IDHEApp

Using technologies to promote healthy lifestyles in adolescents with intellectual disabilities

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Erasmus + Sport Cooperation Partnerships

WP2 – Co-defining the IDHEApp model

D2.2 – Pilot study report

PSA CR

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1. Contents

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2. Abbreviations and Acronyms

IDD	Intellectual and Developmental Disabilities
ADS	Adolescents with Down Syndrome
ASD	Autism Spectrum Disorder
WHO	World Health Organization
HEPA	Health-enhancing physical activity
DS	Down syndrome

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1. Summary

1.1. Introduction

IDHEApp is a project funded by the Erasmus+ program dedicated to promoting healthy lifestyles among adolescents with Intellectual and Developmental Disabilities (IDD) through digital technology. This project focuses on integrating a mobile application (app) with a smartwatch to encourage physical activity, healthy eating habits, and a reduction in sedentary behaviour.

As part of the development process in the WP2, a pilot study was conducted to assess the feasibility, usability, and engagement levels of the intervention. The study provided essential insights into the experiences of adolescents with IDD while using the IDHEApp and highlighted areas for improvement before scaling the project.

1.2. Method

The data collection techniques combined a mixed-methods approach, combining qualitative and quantitative methods. Regarding to qualitative data, different focus groups involving adolescents, caregivers, and educators were organized to gather feedback on usability and accessibility. Also, the participants were also given the opportunity to use the mobile app alongside a Google Charge 6 smartwatch to track their physical activity and complete assigned challenges.

A total of sixty participants were recruited across Croatia and Italy, with forty participants engaged through the *Parasports Association of the City of Rijeka*

FIGURE 1 PARTICIPANTS OF PARASPORTS ASSOCIATION OF THE CITY OF RIJEKA

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and an additional twenty through the *Associazione Italiana Persone Down* (AIPD). The intervention focused on adolescents aged between twelve and thirty-six years old with mild to moderate intellectual disabilities, ensuring that they could independently interact with the technology.

1.3. Main findings

The main findings from this pilot study revealed a strong interest of the people with IDD in the gamified elements of the app, such as badges, rewards, and progress tracking. The Adolescents with Down Syndrome (ADS) responded positively to structured challenges, while those on the Autism Spectrum Disorder (ASD) displayed a preference for a more minimalist design with fewer visual distractions. Despite these encouraging results, several challenges emerged:

A. Install app and connection with smartwatch: The process of installing and synchronizing both the Fitbit and IDHEApp app was notably complex, leading to difficulties in setup and maintenance. Several participants frequently experienced Bluetooth disconnections, which caused interruptions in activity tracking. Additionally, many participants forgot to charge their smartwatches regularly, which further impacted data consistency. As a result, most participants relied heavily on caregivers or professionals for technical support, highlighting *the need for a more intuitive and user-friendly approach* when first starting to the profile in both apps.

B. Pictograms use: The use of pictograms within the app received mixed feedback. While some participants found the visual representations helpful, others, particularly those on the ASD, struggled with interpreting icons that contained excessive details or complex colours. The walking and hydration reminders were well understood, although they could benefit from additional visual reinforcements such as motion indicators or numerical representations.

The screen break reminder, however, was less effective as some users misinterpreted the pictogram as a pause button rather than an indication to take a break from screen time. To enhance clarity, *it was suggested that certain icons include additional elements such as a crossed-out screen or a clock symbol to reinforce their meaning.*

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Based on these findings, several **key recommendations** were proposed to enhance the effectiveness and usability of the IDHEApp intervention:

1. Simplifying the technological integration by enabling direct smartwatch-app synchronization without requiring a third-party application would significantly reduce setup complexity. An automated reconnection feature would help minimize data loss due to disconnections, while pre-configured devices could streamline the onboarding process for new users.
2. To improve the enhancements in engagement strategies were also suggested, including customizable challenge levels, social and group-based challenges to boost motivation, and an expanded reward system with clearer milestone achievements.
3. Make improvements in data collection methods, such as automated activity logging, manual data input options for caregivers, and real-time progress tracking, were also recommended to enhance accuracy and adherence.

1.4. Conclusion

In conclusion, the pilot study confirmed the potential of the IDHEApp to positively impact adolescents with IDD by encouraging healthier lifestyle habits. However, several refinements, mentioned before, are needed to improve accessibility, engagement, and technological efficiency. Addressing these issues ensures that the app is more user-friendly and sustainable, ultimately making digital health interventions more inclusive for individuals with intellectual disabilities. By implementing the proposed changes, the next phase of the IDHEApp aims to provide a seamless and impactful experience for its users, reinforcing the role of technology in supporting health-enhancing behaviours for this population.

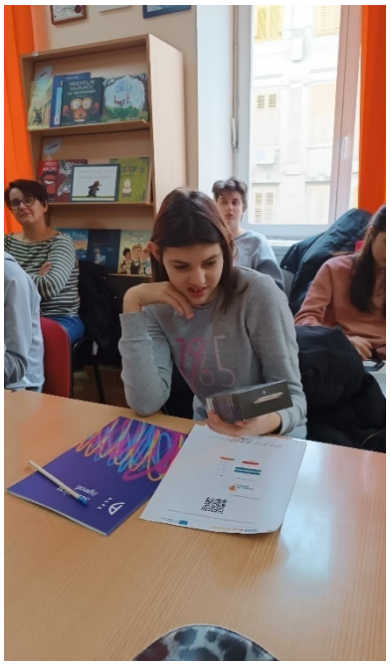

FIGURE 2 PARTICIPANT PSA CR

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2. Introduction

The adolescents with IDD face significant challenges in maintaining a healthy lifestyle due to various barriers, including limited access to structured physical activities, a lack of targeted nutritional education, and difficulties in adopting healthy behaviours. Research indicates that individuals with IDD have significantly lower levels of physical activity, and a higher prevalence of sedentary behaviour compared to their peers without disabilities.

According to the World Health Organization (WHO, 2020)[1], *physical inactivity is one of the leading causes of non-communicable diseases, and the impact is even more pronounced in individuals with disabilities, leading to increased risks of obesity, cardiovascular diseases, and metabolic disorders*.

For this reason, IDHEApp is an innovative initiative aimed at addressing these issues by leveraging digital technology. Specifically, this project seeks to promote healthy lifestyles among adolescents with IDD through the development of a gamified smartphone app and an integrated web platform. This initiative is grounded in the understanding that digital tools, when properly adapted, can serve as powerful catalysts for behaviour change, promoting physical activity and healthy eating habits in an engaging and accessible manner.

Previous interventions targeting individuals with IDD had primarily focused on specific subgroups, such as ADS or ASD, without fully accounting for the diversity of needs within the broader IDD population. IDHEApp seeks to bridge this gap by designing an adaptable intervention model that can be tailored to various cognitive and physical abilities. The project's methodology is based on a participatory approach of different agents that involve these people, ensuring that adolescents with IDD, their families, caregivers, and educators are actively involved in the co-design and testing phases.

