensity	1.02 (0.83–1.26)	0.84	0.04 (−0.02–0.09)	0.18

[a]Exp(B): beta exponent.

Furthermore, in the present study, older adults generally appreciated using the Fitbit activity monitor, particularly for its visibility of step counts, which motivated them to increase their PA. This highlights the potential of wearable activity monitors as valuable tools in mHealth interventions, providing real-time feedback to promote sustained engagement in PA among older adults and enhance the efficacy of such interventions to promote healthy aging. However, some older adults reported inaccuracies in step counting, emphasizing the need for careful consideration of device accuracy depending on the research question in future studies (i.e., the need for detailed PA information). Nonetheless, previous research has repeatedly shown that Fitbit activity monitors are highly accurate for measuring average daily step counts, with any deviations being small and acceptable [35, 36].

However, a significant number of older adults indicated that they were already sufficiently PA. They did not find the stretch- and strengthening exercises necessary to increase their activity levels. For individuals with a higher baseline PA level, self-monitoring (i.e., visibility of step count by using the Fitbit) might be sufficient to either increase or maintain their PA levels [37]. This explains why they may not require additional exercise recommendations. Tailoring intervention strategies to provide personalized recommendations that align with individual PA baseline levels and preferences could enhance engagement and promote sustained participation in PA interventions.

Valuable feedback from older adults regarding the My Health Plan mHealth intervention provided insights not only for improving this specific intervention but also for mHealth interventions in general. While the intervention already included some personalization (i.e., notifications based on step count, customization of notification time window, and the ability to indicate injuries to avoid specific exercises), older adults emphasized the importance of further personalization. They suggested personalizing the timing and number of notifications, as well as suggested exercises to their personal fitness level and preferences (e.g., choosing between stretching and strengthening exercises depending on their own preference at that moment). This need for personalization might relate to their previous comments about not finding the exercises necessary to be active. Older adults with higher baseline PA levels might prefer more advanced exercises or different types of exercises. Previous research showed that personalized and reachable goals positively impact the sustained use of mHealth interventions and facilitate behavior change in older adults [38]. Therefore, mHealth interventions should be tailored to the individual needs of older adults; given their diversity, a universal or "one size fits all" approach may not be effective for this age group [26, 39, 40]. Future research should explore, specifically for older adults, the extent of personalization necessary to achieve significant changes in PA levels, identify which specific aspects (e.g., content of notifications, general settings such as time and number of notifications, and layout of application) of PA interventions require personalization, and explore whether such personalized mHealth interventions lead to greater behavioral changes compared to less or nonpersonalized mHealth interventions. This could provide valuable information for developing tailored mHealth interventions to promote healthy aging.

4.2. Who Is More Likely to Perform the Suggested Exercises? Male older adults, those with a higher baseline level of PA, with lower levels of anxiety, or higher ability to participate in social roles and activities, were more likely to engage in the suggested stretch- and strengthening exercises.

Gender differences are often observed in PA research. Previous research in older adults observed differences in motivating factors and context preferences for PA between men and women [41]. Consequently, it can be expected that gender differences may exist regarding the preferred delivery mode of a PA intervention. While it remains rather speculative, the observed gender difference in this study might suggest that males exhibit a greater preference for mobile (mHealth) interventions compared to females. Previous research in adolescents also showed that males had higher usage of mHealth interventions compared to females [42], supporting this assumption. However, the observed gender difference might also be explained by the fact that men felt more addressed by the content of the suggested exercises or to other aspects of the intervention compared to women. Therefore, multiple explanations are plausible for this finding, and further research is needed to confirm potential gender differences among older adults. Nonetheless, this gender-related insight provides valuable guidance for future mHealth interventions targeting older adults, highlighting the importance of acknowledging gender-specific responses to mHealth interventions. Tailoring interventions to meet the specific needs of individuals may increase exercise performance and overall intervention effectiveness.

