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User-Centered Prototype of a Mobile App to Prevent Dehydration in Vulnerable Populations

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Resumo

À medida que as populações envelhecem e os riscos à saúde relacionados ao clima se intensificam, a desidratação está a tornar-se uma preocupação crescente entre os idosos em todo o mundo. Mudanças fisiológicas relacionadas à idade — como percepção prejudicada da sede, função renal diminuída e consciência cognitiva reduzida — tornam esse grupo especialmente vulnerável. Fatores externos, como aumento da temperatura, efeitos colaterais de medicamentos e mobilidade reduzida, aumentam ainda mais o risco. Embora as ferramentas digitais de saúde sejam cada vez mais utilizadas para apoiar comportamentos de bem-estar, as aplicações móveis focadas na hidratação muitas vezes ignoram as necessidades específicas dos idosos. A maioria das soluções existentes é otimizada para utilizadores mais jovens e experientes em tecnologia, oferecendo funcionalidades complexas e acessibilidade limitada.

Este estudo propõe uma abordagem centrada no utilizador para projetar um aplicativo móvel destinado a prevenir a desidratação em populações vulneráveis, com foco específico nos idosos.

Com base numa revisão sistemática da literatura (PRISMA 2020), o projeto identifica lacunas críticas nas soluções mHealth existentes, incluindo personalização insuficiente, acessibilidade deficiente e falta de estratégias motivacionais de longo prazo. A investigação integra métodos quantitativos (inquéritos) e qualitativos (entrevistas com utilizadores) para

revelar as principais barreiras e preferências na utilização de aplicações relacionadas com a hidratação. Os resultados revelam uma ampla gama de níveis de literacia digital entre os utilizadores idosos, bem como uma clara procura por interfaces simplificadas, lembretes personalizáveis e recursos de apoio emocional.

Com base nessas informações, um protótipo foi desenvolvido iterativamente usando personas de utilizadores e mapeamento de jornada. Foi dada especial atenção às necessidades dos utilizadores com menor confiança digital, implementando a exposição progressiva de recursos e carga cognitiva mínima. Além disso, uma estrutura de testes A/B foi preparada para comparar o acompanhamento do progresso e as estratégias de gamificação baseadas em personagens na motivação de um comportamento de hidratação consistente.

Este trabalho contribui com um conjunto de princípios de design para aplicações móveis destinadas a idosos, enfatizando a acessibilidade, a personalização e o envolvimento emocional. O protótipo, as diretrizes de design e os resultados da pesquisa servem como base para futuros testes de usabilidade e desenvolvimento de produtos a longo prazo. O projeto reafirma a importância do design centrado no utilizador para abordar comportamentos de saúde complexos e apoiar o envelhecimento saudável por meio da tecnologia.

Abstract

As populations age and climate-related health risks intensify, dehydration is becoming a growing concern among older adults worldwide. Age-related physiological changes—such as impaired thirst perception, diminished renal function, and reduced cognitive awareness—make this group especially vulnerable. External factors like rising temperatures, medication side effects, and reduced mobility further increase the risk. While digital health tools are increasingly used to support wellness behaviors, hydration-focused mobile applications often overlook the specific needs of older adults. Most existing solutions are optimized for younger, tech-savvy users, offering complex features and limited accessibility.

This study proposes a user-centered approach to designing a mobile application aimed at preventing dehydration in vulnerable populations, with a specific focus on older adults.

Building on a systematic literature review (PRISMA 2020), the project identifies critical gaps in existing mHealth solutions, including insufficient personalization, poor accessibility, and a lack of long-term motivational strategies. The research integrates both quantitative (survey) and qualitative (user interviews) methods to uncover key barriers and preferences in hydration-related app usage. Findings reveal a wide range of digital literacy levels among older users, as well as clear demand for simplified interfaces, customizable reminders, and emotionally supportive features.

Based on these insights, a prototype was developed iteratively using user personas and journey mapping. Special attention was given to the needs of users with lower digital confidence, implementing progressive feature exposure and minimal cognitive load. Additionally, an A/B testing framework was prepared to compare progress tracking and character-based gamification strategies in motivating consistent hydration behavior.

This work contributes a set of design principles for mobile applications targeting older adults, emphasizing accessibility, personalization, and emotional engagement. The prototype, design guidelines, and research findings serve as a foundation for future usability testing and

long-term product development. The project reaffirms the importance of user-centered design in addressing complex health behaviors and supporting healthy aging through technology.

Keywords: elderly, dehydration, user-centered design, mobile health (mHealth)

Agradecimentos

The journey of research is like water: fluid, essential, and often shaped by the challenges it encounters along the way. Just as water sustains life, knowledge enlightens and transforms, allowing us to grow and evolve.

First and foremost, I would like to express my gratitude to my advisors, who have been an inexhaustible source of wisdom, guiding me with patience and inspiration throughout this journey. I also extend my thanks to the participants of this study, whose contributions were invaluable in deepening the understanding of this topic, as well as to my professors and colleagues, who shared their insights and reflections, enriching every stage of this work.

Finally, I am grateful for science, which, like water, is always in motion, carving new paths and adapting to the needs of humanity. May this study be one more drop in the vast ocean of knowledge.

Irina Boldyreva

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1. Introduction

Dehydration represents a serious health challenge for older adults, particularly in the context of rising global temperatures and climate variability. The aging process brings physiological changes such as diminished thirst perception, reduced kidney efficiency, and an overall decline in fluid regulation, which together elevate the risk of chronic conditions, cognitive decline, and reduced quality of life. Mobile applications and other digital health tools hold promise for supporting hydration monitoring and building awareness in this population. However, the majority of existing solutions are tailored to younger, digitally fluent users, resulting in interfaces that are often too complex or inaccessible for older adults. Additional technologies—such as smart water bottles, wearable hydration trackers, or interactive reminder devices—offer alternative approaches, but they tend to require substantial financial investment, technical setup, and user adaptation. Moreover, many of these tools do not account for dynamic environmental factors like heat or humidity, which are critical in determining hydration needs. As a result, there is a clear need for more inclusive, adaptive, and context-aware solutions designed specifically with the older population in mind.

1.1 Motivation

Developing a mobile application specifically designed to prevent dehydration among older adults is a crucial endeavor aimed at improving their health and quality of life. The issue of dehydration aligns with global health initiatives, including the United Nations Sustainable Development Goals (SDGs). Specifically, Goal 3—"Ensure healthy lives and promote well-being for all at all ages"—emphasizes the importance of creating accessible and effective solutions for improving elderly health.

A personal motivation for conducting this research is a commitment to enhancing the well-being of older individuals, not only from an academic perspective but also from personal experience. Understanding the challenges faced by elderly individuals, including my own

parents, strengthens my resolve to contribute to the development of a practical and accessible technological solution. This study aims not only to analyze existing challenges but also to explore practical solutions that can positively impact the well-being of this demographic.

While many hydration-monitoring applications exist, they often fail to accommodate the unique needs of older adults. Common barriers include complex user interfaces, lack of personalized recommendations, and insufficient motivational mechanisms. The development of an intuitive and senior-friendly mobile application aligns with strategic goals in digital health and contributes to long-term objectives for improving elderly well-being.

1.2 Hypothesis and Research objectives

This study hypothesizes that a user-centered mobile application, offering personalized recommendations, adaptive reminders, and simplified interaction flows, can improve hydration awareness and support consistent fluid intake among older adults. By tailoring the design to cognitive, physical, and behavioral needs of elderly users, such an app can help mitigate the risk of dehydration and foster long-term engagement.

Research Objectives:

- To identify the key barriers, motivations, and interaction patterns of older adults when using digital tools for hydration tracking
- To define design strategies that ensure usability, emotional comfort, and accessibility for users with varying levels of digital literacy
- To develop and iteratively refine a prototype based on user research and feedback, grounded in user-centered design methodology

1.3 Research Methods

This dissertation adopts an applied, user-centered research methodology, combining qualitative and quantitative techniques to inform the development of a mobile prototype for hydration tracking among older adults. The research process began with a systematic literature review conducted using the PRISMA 2020 framework, which helped identify major usability barriers, behavioral patterns, and design gaps in existing mHealth tools related to hydration and elderly care.

Empirical data collection included:

- A quantitative survey to assess hydration habits, reminder preferences, and user profiles

- Open-ended responses to uncover emotional and contextual factors influencing hydration and app usage
- User journey mapping and persona development to visualize pain points and opportunities for design intervention
- Prototype development using iterative, research-informed design in Figma
- Preparation for A/B testing, comparing engagement with different motivational models (progress vs. gamification)

1.4 Structure of the Dissertation

Apart from the introduction, this dissertation consists of several chapters.

Chapter 2, Literature Review, presents the state of the art on dehydration in older adults and examines existing technological approaches to hydration support. The chapter follows the PRISMA 2020 methodology for systematic review and groups findings into three categories: health (physiological risks and behaviors), technology (existing tools and limitations), and design (usability challenges and best practices). Gaps in current solutions are highlighted to justify the need for user-centered innovation.

Chapter 3, User Research, describes the empirical research phase, including a survey and qualitative inquiry. This chapter analyzes hydration behavior, digital literacy levels, motivational needs, and user expectations, leading to the formulation of user personas and journey maps.

Chapter 4, Prototyping, details the design and development of an interactive prototype, incorporating insights from previous chapters. Special attention is given to progressive feature disclosure, simplified interaction flows, and personalized feedback strategies.

Chapter 5, Usability Testing, — presents the results of remote testing sessions conducted with older adults. It outlines observed patterns of interaction, task completion behavior, and user feedback on clarity, motivation, and personalization. The chapter also reflects on the implications of these findings for future interface refinement.

Chapter 6 — Final Discussion and Conclusions — summarizes the key contributions, reflects on user-centered design in elderly health tech, and presents practical design recommendations. Limitations are acknowledged, and a roadmap for future testing and development is proposed.

2 Literature Review

This chapter reviews the current state of research on dehydration prevention in older adults, with a focus on digital solutions and design challenges. The objective is to synthesize existing knowledge, identify limitations in current approaches, and outline the specific needs that remain unmet in this domain.

In addition to mapping the broader academic landscape, the chapter includes an evaluation of technological tools relevant to hydration monitoring. Their strengths and shortcomings are analyzed in relation to the needs of elderly users. This review forms the conceptual and practical basis for subsequent design decisions and the development of a user-centered prototype.

2.1 Introduction

The literature review was conducted using the PRISMA 2020 framework, a standardized method that ensures a transparent and systematic approach to analyzing existing research. PRISMA 2020 was chosen due to its rigorous methodology for identifying, selecting, and evaluating relevant studies. This approach allows for the systematic exclusion of irrelevant or low-quality sources and ensures that the research findings are reliable and applicable to the target audience. The framework provides a comprehensive structure for identifying gaps in existing knowledge and guiding evidence-based recommendations for designing hydration-monitoring applications tailored to older adults.

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Objectives of literature research:

1) Identify the hydration needs of older adults (aged 60 and above).
2) Examine existing studies and solutions addressing dehydration in the elderly population.
3) Investigate factors that encourage or hinder the use of digital health solutions

2.2 Literature search

The review was conducted in December 2024. To identify relevant literature, the Scopus and Web of Science databases were used. The following query was applied for the search:

TITLE-ABS-KEY (("elderly" OR "old* adult" OR "aging population" OR senior) AND ("mobile app" OR "application" OR website OR "technolog* innovat*") AND ("hydration" OR "dehydration" OR "water intake"))

This query yielded a total of 249 articles, with the distribution presented in Table 1.