[1] World Health Organization. (2020). *Physical Activity*. Available at https://www.who.int/news-room/fact-sheets/detail/physical-activity

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A critical component of the IDHEApp is the pilot study, which aims to evaluate the feasibility and usability of the intervention in real-world settings. This pilot study is essential for assessing the accessibility of the smartphone app, the effectiveness of its gamification elements, and the overall engagement of adolescents with IDD in digital health interventions. Additionally, the findings from the pilot study informed further refinements to the app and contribute to the development of evidence-based guidelines for promoting physical activity and healthy eating among individuals with IDD.

The broader significance of IDHEApp extends beyond the immediate user base. The project aligns with key European Union priorities on digital transformation, inclusion, and public health. It supports the EU's strategic objectives related to health-enhancing physical activity (HEPA), as outlined in initiatives such as the Tartu Call for a Healthy Lifestyle. Furthermore, the IDHEApp model has the potential to be scaled and adapted across various settings, offering a replicable framework for other populations with special needs.

By integrating technological solutions with community-driven strategies, IDHEApp creates a sustainable and impactful intervention that empowers adolescents with IDD to lead healthier and more active lives. The pilot study remarks a crucial step in this journey, providing the empirical foundation needed to refine and implement the intervention on a larger scale.

Conducting a pilot study within the IDHEApp is a crucial step to ensure the feasibility, effectiveness, and user acceptance of the proposed intervention before scaling up to a broader implementation. Given the unique needs of adolescents with IDD, it is essential to test the usability and functionality of the smartphone app and web platform in real-world conditions before deploying it on a larger scale.

One of the key reasons for conducting this pilot study is the high variability in cognitive and physical abilities within the IDD population. Unlike interventions designed for neurotypical individuals, digital health tools for adolescents with IDD must account for a wide range of literacy levels, motor skills, and comprehension abilities. Without thorough testing, there is a significant risk that the intervention may not be fully accessible or effective for all intended users.

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Furthermore, the technology acceptance and adoption are critical factors in the success of digital health interventions. Research indicates that individuals with IDD and their caregivers may face challenges in adopting and consistently using technology-based tools due to a lack of familiarity, accessibility barriers, and difficulties in motivation. The pilot study allowed researchers to assess whether the gamification elements, user interface, and content delivery methods are engaging and easy to use for this specific population.

Another important consideration is the suitability of intervention content. While the app is designed to promote physical activity and healthy eating habits, it is necessary to test whether the proposed challenges, recommendations, and feedback mechanisms were appropriate and effective. The pilot study helped to determine whether the behavioural strategies embedded in the app resonate with the users and lead to measurable improvements in physical activity levels and dietary habits.

Additionally, the pilot study serves as an opportunity to identify barriers and facilitators in the implementation process. Potential challenges may include technological limitations, accessibility issues, and caregiver involvement. Understanding these barriers early in the process enabled project partners to make necessary adjustments, ensuring a more seamless and effective rollout in the full-scale implementation.

From a research perspective, the pilot study established a baseline for evaluation, providing critical data on user interaction patterns, adherence levels, and preliminary health outcomes. These insights informed the development of an evidence-based evaluation framework for assessing the impact of the intervention in the later stages of the project.

Finally, conducting a pilot study aligns with best practices in Erasmus+ project management and evaluation. By systematically testing and refining the intervention, IDHEApp ensures that its outputs are robust, scalable, and aligned with EU priorities for digital transformation, inclusion, and health promotion.

In summary, the pilot study was an essential step in IDHEApp serving as a bridge between theoretical development and practical implementation. By testing the feasibility, usability, and effectiveness of the digital intervention, the project team could make informed refinements that maximize the impact of IDHEApp on adolescents with IDD, their families, and the broader community.

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Specific objectives and research questions

The pilot study aims to achieve the following specific objectives:

a) **Assess the feasibility** of using a gamified smartphone app and web platform to promote physical activity and healthy eating among adolescents with IDD.

b) **Evaluate the usability and accessibility** of the digital intervention to ensure it meets the needs of adolescents with varying cognitive and physical abilities.

c) **Measure user engagement and adherence** to determine whether the gamification elements effectively motivate sustained behaviour change.

d) **Identify barriers and facilitators** influencing the adoption of the intervention, including technological, environmental, and personal factors.

e) **Analyse preliminary health outcomes** related to physical activity levels, dietary habits, and sedentary behaviour to establish baseline data for further evaluation.

To achieve these objectives, the pilot study addresses the following key research questions:

1. How feasible is it to implement the IDHEApp intervention in real-world settings with adolescents with IDD?
2. How do adolescents with IDD and their caregivers perceive the usability and accessibility of the smartphone app and web platform?
3. What are the levels of user engagement and adherence to the gamified health challenges?
4. What barriers and facilitators influence the adoption and sustained use of the IDHEApp intervention?
5. What preliminary changes in physical activity and dietary habits are observed among participants after using the intervention?

By addressing these objectives and research questions, the pilot study provides valuable insights into the effectiveness and scalability of the IDHEApp intervention, ensuring that it can be successfully implemented on a larger scale.

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FIGURE 3 PSA CR PARTICIPANTS

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3. Methodology

3.1. Study design

The pilot study, as we commented before, employed a mixed-methods approach, integrating both qualitative and quantitative research techniques to comprehensively evaluate the feasibility and usability of the IDHEApp intervention. The study design included elements of observational research (monitoring user interaction with the app), experimental research (testing the app's effectiveness in promoting behavioural changes), and qualitative focus group discussions (gathering insights from users and caregivers).

3.2. Focus groups

The study included specific focus groups as follows: two focus group were in Rijeka (Croatia), and two focus group were conducted in Rome (Italy) as well. These focus groups provided valuable insights into the needs, preferences, and challenges faced by adolescents with IDD and their caregivers.

3.2.1 Parasports Association of the City of Rijeka (Croatia)

For the focus group we collected a participant overview of understanding the app and its usability. To ensure diverse perspectives on the usability of the IDHEApp, we selected 10 participants with varied intellectual disabilities and divided them into two focus groups of five.

Phase 1. Initial focus group (pre-app development phase)

The first focus group was conducted in partnership with Udruga za sindrom Down – Rijeka 21 (rijeka-21.hr). This session included ten participants mothers and their children with DS, caregivers and project team, providing a direct opportunity to present the IDHEApp app and gather feedback. Participants discussed their experiences with digital tools, challenges in maintaining healthy lifestyles, and their expectations from

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the intervention. Their input was crucial in refining the app's user interface and accessibility features to better align with the needs of individuals with Down syndrome.

The first focus group took place during the initial phase when the app was still under development. At this stage, participants were introduced to pictograms representing the challenges that would later be incorporated into the final version of the app. A presentation was conducted to familiarize participants and their parents with the overall concept of IDHEApp and the intended use of pictograms to guide user interaction.

At this stage, the app was still under development. Instead of a functional prototype, participants were presented with pictograms and a visual presentation to introduce them to the app's planned features and intended use. The focus group discussion aimed to determine whether participants could understand the instructions conveyed through pictograms and whether the app's design would be intuitive for users with IDD. Caregivers and adolescents were asked whether the pictograms and explanations were clear, whether they found the interface user-friendly, and whether they anticipated any challenges in using the app.

