IDHEApp

Designing and implementing the IDHEApp: A gamified mHealth intervention for promoting healthy lifestyles in young people with intellectual disabilities

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Designing and implementing the IDHEApp: A gamified mHealth intervention for promoting healthy lifestyles in young people with intellectual disabilities

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Summary

This chapter introduces the IDHEApp project, an innovative, gamified mobile health (mHealth) intervention designed to promote a holistic and healthy lifestyle among young people with intellectual disabilities (ID). Given the prevalence of health disparities in this population, including physical inactivity, sedentary behaviour, poor nutrition, and sleep disturbances, and the limitations of traditional interventions, the IDHEApp project was conceived to address a critical research gap. The application was co-created with the users themselves, their caregivers, and experts, using user-centred design principles.

The study was implemented as a pilot randomized controlled trial across two centres, Rome (Italy) and Rijeka (Croatia), with 60 participants aged 8 to 35. The methodology included the use of Fitbit wearable devices for objective data collection on physical activity and sleep. The app's usability was evaluated through a mixed-methods approach, which included focus groups and questionnaires. Although the pilot study was not designed to demonstrate large-scale clinical efficacy, it confirmed the feasibility and potential of the gamified approach to foster behavioural change. The qualitative results highlighted that adolescents found the challenges and rewards highly motivating. However, significant limitations were also identified, such as technical issues with device connectivity and the need for a more simplified user interface to reduce caregiver dependence. The chapter concludes with a discussion of the project's implications and proposes next steps for research, including conducting a larger trial to formally evaluate the intervention's efficacy.

Keywords: Intellectual Disability; mHealth; Gamification; Healthy lifestyle; Physical activity; User-centered design; Pilot study.

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1.1. Context and rationale

Young individuals with intellectual disabilities (ID) consistently face significant health disparities rooted in lifestyle-related risk factors, including poor nutrition, sleep disturbances, and reduced quality of life (Allerton et al., 2011). While physical inactivity and high levels of sedentary behaviour are highly prevalent in this population and have received considerable attention, other critical health domains that directly influence overall health and daily functioning have often been overlooked (Oppewal et al., 2018). The collective impact of these behavioural risk factors, including unhealthy dietary patterns and prevalent sleep problems, is a diminished quality of life, which encompasses physical, emotional, and social well-being (Harper et al., 2021).

1.2. Research gap

Traditional, face-to-face interventions aimed at addressing these issues are often resource-intensive and may not be scalable or adequately adapted to the specific cognitive and communication needs of individuals with ID (Mulhall et al., 2018). Although mobile health (mHealth) interventions offer a promising, technology-driven alternative for behaviour change and have shown success in the general population, mHealth research in the field of intellectual disabilities remains scarce (Oudshoorn et al., 2020). Most existing studies have a narrow focus on physical activity, suffer from small sample sizes, and lack the tailored design necessary to address the unique barriers faced by this population, such as difficulties with digital literacy and a lack of caregiver integration. Furthermore, many interventions have concentrated on a single aspect of health rather than adopting an integrated, holistic approach (Michalsen et al., 2022).

1.3. The IDHEApp Project

The IDHEApp project was conceived to fill this critical gap by developing an innovative, gamified mHealth application specifically designed to promote a holistic healthy lifestyle in young people with ID. Moving beyond a narrow focus on physical activity, this project takes a comprehensive approach, jointly analysing and

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addressing the various parameters that influence a healthy lifestyle, including physical activity, sedentary behaviour, nutrition, and sleep patterns. By incorporating digital strategies tailored to this population's needs, the project aims to inform scalable, inclusive models for promoting long-term health and well-being.

1.4. Chapter structure

This chapter details the entire project lifecycle, from the conceptualization and development of the IDHEApp to its implementation and evaluation in a pilot randomized controlled trial. We will discuss the design and implementation procedures, analyse the app's usability, and present the key results related to its effectiveness in promoting sustainable behaviour change and improving overall well-being in this population.