Older adults with a higher baseline PA level were more likely to engage in the suggested stretch- and strengthening exercises. This finding is surprising considering that some older adults indicated they did not need the exercises to be more active, as they believed they already engaged in sufficient PA. However, indicating that they did not need the exercises did not prevent them from performing them, as shown by the current findings. Individuals with a higher PA baseline level have a more positive attitude towards PA, which may positively influence their engagement in the suggested exercises. Regardless of this finding, it is important to explore how mHealth interventions can effectively reach inactive older adults, who may potentially benefit the most from such interventions. While our study provided accessible stretch- and strengthening exercises, it is likely that older adults with lower PA baseline levels may require more than just exercise suggestions. Incorporating behavior change techniques (BCTs) or using motivational messages to increase motivation, intention, and attitude might particularly be important for this subgroup of inactive older adults. Previous research showed that successful mHealth interventions typically integrate such BCTs [25, 26]. Furthermore, for inactive older adults, it might also be important to focus on other accessible types of PA, such as walking.

Third, lower levels of anxiety were also related to higher exercise performance, consistent with previous research [43]. Individuals with higher anxiety may avoid PA to reduce the risk of experiencing feared sensations, such as increased heart rate. Therefore, older adults experiencing higher levels of anxiety, who avoid PA due to anxiety, may benefit more from addressing their anxiety before starting a PA intervention. In the context of the My Health Plan intervention, addressing anxiety could involve more personalization at the individual level, for example, starting with breathing or relaxation exercises to reduce anxiety [44] before suggesting specific exercises for individuals with high anxiety levels. Additionally, PA has been shown to reduce anxiety [45]. Therefore, increasing PA levels may also contribute to reducing anxiety.

Lastly, individuals with a higher capability to participate in social roles and activities tend to have a more active lifestyle overall. Previous research showed that engaging in social activities increases PA, and vice versa, being physically active ensures the physical capability necessary for continued social activity. Prioritizing social health may therefore facilitate PA engagement [46]. Thus, it is plausible that having a higher capability for social roles and activities is associated with a more active lifestyle, potentially increasing the likelihood of engaging in the suggested exercises. However, when considering the percentage of performed exercises, individuals with a decreased ability to participate in social roles and activities showed higher percentages of performance, which is counterintuitive to the results mentioned above. These findings suggest the need for future research to explore the underlying mechanisms and implications of the ability to participate in social roles and activities in the context of PA (mHealth) interventions for older adults.

In this study, it was also observed that the percentage of performed exercises was higher in individuals experiencing increased fatigue and higher pain interference. These findings contrast with the expected explanation for a lack of exercise rather than its occurrence. However, since the stretch- and strengthening exercises were deliberately chosen for their accessibility, even for inactive older adults, these findings are not entirely surprising. The simplicity and approachability of the exercises could contribute to the comfort of older adults in performing them, despite their fatigue or pain. Moreover, older adults might perceive stretch- and strengthening exercises as a way to improve their overall well-being, manage stress, or cope with their health conditions, which could explain the higher percentage of exercise performance despite physical complaints. Stretching exercises, in particular, might offer some relief from pain and stiffness.

4.3. Strengths and Limitations. An important strength of this study is its mixed methods design, providing a comprehensive understanding of older adults' experience with the My Health Plan and mHealth interventions in general. Second, the My Health Plan application already incorporated some level of personalization, which has been shown to be important in previous research.

However, it is important to interpret the findings of this study within the context of certain limitations. First, the use of convenience sampling may introduce selection bias, resulting in a sample of older adults with a relatively high baseline PA level. Nonetheless, the sample achieved an almost even distribution of gender and familiarity with smartphone use, with 30% of nontertiary educated individuals, which limits the potential impact of this bias. Second, older adults with limited smartphone experience were included, which could impact the study results (e.g., reduced engagement or missed notifications). To address these challenges, participants were provided with a comprehensive paper manual and brief training on smartphone use and could contact one of the researchers for assistance. Third, some technical issues, such as poor synchronization between Fitbit, Google Fit, and the My Health Plan application, were experienced during this study, which may have led to a lower-than-expected number of notifications being sent. Nine participants did not receive any notifications, but it is possible that these individuals were on track to meet their daily step goal, as the mean steps per day for the majority of these participants exceeded or were close to the daily step goal of 8000 steps and therefore did not trigger notifications. Additionally, for three participants, notifications were based on smartphone accelerometry rather than Fitbit data, which may be less accurate.