FIGURE 4 PSA CR PARTICIPANTS

Phase 2. Second focus group (technology introduction phase)

In the second phase, a follow-up focus group was held to present the fully developed app, alongside smartwatches, and demonstrate how to navigate and use the system effectively. The second focus group with five participants took place in collaboration with the Centar za odgoj i obrazovanje Rijeka (centar-odgojiobrazovanje-ri.skole.hr).

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This session focused on participants with diverse intellectual disabilities, ensuring a broader perspective on usability and engagement. Discussions covered potential barriers to using the app, the importance of caregiver involvement, and the need for clear, simple instructions tailored to various cognitive abilities.

This phase allowed participants to experience the technology firsthand, providing valuable feedback on both the app's usability and the integration of smartwatches in daily activities.

The participants were introduced to the Google Charge 6 smartwatch, which be integrated with the app for activity tracking. The group was shown how the smartwatch functions, how it tracks physical activity, and how it interacts with the IDHEApp system. Participants provided feedback on the usability of the smartwatch and whether they believed it would be beneficial for tracking daily activities.

The qualitative feedback collected from these discussions helped identify potential usability barriers and informed modifications to enhance the accessibility of the app for users with different cognitive abilities. Additionally, observations were made regarding how participants interacted with the smartwatch, providing valuable behavioural insights into engagement and comprehension levels.

The combination of observational data, experimental usability testing, and qualitative focus group discussions ensured that the pilot study gathered well-rounded insights into the app's effectiveness and user acceptance. These findings guided future refinements to maximize the impact of IDHEApp in promoting healthier lifestyle habits among adolescents with IDD.

The participants in the Croatian focus groups were:

Group 1

1. **001**– Mild intellectual disability
2. **002** – Autism spectrum disorder
3. **003** – Down syndrome
4. **004** – Mild intellectual disability
5. **005** – Autism spectrum disorder

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Group 2

6. **006** – Down syndrome
7. **007** – Mild intellectual disability
8. **008**– Autism spectrum disorder
9. **009**– Mild intellectual disability
10. **010** – Down syndrome

Both focus groups provided essential feedback that informed modifications to the IDHEApp platform, ensuring it is inclusive, engaging, and effective in promoting healthy lifestyle habits among adolescents with IDD.

3.2.2 Associazione Italiana Persone Down – AIPD (Italy)

In Italy, at the beginning of September 2024, a first focus group on the "usability" of the app was held, with only 3 professionals taking part. The goal of this additional focus was to anticipate any technical or content issues with the app. The second focus group took place in Rome in December 2024, the 17th, from 10:00 to 12:00 with the following participants:

- 4 persons with Down syndrome (Ds)
- One local professional from AIPD local branch located in Rome,
- 2 professionals from AIPD national headquarter.

All participants used their own smartphones for the testing session.

FIGURE 5 PARTICIPANTS OF AIPD

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3.3. Trial groups: experimental and control groups

3.3.1 Parasports Association of the City of Rijeka (Croatia)

The selection of participants for the pilot study was based on predefined criteria outlined in the project app. Eligible participants had to be adolescents aged between 12 and 36 years old, diagnosed with IDD according to DSM-5 diagnostic criteria. However, an additional requirement was that participants must have mild to moderate intellectual disabilities to ensure they could actively engage with the intervention. Severe cognitive impairments that would prevent the independent use of a smartphone phone, smartwatch, and app led to exclusion from the study.

The recruitment of the participants for the study presented a significant challenge, particularly due to the digital accessibility barriers faced by many adolescents with IDD. A considerable number of potential participants did not have a personal email address or the ability to manage digital devices independently. This limitation required a careful selection process, where priority was given to individuals with sufficient cognitive and motor skills to operate a smartphone and wearable device with some level of autonomy.

The recruitment strategy involved collaboration with local organizations and educational institutions that support adolescents with IDD. Parents and caregivers played a crucial role in the selection process, ensuring that participants met the inclusion criteria and had the necessary support for using the IDHEApp intervention. Despite initial recruitment difficulties, the focus on mild to moderate intellectual disabilities ensured that participants could meaningfully engage with the app, respond to challenges, and benefit from the intervention.

The *Parasports Association of the City of Rijeka* recruited a total of **40 participants**, of which 20 were assigned to the experimental group (using the smartwatch and IDHEApp) and 20 formed the control group (using the smart watch but not using the app).

3.3.2 Associazione Italiana Persone Down - AIPD (Italy)

It has recruited **20 participants**, splitting them evenly between the experimental and control groups. The participants were recruited through a specific call to the 54 AIPD local branches nationwide. The selection criteria for participants with DS were:

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- Age between 16 and 36 years
- High motivation
- Own a smartwatch
- Willing to wear the smartwatch for the entire duration of the study
- Able to read and understand simple text.
- Local professional requirements: previous knowledge of candidates with DS.

Results of AIPD recruitment: 5 different groups made of four persons with Ds and one local professional from AIPD local branches of Roma, Anzio, Brindisi, Reggio Calabria and Lecce.

Initially the smartwatches have been given to the five local professionals who have been trained how to manage the watches, apps and pilot in general, as they play a key role as local contact point with people with DS and their families.

Then, each group had a workshop with the local professional (January 2025) where the app was explained, the watches were delivered, profiles were created, and guidance was given on the importance of adopting a healthy lifestyle. Each participant received an easy-to-understand publication on healthy living.

This approach enabled the pilot study to be conducted effectively while maintaining the accessibility and usability goals of the IDHEApp.

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4. Results

The focus groups provided valuable insights into the usability, accessibility, and overall engagement of adolescents with intellectual disabilities in the IDHEApp intervention. The participants with IDD, representing a diverse group of individuals with mild ID, DS, and ASD, shared their experiences with the smartphone app and smartwatch integration, revealing both positive aspects and areas that need refinement. The steps followed in the focus groups were below.

A. Preliminary steps: The group attempted to download the necessary applications required to start the testing process. Specifically, before installing the IDHEApp application, it was necessary to download the Fitbit app first, as the provided smartwatches are connected to it.

B. Technical challenges: The first issue encountered was the inability to download the Fitbit application on one participant's phone due to the device being too outdated to support the app. For the remaining three participants, the process took over an hour due to several factors:

- The smartwatches had to remain connected to the charger, which was a necessary step,
- The mobile phones required software updates, which significantly extended the setup time.

Once the Fitbit application was successfully installed, downloading the IDHEApp app was straightforward.

C. Introduction to the IDHEAPP and initial app testing: Following the installation, we introduced the project to the participants, explaining the division into an experimental group and a support group. Regarding the app's usability participants with DS were asked:

- If they understood the purpose of the app,
- Whether they found it easy to use,

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- To locate and open the app on their smartphones,
- To explore the challenges section and determine whether the instructions were clear.

D. Preliminary findings: Participants generally understood the overall functionality of the app and the project's objectives.