Table 1: Results of Literature search

Source	Number of articles
Web of science	58
Scopus	191

2.2.1 Data Synthesis and Analysis

To eliminate duplicate records, the Rayyan.ai service was used, resulting in the automatic exclusion of 101 articles. The remaining studies were categorized into two main research areas: “Health,” which focused on determining the necessary water intake to prevent dehydration in older adults, and “Technology,” which examined existing market solutions, evaluated research on these solutions, and identified specific usability requirements for older users.

Articles were excluded based on the following criteria:

Health:

1. Studies focused on specific disease groups.
2. Studies involving individuals taking specific medications.
3. Aesthetic medicine studies related to skincare rather than physiological water consumption.
4. Research not primarily focused on water intake.

Technology and Design:

1. Studies where the primary respondents were not older adults.
2. Studies focused on individuals with specific medical conditions.
3. Applications unrelated to healthcare.

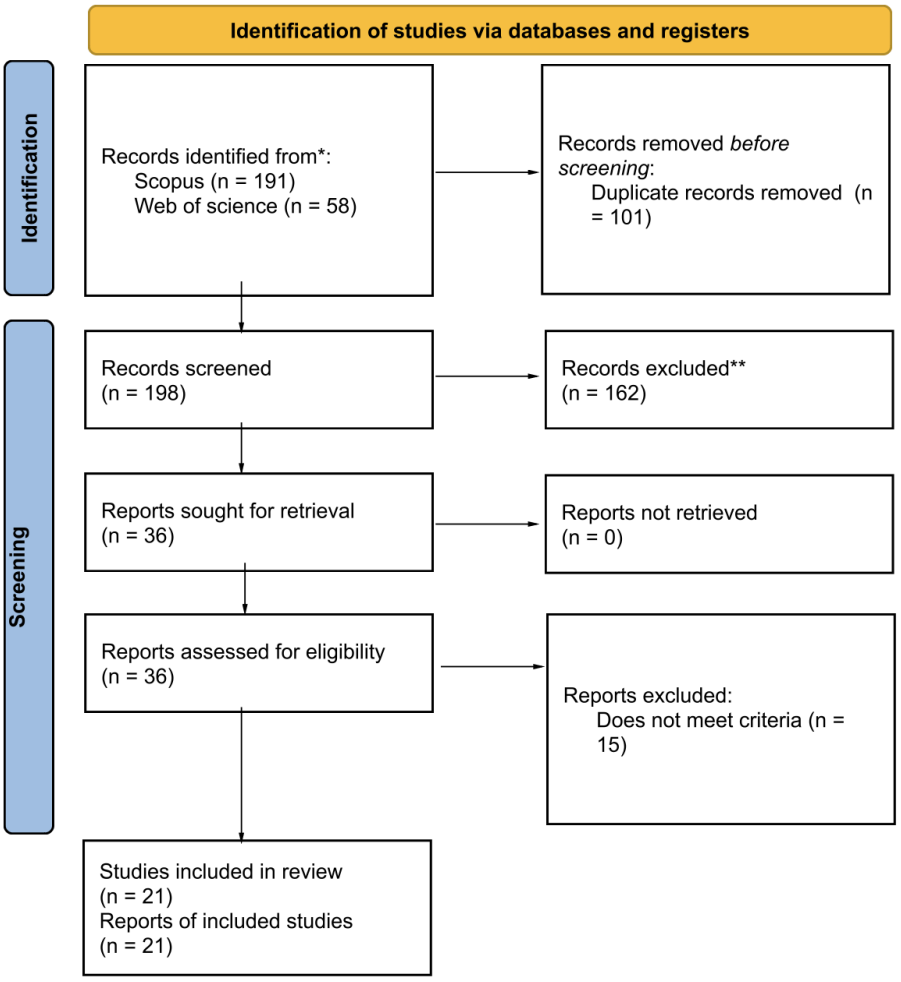


Figure 1: Process of identification and inclusion of articles - PRISMA Flow Diagram.

The initial PRISMA-based review did not specifically include barriers to technology adoption in its search query. After analyzing the selected literature, it became clear that barriers were underrepresented, limiting the scope of the analysis. To address this, several additional articles were incorporated based on their relevance and methodological quality. An overview of these materials is included in the Design category of the Results section.

2.3 Summary and Research Gap

2.3.1 Health

Dehydration is a significant concern for older adults due to various factors, including physiological changes, lack of awareness regarding fluid intake, and psychological aspects.

According to Begum and Johnson (2010), dehydration is the most prevalent fluid and electrolyte imbalance among the elderly. Abdullah Sani and Petrie (2011) report that in the United Kingdom, the average daily fluid intake for individuals over 65 years old is only 1.2 liters for men and 1.3 liters for women, which is considerably lower than the recommended levels. This inadequate intake can lead to severe consequences, such as fatigue, cognitive decline, and an increased risk of falls.

Dehydration poses specific risks for older adults, exacerbating health issues such as weakened immune function, which makes individuals more susceptible to infections like pneumonia and urinary tract infections. Additionally, dehydration reduces blood volume, increasing the likelihood of thrombosis, arrhythmias, and other cardiovascular complications. Impaired kidney function, potentially leading to kidney failure, is another severe consequence, especially for older adults with preexisting conditions.

Aging also increases susceptibility to dehydration due to physiological changes. Studies indicate that osmoreceptor sensitivity declines with age, leading to a diminished sense of thirst (Begum & Johnson, 2010). Consequently, older adults may not recognize the need for fluid intake even when their bodies require hydration. Furthermore, renal function deteriorates with age, reducing the kidneys' ability to concentrate urine and retain water, which accelerates fluid loss. Additionally, chronic illnesses such as diabetes, heart failure, and kidney disease further elevate the risk of dehydration in this population.

2.3.2 Technology

Mobile applications have emerged as a promising tool for assisting older adults in monitoring their fluid intake. Research suggests that such applications can facilitate positive behavioral changes, thereby enhancing health and well-being. For instance, the "MyHealthyLiving" app (Haslinda, Sani, & Petrie, 2017) was developed to help older adults track their intake of fruits, vegetables, and fluids. While the app proved beneficial and user-friendly, the study only lasted two weeks, highlighting the need for long-term research on user engagement and adoption patterns among older adults.

Studies on water intake app evaluation have identified key barriers that hinder hydration among older users. Common issues include small font sizes and tiny control elements, leading to user errors and reduced confidence in app usage. Additionally, complex navigation structures with multiple menu layers can cause confusion, leaving users uncertain about how to return to a previous screen or complete a task (User Evaluation of an App for Liquid Monitoring by Older Adults, 2017). Psychological factors, such as fear of making mistakes, also play a role; users may struggle with app functionality if clear visual cues and instructions are lacking. Simple

icons and step-by-step guidance can improve user comprehension. However, some participants expressed a preference for direct task execution rather than prolonged instructions, suggesting that apps should prioritize action-oriented design rather than lengthy explanations.

Another study, "Implementation of an Innovative Hydration Monitoring App in Care Home Settings: A Qualitative Study" (Steven et al., 2019), examined the use of the Hydr8 app and found that it improved residents' knowledge of hydration through visual illustrations. This underscores the importance of incorporating graphical elements in hydration apps for older adults. Additionally, visual indicators such as urine color and volume can aid users in assessing their hydration levels, with the app providing recommendations based on these indicators.

Further research highlights the importance of personal drink preferences in hydration strategies. Bak, Tsiami, and Greene (2017) emphasize that successful hydration programs in nursing homes account for individual preferences, such as choosing between water, juice, and tea, to encourage fluid intake. An effective hydration app could integrate this approach by allowing users to select and log preferred beverages, thereby fostering sustained engagement and hydration adherence.

A key challenge identified in user research is the lack of motivation among older adults to continue using hydration apps over time (User Evaluation of an App for Liquid Monitoring by Older Adults, 2017). If an app fails to offer sufficient incentives or clear benefits, users may lose interest. For example, the absence of interactive and rewarding features, such as goal-based achievements, can diminish motivation. Participants highlighted the need for progress-tracking features and health-based recommendations to maintain user interest. Researchers have also pointed to the effectiveness of gamification elements in driving engagement. Features such as hydration progress tracking, reward systems for consistent fluid intake, and visually appealing graphics related to hydration can enhance motivation (Plum, 2010).

The use of visual and auditory reminders has also proven effective in hydration interventions. A study on "Bibo the Moving Cup for People Affected by Dementia: Design, Ethical Considerations, and First Observations in Use" (2023) highlights existing solutions incorporating light and sound alerts to remind users to hydrate. Similarly, hydration apps should employ notifications with vibrant and intuitive visualizations to enhance adherence and ensure that older adults meet their hydration needs effectively.

2.3.3 Design

As previously established, dehydration poses significant health risks, including cognitive decline, kidney problems, and increased hospitalization rates. Mobile health (mHealth)

applications offer a promising solution, but their effectiveness depends on overcoming barriers such as digital literacy, user trust, usability, and cognitive limitations (Ahmad et al., 2022)

Studies indicate that elderly users often face difficulties in using mobile technologies due to a lack of digital experience. Navigating complex interfaces and remembering sequences of actions create additional obstacles (Dequanter et al., 2022). Trust is another key factor, as many elderly users are concerned about data security and unauthorized access to personal information (Pywell et al., 2020).

Despite existing barriers, several factors contribute to the successful adoption of mobile technologies among older adults. Personalized settings tailored to individual needs enhance user convenience and engagement (Ahmad et al., 2022). Social and professional support also plays a crucial role, allowing family members or healthcare providers to monitor hydration levels and provide reminders when needed (Bertolazzi et al., 2024).

Educational programs aimed at improving digital literacy further increase technology acceptance. Training based on observation and guided learning helps elderly users feel more comfortable with digital tools and reduces anxiety associated with their use (Ma et al., 2020). Voice commands and adaptive interfaces are particularly beneficial for users with cognitive impairments, reducing cognitive load and simplifying interactions (Floyde et al., 2011).

User-friendly design plays a crucial role since complicated controls and poor text readability may reduce engagement and hinder consistent app use (Floyde, A., et al. (2011). Additionally, elderly individuals with mild cognitive impairments struggle to learn new digital tools and maintain regular usage, making simplicity and support essential for this group (Dequanter et al., 2022).

Based on a literature review, key design principles for an effective mobile application to prevent dehydration among older adults have been identified. Essential components include personalized hydration plans that consider age, health status, and physical activity levels. An adaptive notification system is necessary to adjust reminder frequency according to user behavior, preventing alert fatigue.

Voice control and feedback are vital to facilitate interaction and improve accessibility for users with cognitive limitations. Integration with remote monitoring systems allows family members and healthcare professionals to oversee hydration levels. Gamification elements, such as encouraging messages and progress tracking, help boost user motivation. To maximize accessibility, the interface should be minimalistic, featuring large controls and offline functionality.

The reviewed literature highlights that while mHealth applications offer a promising solution for improving hydration among older adults, their design must prioritize usability,

personalization, and trust-building. Addressing these aspects is essential for enhancing adoption and ensuring sustained usage, ultimately leading to better health outcomes.

An effective dehydration prevention app for older adults should incorporate personalized hydration plans, allowing users to set goals based on their age, health conditions, and activity levels. Adaptive notifications and reminders should be customizable, adjusting to user behavior and preferences to prevent alert fatigue. Voice control and speech feedback can enhance accessibility by guiding users through hydration tracking and reminders. Integration with caregivers and remote monitoring features would enable family members or healthcare providers to track hydration status and offer support when needed. Gamification elements, such as encouragement messages, hydration streaks, and small incentives, could help maintain engagement and motivation. Lastly, the application should feature a simple, minimalistic user interface with large icons and intuitive navigation to accommodate the needs of older users.