5. Conclusions

This exploratory mixed methods study provides insights into older adults' experiences with the My Health Plan mHealth application and identifies factors influencing engagement in the suggested exercises. The positive experiences reported suggest that mHealth interventions hold promise for promoting PA in older adults. To fully harness the potential of mHealth interventions, it is essential to incorporate personalization, tailored to the unique needs of older individuals, as observed in this study regarding gender and baseline PA level. In an evolving digital landscape, leveraging mHealth interventions can contribute to promoting healthy aging and enhancing the PA levels of older adults. This study not only offers current insights into older adults' positive experiences with mHealth but also lays the groundwork for future interventions aimed at optimizing the impact of mHealth in promoting an active and healthy lifestyle in older adults.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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Supplementary Materials

Supplementary file 1 contains a figure presenting the study procedure. Supplementary file 2 contains the third part of the intake questionnaire, translated in English. Supplementary file 3 contains screenshots of the My Health Plan application, translated in English. Supplementary file 4 contains the feedback options participants were able to choose from in the application. Supplementary file 5 contains the questions of the semistructured interview conducted at the end of the study, translated in English. Supplementary file 6 contains a table with the descriptive statistics of the Fitbit step count and exercises for all participants together and individually. (*Supplementary Materials*)

References

[1] World Health Organization, *Ageing and Health*, WHO, Geneva, Switzerland, 2018.

[2] P. C. Hallal, L. B. Andersen, F. C. Bull et al., "Global physical activity levels: Surveillance progress, pitfalls, and prospects," *The Lancet*, vol. 380, no. 9838, pp. 247–257, 2012.

[3] European Commission, "Special eurobarometer 472 report-sport and physical activity," 2018, https://ec.europa.eu/sport/news/2018/new-eurobarometer-sport-and-physical-activity_en.

[4] A. Biswas, P. I. Oh, G. E. Faulkner et al., "Sedentary time and its association with risk for disease incidence, mortality, and hospitalization in adults a systematic review and meta-analysis," *Annals of Internal Medicine*, vol. 162, no. 2, pp. 123–132, 2015.

[5] C. Y. Jeon, R. P. Lokken, F. B. Hu, and R. M. Van Dam, "Physical activity of moderate intensity and risk of type 2 diabetes: A systematic review," *Diabetes Care*, vol. 30, no. 3, pp. 744–752, 2007.

[6] E. M. Monninkhof, S. G. Elias, F. A. Vlems et al., "Physical activity and breast cancer: A systematic review," *Epidemiology*, vol. 18, no. 1, pp. 137–157, 2007.

[7] J. Sattelmair, J. Pertman, E. L. Ding, H. W. Kohl III, W. Haskell, and I.-M. Lee, "Dose response between physical activity and risk of coronary heart disease A meta-analysis," *Circulation*, vol. 124, no. 7, pp. 789–795, 2011.

[8] K. Y. Wolin, Y. Yan, G. A. Colditz, and I. M. Lee, "Physical activity and colon cancer prevention: a meta-analysis," *British Journal of Cancer*, vol. 100, no. 4, pp. 611–616, 2009.

[9] J. A. Avila-Funes, S. D. Pina-Escudero, S. Aguilar-Navarro, L. M. Gutierrez-Robledo, L. Ruiz-Arregui, and H. Amieva, "Cognitive impairment and low physical activity are the components of frailty more strongly associated with disability," *The Journal of Nutrition, Health & Aging*, vol. 15, no. 8, pp. 683–689, 2011.

[10] C. B. Guure, N. A. Ibrahim, M. B. Adam, and S. M. Said, "Impact of physical activity on cognitive decline, dementia, and its subtypes: Meta-analysis of prospective studies," *BioMed Research International*, vol. 2017, pp. 1–13, 2017.

[11] B. M. Martínez-Hernández, O. Rosas-Carrasco, M. López-Teros et al., "Association between physical activity and physical and functional performance in non-institutionalized Mexican older adults: A cohort study," *BMC Geriatrics*, vol. 22, no. 1, p. 388, 2022.

[12] P. T. Williams, "Physical fitness and activity as separate heart disease risk factors: A meta-analysis," *Medicine & Science in Sports & Exercise*, vol. 33, no. 5, pp. 754–761, 2001.

[13] F. C. Bull, S. S. Al-Ansari, S. Biddle et al., "World Health Organization 2020 guidelines on physical activity and sedentary behaviour," *British Journal of Sports Medicine*, vol. 54, no. 24, pp. 1451–1462, 2020.