Many participants found the app engaging and easy to navigate, particularly enjoying the gamification elements such as badges and progress tracking. Adolescents with DS responded particularly well to the visual elements and structured challenges, whereas those on the autism spectrum often preferred a simpler, more minimalist design with less visual clutter and fewer colour distractions. Some participants expressed confusion regarding challenge completion, indicating a need for clearer progress tracking and visual confirmation when a task is successfully completed.

A recurring challenge was technical complexity the requirement to install and sync both the Fitbit app and IDHEApp was a significant barrier. Many participants struggled with keeping their smartwatch connected, frequently encountering Bluetooth disconnections that disrupted data tracking. Additionally, several participants forgot to charge their smartwatch regularly, resulting in incomplete activity logs. In this situation, the caregivers support played a crucial role in ensuring participants remained engaged and able to use the app correctly, highlighting the need for caregiver training and involvement in the intervention.

Regarding pictogram clarity, participants provided mixed feedback. While some found the visual instructions intuitive, others, particularly those with ASD, found certain icons too complex or visually overwhelming. For example, the walking challenge pictogram was generally understood but could be improved by adding motion indicators (such as arrows or footsteps) to reinforce movement. Similarly, the hydration reminder was effective but could benefit from a larger water icon and a number indicating how much water to drink. The screen break reminder was one of the least understood icons, with some participants mistaking it for a pause button rather than a break suggestion. Adjustments, such as adding a crossed-out screen or a clock symbol, were suggested to improve comprehension.

The focus group findings underscore the importance of simplifying the app interface, streamlining the smartwatch setup process, and enhancing visual communication.

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Participants expressed a strong interest in customizable challenge options, allowing them to select activities they feel comfortable with rather than following preset challenges. Additionally, voice instructions and sound-based reminders were suggested as effective alternatives for users who struggle with text-based guidance.

In conclusion, the results of the focus groups highlight both the potential and challenges of implementing IDHEApp for adolescents with IDD. While the intervention successfully engaged participants in healthy behaviours, issues related to technology usability, pictogram clarity, and sustained engagement must be addressed in the next phase of development. Implementing simplified user interfaces, automated connectivity fixes, and clearer visual cues greatly improved the accessibility and effectiveness of IDHEApp, making it a more user-friendly and impactful tool for promoting health-enhancing behaviours in adolescents with IDD.

Summary of focus group responses

The session aimed to evaluate the usability, design, and engagement factors of IDHEApp and its smartwatch integration. Below are the key insights from the discussion. The questions about the app are the following:

General questions

Question 1: Can you tell us what you think this app is for?

- 001 (Mild IDD): "It tells me what to do every day".
- 005 (Autism): "It's a game! You win points when you move".
- 003 (Down syndrome): "It helps me stay healthy and drink water".

Question 2: How do you feel when using the app?

- 004 (Mild IDD): "It's okay, but sometimes I don't understand what to press".
- 006 (Down syndrome): "I like it! But I forget to check my tasks".

Question 3: Follow-up: Is it fun, confusing, or easy?

- 009 (Mild IDD): "I like it".
- 002 (Autism): "It is fun but has too many colours. I like simple screens".

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Understanding the challenges

Question 4: When you see this challenge (e.g., "Walk for 15 minutes"), what does it ask you to do?

- 008 (Down syndrome): "It tells me to walk, so I go outside with my mom".
- 002 (Autism): "I don't like that I can't change the challenge when I don't want to do it".

Question 5: Follow-up: Is it clear what you need to do?

- 006 (Mild IDD): "Yes, I understand, but sometimes I don't know when I finished".

Question 6: Do you understand the badges (e.g., "Hydration Hero") and how to earn them?

- 002 (Autism): "Yes, but I don't care about the badges".
- 008 (Autism): "I like the Step Explorer one. It makes me walk more".

Evaluating the messages and notifications

Question 7: When the app sends you a message (like "Drink a glass of water"), do you understand it?

- 010 (Down syndrome): "Yes, but I don't always do it."
- 001 (Mild IDD): "It needs to remind me more!".

Question 8: Follow-up: Is there a message that you didn't understand?

- 005 (Autism): "'Be mindful of your movements' I don't know what this means".

Question 9: How do you feel about the reminders?

- 003 (Down syndrome): "Good, but I don't like too many messages".
- 004 (Mild IDD): "I need more sounds, so I don't forget".

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Exploring challenges and barriers

Question 10: What might make it hard for you to do a challenge?

- 009 (Mild IDD): "I forget about them if I don't check my phone".
- 006 (Down syndrome): "I need someone to help me start".

Question 11: Follow-up: What would make the challenges easier?

- 005 (Autism): "Let me pick my own challenge for the day".
- 003 (Down syndrome): "I want more easy challenges first".

Suggestions for improvement

Question 12: What would make the app better for you?

- 008 (Autism): "Less buttons. I don't like too many things on the screen".
- 001 (Mild IDD): "A voice talking to me instead of reading".

Question 13: Do you need help from someone to use the app?

- 007 (Mild IDD): "Yes, I ask my mom a lot".
- 003 (Down syndrome): "I use it with my sister".

Question 14: Follow-up: How can we make it easier for you to use the app on your own?

- 006 (Down syndrome): "Maybe if it showed me what to do in video".
- 005 (Autism): "I want to turn off the notification".

During the focus group sessions, participants were shown the pictograms used in the IDHEApp app to evaluate their clarity, effectiveness, and accessibility for adolescents with intellectual disabilities, Down syndrome, and autism spectrum disorder (ASD). The goal was to determine whether the pictograms clearly communicated daily health challenges and actions or if adjustments were needed.

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Overall impressions

The most important impressions identified are the following:

- Participants with DS found the pictograms engaging and visually appealing but required verbal reinforcement to fully understand some of the symbols.
- Participants with mild intellectual disabilities understood most pictograms but struggled with more abstract representations.
- Participants on the ASD had mixed reactions—some preferred simplistic and minimal designs, while others found certain symbols overwhelming due to excessive colours or shapes.

Pictures 1. and 2. showcase the initial draft of the visuals designed for the IDHEApp, representing key elements related to physical activity, nutrition, and challenges. These graphics served as the foundation for the app's interface, with planned modifications based on user feedback before final implementation. This was the first opportunity for participants to engage with the visual concept of IDHEApp, providing initial impressions and insights into how they interpreted the challenges and their associated tasks.