2. Project methodology

2.1. Study design

This project was designed as a multicenter, randomised controlled pilot trial with a pre-post-intervention design, which aimed to evaluate the effectiveness of the IDHEApp. The study was conducted over an 8-week period, with data collection occurring at baseline (pre-intervention) and immediately following the intervention (post-intervention). Participants were randomly assigned to one of two groups: an experimental group that received the gamified IDHEApp intervention, and a control group that maintained their usual routine without additional support from the app. The pilot design was intended to assess the feasibility, usability, and preliminary efficacy of the intervention before a larger-scale trial.

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2.2. Participants and setting

The study was conducted across two sites: Rome (Italy) and Rijeka (Croatia), with a total sample size of 60 young individuals with intellectual disabilities (ID) aged 8-35 years. The two sites were chosen to allow for the inclusion of diverse subgroups of the ID population; the site in Rome focused on adolescents and young adults with Down syndrome, while the site in Rijeka included individuals with mild to moderate ID of various etiologies. Participants were recruited through local associations and centers dedicated to supporting individuals with ID. A key inclusion criterion was the ability to understand and follow basic instructions, as well as the support from a caregiver or supervisor to assist with the intervention.

2.3. Tools and measures

2.3.1. Wearable devices (Fitbit): Objective data for physical activity and sleep patterns were collected using Fitbit Charge 6 devices (Fitbit Inc., San Francisco, CA, USA). Participants wore the devices for the duration of the study, and data were automatically synchronized with a dedicated platform.

2.3.2. Outcome measures: The primary outcomes were physical activity and sedentary behaviour, measured in daily steps, time spent in light, moderate, and high-intensity activities, and time spent sitting and standing. The study also evaluated secondary outcomes related to sleep patterns (e.g., sleep duration, quality) and perceived quality of life using validated questionnaires. Macronutrient intake was also assessed pre- and post-intervention using the Eating Habits Questionnaire. This self-report instrument evaluates the frequency and quality of food consumption patterns, including intake of carbohydrates, proteins, and fats, as well as dietary habits related to portion control, meal timing, and snack choices. Administered at both time points, the questionnaire allowed for the examination of changes in nutritional behaviours potentially associated with the mHealth intervention.

2.3.3. Usability measures

The usability and satisfaction with the IDHEApp were assessed through a mixed-methods approach that combined qualitative and quantitative research techniques.

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In addition to objective data from the app and wearable devices, a qualitative approach was implemented through a series of focus groups involving adolescents, caregivers, and educators.

Different focus groups were conducted in Rijeka, Croatia, and in Rome, Italy. These sessions were designed to gather valuable feedback on the app's usability and accessibility and to understand the specific needs, preferences, and challenges faced by participants.

The focus groups were held in two phases:

- **Initial focus groups (app development phase):** The first sessions were conducted while the app was still in its final development stages. Participants, including parents and their children with ID, caregivers, and the project team, were introduced to the IDHEApp concept and its key features, such as the use of pictograms. The goal was to determine if the participants could understand the instructions conveyed through these visual aids and if the proposed design was intuitive for users with intellectual disabilities. A key finding from these early sessions was the need for significant design modifications. Feedback from the participants led to proposed changes related to the color palette to enhance contrast, the size of the font for improved readability, and the typology of the pictograms to ensure they were universally understandable. Furthermore, and of fundamental importance, was the feedback on the language used within the app, which led to a concerted effort to implement more inclusive and accessible language throughout the interface.

- **Second focus groups (technology introduction phase):** Follow-up sessions were held to present the fully developed app and demonstrate its integration with the Fitbit Charge 6 smartwatch. These discussions focused on potential barriers to using the technology, the importance of caregiver involvement, and the need for clear, simple instructions. This phase allowed participants to interact directly with the technology and provide firsthand feedback on its usability and how well the smartwatch integrated into daily activities.

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2.4. Intervention procedures

2.4.1. Description of the IDHEApp application: The IDHEApp is a gamified mHealth application developed specifically for young people with ID. It features a user-friendly interface with visual aids and simplified language. The app's core functionality is to track and promote healthy behaviours in physical activity, sedentary behaviour, and nutrition (Figure 1).