[14] F. Sun, I. J. Norman, and A. E. While, "Physical activity in older people: A systematic review," *BMC Public Health*, vol. 13, no. 1, p. 449, 2013.

[15] R. Buyl, I. Beogo, M. Fobelets et al., "E-Health interventions for healthy aging: A systematic review," *Systematic Reviews*, vol. 9, 2020.

[16] V. Klusmann, A. J. Gow, P. Robert, and G. Oettingen, "Using theories of behavior change to develop interventions for healthy aging," *The Journals of Gerontology: Series B*, vol. 76, no. Supplement_2, pp. S191–S205, 2021.

[17] R. J. Moss, A. Süle, and S. Kohl, "EHealth and mHealth," *European Journal of Hospital Pharmacy*, vol. 26, no. 1, pp. 57-58, 2019.

[18] S. Shiffman, A. Stone, and M. Hufford, "Ecological momentary assessment," *Annual Review of Clinical Psychology*, vol. 4, no. 1, pp. 1–32, 2008.

[19] D. Kumar, Y. Hasan, and S. Afroz, "Mobile health monitoring system: A comprehensive review," *International Journal of Research Publication and Reviews*, vol. 4, no. 6, pp. 1922–1954, 2023.

[20] G. F. Dunton, "Ecological momentary assessment in physical activity research," *Exercise and Sport Sciences Reviews*, vol. 45, no. 1, pp. 48–54, 2017.

[21] J. L. Mair, L. D. Hayes, A. K. Campbell, D. S. Buchan, C. Easton, and N. Sculthorpe, "A personalized smartphone-delivered just-in-time adaptive intervention (JitaBug) to increase physical activity in older adults: Mixed methods feasibility study," *JMIR Formative Research*, vol. 6, no. 4, pp. 346622–e34717, 2022.

[22] L. De Marez, R. Sevenhant, F. Denecker, A. Georges, G. Wuyts, and D. Schuurman, "imec.digimeter.2022," 2023, https://www.imec.be/sites/default/files/2023-03/imec_digimeter_2022.pdf.

[23] L. De Marez, R. Sevenhant, F. Denecker, A. Georges, G. Wuyts, and D. Schuurman, "imec.digimeter.2023," 2024, https://www.imec.be/nl/kennisuitwisseling/techmeters/digimeter/imecdigimeter-2023.

[24] K. R. Hosteng, J. E. Simmering, L. A. Polgreen et al., "Multilevel mhealth intervention increases physical activity of older adults living in retirement community," *Journal of Physical Activity and Health*, vol. 18, no. 7, pp. 851–857, 2021.

[25] D. Yerrakalva, D. Yerrakalva, S. Hajna, and S. Griffin, "Effects of mobile health app interventions on sedentary time, physical activity, and fitness in older adults: Systematic review and meta-analysis," *Journal of Medical Internet Research*, vol. 21, no. 11, Article ID e14343, 2019.

[26] L. McGarrigle and C. Todd, "Promotion of physical activity in older people using mHealth and eHealth technologies: Rapid review of reviews," *Journal of Medical Internet Research*, vol. 22, no. 12, Article ID e22201, 2020.

[27] C. Nebeker and Z. Z. Zlatar, "Learning from older adults to promote independent physical activity using mobile health (mHealth)," *Frontiers in Public Health*, vol. 9, Article ID 703910, 2021.

[28] C. L. Craig, A. L. Marshall, M. Sjöström et al., "International physical activity questionnaire: 12-Country reliability and validity," *Medicine & Science in Sports & Exercise*, vol. 35, no. 8, pp. 1381–1395, 2003.

[29] H. Schroé, C. Van Der Mispel, I. De Bourdeaudhuij, M. Verloigne, L. Poppe, and G. Crombez, "A factorial randomised controlled trial to identify efficacious self-regulation techniques in an e- and m-health intervention to target an active lifestyle: Study protocol," *Trials*, vol. 20, no. 1, pp. 340–414, 2019.

[30] C. Terwee, L. Roorda, H. de Vet et al., "Dutch-flemish translation of 17 item banks from the patient-reported outcomes measurement information system (PROMIS)," *Quality of Life Research: An International Journal of Quality of Life Aspects of Treatment, Care and Rehabilitation*, vol. 23, no. 6, pp. 1733–1741, 2014.