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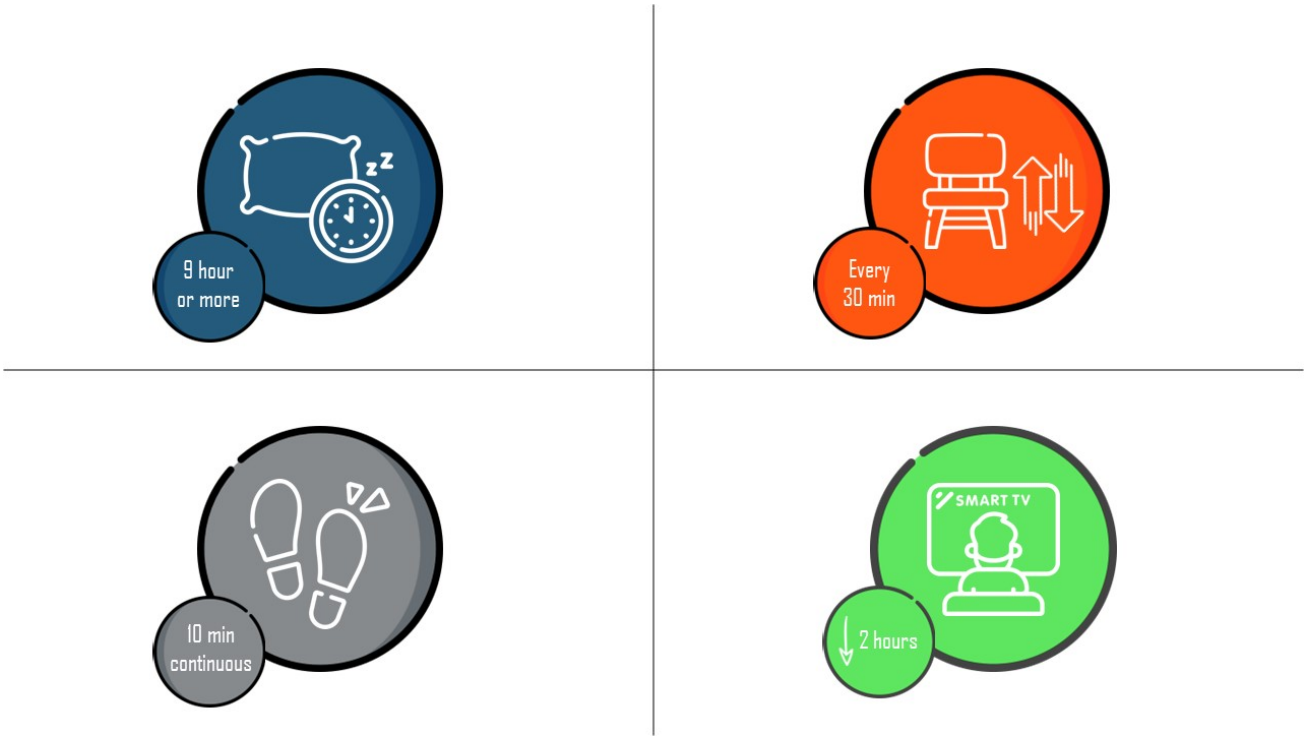
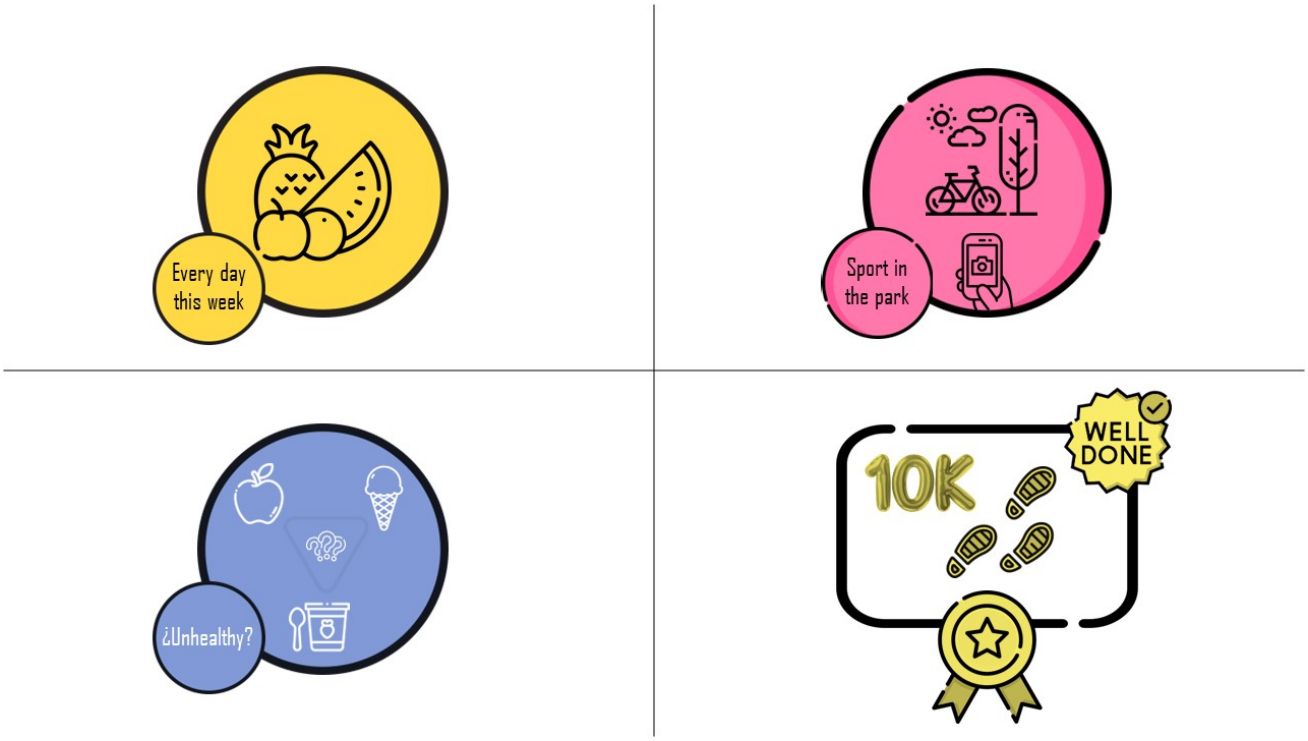
Picture 1. Design by CEIPES



Picture 2. Design by CEIPES



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Key feedback from participants

1. ***Pictograms representing physical activities:*** About the "Walking challenge" (15-minute walk) the participants commented:

    - 008 (Autism): "It looks okay, but I don't like too many things in one picture. Just a simple shoe would be better".
    - 006 (Down Syndrome): "I see a person walking, so I know what to do! But my friend didn't understand if it was about running or walking".
    - 004 (Mild IDD): "It's clear but maybe add arrows to show movement".

    Recommendation: Use simpler icons with fewer details and add motion lines or arrows to reinforce the action.

2. ***Pictograms representing nutrition challenges:*** For example, about "hydration reminder" (Drink water) the comments were:

    - 003 (Down Syndrome): "I like the picture, but I forgot if I should drink one glass or more".
    - 002 (Autism): "It's too small. Maybe a bigger water bottle?".
    - 005 (Autism): "I like it, but I don't like the blue colour in the background. It looks too much".

    Recommendation: Enlarge the water bottle and add a number (e.g., "1 glass") for better clarity.

    Other example was related with "fruit consumption challenge" (Eat a piece of fruit) where the participants though:

    - (Mild IDD): "It is nice, but maybe show different fruits instead of just an apple".
    - 003 (Down Syndrome): "I knew it was about fruit, but my friend thought it was a game".
    - 002(Autism): "It's okay, but I like real photos better".