Figure 1. Screenshots of the IDHEApp

2.4.2. Details on gamification and challenges: The application used a variety of gamified elements to motivate participants. This included daily and weekly challenges, a point-based reward system, badges for achieving goals, and a leaderboard to foster friendly competition among peers. These elements were tailored to be engaging and accessible for the target population. For instance, in the nutrition challenges section, participants were tasked with goals such as having a "healthy breakfast, rich in fruit," while the physical activity challenges included specific targets like "Today I will do 3000 steps." This approach made the health objectives tangible and fun, encouraging active participation (Figure 2).

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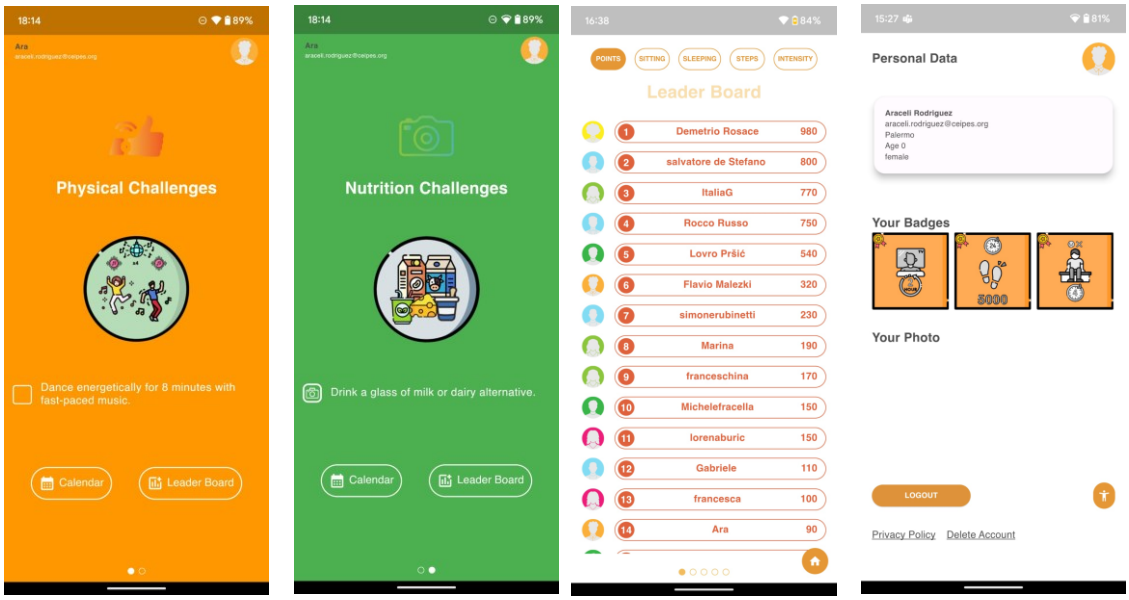

Figure 2. Examples of challenges and badges and gamification elements in the Application

2.4.3. Role of caregivers and supervisors: Given the potential cognitive and communication challenges of the participants, caregivers and supervisors played a crucial role. They were trained to support participants in using the app, explaining the challenges, helping to log data, and providing encouragement. The IDHEApp included specific functionalities to facilitate this collaborative process.

3. IDHEApp design and usability

The development of the IDHEApp was based on user-centered design principles and "easy-reading" techniques to ensure its accessibility and adaptation to the cognitive and communication needs of young people with ID. Using a co-definition model, the project involved key stakeholders, such as adolescents with ID, their caregivers, and professional experts, in the initial stages of its design. This

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collaborative process ensured that the app's features, visual language, and structure were developed with direct input from the target user group. A primary focus of this method was to simplify complex information through the use of clear and intuitive visual cues, such as pictograms, to facilitate understanding and independent use. Furthermore, the design was developed following "easy-reading" principles, which involve the use of simple, concise vocabulary, short sentences, high-contrast layouts, and clear font types. Symbols, icons, and supportive images were also integrated to reduce cognitive load and improve navigation ability. By incorporating these strategies into the instructions, feedback messages, and menu options, the design team aimed to maximize clarity and usability for users with varying levels of comprehension and literacy, while also incorporating caregiver support as a central component.

3.2. Interface features and functionality

The IDHEApp's interface was designed to be visually appealing and straightforward, with core functionalities divided into distinct health modules.

