Sustaining Elderly Engagement in IoT-Based Health Self-Monitoring through Incentives and Family Involvement

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Abstract. Older adults often adopt IoT-based health self-monitoring devices with initial enthusiasm, but long-term engagement typically declines. This study explores two strategies to sustain usage among adults aged 60 and above: (1) gamified economic incentives and (2) parent–child interaction. Grounded in human–computer interaction (HCI), behavioral economics, and gerontechnology, we review related work on motivation and social support in aging. We then present a smart self-monitoring system combining a points-based reward mechanism and a companion app for intergenerational engagement. A preliminary usability study with 10 elderly–child dyads confirmed system accessibility and suggested both rewards and family involvement boost emotional engagement. We propose a 2×2 factorial experiment to evaluate the strategies' effects on long-term usage. This research aims to inform HCI and aging-focused design by demonstrating how behavioral and social interventions can enhance elderly engagement with health technologies.

Keywords: Sleep Monitoring · Elderly Care · Health Awareness · User Engagement · Economic Incentives · Family Support.

1 Introduction

Despite the growing availability of IoT-based health technologies, sustaining long-term engagement among older adults remains a major challenge. In our current project, we build upon an existing commercial system centered around the Slaap Lekker sleep monitor, which is already in use alongside three other connected devices: a blood pressure monitor, a pulse oximeter, and a body composition scale. These devices form the IoT backend of the system, which collects daily health data and transmits it to a mobile app used by elderly users and their families.

The app enables older adults to view their own health data and optionally share it with their children or caregivers. While initial uptake has been positive, our field data reveals a sharp drop in usage over time. Many users decrease their engagement significantly after the first few weeks of use, limiting the long-term benefits of these health monitoring tools.

From a Human–Computer Interaction (HCI) perspective, this problem extends beyond usability. Though the app is functional and the interface is accessible to smartphone-literate seniors, continued usage also depends on users' motivation and emotional engagement. Prior research shows that sustained interaction with health technology in older adults requires addressing both practical ease-of-use and deeper behavioral drivers.

Behavioral economics suggests that extrinsic motivators, such as rewards, can support health behavior change by providing immediate positive feedback. However, older users may react differently to such incentives than younger users, particularly if the rewards feel transactional or misaligned with personal values. At the same time, aging theories such as socioemotional selectivity highlight that social and emotional support—especially from close family members—becomes increasingly important in motivating behavior later in life.

Given this context, our study explores two complementary strategies to enhance long-term engagement with the existing health monitoring system:

- *Gamified economic incentives* Which aim to make self-tracking feel more rewarding and fun.
- *Parent–child interaction* Which enables adult children to remotely support their parents through a linked companion app.

By combining behavioral and emotional motivators, we aim to support both the "will" and the "habit" of continued health tracking. In the sections that follow, we review prior research, describe our system and interventions, present findings from a pilot usability study, and outline our formal experimental design to evaluate the effectiveness of these strategies.

2 Background and Related Work

2.1 Engagement Challenges in Elderly Health Technologies

Older adults face specific challenges in sustaining the use of health technologies. Usability is a key concern. When systems are too complex or interfere with daily life, disengagement is likely. However, many smartphone-literate seniors are able to use well-designed tools if interfaces are clear and intuitive.

In our project, although the IoT system is generally user-friendly, many users gradually reduce usage after initial adoption. This pattern aligns with findings in the literature. Initial motivation often fades without habit formation or ongoing support. By contrast, users who develop routines and receive encouragement are more likely to maintain long-term engagement.

2.2 Motivational Design and Economic Incentives

To address declining motivation, many health technologies use strategies such as gamification, goal-setting, and rewards. Gamification adds elements like points, badges, and progress tracking to make health tasks more engaging. While common among younger users, such methods are less explored in older populations.

Economic incentives, rooted in behavioral economics, offer tangible or symbolic rewards to reinforce desired behaviors. In our study, we compare two reward types—symbolic virtual points and small cash rewards—and also vary the recipient. In some groups, rewards go directly to the older adult; in others, they go to the adult child, aiming to motivate family support.