2.3.4 Research Gaps

In light of the above review, several critical gaps in the literature have been identified. First, there is a lack of mobile hydration applications specifically tailored to older adults' needs, especially considering age-related cognitive and sensory limitations. Many existing "drink water" apps are designed for a general or younger audience and feature complex interfaces or small, dense displays, making them less accessible and effective for seniors. The unique challenges older users face – from declining vision and dexterity to memory impairment – are seldom fully accounted for in current app designs. This gap underscores a need for more inclusive, age-friendly design approaches, as most available solutions fail to accommodate the limitations and preferences of elderly individuals.

Second, hydration needs can be significantly affected by external factors like ambient temperature and humidity, yet most apps do not adapt or provide guidance based on weather or climate conditions. For example, an older adult's fluid requirements on a hot, humid day may be much higher, but mainstream apps typically calculate targets using only personal metrics (e.g. weight, activity level) while ignoring context. The omission of real-time environmental data represents a gap in personalization: existing technologies rarely leverage climatic or environmental information to adjust hydration advice, which is particularly crucial for vulnerable older users in extreme weather scenarios. Integrating such context-aware features remains an open challenge in the design of hydration apps.

Third, there has been insufficient exploration of motivational strategies (e.g. gamification vs. simple progress tracking) that are truly effective and appropriate for encouraging hydration

in elderly users. Digital health interventions often employ gamified elements – such as points, badges, or rewards – to drive engagement, but most gamification research has targeted younger populations, with older adults receiving only limited attention. It remains unclear how well seniors respond to game-like features versus more straightforward encouragement. Early evidence suggests that while older people can benefit from gamification, the effects are modest, and poorly tailored game mechanics might even overwhelm or frustrate some individuals. The literature lacks consensus on which motivational design techniques (for example, social encouragement, achievement badges, reminder feedback, or progress charts) work best for sustaining older adults' interest and compliance in a hydration app. This gap indicates the need for comparative research on engagement strategies – specifically adapted to seniors' preferences – to determine what truly motivates long-term behavior change in this group.

In summary, no study to date appears to unite all these aspects – geriatric-focused app design, environmental adaptiveness, tailored motivational techniques, and rigorous user-centered development – within a single solution. This dissertation targets these unmet needs by proposing and iteratively developing a prototype explicitly aimed at preventing dehydration in older adults, thereby directly responding to the gaps identified.

3 User Research

Understanding the behavioral attitudes, motivations, and barriers of the target audience is a key step in developing a digital solution aimed at changing everyday habits. In the context of this study, particular attention is paid to older users, who are characterized by specific patterns of interaction with technology, as well as individual characteristics related to physiological and cognitive perception.

This section includes a comprehensive analysis of user experience based on a combination of quantitative and qualitative sources: survey data, open comments, analysis of secondary literature, and user reviews of similar digital products. The methodological approach is focused on identifying not only general trends but also differences between user types, which allows laying the foundation for personalized interface design and interaction logic.

As a result of the research, prototypical user personas will be formulated, describing key behavioral scenarios, levels of digital confidence, and preferences regarding reminders and interface solutions. This data will be used in the next stages of design, including the construction of the user journey and the development of a functional model of the product.

3.1 Methodology Overview

The study is based on a combined quantitative and qualitative approach, with an emphasis on quantitative methods. The main objective was to identify water consumption habits, digital literacy levels, and preferences among users aged 60 and older in the context of the potential use of a mobile application for monitoring water balance. The main tool used was a structured online survey implemented via the Google Forms platform and available in three languages (Russian, English, Portuguese). This ensured formal compliance with the principles of inclusive design and expanded the potential linguistic coverage of the audience.

The questionnaire was pre-tested and included age filtering to exclude respondents under the age of 60. The questionnaire structure included three content blocks: demographic parameters and digital behavior, behavioral and cognitive aspects related to water consumption, and preferences in interface and functional elements of mobile applications. This questionnaire structure allowed for a consistent transition from fixed behavioral patterns to the subjective attitudes and expectations of users.

Despite the limited sample size, the data obtained allowed us to identify a number of consistent trends and prerequisites that require further empirical clarification. As a compensatory measure, we additionally analyzed secondary sources and synthesized user profiles based on available open data and respondent comments.

3.2 Quantitative Survey

The quantitative study was a standardized online survey designed to collect structured data on daily water consumption practices, awareness of hydration issues, and attitudes toward digital reminder and monitoring tools.

The purpose of the survey was to record quantifiable behavioral patterns and to identify initial preferences regarding digital interaction formats. The survey structure allowed to collect data on demographic characteristics, smartphone usage frequency, water consumption habits, and desired interface parameters for a hypothetical mobile application. In addition, levels of trust in digital health products and attitudes toward personal data protection were recorded.

The survey demonstrated that most participants recognize the importance of water balance but do not maintain it regularly. Participants tend to focus on external circumstances (heat, physical activity) rather than internal sensations. It also became clear that the older audience has difficulty perceiving complex interfaces and is interested in minimalistic, understandable, and calm solutions with visual feedback. This will be taken into account in the MVP design.

3.2.1 Participants and Tools

The survey included 43 people between the ages of 55 and 80+. The gender distribution of participants was as follows: 65% women (28 people) and 35% men (15 people). The age range was representative of the project's intended target audience, with the highest representation in the 60–64 and 65–69 age segments. Automatic filtering by age criterion, built into the Google Forms form, was used to select participants.

With regard to smartphone usage frequency, the data showed a high level of digital engagement: 90% of respondents reported using smartphones daily, indicating a potential readiness to adopt mobile solutions provided that the interface is compatible with their cognitive and motor characteristics.

The survey was conducted online. Google Forms and Google Sheets were chosen for their accessibility, versatility, and ability to provide data collection in three languages. The choice of these platforms also minimized the entry threshold for respondents with varying levels of digital literacy.

The questionnaire's content structure included three logically interrelated sections: (1) demographic and behavioral characteristics, (2) water consumption habits and triggers, (3) interface and functional preferences regarding health apps. This structure made it possible to trace the relationships between levels of digital literacy, behavioral scenarios, and potential requirements for a digital product.

The survey included both closed and open-ended questions. The latter helped to gather individual qualitative insights and comments, which were then taken into account when forming hypotheses and building user profiles. This survey format made it possible not only to collect statistics, but also to record the emotional and behavioral aspects of interaction with the potential product.

3.2.2 Key Findings

Analysis of the quantitative survey results revealed a number of consistent behavioral patterns and attitudes characteristic of the target audience—users over 60 years of age. The following are the key patterns that can be identified on the basis of the data collection. These findings are further illustrated in Appendix A, which includes graphs summarizing the respondents' answers.

3.2.2.1 Digital engagement and technological confidence

The survey results indicate a high level of daily smartphone use among respondents: 91% of participants said they use mobile devices every day. Only 9% indicated that they do so several times a week. Such data testify to established digital practices in this age group and provide a basis for assuming the admissibility of using mobile solutions in the field of behavioral health support.

In contrast, users' experience with specialized tools remains limited. 46,5% of respondents reported that they had ever used such tools, most often in the form of pedometers or built-in

apps. The lack of regular experience using more complex applications aimed at monitoring water consumption indicates a gap in digital behavior that could be filled with a clear and adapted interface.

Most participants demonstrated positive or neutral self-assessment in terms of confidence when learning new applications. Only 11% of respondents expressed complete uncertainty. This indicator confirms the possibility of introducing a training or step-by-step scenario for using the application during the onboarding stage.

3.2.2.2 Behavioral patterns related to water consumption

The data revealed indicates a low level of regular hydration practices. About 30% of participants reported that they do not think about when and how much water they drink during the day. An additional 37% rely primarily on the physiological sensation of thirst as their main behavioral trigger. Thus, only about 33% demonstrate signs of conscious control of their water balance, including through the formation of daily habits.

The most common circumstances contributing to water consumption were identified as: the availability of water within sight, physical thirst, and external conditions such as heat or physical activity. This indicates a predominantly reactive rather than proactive behavior pattern.

According to respondents' self-assessment, water consumption in most cases ranges from 1 to 1.5 liters per day, which may be insufficient in terms of age-related physiological norms.

3.2.2.3 Attitude toward reminder functions and methods

Indicators related to attitudes toward the functionality of reminders show a preference for unobtrusive and adaptable solutions. The most frequently mentioned formats include audio signals, visual indicators (e.g., graphical progress bars), vibration, and text notifications. At the same time, 29% of participants indicated that they would not want to receive reminders in any form, even if they were to hypothetically use the app. This underscores the need for flexible configuration and personalization, as well as the ability to completely disable notifications without losing app functionality.

Expected features that could increase motivation to use the app regularly include progress visualization (reported by 44% of respondents), health advice (50%), and a simplified user interface with enlarged controls (26%). These preferences are consistent with literature research findings that emphasize the importance of interface transparency and low cognitive load for older audiences.

3.2.2.4 Trust in digital products and attitudes toward data security

Respondents' level of concern about personal data protection was moderate. About one-third of participants expressed a high degree of concern about the security of personal information when using health apps. Approximately half took a neutral position, while the remaining participants reported no concerns.

Therefore, a transparent and understandable privacy policy is important to a significant portion of the audience. This factor can influence the level of trust in the application and the willingness to use it.

3.2.2.5 Qualitative Insights from Open-Ended Responses

In the final part of the survey, respondents were given the opportunity to provide free comments regarding their water consumption habits or interaction with digital applications. Despite the limited number of detailed responses, some of the comments are interesting in terms of revealing latent motivations, barriers, and cognitive biases that cannot be captured by closed-ended questions.

The excerpts below have been translated from Russian and Portuguese and interpreted within the framework of thematic analysis.

Table 2: Qualitative Insights from Open-Ended Responses

Citation	Interpretation
“I have never felt thirst, but since all digital media constantly emphasize the need to drink at least 2.5 liters of water per day, I sometimes force myself to drink at least half a liter throughout the day.”	The comment reflects a common situation where behavior is shaped more by the information field than by personal needs. For such users, unobtrusive support and a gentle interaction format are important: reminders should not be pushy, but rather delicately draw attention back to the topic. Calm, respectful notifications with the ability to customize the tone and frequency are particularly suitable for them. As part of the personas that will be developed in the next stage, this scenario will be presented as a type of perception that is sensitive to the form of information presentation.
“I am used to following the rules, and I always keep a bottle of water near me because I live in a city with consistently high temperatures.”	This comment illustrates the existence of an established behavioral strategy based on contextual conditions and routine actions. In such cases, the digital system may not require

	active reminders, but rather act as a confirmation and tracking tool. Such differences in water consumption patterns will be included in the formation of personas reflecting different levels of self-regulation.
“One could also use reminders placed around the house, so that when a person walks past these places, they would be reminded and feel responsible for drinking enough fluid.”	The statement suggests an alternative model of interaction with reminders, based on spatial-associative anchors. This could be implemented in the form of geolocation notifications — for example, when in the kitchen — or through integration with wearable devices (such as smart watches) that remain on the user even when the phone is in another room. Such mechanics will form the basis for interaction scenarios in the design of user personas.

The substantive focus of the comments underscores the importance not only of functional aspects but also of value-based aspects of interaction with digital products: trust, autonomy, compatibility with one's usual rhythm of life, and sensitivity to individual perceptions of norms. On this basis, personas will be developed in Chapter 4.