- **3.2.1. Gamification:** challenges, points, and rewards: To enhance motivation and engagement, the app integrated several gamification elements. Participants were presented with daily and weekly challenges focused on different health domains. Successful completion of these challenges earned them points and virtual rewards, such as badges, which provided a tangible sense of accomplishment. A leaderboard was also included to foster friendly competition and peer motivation (Figure 3).

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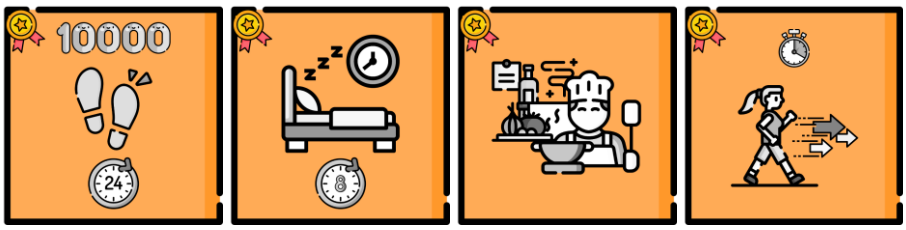

Badge 1: "The tireless walker." Congratulations, you have reached 10,000 steps in a single day

Badge 2: Sweet Dreams: Well done! You've slept for 8 hours or more.

Badge 23: Recipe Creator: Fantastic! You've prepared your favorite healthy recipe.

Badge 14: Brisk Walker: Excellent! You've walked briskly for 20 minutes.

Figure 3. Example of badges used in the IDHEApp

- **3.2.2. Progress monitoring and feedback:** The app provided clear and consistent feedback on a user's progress toward their health goals. By synchronizing with a wearable device, it offered a real-time view of achievements, such as daily step counts or time spent in physical activity. This progress tracking feature was a key facilitator, encouraging continued engagement and allowing users to see the direct results of their efforts (Figure 4).

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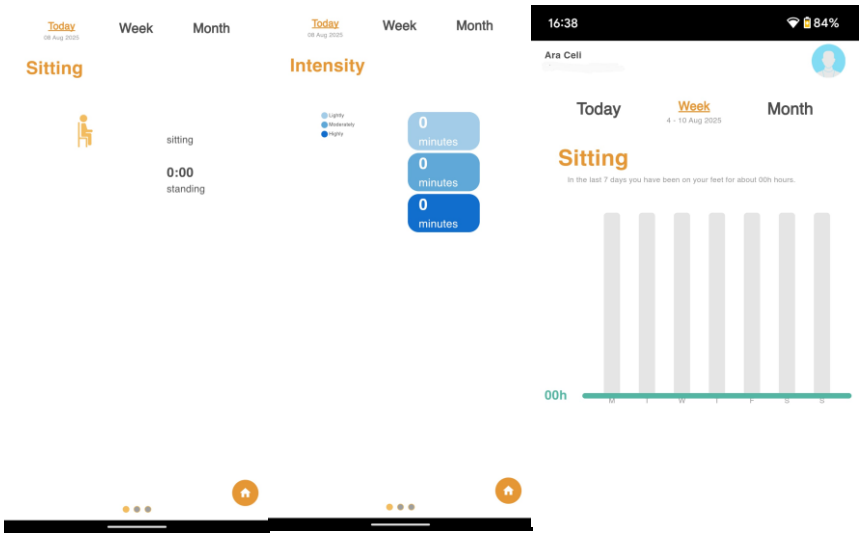

Figure 4. Examples of feedback offered by the IDHEApp

- **3.2.3. Health modules: physical activity, nutrition, and sleep:** The IDHEApp adopted a holistic approach to health, with dedicated modules for three main domains. The physical activity module tracked daily steps and activity intensity. The nutrition module presented challenges related to healthy eating habits, such as fruit and vegetable consumption. Finally, a sleep module monitored sleep patterns and provided insights into sleep duration and quality. Each module relied on visual cues and reminders to make tasks easy to understand and follow.

3.3. Usability evaluation

- **3.3.1. Methods used:** The usability of the IDHEApp was comprehensively evaluated through a mixed-methods approach that combined direct user feedback with objective data. The primary qualitative method was the use of structured focus groups with the adolescents and their parents/caregivers. In addition, feedback was gathered from a custom questionnaire administered to participants in the experimental group at the conclusion of the pilot study.