[31] B. Ewald, J. Attia, and P. McElduff, "How many steps are enough? dose-response curves for pedometer steps and multiple health markers in a community-based sample of older Australians," *Journal of Physical Activity and Health*, vol. 11, no. 3, pp. 509–518, 2014.

[32] Vlaams Instituut Gezond Leven vzw, "Krachtoefeningen in beeld," 2023, https://www.gezondleven.be/themas/beweging-sedentair-gedrag/beweegoefeningen/krachtoefeningen.

[33] Vlaams Instituut Gezond Leven vzw, "Stretch-en evenwichtsoefeningen," 2023, https://www.gezondleven.be/themas/beweging-sedentair-gedrag/beweegoefeningen/stretch-en-evenwichtsoefeningen.

[34] S. Tedesco, M. Sica, A. Ancillao, S. Timmons, J. Barton, and B. O'Flynn, "Validity evaluation of the fitbit charge2 and the garmin vivosmart HR+ in free-living environments in an older adult cohort," *JMIR mHealth and uHealth*, vol. 7, no. 6, pp. 130844–e13115, 2019.

[35] N. Straiton, M. Alharbi, A. Bauman et al., "The validity and reliability of consumer-grade activity trackers in older, community-dwelling adults: A systematic review," *Maturitas*, vol. 112, pp. 85–93, 2018.

[36] G. Chevance, N. M. Golaszewski, E. Tipton et al., "Accuracy and precision of energy expenditure, heart rate, and steps measured by combined-sensing fitbits against reference measures: Systematic review and meta-analysis," *JMIR mHealth and uHealth*, vol. 10, 2022.

[37] U. A. R. Chaudhry, C. Wahlich, R. Fortescue, D. G. Cook, R. Knightly, and T. Harris, "The effects of step-count monitoring interventions on physical activity: Systematic review and meta-analysis of community-based randomised controlled trials in adults," *International Journal of Behavioral Nutrition and Physical Activity*, vol. 17, no. 1, p. 129, 2020.

[38] R. Kampmeijer, M. Pavlova, M. Tambor, S. Golinowska, and W. Groot, "The use of e-health and m-health tools in health promotion and primary prevention among older adults: A systematic literature review," *BMC Health Services Research*, vol. 16, no. S5, p. 290, 2016.

[39] L. Gosetto, F. Ehrler, and G. Falquet, "Personalization dimensions for mhealth to improve behavior change: a scoping review," in *Studies in Health Technology and Informatics*, pp. 77–81, IOS Press BV, Amsterdam, Netherlands, 2020.

[40] R. Jakob, S. Harperink, A. M. Rudolf et al., "Factors influencing adherence to mHealth apps for prevention or management of noncommunicable diseases: systematic review," *Journal of Medical Internet Research*, vol. 24, 2022.

[41] J. G. Z. Van Uffelen, A. Khan, and N. W. Burton, "Gender differences in physical activity motivators and context preferences: A population-based study in people in their sixties," *BMC Public Health*, vol. 17, no. 1, p. 624, 2017.

[42] E. Egilsson, R. Bjarnason, and U. Njardvik, "Usage and daily attrition of a smartphone-based health behavior intervention: Randomized controlled trial," *JMIR mHealth and uHealth*, vol. 11, Article ID e45414, 2023.

[43] C. E. J. DeWolfe, M. K. Galbraith, M. M. Smith et al., "Anxiety sensitivity and physical activity are inversely related: A meta-

analytic review," *Mental Health and Physical Activity*, vol. 25, Article ID 100548, 2023.

[44] R. Jerath, M. W. Crawford, V. A. Barnes, and K. Harden, "Self-Regulation of breathing as a primary treatment for anxiety," *Applied Psychophysiology and Biofeedback*, vol. 40, no. 2, pp. 107–115, 2015.

[45] S. A. Paluska and T. L. Schwenk, "Physical activity and mental health current concepts," *Sports Medicine*, vol. 29, no. 3, pp. 167–180, 2000.

[46] S. Dogra, D. W. Dunstan, T. Sugiyama, A. Stathi, P. A. Gardiner, and N. Owen, "Active aging and public health: Evidence, implications, and opportunities," *Annual Review of Public Health*, vol. 43, no. 1, pp. 439–459, 2022.