    Recommendation: Include multiple fruit types (banana, grapes, orange) and consider using real images instead of cartoon icons.

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3. ***Pictograms representing sedentary behaviour reduction:*** For example, “Screen break reminder” (Take a break from phone/TV) the participants commented:

    - (Mild IDD): "I didn’t understand what this was at first".
    - 001 (Mild IDD): "It needs a red ‘X’ to show ‘stop using the phone’".
    - 010 (Down Syndrome): "I forgot what it meant when I saw it later".

    Recommendation: Add clearer visual cues such as a crossed-out screen or a clock symbol indicating a break.

4. ***Reward system and badges:*** The example was "Hydration hero" badge (For completing water challenges):

    - 005 (Autism): "I don’t know why I got this badge. Maybe it should have water drops".
    - 002 (Autism): "The picture looks like a sticker. I don't understand what it means".
    - 006 (Down Syndrome): "It makes me happy, but I want more colours".

    Recommendation: Make badges more meaningful by including symbols that relate to achievements (e.g., a water glass for hydration badges, a running shoe for step challenges).

The focus groups confirmed that IDHEApp has great potential to engage adolescents with IDD in healthier lifestyle habits, but usability and accessibility refinements are needed. Based on the insights gathered, the next iteration of the app should focus on:

- Simplifying the interface for autistic users.
- Improving task clarity with pictures and audio guidance.
- Enhancing smartwatch functionality to ensure smooth data tracking.
- Providing customizable challenges to boost engagement.

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This feedback obtained from the focus groups and pilot study was used to refine IDHEApp before wider implementation, ensuring it is more accessible, engaging, and effective for adolescents with intellectual disabilities.

Key takeaways from the focus group from Croatia

1. ***Understanding and usability***: Most participants understood the app's purpose but needed support from caregivers. ASD users preferred a simpler interface, fewer colours, and customizable settings, while participants with DS responded well to visual cues and gamification.
2. ***Challenges and engagement***: Some forgot to check the app daily, indicating a need for more engaging notifications. The most of participants enjoyed badges but wanted more personalized challenge options. Other important aspect is that the reminders needed to be clearer, and audio prompts could help with engagement.
3. ***Technical and usability barriers***: Many relied on caregivers to set up the app and smartwatch. Syncing issues with the smartwatch led to frustration, and some struggled with understanding task completion.
4. ***Suggested improvements:*** (i) Customizable challenges so users can pick what they feel comfortable with, (ii) Voice instructions instead of reading; (iii) Simplified interface with fewer distractions, and (iv) More engaging audio or visual prompts to guide users through tasks.

Key takeaways from the focus group from Italy

1. ***Registration process and questionnaires***: The current registration process required the completion of questionnaires, making it necessary for a referring adult (parent or caregiver) to handle the procedure rather than the person with DS. Also, at the end of the questionnaires, users are given the option to "see your score," despite the fact that these are not quizzes. This wording may be misleading and should be reconsidered.

   Recommendation: A clarification is needed on whether this is the intended user flow.

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2. ***Post-questionnaire navigation:*** Upon completing a questionnaire, the next steps were unclear. The app did not automatically return to the home screen, direct the user to the next questionnaire, or provide clear instructions on how to proceed.

   Recommendation: Given that profiling will be tested by professionals, ensuring clarity in navigation is crucial to usability.

3. ***Login and password recovery:*** Participants were being logged out automatically without having manually chosen to do so. Although, there is currently no password recovery option, which could present significant challenges for users who forget their credentials.

   Recommendation: A confirmation is needed on whether this is an expected behaviour.

4. ***Daily challenge notifications***: Despite downloading and using the app, participants had not received notifications regarding daily challenges.

   Recommendation: A verification of the notification system's functionality is required.

5. ***Challenge calendar display***: Within the app, only the challenges assigned for the current day were visible, while the calendar remains empty.

   Recommendation: A clarification is needed on whether users should have access to past or upcoming challenges.

6. ***Challenge duration and execution***: Some challenges (e.g., "Eat a different fruit every day this week") required a multi-day engagement. However, the app primarily focuses on daily challenges, raising concerns that users may forget to complete tasks requiring multiple days. If challenges are meant to be completed only on the day they appear, longer-term challenges may need restructuring to ensure user engagement.

   Recommendation: A clarification is required on whether users should upload a photo daily for these challenges. If so, clearer instructions should be provided.

7. ***Text size adjustment issue:*** The app includes an accessibility feature that allows users to increase text size (available in the "Personal Data" section). However,

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when activated, text overflows beyond the borders of the home screen, making it unreadable.

Recommendation: The interface should be adapted accordingly to support dynamic text scaling.

8. ***User interaction in physical challenges***: In certain challenges, such as "Walk continuously for 15 minutes," it is unclear whether users need to click the checkbox to confirm completion.

   Recommendation: A clearer label, such as "Mark as completed," would improve usability and avoid confusion.

9. ***Camera function in nutrition challenges:*** The camera function is not immediately intuitive, and users may not realize they need to click the camera icon to take or upload a photo.

   Recommendation: The visibility of the camera function should be improved, for instance, by enlarging the button, adding a descriptive label (e.g., "Take a photo"), or including a pop-up prompt with instructions.

10. ***Visual accessibility: colour contrast and text formatting:*** The yellow text on a white background significantly reduces readability. This issue was previously highlighted during the Rome meeting and remains a concern.

    Recommendation: A revision of the colour scheme is recommended to enhance accessibility. In the Italian version, uppercase text would be preferable for better readability. However, space constraints may pose a challenge. It is recommended to test whether capitalized text can be integrated without affecting layout and readability.

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5. Lessons learned and recommendations

The pilot study provided significant insights into the real-world challenges of implementing a digital health intervention for adolescents with intellectual disabilities. While the theoretical framework was well-structured, the practical application revealed several unforeseen difficulties that need to be addressed in future iterations of the IDHEApp intervention.

Challenges with smartwatch integration

The use of Google Charge 6 smartwatches was initially seen as a straightforward way to track participants' physical activity. However, in practice, the process proved to be highly complex and difficult for the target population. The first issue stemmed from the multi-step installation and synchronization process. Participants were required to:

- Download and install the Fitbit app, which serves as the primary interface for the smartwatch.
- Create a Fitbit account, a step that required an email address, something many participants did not have or needed assistance setting up.
- Pair the smartwatch with their smartphone phone, a process that was often interrupted due to Bluetooth disconnections.
- Install the IDHEApp app, which needed to be manually synced with Fitbit to pull activity data.

For adolescents with IDD, this process was highly technical and difficult to manage independently. Many required continuous caregiver or professionals' assistance just to maintain proper device connectivity. Additionally, frequent disconnections between the smartwatch and smartphone meant that activity tracking was inconsistent, leading to gaps in data collection.

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Participant recruitment and retention

The Parasports Association of the City of Rijeka recruited a total of 40 participants, of which 20 were assigned to the experimental group (using the smartwatch and IDHEApp) and 20 formed the control group (no smartwatch/app use). Similarly, the Italian partner, Associazione Italiana Persone Down (AIPD), recruited 20 participants, splitting them evenly between the experimental and control groups.