3.2.3 Identified Gaps and Feasible Directions for Further Research

Analysis of the data obtained during the quantitative survey revealed important trends in the behavior and perception of digital solutions by elderly users. However, a number of substantive issues remain insufficiently explored and require further study in subsequent stages. Below are the main areas where there is a lack of information that needs to be empirically clarified.

3.2.3.1 Behavioural scenarios and motivational preferences

The survey revealed the frequency of water consumption practices, but did not provide a complete picture of motivational models — why users are inclined or not inclined to follow the regime, what internal and external incentives are considered significant, what forms of reminders are perceived as acceptable, and which as excessive. The next step in exploring this issue will be to conduct a thematic analysis of user comments on popular health tracking apps.

3.2.3.2 Attitudes towards gamification, progress visualisation and social engagement

Respondents indicated various preferences regarding reminders and visual feedback, but the survey data does not allow for clear segmentation of users based on their perception of game elements, progress scales, and reward mechanics (achievements, levels, virtual rewards). Thus, it remains to be investigated which forms of motivation can be perceived as useful and which as annoying or inappropriate for the age group.

To obtain this data, a comparative analysis of user reviews of applications with different types of motivational scenarios (gamification, social comparison, visual progress tracking) will be conducted. The analysis will be supplemented by a comparison with recommendations from studies on motivation in digital self-tracking systems for elderly users.

3.2.3.3 Digital interaction practices and interface perception

Although most respondents reported daily smartphone use, and about 80% rated their confidence in learning new apps as positive or neutral, the survey did not address specific challenges users face when interacting with the interface: typography, menu structure, notification type, navigation logic.

To study this issue, the next stage involved desk research, including secondary analysis of the results of usability tests of applications for elderly users, and analysis of criticism of interface solutions reflected in user reviews in the App Store and Google Play.

3.2.3.4 Conclusion

Thus, the quantitative survey allowed us to identify the basic behavioral characteristics and preferences of the target group, but did not reveal important aspects of the user experience. To refine and deepen the conclusions, the next stage of the research will involve a series of secondary empirical procedures: thematic and comparative analysis of user comments on relevant applications, desk research on usability and motivation, and substantive interpretation of personalization and engagement practices. These methods will ensure the empathetic richness and conceptual reliability of design solutions.

3.3 Thematic Analysis (Desk Research)

This section presents findings from supplemental research conducted to address gaps identified in the literature review and user survey. Existing sources – including user reviews of popular health apps and prior studies on older adults' routines – were analyzed to gain insights

into elderly users' motivations, engagement with gamified features, and usability needs. By examining real-world user comments and design guidelines, this section derives evidence-based personas and pinpoints key pain points and preferences relevant to the target population. It is important to note that the age of users leaving reviews on the App Store and Google Play is not usually specified. Nevertheless, the sample of reviews is considered relevant, as the analyzed applications are widely used by a broad audience, including older users, which is confirmed by the content of a number of reviews (e.g., mentions of vision problems, treatment of chronic diseases, use in tandem with relatives, etc.). In addition, the identified patterns of behavior, expectations, and complaints of users correlate well with the barriers described in the scientific literature on the design of digital solutions for older adults.

3.3.1 Thematic Research Strategy

A structured approach was used to guide the review and selection process. Initially, a broad search identified 41 mobile apps relevant to hydration tracking, self-monitoring, or digital health routines. Of these, 27 were excluded based on one or more of the following criteria: (1) insufficient user feedback volume (<1000 reviews), (2) paywall restrictions that hinder full usability assessment. After that 6 was excluded based on (3) outdated interface inconsistent with recent accessibility guidelines. The final list included 8 apps most frequently mentioned or praised across platforms (App Store, Google Play) and within academic reviews of geriatric

media.

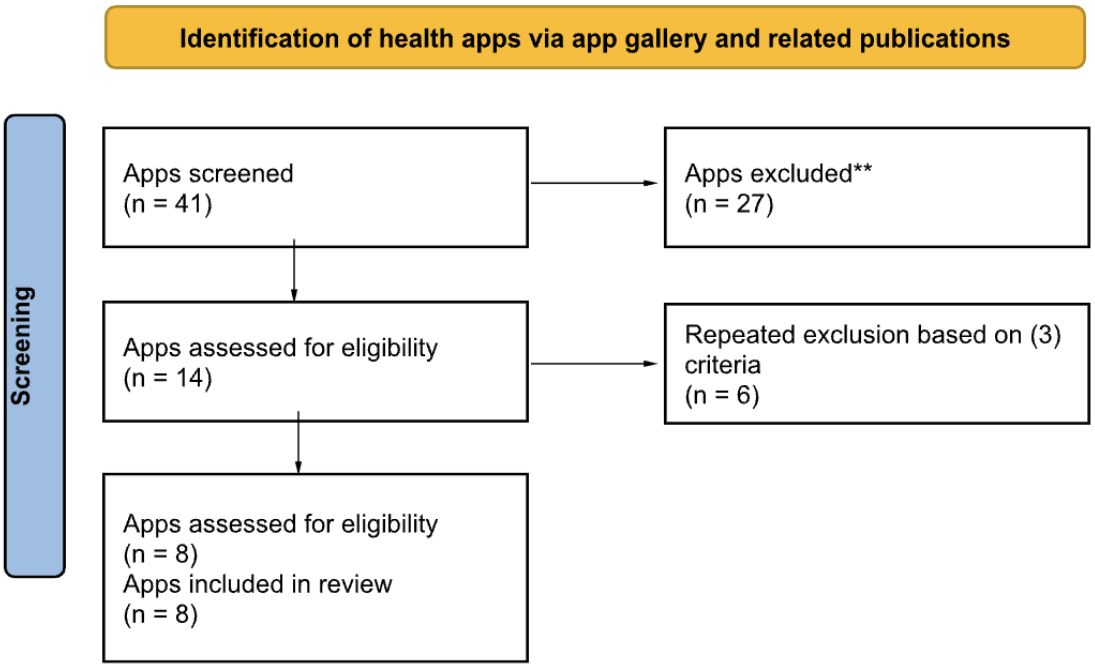


Figure 2: Process of identification and inclusion of apps - PRISMA Flow Diagram.

To address the questions above, was examined a selection of popular health apps (recent as of 2020–2025, mostly free) and available on general play markets (AppStore and/or Google Play).

Table 3: Final App Selection

App name	Platform	Comments
Water Time Pro[1]	Android, iOS	A highly-rated water reminder app known for balanced notifications. User reviews highlighted its non-annoying reminders, flexible schedule (including a night mode), and positive impact on daily intake.
Water Drink Reminder[2]	Android	Hydration tracker with millions of users. Reviews (including in Portugal) noted its simplicity and effectiveness for health

[1]https://play.google.com/store/apps/details?id=com.mobilecreatures.drinkwater&pcampaignid=web_share

[2] https://play.google.com/store/apps/details?id=com.northpark.drinkwater&pcampaignid=web_share

		needs. Demonstrated the importance of easy logging and health context.
Waterful[3]	Android, iOS	A newer app (within 5 years) featuring challenges and a clean UI. It was App of the Day in several regions. Older users appreciated its fun but straightforward interface, large fonts, and integration with Apple Health/Watch.
Plant Nanny[4]	Android, iOS	A gamified app (virtual plants) awailiable globally since 2013. User community feedback: many enjoy the game-like incentive to “keep plants alive” by drinking water, but some older users reported the game elements being a bit too cutesy or complex, especially after updates that introduced monetization. This comparison helped gauge the appropriate level of gamification.
Waterllama[5]	iOS	The app stands out for its playful design – the main character (a cute llama) and dozens of unlockable characters motivate users to drink more water, while high ratings and Apple awards (App Store Award, Design Award Finalist) confirm its status.
Hydro Coach[6]	Android	A water tracker that calculates personalized goals and emphasizes progress visualization. Reviews praised its notification system and the scheduling component that can adapt to one’s routine. This reinforced the value of adaptable reminder timing and minimal intrusion.
Drink Water[7]	iOS	The app offers a clean and intuitive interface with vivid animations — a human silhouette fills with water with each sip, which looks impressive and is intuitive to understand. The reminder system is fully customisable (there is a "do not disturb" night mode), the user sets the glass volume and interval themselves,

[3] https://apps.apple.com/pt/app/drink-water-reminder-waterful/id1515530685?l=en-GB
[4] https://sparkful.app/plant-nanny
[5] https://apps.apple.com/pt/app/water-tracker-waterllama/id1454778585?l=en-GB
[6] https://play.google.com/store/apps/details?id=com.codium.hydrocoach&pcampaignid=web_share
[7] https://apps.apple.com/pt/app/drink-water-drinking-reminder/id1478980974?l=en-GB

		and built-in achievements and statistics help motivate the completion of the daily plan.
Daily Water	iOS	The app is simple and minimalistic – users manually set their goals and mark each glass they drink, while also being able to customise the volume of each "glass" and plan their drinking schedule. There are basic statistics (daily/weekly/monthly graphs) and a set of 10 notification melodies, which users find convenient for forming the habit of drinking water at the right time.

3.3.2 User Pain Points and Design Preferences

The following analysis identifies key pain points, usability challenges, and feature preferences for elderly users, based on a thematic review of app reviews and relevant usability studies.

3.3.2.1 Motivational Reminders

A consistent theme in user feedback was the balance between helpful reminders and “alarm fatigue.” For instance, the app Water Time Pro received praise for its sleep mode to disable late-night alerts. Users reported that such gentle, configurable reminders supported habit-building. In contrast, overly frequent or inflexible alerts were cited as a turn-off. A user of Water Drink Reminder left a comment saying that "I indicated that I drank 1.5 litres and the norm was fulfilled, but the notification still works, suggesting to add a cup or postpone." Customizability emerged as a crucial feature: individuals want control over reminder frequency and timing. A reviewer of Hydro Coach highlighted the ability to tailor both the interval and the notification message, unlike other apps that did not have a flexible platform to meet user specific needs. These findings indicate that adults prefer reminder systems that are predictable, adjustable, and context-aware (e.g., pausing during sleep). Effective hydration tools should therefore offer scheduling options (e.g. syncing with meal times or personal routines) and simple ways to acknowledge or snooze reminders, ensuring encouragement without perceived intrusion.

3.3.2.2 Attitudes on Gamification and Social Features

A comparative analysis was conducted to evaluate user responses to gamified design elements and social feedback. While gamification can foster engagement, findings reveal mixed reactions among the audience. Plant Nanny, a gamified app where each drink grows a virtual plant, illustrates this dichotomy. Some users valued its playful approach, describing it as "fun to use" and providing incentive to stay hydrated. Others, particularly older adults, found the graphics off-putting or mechanics overwhelming, especially after updates introducing monetization. These results suggest that although visual progress and rewards (such as growing a plant or earning badges) can enhance morale, the design must be carefully tailored for seniors' cognitive preferences. Simpler achievement systems appear more effective. For example, Water Balance incorporates badges and was called a favorite by one user who appreciated the positive reinforcement. Notably, this user appreciated the app's simplicity and expressed only a desire for optional playful sound effects, indicating that lightweight gamification (small rewards, subtle visuals) may motivate older adults without overwhelming them.

Social features were less frequently mentioned in hydration app reviews. However, relevant studies suggest that older adults may respond positively to social comparison, particularly if they are habitual users of digital tools. External literature supports the use of caregiver-linked reminders, as implemented in medication apps like Medisafe. In summary, gamification and social engagement can be effective for older users if implemented minimally and optionally – such as through straightforward progress visualization, badges for achievements, and the ability to share updates with selected contacts.