By examining both reward form and reward target, we explore how different incentive models affect older adults' long-term engagement. All rewards are presented positively, with a focus on habit-building, emotional meaning, and family connection, rather than transactional gain.

2.3 Family-Based Support and Intergenerational Interaction

Social support is a key factor in shaping health behavior among older adults. When family members show care, older users are more likely to maintain routines such as daily self-monitoring. Involving adult children can also increase confidence and emotional motivation, especially when they pay attention to their parents' health data.

As people age, close relationships become stronger motivators. Socioemotional selectivity theory suggests that emotional bonds increasingly guide decisions. In cultures like China, where adult children often support aging parents remotely, technology can help maintain this connection.

In our system, parents can share their health data with their children via a linked app. After viewing the data, children can respond with a simple "like" to express encouragement. This small gesture fosters emotional connection and turns self-monitoring into a shared, family-supported experience.

3 Intervention Design and Preliminary Usability Study

3.1 System Overview

Our system is centered around a connected sleep monitoring device, supported by three Bluetooth-enabled health tools: a blood pressure monitor, a pulse oximeter, and a body composition scale. These devices are integrated into a mobile app designed specifically for older adults, which presents health data in a clear, easy-to-read format and supports optional sharing with family members.

To address the challenge of declining long-term engagement, we introduced two intervention modules into the existing app: a gamified incentive mechanism and a parent–child data sharing feature. These are intended to enhance both behavioral motivation and emotional support.

When designing the new feature prototypes, we optimized the interface based on usability principles, focusing on visual clarity, intuitive navigation, and low interaction burden—ensuring accessibility for smartphone-literate older users.

3.2 Intervention Modules

Gamified Economic Incentive Mechanism The gamified incentive module rewards users with points for daily health measurements using connected devices. Points are displayed in the app and can be redeemed depending on group assignment: some users receive symbolic rewards (e.g., badges), while others receive small cash rewards.

The app sets simple goals, like completing all measurements in a day or maintaining daily use. Visual feedback—such as progress bars or "You earned 10 points today" messages—helps reinforce consistent use.

Reward framing varies across groups. Symbolic rewards emphasize fun, achievement, or altruism, while cash rewards highlight tangible value. This setup allows us to examine how different incentive types affect long-term engagement in older adults.

Parent–Child Data Sharing Feature The parent–child data sharing feature allows older adults to link their app with a companion app used by their adult child. With consent, summary health data (such as daily measurement completion or progress updates) is shared to the child's app. In response, the child can give simple positive feedback—such as tapping a "like" icon—which is then displayed on the elder's interface.

This lightweight interaction is designed to reinforce emotional connection and create a sense of being seen and supported. Unlike active messaging or reminders, the feedback is minimal and non-intrusive, aiming to respect the elder's autonomy while still providing subtle encouragement.

The design draws on intergenerational dynamics common in many cultures, where adult children continue to care for aging parents, often remotely. By enabling visibility of daily effort and allowing children to show acknowledgment with a single tap, we aim to turn health tracking into a shared experience rather than a solitary routine.

3.3 Usability Study with Older Adult–Child Pairs

Before launching the full experiment, we conducted a preliminary usability study to evaluate the interface design and user acceptance of the two intervention features—gamified economic incentives and parent–child data sharing. We used a Figma-based interactive prototype to simulate the features.

Ten elder–child dyads were recruited. Older participants were required to be over 60 and have some experience using smartphones. In the first home visit, we installed our existing app and IoT devices (sleep monitor, blood pressure monitor, pulse oximeter, and body fat scale) on their phones and guided them through initial usage. Over the following 3–7 days, participants used the system at home to familiarize themselves with the product.

In the second visit, after this initial hands-on experience, we introduced the two new features by letting participants interact with the Figma prototype directly on their smartphones. Their responses provided key usability insights:

Age-related independence Most users aged 60–70 could independently operate the app, while users over 70—even those who owned smartphones—typically used them only for calls and needed assistance from their children.

Comprehension Participants who could use apps like WeChat or browse news were generally able to understand and operate the interface without difficulty. No major comprehension barriers were reported for the new feature prototypes.