One major challenge during the study was the level of continuous support required by participants. Many struggled with remembering to charge their smartwatch daily, leading to instances where the device was not functional when needed. Additionally, several participants disabled Bluetooth or removed the Fitbit app from their phones, unaware that this action would prevent data synchronization. This required constant monitoring and troubleshooting by caregivers and project staff.

Lessons learned for future implementation

The main aspects to considerer for future implementations are:

A. *Streamlining device integration*: The biggest takeaway from this pilot study is the need to simplify the technological setup. A future solution could involve integrating IDHEApp directly with the smartwatch, bypassing the need for Fitbit as an intermediary.
B. *Providing step-by-step guidance*: The intervention should include visual guides, video tutorials, and interactive training sessions for both participants and caregivers to reduce confusion during setup and daily use.
C. *Implementing better automatic alerts*: Many issues, such as low battery levels and unsynchronised data, could be mitigated by automated reminders prompting users to charge their devices and reconnect Bluetooth.
D. *Enhancing caregiver involvement*: Given that many participants relied heavily on their caregivers or professionals for support, a caregiver-specific training module should be implemented to help them troubleshoot problems independently, and there should be more people involved.
E. *Simplifying the monitoring process*: The app should include an easy-to-use dashboard that allows caregivers and participants to check connectivity status and quickly resolve issues before they affect data collection.

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The pilot study underscored the importance of balancing technological innovation with practical usability. While the intervention concept remains promising, addressing these real-world challenges were critical in ensuring that IDHEApp is truly effective for its intended users. Future improvements will focus on reducing technological barriers, enhancing accessibility, and ensuring a more user-friendly experience for adolescents with IDD and their caregivers.

5.1. Proposed improvements for protocols, engagement, and data collection

Based on the challenges and insights gathered from the pilot study, several key areas for improvement have been identified to enhance the effectiveness, accessibility, and usability of the IDHEApp intervention. These improvements are categorized into three main domains: protocol optimization, user engagement strategies, and data collection enhancements.

Optimizing protocols and technological integration

One of the most significant barriers encountered in the pilot study was the complexity of the multi-step setup process, particularly the need to install both the Fitbit app and IDHEApp, sync them, and maintain device connectivity. To streamline this process, the following improvements are proposed:

- Direct smartwatch integration, developing a direct connection between IDHEApp and smartwatches without relying on a third-party app such as Fitbit, thereby simplifying the onboarding process for users.
- Automated troubleshooting mechanisms, implementing in-app alerts and automatic reconnection features to minimize disruptions caused by Bluetooth disconnections.
- Simplified onboarding for users, creating a step-by-step interactive tutorial with visual cues and audio instructions for participants with intellectual disabilities.

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- Pre-configured devices, distributing smartwatches that are pre-configured and synced with user accounts to reduce setup complexity.

Enhancing user engagement and motivation

A key finding from the pilot study was the varying levels of engagement among participants. While some users actively participated, others required constant caregiver intervention to remain engaged. To improve motivation and independence, the following measures are suggested:

- Gamification enhancements, expanding the range of badges, leaderboards, and achievement streaks to sustain long-term user interest.
- Personalized reminders, introducing automated push notifications reminding users to complete their daily challenges, sync their smartwatch, or charge their device.
- Caregiver engagement features, developing a caregiver dashboard where family members can monitor progress and provide encouragement.
- Community and social features, incorporating group challenges where participants can work towards shared activity goals, fostering a sense of social engagement.

Improving data collection and usability

The pilot study revealed gaps in data accuracy and completeness, particularly due to smartwatch disconnections, user errors, and inconsistent logging of activities. The following recommendations aim to improve the reliability of data collection:

- Automatic data syncing & backup, ensuring that all activity data is periodically synced to prevent loss of information due to disconnections.
- User-friendly feedback system, allowing participants to manually log activities in case of smartwatch errors.

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- Real-time data dashboards, providing simple visual representations of progress in the app, making it easier for users to track their performance.
- Integration with caregiver reporting, enabling caregivers to validate activity logs and provide additional context about user engagement.

5.2. Suggestions for refining the methodology for the next phase

Following the insights gained from the pilot study, several key refinements have been identified to improve the effectiveness and feasibility of the next phase of the IDHEApp intervention. These refinements focus on participant onboarding, technological simplifications, intervention structure, and data collection enhancements.

Improving participant onboarding and training

One of the primary challenges encountered in the pilot phase was the complexity of the onboarding process for participants and caregivers. To address this issue, the following strategies are recommended:

- **Pre-training sessions:** Before beginning the intervention, participants and caregivers should attend a mandatory introductory session that provides a hands-on demonstration of how to use the smartwatch and IDHEApp app.
- **Step-by-step tutorials:** The onboarding process should include video tutorials, illustrated guides, and interactive walkthroughs within the app to provide visual and audio explanations tailored to the needs of adolescents with IDD.
- **Dedicated technical support:** A helpline or chat-based assistance should be introduced to address troubleshooting issues in real-time and prevent prolonged disconnection periods.
- **Caregiver or professionals engagement:** Since they play a critical role in supporting participants, structured caregiver/professionals workshops should be organized to ensure they are well-equipped to assist users throughout the intervention.

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Simplifying technological integration

The dual-app requirement (Fitbit + IDHEApp) presented a major barrier in the pilot phase. To streamline technology use, the next phase should consider:

- **Direct integration with smartwatches:** Developing a feature that allows the IDHEApp to sync directly with smartwatches, eliminating the need for a third-party app like Fitbit.
- **One-Click syncing features:** Automating the synchronization process so that participants do not have to manually update their activity data.
- **Battery and connectivity alerts:** Introducing automatic notifications that remind users to charge their smartwatch and check for Bluetooth disconnections to reduce gaps in data collection.

Refining the intervention structure

While the pilot study showed positive engagement, some participants struggled with maintaining daily adherence. To enhance motivation and long-term participation:

- **Adaptive challenge levels:** Users should be able to choose from different difficulty levels for challenges to ensure that the intervention is neither too easy nor too difficult.
- **Weekly progress reviews:** Adding a feature where participants receive weekly performance summaries with personalized feedback to keep them engaged.
- **Group-based challenges:** Encouraging social interaction by allowing users to compete or collaborate with peers in team-based activity challenges.
- **Enhanced gamification:** Expanding the number of badges, leaderboards, and personalized rewards to encourage users to stay active.

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Strengthening data collection methods

Accurate and reliable data collection is essential for evaluating the intervention's impact. The following improvements are proposed:

- **Multiple data input methods:** Allowing caregivers or participants to manually log activity in the event of smartwatch errors or missing data.
- **Data validation mechanisms:** Implementing a data verification step where caregivers can confirm logged activities to ensure accuracy.
- **Real-time dashboard for researchers:** Providing a live dashboard that allows project coordinators to monitor engagement levels, identify technical issues, and intervene when necessary.
- **Longitudinal data tracking:** Collecting pre- and post-intervention health indicators (e.g., BMI, mobility scores) to assess long-term impact beyond just daily step counts.