3.3.2.3 Interface Usability and Accessibility

Common UI/UX challenges experienced by older users were identified through a review of app store comments and usability studies. Two key principles repeatedly emerged: interface simplification and enlarged visual elements. For example, a user of My Water Reminder reported that the "add water" button was pushed off-screen late in the day, complicating intake logging. Such issues underline the importance of responsive design and visibility of interactive controls – particularly for users with visual impairments or those using larger system font settings.

Conversely, some apps were positively highlighted for their accessibility. Waterful, selected as App of the Day in several regions, received praise for its simple interface. One reviewer noted that the app provided usable data for clinical consultations and integrated well with Apple Watch.

Font size and contrast were frequently cited in both user reviews and literature as vital. Research recommends the use of large text (18–30 pt) and high contrast to accommodate age-related vision decline. Other interface improvements include tutorial guidance, intuitive navigation, and customizable settings (e.g., measurement units, drink size). These features were consistently linked to positive experiences and higher retention.

These app evaluations and literature sources informed the development of personas, journey mapping, and subsequent prototype design strategies. The findings ensured that identified features and interactions are based on empirical evidence and aligned with the behavioral and cognitive profiles of older adult users.

3.4 Persona Development

In the context of developing a mobile application to help prevent dehydration in older adults, creating user personas and developing scenarios were made for ensuring user-centered design. These characters are created based on a synthesis of various empirical data sources, including survey responses, app reviews, and observational studies related to aging and behavior in digital interactions. The purpose of this methodological step is to base design decisions on the real experiences of typical users, especially considering the cognitive, motivational, and behavioral diversity of older adults.

User journey mapping complements character development by visualizing the step-by-step interactions that a user may have with the proposed solution. This step is taken to identify potential barriers and emotional triggers. As Kalbach (2016) notes, experience mapping is necessary to reflect the real context and align digital services with user behavior patterns. Given the unique needs of an aging population, such as declining working memory, variable routine stability, and varying levels of comfort with technology, mapping app usage scenarios helps to identify useful ideas.

Following best practices outlined in key UX and service design literature (Kalbach, 2016; Travis, 2019; Mulder, 2016), this study employed a rigorous approach to persona creation. Personas were iteratively refined through qualitative insights and quantitative findings, ensuring they reflected distinct motivational profiles and routine types among older users. By doing so, the resulting profiles supported not only empathy-driven design but also provided strategic direction for feature prioritization, UI clarity, and motivational element integration.

3.4.1 Persona 1 – Experienced Older User with Consistent Hydration Habit

Profile: Pedro, 72, retired. Lives independently, physically active, uses a smartphone confidently for daily activities. Fully aware of the benefits of hydration and already drinks approximately 2 liters daily. Uses the app primarily for accurate tracking and to maintain consistency. Reminders and gamification are not essential for him; historical data and health insight are key.

Table 3: User 1 scenario walkthrough

Phase	User Goal	Actions Taken	Emotions and Thoughts	Pain Points and Opportunities
Awarness	Confirm app's usefulness despite already having the habit	Learns about the app through media or friends; explores its tracking features	Curious but skeptical – "Do I need this if I already drink water?"	Pain point: benefit not immediately obvious. Opportunity: historical logging and precise data (which many water trackers don't offer to older adults) .
Onboarding	Set it up quickly and manually	Installs the app; customizes water goal manually; disables unnecessary features	Calm, goal-oriented – "Let's see how it works"	Pain point: frustration if onboarding is long. Opportunity: fast setup, option to skip registration, large typography for comfort.
First Use	Track daily intake accurately	Logs first glass using quick button; browses stats/history section	Satisfaction – "Simple and effective"	Pain point: fixed portion sizes may be limiting. Opportunity: flexible logging, instant visual feedback boosts engagement.
Reminders	Receive non-intrusive, optional nudges	Edits reminders, possibly disables most	Appreciates control – "Don't bother	Pain point: redundant alerts are annoying.

			me if I don't need it"	Opportunity: advanced settings (e.g., only remind if not on track by 5 p.m.).
Progress	Track trends and performance	Checks stats weekly/monthly; compares with past performance	Proud – "I'm staying consistent"	Pain point: if data history is lacking. Opportunity: trend visualization, exportable data for sharing with physician or self-monitoring.
Routine Formation	Reinforce his habit with minimal input	Uses app after each glass; syncs with routine (e.g., morning and bedtime check)	Confident – "Part of my daily rhythm now"	Pain point: boredom with logging. Opportunity: smart tips, gentle dynamic goals (e.g., extra intake in heat) maintain interest.
Continued Use	Long-term hydration tracking	Maintains daily use; may customize features over time	Peace of mind – "This tool helps me stay on track"	Pain point: monotony. Opportunity: light data insights, integration with other health metrics (steps, BP) to maintain engagement.

3.4.2 Persona 2 – New Hydration Learner Encouraged by Physician

Profile: Joana, 68, retired. Lives alone. Wasn't used to drinking water regularly. Her doctor recently explained how dehydration might affect her fatigue and dizziness. Not very confident with technology; needs an app that is easy, clear, and motivating. She benefits from reminders, visual progress indicators, and simple language.

Table 4: User 2 scenario walkthrough

Phase	User Goal	Actions Taken	Emotions and Thoughts	Pain Points and Opportunities
Awarness	Understand why hydration is important	Learns from physician; hears about app from family	Concerned → hopeful – "Maybe this can help"	Pain point: used to underestimate hydration's role. Opportunity: expert recommendation builds trust; app and doctor bridge knowledge gap.
Onboarding	Set up the app with or without help	Installs app (alone or with family); accepts default goal	Slight anxiety → pride – "I managed to do it"	Pain point: complex setup, small text . Opportunity: simplified onboarding, skip account creation, large buttons, senior mode.
First Use	Log first glass, feel successful	Follows tutorial; taps "+250 ml" after drinking; sees progress bar	Encouraged – "It works, I can do this"	Pain point: confusion if UI unclear. Opportunity: one prominent button, immediate positive feedback.
Reminders	Stay consistent throughout the day	Receives reminders (e.g., every 2 hours); drinks and logs	Supported – "I'm glad it reminds me"	Pain point: may miss reminders if quiet . Opportunity: personalized tones, visual+audio alerts, even recorded family messages .
Progress	Feel rewarded and track improvement	Reviews water intake daily; gets weekly stats	Proud – "I'm doing well!" or disappointed if off-track	Pain point: too abstract stats. Opportunity: simple visual feedback, daily encouragement, hydration benefits pop-ups for

				motivation .
Routine Formation	Build a stable hydration habit	Starts drinking with meals; fewer reminders needed over time	Confident – "I'm used to this now"	Pain point: habit regression during disruption. Opportunity: adaptive reminders, link to daily anchors (meals/meds) .
Continued Use	Maintain hydration and avoid setbacks	Uses fewer reminders; logs water at key moments; shows doctor progress data	Empowered – "I feel healthier and in control"	Pain point: motivation drop. Opportunity: light ongoing education, family encouragement, stable UI, optional insights (e.g., tips for hot weather) .

3.5 Summary of User Needs

The findings from the quantitative survey, open-ended responses, and desk research reveals a diverse and nuanced set of user needs that must be addressed in the development of a digital hydration monitoring solution tailored to older adults.

A key challenge is the heterogeneity in digital literacy within the target group. While 90% of surveyed users report daily smartphone use, their confidence and experience with health-related apps vary significantly. This discrepancy necessitates a progressive onboarding strategy. Instead of offering full functionality upfront, the interface should support gradual feature exposure: users with less confidence should begin with core functions—such as hydration reminders and basic tracking—while more experienced users should be able to activate advanced features, such as historical statistics or integration with other health data, at their own pace. This layered approach supports autonomy while avoiding cognitive overload for less digitally fluent individuals.

The survey's Key Findings indicate a tendency toward reactive hydration behavior, largely driven by external cues like temperature or visibility of water. Only a minority actively track intake. This underscores the importance of incorporating visual cues (such as a persistent progress bar or friendly icons) and aligning reminders with natural routines (e.g., meals,

medication). It is also important that notifications remain customizable and non-intrusive, as 30% of users preferred not to receive them at all. Features that allow full control over timing, sound, and frequency—along with the option to disable reminders entirely—will therefore be essential to support user comfort and autonomy.

Analysis of qualitative responses reveals additional emotional dimensions. Some users feel pressured by general health narratives (e.g., the 2.5-liter rule), while others derive motivation from structured routines or family support. This suggests that the application should respect user agency and offer a flexible tone of communication—supportive rather than prescriptive. Including optional educational elements (e.g., hydration facts or expert tips) rather than fixed goals may reduce friction and promote intrinsic motivation.

The desk research adds further clarity around interface design preferences. Visual clarity, large buttons, and simplified flows are repeatedly cited as critical to usability. In contrast, hidden menus, excessive text, or gamified interfaces without clear utility are seen as confusing or infantilizing. However, lightweight gamification—such as achievement badges or visual encouragement—can be motivating if implemented subtly and presented as optional. Importantly, features must be easy to ignore or disable without impairing the primary functionality.

One important unmet wish emerging from qualitative insights durind quantitative survey is the desire for spatial and contextual relevance. A comment about placing physical reminders in specific home zones points to the potential for geolocation-based nudges (e.g., hydration prompts when entering the kitchen), or syncing with wearables that remain with the user throughout the day. This suggests opportunities for extending functionality beyond the mobile screen, enhancing habit formation through environmental anchoring.

In summary, older adult users require a hydration app that is empathetic, flexible, and adaptive. Their needs include a minimal initial interface with optional expansion, customizable and respectful reminders, simple interaction mechanics, and trust-building through transparency. Emotional comfort, routine alignment, and the option to personalize every aspect of interaction are central to user satisfaction.

These findings will serve as the foundation for the next phase of this project — the prototyping process. A modular and inclusive interface will be developed that reflects the diversity of user experience and accommodates both novice and confident digital users without sacrificing usability or prolonged engagement.

4 Prototyping Process

The prototyping phase translated the insights from user research and the literature review into tangible design solutions for the mobile hydration app. Chapter 4 details how initial design requirements were defined, the development of a first prototype, its evaluation against user needs, and the subsequent refinements leading to a final prototype and design system. The process was iterative and user-centered, ensuring that the evolving design remained aligned with older adults' needs for hydration habit support, accessibility, and engagement.

4.1 Design Requirements

The design of the prototype was guided by key requirements derived from the literature review and user research findings. These requirements ensure that the application's features and interface address the needs and limitations of older adult users, focusing on necessary functionality and accessibility considerations.

4.1.1 Functional Requirements

By adhering to these requirements, the prototype aims to be both functional in addressing the hydration monitoring needs and accessible to the target user group. Each requirement above was used as a guideline in the creation of the first prototype, ensuring that design decisions are grounded in user-centered principles and evidence from prior research.

4.1.1.1 Personalized Hydration Goal

The application should provide personalized hydration goals and plans tailored to each user's characteristics (age, health conditions, activity level). This customization ensures relevance and effectiveness for diverse users, aligning with best practices that emphasize personalized settings to enhance user convenience (Ahmad et al., 2022).

Since literature noted that existing apps often account for weight/height/age but ignore environmental factors. To address this gap, the app should include ambient temperature or weather data when setting goals, as hotter conditions demand higher intake. This requirement aligns with findings that most apps neglect environmental context even though it is crucial for older adults' hydration needs.