Gamified incentives Many elders expressed positive interest, describing the feature as fun and motivating. Most said the cash reward was secondary, and that the gamified aspect was more appealing.

Parent–child interaction Some elders—especially those not cohabiting with their children—found this feature valuable. They appreciated the way it enabled children to notice their health status without requiring the elder to initiate conversations about discomfort or illness. However, participants who lived with their children expressed less interest, noting that they already communicated frequently in daily life.

Emerging user needs Beyond interface feedback, some elders voiced a strong desire for the app to offer more interpretive guidance on their health data. They hoped the system could not only display measurements but also provide actionable insights for managing their health.

4 Next Steps: Experimental Plan and Future Directions

4.1 Experimental Plan

Building on usability feedback, we developed a field experiment to evaluate how reward types (virtual vs. cash) and recipient roles (elder vs. child) influence older adults' sustained use of self-monitoring technologies.

Unlike a simple 2×2 factorial design, our setup includes four experimental groups designed to explore the interaction between reward format and family dynamics:

Elder–Virtual Group Older adults complete daily tasks independently and receive virtual rewards (e.g., badges, points, charitable donations). No child involvement.

Elder–Child Virtual Group Older adults complete tasks together with their adult children via the app. They receive virtual rewards, with positive feedback features (e.g., likes) enabled between the pair.

Elder–Child Cash Group Cash to Elder Tasks are completed jointly by elder and child. Cash rewards are given to the older adult.

Elder–Child Cash Group Cash to Child Tasks are completed jointly by elder and child. Cash rewards are given to adult child instead of the elder.

By comparing across these conditions, we aim to answer:

- Whether virtual or cash incentives are more effective
- Whether motivating the elder vs. their child yields different long-term outcomes
- Whether family participation alone (without financial rewards) already helps maintain engagement

4.2 Future Directions

Moving forward, we identify four key directions to expand this work:

Personalized and Adaptive Motivation Future systems could tailor incentive types (gamified, financial, or social) to individual preferences, assessed through onboarding or early behavior. This personalization may improve long-term adherence.

Expanding Social Roles and Family Models Beyond parent–child interactions, other social relationships—spouses, grandchildren, or community caregivers—could be explored. Different roles may offer unique forms of emotional or practical support.

Long-Term Engagement and Health Outcomes Extending the study duration could reveal whether short-term incentives lead to lasting habits. Additionally, future studies could link usage behavior with actual health improvements and medical decisions.

Enhanced Guidance and Accessibility Users expressed a need for simple health explanations and actionable tips. Future iterations might include health coaching features, voice interfaces, or integration with healthcare professionals, especially for users with limited vision or mobility.

These directions aim to support both sustained behavior and meaningful health engagement in aging populations.

5 Conclusion

This study explored how to improve long-term engagement of older adults with IoT-based self-monitoring technologies through two strategies: economic incentives and intergenerational interaction.

Drawing from HCI, behavioral economics, and aging theory, we developed a system that combines gamified or financial rewards with family participation features. A preliminary usability study with 10 elder–child pairs showed that

smartphone-literate seniors could use the app independently, and that both incentive mechanisms and family sharing were positively received. These insights informed the design of a full-scale experiment involving four user groups to compare different combinations of reward types and recipient roles.

Our approach emphasizes the value of designing not just for the individual elder, but for their broader social and motivational context. As populations age, supporting healthy behavior through personalized, emotionally resonant, and socially connected systems will be critical. We hope this work contributes to more inclusive, meaningful, and sustainable health technology solutions for aging societies.

About Qingyuan Lin Qingyuan Lin is an EngD researcher in Human-System Interaction at the Department of Industrial Design, Eindhoven University of Technology (TU/e). She holds an MFA in User Interface and User Experience Design, as well as a Bachelor's degree in Finance. Her current research explores how interaction design can support long-term engagement in health self-monitoring among older adults, especially through IoT-based systems.

Previously, she took part in research at Zhejiang University's College of Computer Science and co-authored papers presented at international conferences. She has also worked on projects related to sensor-based design and emotional experience in digital products. Her design work has been shown at events such as Milan Design Week and the BIEAF in Busan. She was awarded a First-Class Scholarship in recognition of academic performance.

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