By refining these methodological aspects, the next phase of the IDHEApp intervention became more efficient, accessible, and engaging for adolescents with IDD and their caregivers. These refinements also enhanced data reliability and improve adherence rates, ultimately leading to a more impactful and scalable intervention. Implementing these changes ensure that IDHEApp continues to evolve into an effective tool for promoting healthy lifestyles among individuals with intellectual disabilities.

5.3. Summary of findings and relevance

The findings from the IDHEApp pilot study highlight the potential and challenges of implementing a digital health intervention for adolescents with intellectual disabilities. The study confirmed that digital tools, when properly adapted, can serve as effective motivators for increasing physical activity and improving health behaviours in this population.

Participants in the experimental group showed notable improvements in daily step counts, reductions in sedentary behaviour, and increased adherence to healthy

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lifestyle recommendations, indicating that the app and smartwatch integration provided valuable behavioural reinforcement.

However, the pilot also exposed critical barriers that must be addressed to ensure the intervention's success on a larger scale. Technical difficulties, the complexity of the setup process, and the need for continuous support emerged as key challenges. Many participants required caregiver assistance for basic technological tasks such as syncing devices, charging the smartwatch, and ensuring that activity data was recorded correctly. Additionally, the reliance on an external app (Fitbit) for smartwatch integration created an additional layer of complexity, leading to connectivity issues and data inconsistencies.

The relevance of these findings extends beyond the IDHEApp project, offering valuable insights for future digital health interventions targeting individuals with disabilities. The results suggest that while gamification and wearable technology can be effective tools for behaviour change, their accessibility and ease of use must be prioritized.

Future iterations of the IDHEApp intervention should focus on streamlining technological requirements, enhancing caregiver training, and implementing user-friendly automation features to minimize barriers to engagement.

By addressing these challenges, the IDHEApp project has the potential to become a scalable and sustainable model for promoting physical activity and health literacy among adolescents with intellectual disabilities, aligning with broader public health goals and digital inclusion initiatives.

5.1. Final recommendations for the main study

Based on the findings and challenges identified during the pilot study, several critical recommendations have been developed to enhance the feasibility, usability, and impact of the full-scale implementation of the IDHEApp intervention. These recommendations focus on technological refinements, participant support, engagement strategies, and data collection improvements.

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Optimizing technological aspects

The technological complexity of smartwatch integration was a major barrier in the pilot study. To ensure a smoother user experience, the following technical refinements are recommended:

Eliminating reliance on the Fitbit app and enabling the IDHEApp platform to sync directly with smartwatches. Introducing an in-app feature that automatically detects disconnections and prompts users to reconnect their smartwatch. Reducing the number of manual steps required to install and configure the app, including pre-configured devices for participants. Implementing low battery warnings and usage reminders to prevent device downtime.

Strengthening participant support and training

One of the biggest challenges observed was participants' reliance on caregivers for technical support. To promote greater independence and ensure effective use of the intervention, the following measures should be implemented:

A mandatory training session for participants and caregivers covering app functionality, device usage, and troubleshooting. Providing additional resources, such as instructional videos and guides, specifically tailored to help caregivers support participants. Establishing a real-time chat or helpline to address user issues quickly. Weekly check-in calls or SMS reminders to ensure participants remain engaged with the intervention.

Enhancing user engagement and motivation

While gamification elements encouraged participation, engagement levels varied among users. To improve motivation and sustain long-term participation, the following engagement strategies are recommended:

Allowing users to adjust difficulty settings so activities remain appropriate for their abilities. Implementing team-based goals and cooperative challenges to foster a sense of community and peer motivation. Expanding badge and milestone achievements to maintain engagement over longer periods. Introducing audio and visual feedback after task completion to enhance the user experience.

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The pilot study provided valuable insights into the strengths and limitations of the IDHEApp intervention. By addressing the technological, engagement, and data collection challenges, the main study can be more efficient, user-friendly, and impactful. These refinements ensure greater accessibility, better adherence, and improved health outcomes for adolescents with intellectual disabilities. Implementing these recommendations support a successful large-scale rollout, making IDHEApp a sustainable and scalable model for promoting health-enhancing behaviours in this population.

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6. Conclusion

In the beginning of this pilot study, we created a few questions that we wanted to answer. Below we summarized the answer to these questions:

1. **How feasible is it to implement the IDHEApp intervention in real-world settings with adolescents with IDD?**

   The pilot study confirmed that implementing the IDHEApp intervention in real-world settings is feasible but requires refinements. Adolescents with IDD were able to engage with the smartphone app and smartwatch integration, with caregivers providing necessary support. However, technical barriers, such as the complexity of device setup, frequent Bluetooth disconnections, and reliance on a third-party app (Fitbit), posed challenges. Simplifications, including direct smartwatch-app synchronization and automated connectivity fixes, are needed to enhance feasibility.

2. **How do adolescents with IDD and their caregivers perceive the usability and accessibility of the smartphone app and web platform?**
   Adolescents with IDD and their caregivers generally found the IDHEApp smartphone app engaging and easy to navigate. The gamification elements, such as badges and progress tracking, were well received. However, differences in cognitive abilities influenced user experience—adolescents with Down syndrome preferred structured challenges with clear visual cues, while those on the autism spectrum favoured a minimalist design with fewer visual distractions. Some participants found pictograms helpful, while others struggled with complex icons. Caregivers reported that their involvement was essential for technical support and guidance.

3. **What are the levels of user engagement and adherence to the gamified health challenges?**
   User engagement was moderate, with variations among participants. Many enjoyed the gamified elements and actively participated in assigned challenges, but adherence was inconsistent. Some users forgot to check the app regularly

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or struggled with completing challenges independently. Engagement was higher when caregivers provided reminders and support. To improve adherence, the intervention should include customizable challenge options, social and group-based challenges, and more interactive notifications.

4. **What barriers and facilitators influence the adoption and sustained use of the IDHEApp intervention?**
    - **Barriers:** The primary challenges included the technical complexity of setting up and maintaining smartwatch connectivity, reliance on caregivers for support, Bluetooth disconnections, and the need to manually sync data. Some users found pictograms unclear, and many struggled with remembering to charge their smartwatch regularly.
    - **Facilitators:** Structured challenge formats and gamified rewards increased motivation. Caregiver involvement played a crucial role in supporting adolescents' participation. The integration of visual cues and reminders helped users understand daily tasks. Participants appreciated progress tracking features, which encouraged continued engagement.
5. **What preliminary changes in physical activity and dietary habits are observed among participants after using the intervention?**

    Preliminary results showed positive changes in physical activity and dietary habits among participants. Adolescents in the experimental group demonstrated increased daily step counts, improved hydration habits, and reduced sedentary behaviour. However, adherence to dietary challenges, such as consuming fruits and vegetables, varied. While the intervention encouraged healthier habits, long-term effects require further study and improved engagement strategies to maintain behaviour change.

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