4.1.1.2 Easy Logging of Intake

Users need to log each glass of water or beverage consumed with minimal effort. The app should provide one-tap quick-add buttons for common portion sizes (e.g. a glass or cup) and an option for custom volume input. This reduces reliance on typing, important for older users who may find on-screen keyboards cumbersome, as latest studies suggest (Gomez-Hernandez, 2023a). The input method should favor simple taps over complex gestures, consistent with guidance to "favor control tapping over gesture interactions" for seniors.

4.1.1.3 Reminder System with Flexibility

Reminders are central to habit formation in this context, as older adults may have a diminished thirst perception and often simply forget to drink (a problem noted in user research). The app must include automatic drink reminders at intervals or times that can be customized. Rigid reminder schedules in off-the-shelf apps were seen as a poor fit – some users wanted gentle hourly nudges, while others preferred fewer reminders to avoid annoyance.

Therefore, a flexible scheduler is required, allowing users (or their caregivers) to set the frequency (e.g. every 2 hours by default) and to define an active period (such as 8 AM–8 PM) so that no reminders occur during sleep or inconvenient times. Additionally, Gomez-Hernandez claims that reminders should be multi-modal (audible chime plus phone notification) to ensure they catch the user's attention even if vision or hearing is impaired.

The reminder system should be adaptive and customizable, allowing adjustment of reminder frequency and timing based on user behavior and preferences. This flexibility helps prevent alert fatigue by ensuring notifications remain helpful rather than intrusive. Users who

find frequent alerts frustrating can reduce or silence them, while those needing extra encouragement can receive more frequent prompts.

4.1.1.4 Feedback and Progress Tracking

To support habit formation, the app should give clear feedback on daily progress. Users need to see how much they have drunk and how much remains towards the daily goal. A simple progress visualization (e.g. a filling water droplet icon or a percentage complete) and textual feedback (e.g. "1600 ml out of 2000 ml, 80% of today's goal") fulfill this need. Prior studies highlight that showing such "visibility of system status" helps users stay aware and motivated (a principle akin to Norman's insistence on immediate feedback for actions), (Gomez-Hernandez, 2023a). The app should also acknowledge each logged intake (e.g. a brief confirmation message or animation) so that the user knows the action was successful. Beyond daily progress, the app must log history over time, enabling users to review past performance. Our target users and geriatric health experts expressed that seeing trends (e.g. a week's average intake) or streaks of goal achievement can reinforce the habit. Thus, a History section is required, summarizing past days and weeks. This history should be presented in an easy-to-understand format, avoiding dense tables or excessive statistics. A succinct summary (average daily intake, number of days goal met in a week, etc.) with the ability to export data (e.g. as a PDF report for a doctor) was identified as desirable.

4.1.1.5 Motivational Features

The application should incorporate lightweight gamification or motivational feedback to encourage consistent use. Examples include positive reinforcement messages, achievement badges for meeting daily goals, or a progress visualisation (daily streaks, percentage of goal achieved). These elements must be subtle and optional to avoid overwhelming the user. The goal is to boost engagement and motivation in a respectful manner, as studies suggest older adults can benefit from gentle encouragement and progress tracking to maintain new health habits (Gomez-Hernandez, 2023a).

4.1.1.6 Integration and Data Input Options.

Some tech-savvy seniors use devices like smartwatches or have health data on their phones. To leverage this and reduce user burden, the app may integrate with platform health services

(e.g. Apple Health or Google Fit). For instance, if the user consents, it could import weight or activity data to refine hydration calculations. The requirement is to support such integrations in a user-friendly manner (clear explanation and easy put out) for those who can benefit, without making it mandatory.

Additionally, exploring voice interaction is worthwhile: some users with arthritis or low vision might prefer speaking ("Log a glass of water") instead of tapping on the interface. While advanced, this aligns with recommendations to minimize keyboard use and utilize voice input for accessibility (Gomez-Hernandez, 2023a). Thus, the design should keep an open path for voice control or voice-assisted interaction.

4.1.2 Accessibility Considerations

Accessibility and usability considerations for older adults were paramount in the design requirements. People's physical and cognitive abilities change with age, and the app's design must accommodate those changes to be effective.

4.1.2.1 Visual Clarity

The interface must use large, legible text and high-contrast visuals. Generous base font size for all text (no small fine print anywhere) and simple, sans-serif typography for readability. Headings and key data displayed in extra-large text (e.g. 18–24 pt, depending on hierarchy), well above typical mobile app defaults. This is in line with recent design guidelines that explicitly recommend large font sizes for older users (Gomez-Hernandez, M. (2023).

The color palette needs to provide sufficient contrast between text/icons and the background. For example, the prototype avoids light gray text on white (a common issue in modern apps that can render text illegible to seniors). Instead, we use dark text on light backgrounds or vice versa, meeting contrast ratios consistent with accessibility standards (WCAG 2.1 Level AA requires ~4.5:1 contrast for body text) unnecessary detail or decoration is minimized.

4.1.2.2 Motor and Touch-Friendly Design

Age-related motor skill decline (tremors, reduced precision) means the app must be easy to navigate by touch without requiring fine motor control. led to designing large tappable buttons and controls with generous spacing between them. The wireframes specified buttons at least

7-10 mm in height on screen, exceeding typical guidelines for touch targets, to accommodate less precise tapping. The initial prototype's main screen followed this: the quick-add drink buttons ("Glass 150ml", "Cup 250ml", etc.) were large rectangular tiles, with ample padding between them, making it easy to hit the intended one (see Section 4.2.2). Similarly, tappable text (like "Allow Location" or menu labels) was presented in a reasonably large touch area. By keeping important buttons away from screen edges, we reduce the chance of missing the target or triggering OS-level gestures by mistake. Scrolling requirements are kept minimal – most screens fit on a single view or use simple swiping within a controlled context. In forms, default values and suggestions were provided where possible to minimize typing. For instance, in onboarding, if the app has access to Health data it can pre-fill age or weight, sparing the user from typing them. When typing is necessary, the app uses the appropriate simplified keyboards (number pad for numeric input, as was done for entering weight or ounces) to reduce input error. We also considered offering voice input as an alternative for logging ("Hey Siri, I drank a glass") since speaking can sometimes be easier than tapping for those with severe arthritis, aligning with the advice to explore voice interaction for accessibility. While full voice control integration is beyond the prototype stage, the design keeps text alternatives and clear pathways that would later allow adding such features.

4.1.2.3 Cognitive Load and Navigation

Cognitive changes with age (e.g. memory limitations, difficulty multitasking) demand a simple and consistent navigation structure.

4.1.2.4 Guidance and Onboarding

Provide built-in guidance to help users get started and continue using the app confidently. This can include an onboarding tutorial that introduces the basic functions with simple instructions, as well as context-sensitive hints or tooltips for new features. The design should accommodate a progressive onboarding approach: users can begin with core features and later "unlock" or explore advanced features at their own pace. Such supportive onboarding and gradual feature exposure address the diversity in digital literacy among older adults, ensuring less experienced users are not overwhelmed initially.

4.1.2.5 Offline Functionality

The core features of the app (such as viewing reminders and logging water intake) should be available without requiring continuous internet connectivity. Many older users may have limited access to mobile data or Wi-Fi, so the application must retain essential functionality offline and sync data when connectivity is available. Ensuring offline capability improves reliability and accessibility of the tool in various environments (e.g., outdoors or in homes without constant internet), so that hydration tracking is not interrupted by network issues.

4.2 First Prototype Development

Using the design requirements as a foundation, a first iteration of the mobile application prototype was developed. This first iteration prototype translated the specified functional requirements and accessibility guidelines into a layout. The development process focused on implementing the necessary features while keeping the interface as simple and senior-friendly as possible. All elements of the prototype were crafted in an impersonal, user-focused manner (avoiding any reliance on specific individuals' preferences), and the language and interactions were designed to be clear and approachable for older adults.

4.2.1 Wireframes

During the development of the first prototype, low-fidelity wireframes were created to map out the application's layout and interface elements. Each wireframe sketched the content and controls of a key screen, such as the user onboarding screen, the daily log (home) screen, the hydration history. Emphasis was placed on a clean and minimalistic design in these wireframes: for instance, the home screen wireframe featured a large display of the daily goal and progress, a prominent single button for logging a glass of water, and a straightforward navigation bar for accessing other sections (like History or Settings). By visualizing the interface structure in this way, it was ensured that every element served a clear purpose and that the overall layout remained uncluttered. The wireframing process also allowed early testing of different interface ideas (such as placement of the log button or the size of text) to ensure they aligned with the accessibility requirements (e.g., confirming that text and button sizes in the wireframes were sufficiently large for older users). These wireframes acted as blueprints, guiding the subsequent detailed design of the prototype screens in a consistent and user-friendly manner. Prototypes of the first iteration can be found in Appendix B.

4.2.2 Initial user flow

In parallel with wireframing, an initial user flow was drafted to outline how users would move through the app's main tasks. The prototype screens were given basic styling (using a neutral color scheme, e.g. high-contrast dark text on light backgrounds, and larger font sizes as planned). This prototype was not fully polished but was sufficient to perform usability walkthroughs.

The user flow begins with a first-time onboarding sequence. When the app is opened initially, the prototype flows through steps shown in Table 5.

Table 5: Onboarding flow

Screen	Description
Welcome Screen	The user is greeted with a friendly introductory message ("This app helps you drink enough water every day") and a clear call-to-action button "Set up." This succinct welcome was designed based on user research feedback that older adults prefer apps to get to the point quickly without lengthy intros. Tapping "Set up" moves to the next step.
Personalization – Health Data or Manual	he user is asked to personalize their hydration goal. In the prototype, this was a two-step process. First, a screen offers to connect to the phone's health data. The screen had two large options: "Connect to Health" and "Manual input." If the user tapped Connect, the idea was to integrate with Apple Health (for iOS) to fetch existing age, weight, or even recent hydration data. (This flow could not be fully simulated in a prototype without actual data access, but it was represented for conceptual purposes.) Alternatively, tapping "Manual input" allowed the user to enter their weight (in kg) and age. The prototype showed simple number fields for these, with plus/minus buttons to adjust values to avoid keyboard typing. After input, the user hits "Continue."
Goal Calculation Feedback	Immediately after entering weight and age, the next screen in the prototype displayed the calculated daily water goal. For example, if a user entered 65 kg and age 61, the app showed "≈2200 ml per day" as the recommended goal (the formula was basic for the prototype, e.g. 30 ml per kg plus an age factor). This screen served two purposes: to reassure the user that a personalized goal was set, and to allow a quick review or adjustment. Users could go back to adjust inputs if something was wrong, or simply proceed. The inclusion of this confirmation step was guided by the idea of

	giving users a sense of control and understanding.
Personalization – Environment Context	Next in the onboarding flow, the prototype asked for location permission to factor in the weather. The screen explained in plain terms. Two options were provided: a button “Allow Location Access” and an alternative “Manual input” with a city text field. This design (two clear choices) was chosen to ensure even users wary of granting location data could still proceed by typing a city name. In the prototype, entering a city and tapping “Continue” would simulate fetching the current temperature (in our example, “Porto, 22° C”) and then move to the final step. If the user allowed GPS location, that step would be automated. The interface used simple language and avoided technical jargon like “GPS” – it said “Allow Location” and “Enter your city,” which are straightforward terms.
Completion of Setup	After setting location, the onboarding concluded, and the user was taken to the main app (Today screen), included a friendly prompt on this transition: “Setup complete! Let’s log your first intake.” This prompt was to immediately engage the user in the primary task (drinking water) and illustrate how to use the main screen.