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- **3.3.2. Key findings on ease of use and user satisfaction:** The pilot study report identified several key findings regarding the app's usability, highlighting both barriers and facilitators to adoption. Participants, particularly the adolescents, found the structured challenges and gamified rewards highly motivating. They also appreciated the progress tracking features, which helped them stay engaged. However, several barriers were identified. The primary challenges included the technical complexity of setting up and maintaining the smartwatch connectivity, frequent Bluetooth disconnections, and the need to manually sync data. The heavy reliance on caregivers for technical support was also noted as a potential barrier, as was the need to constantly remember to charge the smartwatch. Some users also found certain pictograms to be unclear, indicating a need for further refinement in the app's visual language. Overall, the qualitative feedback confirmed the potential of the gamified approach but underscored the critical need for a more technically robust and user-friendly design to overcome significant usability challenges.

4. Main intervention results

Based on the provided pilot study report, the document focuses on the feasibility and usability of the IDHEApp, rather than providing detailed quantitative results on the effectiveness of the intervention. The report emphasizes qualitative findings and lessons learned, which will be used to refine the intervention for a larger-scale study.

Here is a summary of the main qualitative and quantitative results and findings from the pilot study:

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4.1. Changes in physical activity and sedentary behaviour

The pilot study was designed to promote healthy lifestyles, including an increase in physical activity and a reduction in sedentary behaviour. The study's main goal was to assess if the intervention was engaging and user-friendly enough to potentially lead to these behavioural changes in a future, larger study.

A statistically significant between-group difference was found for the daily step count, with the experimental group increasing by 2,233 steps/day more than the control group. Moderate, though non-significant, positive trends were observed for light physical activity and standing time. Importantly, no differential effects were found between participants with Down syndrome and those with other forms of ID.

4.2. Impact on sleep patterns and quality of life

The findings from our study on the impact of the intervention on quality of life suggest that the program did not have a substantial effect. After accounting for baseline differences between the groups, the statistical analysis revealed no significant changes in the post-intervention scores across any of the measured dimensions: Social Interaction, Positive Emotions, Negative Emotions, Physical Health, Leisure and the Outdoors, or Independence.

The data indicates that while some participants showed a degree of improvement, this was not consistently linked to their participation in the experimental group. In fact, the average changes were so small that they could be considered negligible and likely due to chance. Consequently, the intervention does not appear to have been a key driver in enhancing the participants' self-reported quality of life. This result highlights the complexity of influencing such a multifaceted construct with this particular type of programme.

In terms of sleep quality, both the experimental and control groups began the program with very similar baseline scores on the Pittsburgh Sleep Quality Index

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(PSQI), indicating that participants in both groups experienced comparable levels of sleep disturbance at the outset. After the intervention, a slight improvement was observed in both groups, reflected in a modest reduction in their PSQI scores. This suggests that, on average, participants reported marginally better sleep quality than before the programme began. However, when comparing the magnitude of change between the experimental and control groups, no meaningful differences emerged. In practical terms, this means that while some participants may have benefited individually, perhaps due to increased awareness of healthy routines or indirect effects of participating in the study, the intervention itself did not produce a noticeable advantage over the control condition in improving overall sleep quality.

These findings point to the complexity of influencing sleep patterns through short-term interventions, particularly in populations where multiple factors (e.g., lifestyle, daily structure, and underlying health conditions) can impact rest. They also suggest that any improvements in sleep may require targeted strategies, longer follow-up periods, or more specific components directly addressing sleep hygiene.

4.3. Effects on Nutrition

The IDHEApp was designed to encourage healthy eating habits. The intervention produced a clear and meaningful improvement in the dietary patterns of the participants in the experimental group compared to those in the control group. In particular, there was a marked increase in the regular consumption of vegetables and fruits. Participants in the intervention group not only incorporated these foods into their meals more frequently throughout the week, but also increased the number of daily servings, suggesting that the change went beyond occasional choices and reflected a genuine shift in eating habits.

These changes were not observed for all dietary variables. Water intake and the consumption of soft drinks and juices remained relatively stable across both groups, indicating that the intervention's influence was more pronounced in food choices than in beverage consumption. This pattern suggests that future efforts could explore additional strategies to encourage healthier hydration habits.