On the Home screen, the user sees their daily status and can log water. In the first prototype, this screen has the header with the location and temperature (“Porto 22°”) to subtly remind the user that weather is being considered. The center showed a large percentage and remaining amount (“75% complete, 900 ml remaining” in a later state; when first used it would be “0% complete, 2200 ml remaining out of 2200 ml”). A large water droplet graphic was used as a background or side element – initially envisioned to fill up graphically as water is logged (though in the prototype it was a static gray droplet icon, due to time constraints in prototyping). Beneath this, the logging panel offered the preset volume buttons (Glass, Cup, Bottle). The user could tap any of these after drinking to immediately log that amount. For instance, if they drank a cup (~250 ml), one tap on “Cup 250ml” would subtract 250 from the remaining amount and update the display (e.g. from 2200 ml remaining to 1950 ml remaining). The prototype demonstrated this by hyperlinking the buttons to alternate versions of the Today screen with updated numbers (one showing 10% complete, another with 75%, etc., to simulate progressive logging).

For amounts different from the presets, the user could hit “Input manually”, which in the prototype brought up a numeric keypad overlay. Since numeric input is a potential pain point for some older users, it only has an alternate path (presets first) and using a familiar telephone-style keypad (with large keys), that has mitigated difficulties. This design decision came directly from

user requirements for efficiency and error avoidance – tapping predefined buttons is quick and has low cognitive load, whereas typing a number gives flexibility for edge cases (like an unusual bottle size) while still being as simple as possible. In a future iteration we considered allowing voice input here ("Add 200 ml"), but that was beyond the initial prototype's scope.

After each logging action, the Today screen was designed to display feedback. The prototype, for example, after logging 220 ml, showed a small line "Last intake: 220 ml at 8:19 AM" below the main progress text. This immediate logging confirmation reassures users and builds a sense of accomplishment. The Next reminder timing was also shown on this screen: e.g. "next reminder in 2 hrs." In the prototype, this was a static placeholder, but the intended behavior is to count down based on the user's chosen reminder interval and last log time. This way, users always know when to expect the next notification, which can help them align with their routine (and also serves as a hint – if they see "next reminder in 30 min" they might decide to drink earlier).

Navigating the prototype, the user could switch to the History screen or Settings screen via the menu. In the first prototype, we implemented simple navigation: tapping the "History" label (or icon) would jump to the History section. The History screen in the prototype was basic but functional. It displayed the days of the past week with the total intake for each (e.g. Monday – 2000 ml, Tuesday – 2200 ml, etc.), and a message like "Last streak: 7 days in a row, earned 18.05 points" as a motivational summary. It also had an option to toggle to "Month" view, though in the prototype this just showed a similar summary for the month. At the bottom of the History screen, was included a note "You can export a hydration summary (PDF) for medical review," anticipating the need to share data with doctors. This feature wasn't interactive in the prototype.

The Settings screen allowed the user to adjust reminder preferences. The prototype's Settings screen included controls for Notification frequency ("Every 2 hours" by default, tapping it would allow choosing 1, 2, 3... hours from a picker), the start and end time for reminders ("Start at 7:30 AM" and "End at 9:00 PM" in the prototype example), and toggles for sound and vibration. In the prototype, changing these settings wasn't functional, but the screen design conveyed what options would be available.

4.3 Prototype Revision Based on Persona Scenario Walkthroughs

Following the initial prototype development, the design underwent a systematic evaluation phase using scenario-based walkthroughs with previously developed user personas (Chapter 3.4 Persona Development). This method was selected to identify usability gaps and alignment issues

between the proposed user experience and the distinct cognitive, motivational, and behavioral profiles of the target audience. Structured walkthroughs were performed using the personas of Pedro (a confident, habit-driven user) and Joana (a newly motivated user relying on reminders and guidance). Each persona was guided through critical user scenarios that represent typical interactions with the application.

4.3.1 Scenario 1: First-Time Setup and Onboarding

Tested screens: welcome screen, profile setup, hydration goal calculator (based on age/weight), and reminder configuration.

Pedro's walkthrough revealed a mismatch between the onboarding flow and his needs. As someone with an established hydration habit, Pedro already knew his ideal water intake and would have preferred to manually input his own daily goal at the start. However, the application forced him through steps calculating hydration needs based on age and weight, which he found unnecessary. Also noted the absence of settings to later change this goal. In contrast, Joana experienced onboarding fatigue: she was overwhelmed by the number of setup steps before being able to start using the app. She needed more encouragement and would have benefited from delaying reminder setup until after she logged her first drink. In her case, the health conditions she mentioned (which could influence hydration needs) were not considered by the app, leaving the proposed goal feeling impersonal.

Recommended Revisions: Include a manual input option for hydration goals early in onboarding. Allow modification of daily goal within the app's settings. Reduce the number of setup screens and delay notification customization until after first interaction with the app. Consider including a question about known health conditions to better tailor recommendations.

4.3.2 Scenario 2: Logging Water Intake

Tested screens: main home screen, water logging button, portion size selector.

For Pedro the pre-set volume buttons (e.g., 250 ml) inadequate, as he typically drinks from a personal 450 ml bottle. He had to input custom volumes repeatedly, which was inconvenient. A useful enhancement would be the ability to save the last used volume or define a default. Also noted the lack of an easily accessible "undo" option, which could create friction if users make mistakes. Joana, who is still developing a hydration habit, does not always remember to log every drink. Instead, she would enter the total amount retroactively at the end of a walk. She could benefit from tips encouraging her to drink and log in smaller increments, aligned with better hydration practices.

Recommended Revisions: Implement a memory feature that recalls the last custom input or allows users to define their standard drink size. Add a prominent “undo” button for recently logged entries. For users like Joana, offer contextual tips about optimal drinking behavior (e.g., smaller sips throughout the day).

4.3.3 Scenario 3: Reminders and Notifications

Tested screens: reminder configuration during onboarding, sample push notifications (mocked), reminder preferences in settings.

Pedro did not require regular reminders and preferred minimal interference from the app. Joana, however, relied on reminders and wanted them tied to her daily routine, such as post-meal or medication times. She might benefit from supportive suggestions on how and when to hydrate.

Recommended Revisions: Provide fully customizable reminders, including scheduling reminders at specific hours and associating them with daily events (e.g., after meals). Introduce an optional series of motivational and educational tips within reminders to encourage consistent use. Simplify notification tone and design to make prompts feel supportive rather than prescriptive.

4.3.4 Engagement and Retention Recommendations

Based on the scenario walkthroughs, user retention can be improved not only through smoother onboarding and adaptable logging, but also through long-term engagement strategies. Joana would benefit from gentle in-app encouragement, such as milestone achievements (e.g., five days in a row of logging) and personalized hydration tips. Pedro may prefer access to historical data and periodic summaries that reinforce his existing habits.

A “streak” indicator, periodic summary screens (e.g., weekly intake overview), and customizable hydration education modules. For less confident users, a re-engagement message after 48 hours of inactivity could prompt return use with a friendly message and a single-tap logging shortcut.

4.4 Final Prototype and Design System

The final version of the prototype preserves the structure and screen flow developed during the initial design phase. However, significant modifications were implemented in response to the

usability insights identified in Section 4.3. These changes aimed to improve accessibility, streamline onboarding, and tailor hydration goal personalization to better reflect the needs of both confident and newly motivated users.

Table 6: Updated user flow

Screen	Modifications from Initial Version
Welcome Screen	Simplified layout; improved color contrast; larger typeface for enhanced legibility
Personalization – Health Data or Manual	Optional manual input of hydration goal added; dropdown menu for selecting relevant medical conditions (e.g., kidney disease, diabetes, heart failure)
Goal Calculation Feedback	Added health guideline reference; hydration goal now shown in both liters and visual equivalents (e.g., glasses)
Personalization – Environment Context	
Completion of Setup	Notification settings moved to post-onboarding; improved clarity of final instruction text
Main Screen (Hydration Tracker)	Larger “Add Water” button; portion presets adjustable; undo button added; hydration progress shown both numerically and visually
Logging Panel	User-defined default volume retained; improved haptic and visual confirmation feedback after input
Reminder Settings	Full customization of reminder times added; explanation of purpose included; softer tone used in notification text
Profile and Preferences	Added settings to edit daily goal, medical data

The development of the prototype and its evolution into the final design was facilitated by modern UI design and prototyping tools, and developed in Figma. The Figma prototype includes interactive flows for onboarding, water intake tracking, and reminder configuration.

A shared design system was implemented using Figma's components and style tokens, covering text styles, colors, spacing guidelines, and button states. This system ensures consistency across screens and supports future development of additional features, including environmental context personalization and caregiver-linked accounts.

5 Usability Testing

Usability testing was conducted to evaluate how older adults interact with the prototype and to uncover potential usability issues before proceeding to further design iterations. This phase aimed to ensure that the application is not only functionally correct but also intuitive, accessible, and emotionally comfortable for the target audience. The feedback gathered in these sessions played a key role in validating design choices and refining interface elements in accordance with user needs and digital confidence levels.

5.1 Methodology and Setup

To evaluate the usability of the prototype developed for older adults, a series of individual remote sessions were conducted. The main objective was to observe how older users interact with the application, identify potential difficulties, and collect qualitative feedback that could inform further improvements.

Each session followed a structured yet conversational format and lasted 30–60 minutes. Participants joined the session via Telegram or WhatsApp, depending on what was more convenient for them. At the beginning of each session, participants were briefly introduced to the purpose and goals of the project. They were instructed to treat the screen images as if they were real app screens and were encouraged to freely share their thoughts, impressions, and questions while completing the tasks. Interface screens were shown one by one as images sent through chat during the call. Sessions followed predefined user task scenarios described in section 5.3. Each participant was guided through the full interface flow, beginning with the onboarding screens and continuing through the main home screen, hydration logging, reminder setup, progress tracking, and settings, and the history view. This walkthrough provided a comprehensive look at how the app is intended to be used in everyday scenarios. This structure helped identify which elements were immediately clear to users and where confusion or

hesitation occurred. No interaction with the prototype was required from participants themselves — they were guided through the prototype and asked to indicate what they would do on each screen.

Participants were encouraged to verbalize their thoughts, expectations, and preferences during the walkthrough. Additionally, on screens where users were presented with a choice — such as allowing location access versus entering a city manually — participants were first asked to confirm that they recognized this as a decision point. Their selections were then discussed in terms of underlying reasoning and motivational factors to better understand the logic behind their preferences. Observer notes were taken during each session to document usability issues, hesitations, positive reactions, and spontaneous comments.

5.1.1 Participants

The usability test involved 6 participants aged between 60 and 75, included three women and three men, with varying levels of digital literacy. All participants owned a smartphone and used it daily, but not all had previous experience with health-related mobile applications. Some participants mentioned that they already drink water regularly and saw potential in using the app to track their intake more precisely. At the same time, most shared that they do not have a clear idea of how much water they drink daily and noted that they might use the app primarily as a gentle reminder and hydration assistant.

Participants were recruited through personal networks and community connections. Prior to the session, they were informed about the goals of the project and gave verbal consent to participate.