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When exploring the results by gender, interesting differences emerged. Male participants tended to show a greater increase in the daily portions of vegetables and fruits, while female participants more often increased the number of days per week in which they consumed fruits and, in some cases, processed meats. These nuances highlight the importance of considering gender-specific approaches when designing interventions, as the same strategy may influence men and women in different ways.

Taken together, the findings point to the effectiveness of the programme in promoting healthier dietary behaviours, particularly in relation to fruit and vegetable consumption, and provide valuable insight into how these improvements may vary depending on participant characteristics. This reinforces the idea that well-designed, targeted interventions can play a crucial role in fostering long-term, sustainable changes in nutrition among diverse populations.

4.4. Subgroup Analysis

While the quantitative analysis did not reveal any statistically significant differences between the Down syndrome and other intellectual disability subgroups, qualitative feedback from the participants highlighted notable distinctions in their interaction with the application. Adolescents with Down syndrome showed a positive response to the app's structured challenges and the use of pictograms. In contrast, participants on the Autism Spectrum Disorder (ASD) subgroup expressed a clear preference for a more minimalist design with fewer visual distractions. Their reactions to the pictograms were mixed; some were found to be helpful, while others were perceived as overly detailed or complex. These qualitative differences, which were not captured by the quantitative data, may be attributable to the younger age of some participants or the specific limitations associated with their conditions, suggesting that future interventions should consider a more tailored approach to cater to the diverse needs within the intellectual disability population.

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5. Conclusions and Future Directions

5.1. Key Conclusions

The IDHEApp pilot study demonstrated that it is both feasible and promising to use a gamified mHealth intervention to promote healthy lifestyles among young people with ID. The user-centered design, which incorporated feedback from adolescents, caregivers, and educators, was a critical factor in the development of a tailored and engaging application. The qualitative findings from the focus groups confirmed that the gamified challenges and progress-tracking features were motivating for participants. Crucially, the pilot revealed significant insights into the practical barriers to implementation, such as technical issues with device connectivity, the need for a simplified user interface, and the essential role of caregiver support. The project successfully laid the groundwork for a larger-scale study by proving the viability of this innovative approach and identifying key areas for improvement.

5.2. Limitations of the Pilot Project

As a pilot study, the project faced several limitations. The small sample size and limited duration of the intervention (8 weeks) mean that the findings are primarily focused on feasibility and usability, and thus, the effectiveness of the intervention could not be conclusively determined. The reliance on caregiver support for technical aspects of the app and data collection also highlights a potential constraint on the scalability of the intervention. Furthermore, the technical challenges, such as frequent Bluetooth disconnections, were a significant limitation that could have impacted user engagement and the reliability of the collected data.

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5.3. Implications for Practice and Policy

The results of this pilot study have important implications for both clinical practice and policy. The positive reception of the gamified mHealth approach suggests that technology can be a valuable tool for promoting healthy behaviours in individuals with ID, offering a more scalable and accessible alternative to traditional face-to-face methods. The findings underscore the importance of designing interventions that are not only technologically sound but also deeply integrated with a user-centred design and a strong support system from caregivers. For policymakers, the success of this model indicates that funding and resources should be directed toward developing and evaluating similar, inclusive digital health solutions.

5.4. Next Steps for Research

The findings of this pilot study provide a clear roadmap for future research. The next steps should include:

- **Conducting a larger, fully-powered randomised controlled trial (RCT)** to rigorously assess the effectiveness of the IDHEApp in producing statistically significant and clinically meaningful changes in physical activity, sedentary behaviour, sleep, and quality of life.
- **Improving the technological robustness of the application** to address the connectivity issues identified in the pilot.
- **Refining the user interface** based on feedback from the focus groups, particularly by simplifying pictograms and streamlining navigation to reduce the burden on caregivers and promote greater user autonomy.
- **Including a long-term follow-up component** in a future study to determine if the behavioural changes achieved during the intervention are sustained over time.
- **Expanding the subgroup analysis** to gain a deeper understanding of how the intervention's effectiveness may vary across different intellectual disabilities and support needs.

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