5.1.2 Tasks and Scenarios

Each participant was guided through a series of common tasks that reflected realistic use of the app. Table 7 presents the task scenarios. The scenarios were presented as part of a continuous flow, starting from onboarding and proceeding through all key screens of the application. If a participant was unsure about what action to take on a screen, gentle guiding questions were asked as prompts to guide them toward possible actions in a natural and non-intrusive way. If this still did not lead to a decision, the expected action was shown and followed by a question about how the screen could be improved to make the next step more intuitive for them. Depending on the flow of the conversation and the participant's level of familiarity with mobile apps, additional follow-up questions were asked to clarify expectations

and uncover implicit needs. This approach ensured that both usability issues and user expectations were actively explored throughout the session.

Table 7: Usability Testing Tasks

Scenario	Approximate Task Prompt	Goal and Expected Action	Additional Questions
Scenario 1 – Set a Daily Hydration Goal	"You've just opened the app for the first time. Please set a goal for how much water you'd like to drink every day."	Evaluate clarity of onboarding and goal-setting flow. The participant is expected to either fill in the volume directly or tap "Edit" to manually enter a preferred amount.	What type of input do you expect to see — dropdown menu, manual typing, or scrollable picker (wheel)?
Scenario 2 – Log a Glass of Water	"Imagine you've just finished drinking a glass of water. Please record it in the app."	Assess ease and clarity of the water input process. The participant is expected to tap the main input button and select or enter the water amount.	How do you usually drink water during the day — from one specific cup or using any available container?
Scenario 3 – Adjust Reminder Settings	"After logging your first glass of water, the app suggests setting up reminders. How do you understand what the app is prompting you to do? How would you adjust the reminder times?"	Test understanding of notification settings in the second phase of onboarding. Expected actions include choosing specific reminder times or adjusting the default schedule via onboarding screens.	What type of input do you expect to see — dropdown menu, manual typing, or scrollable time picker (wheel)?
Scenario 4 – Check Your Progress	"Now check how much you drank on previous days, and view your hydration statistics overall."	Assesses ability to interpret visual data and locate tracking/history section.	Would you personally find this type of progress overview interesting or helpful? Would you check this screen regularly to track your results or

			achievements?
Scenario 5 – Edit or Delete Today's Entries	"You've logged a few glasses of water today. Now try to edit or delete one of your earlier entries from the main screen."	Evaluate whether participants can locate the list of today's entries and understand how to interact with them (e.g., tap to edit, swipe or long-press to delete). Expected interaction occurs on the main screen showing recent logs.	How would you expect to change or remove an entry — by dragging it, tapping and holding, or something else?

5.2 Findings and Design Changes Based on Usability Testing

5.2.1 Onboarding – Phase 1: Goal Setting

Most participants were able to complete the goal-setting step without major difficulty. However, one participant noted that the phrase "This app helps you drink enough water every day" might not accurately reflect the purpose of the app, since most people do drink water daily to some extent. They suggested that the goal is rather to support regular hydration or provide structured reminders.

On the "Set your hydration goal" screen, all participants understood that they could either fill in the form for automatic calculation or manually enter a goal. In practice, all chose to complete the form, stating they did not have specific recommendations from a doctor. The field "Chronic conditions" raised questions for some participants, who considered it too personal to share with an app. However, after a short explanation that certain health conditions may affect hydration needs, they said they would likely be willing to fill it in.

The "Edit" button used for manual goal input was not immediately recognized as interactive by two participants. Despite that, once on the manual input screen with a slider, all users found the scroll interaction intuitive and had no issues adjusting the value.

On the "Tailor your goal" screen, where users could choose a location, one participant was confused that the toggle to grant location access remained visible even after they opted to type in their city manually. Nevertheless, they noticed the "Continue" button became active and said

they would have clicked it. The “Skip” button was clearly visible and used confidently by all participants.

Later in the session, while on the main screen, one participant remarked that it was not obvious the location might need to be changed manually if they traveled to a different city. They suggested adding a brief explanation during onboarding when manual input is selected.

Design Adjustments Implemented

- The initial onboarding message was refined to emphasize consistency and reminders (“This app helps you stay hydrated throughout the day. Every day.”).
- The label for the “Chronic conditions” field was updated to “Relevant health conditions” to clarify its purpose.
- The “Edit” button was redesigned to improve its recognizability as an interactive element.
- On the location selection screen, the system location toggle was hidden once a city was entered manually.
- A short note was added during onboarding to explain that manually set locations will not update automatically.

5.2.2 Main Screen: Logging Water

The main screen was shown in two states: the “Log your first intake” version and the version reflecting continued daily interaction, following reminder setup in the second phase of onboarding.

Initial state – Log your first intake.

The central action button was generally perceived as intuitive. All participants said they would confidently tap one of the suggested volume options or choose “Enter manually.” The manual input field was also described as intuitive. One participant noted that they initially expected a slider, as seen during onboarding, but said “typing works fine too.” Considering the ease with which participants had interacted with the slider previously, it may be a more accessible input method for older users, especially those with limited motor control.

Some participants expressed uncertainty about the volume of their glass or cup. In this case, a combined visual reference — for example, a highlighted predefined portion aligned with the slider—could help users better estimate how much water they consumed.

Long-term use state.

The water intake chart, showing the drop icon and remaining volume, was understood by all users. Half of the participants said they perceive the percentage better, while the other half paid more attention to the remaining milliliters — indicating that including both metrics supports varied user preferences.

However, all participants were unsure how to interpret the middle part of the screen, which showed intake history and the next scheduled reminder. Several initially thought these values were hydration suggestions for the near future. After guiding questions and clarification, five users said the order of entries would be more understandable if reversed — starting from the earliest logged intake and ending with the upcoming reminder.

The main action button in this state was also generally clear. Still, not all participants understood that tapping the "+" icon would lead to manual input, rather than confirming a predefined option such as "Glass" or "Cup." While the "Last input" button was conceptually clear to everyone, four participants said they would prefer it to function as a "Favorite volume" button, allowing them to reuse the typical container they drink from. For example, one participant mentioned using the same disposable cup at work, while another said they always drink from a particular glass of non-standard size.

Icon-only buttons caused confusion among less experienced users. While all participants correctly identified the gear icon in the top-left corner as a way to open settings, five needed prompting to find the statistics screen via the graph icon in the top-right corner. During task completion, four participants reported they would have tapped the drop image or percentage chart instead.

Design Adjustments Implemented

- A slider was introduced as the primary input method for logging water volumes during early use. A visual link was added between selected amounts and familiar containers (e.g., "glass," "cup") to support better estimation.
- The order of logged water entries in the intake history was reversed, now showing from earliest to latest.
- The "+" button was names to indicate manual input.
- A "Favorite volume" option was added, allowing quick input based on commonly used containers.
- The visibility of the statistics section was improved by adding an alternative entry point via the progress chart.

5.2.3 Onboarding – Phase 2: Reminder Setup and Settings

Since reminder settings were part of the onboarding process and the screens involved repeated similar components, the findings are combined into a single section.

Users clearly understood the purpose of configuring reminders. All participants immediately recognized the function of the start and end time fields. One participant, despite understanding that the "Start at" and "End at" fields were editable, suggested adding arrows on the right side of the input fields to signal interactivity — similar to the interface used for selecting notification intervals.

The screen for enabling Hydration Tips was also immediately understood by all participants. Five participants said they would enable this feature; one of them added that they would only keep it on temporarily, "until the habit of drinking water is formed," and would later turn it off to reduce notification frequency.

Among those who said they would activate the tips feature, several participants expressed preferences about the content. They said they would appreciate personalized suggestions based on their actual water consumption data (one participant explicitly stated they had no concern about the app analyzing their hydration patterns). Additional suggestions included advice on how much to drink at different times of the day (e.g., a full glass in the morning or avoiding large amounts during meals). Participants felt that such practical and relevant guidance would help reinforce a more mindful hydration habit.

Design Adjustments Implemented

- Arrows were added to the "Start at" and "End at" fields to clearly indicate that they can be adjusted.

5.2.4 Progress and History

The History screen was generally understood by participants. The icons representing individual water intake entries were correctly interpreted. However, three participants mentioned that they would prefer to also see numeric values showing how much water had been consumed on previous days.

The "Last strike" achievement was perceived as "a nice bonus" and motivating by several users, but some expressed difficulty understanding how the feature worked. Similarly, the "Your statistic" — some participants felt that the section lacked clear personal relevance and was difficult to interpret in a meaningful way.

Design Adjustments Implemented

- Daily numeric totals for water intake were added to the history view to complement icon-based entries.
- A visual system of stars was introduced: each day where the hydration goal was reached is marked with a small star above the bar, and a summary below the graph displays the current and longest streaks (e.g., “Streak: 4 days in a row” and “Longest streak: 7 days”).
- The “Your statistics” section was revised to present more individualized insights, such as “Most skipped times,” “Improvement over time,” and “Week trends,” making the data more meaningful and easier to relate to personal habits.

6 Conclusions and Future Work

This study explored the hydration habits and digital preferences of older adults, aiming to inform the design of an accessible, personalized mobile application for hydration monitoring. Quantitative data from the survey revealed a generally high level of smartphone engagement among older users, but limited familiarity with specialized health apps. Many participants displayed reactive hydration behaviors, relying on environmental cues rather than structured intake habits.

Further insights from open-ended responses and secondary analysis emphasized the importance of interface clarity, personalized reminders, and motivational features that do not infantilize the user. Thematic desk research and analysis of user reviews of existing health applications helped to uncover consistent usability barriers, such as small fonts, complex onboarding flows, and rigid reminder systems. These insights were synthesized into two personas representing distinct user needs and interaction patterns, which were subsequently used to guide the prototyping process.

To validate the design, remote user testing sessions were conducted with older adults. These sessions provided critical feedback on navigation, input preferences, and content clarity, allowing for direct refinements to the prototype and strengthening the relevance of the proposed solution.

6.1 Summary of Contributions

This study aimed to identify the behavioral characteristics, interface preferences, and motivational attitudes of older adults in the context of digital solutions for hydration tracking. Based on quantitative survey data, open-ended responses, and secondary analysis of user reviews, key usage scenarios were formulated and represented as two prototype personas. These

personas formed the basis for the design of a functional mobile app prototype, addressing accessibility, notification flexibility, and varying levels of digital confidence.

Special attention was given to personalization, alignment of reminders with daily routines, and minimizing cognitive load. The prototype accommodates various daily contexts, with minimal effort required from users unfamiliar with digital health tools.

6.2 Empirical and Design Insights

Several key insights emerged from the combination of survey results, user interviews, and usability testing sessions:

First, although most participants reported daily use of smartphones, many demonstrated limited familiarity with health-related applications and behavior-tracking tools. Hydration routines were largely reactive, shaped by situational cues such as weather or physical discomfort, rather than consistent planning. Some participants mentioned that they forget to drink water simply because their phone is not always with them—particularly while gardening, walking, or doing chores—highlighting the need for reminder strategies that extend beyond device-centric interactions.

Second, preferences for reminders varied widely. While some users expressed appreciation for regular prompts, others found notifications distracting or unnecessary. Participants emphasized the importance of being able to control the timing and tone of reminders. Many preferred gentle encouragement over rigid scheduling or fixed intervals.

Third, motivational features such as progress tracking and achievements produced mixed reactions. While several participants found them encouraging, others saw them as irrelevant or unclear. The “Last strike” streak feature, for example, was generally liked when presented visually on the progress chart but required clearer explanation to be fully understood.

Fourth, visualization of hydration data was effective when presented in multiple formats. Some users focused on percentages, while others preferred to see milliliter values. Numeric totals for daily intake were considered helpful, and a combination of visual and textual data allowed for greater flexibility in how users interpret their progress.

Finally, participants expressed a preference for meaningful, context-aware hydration tips—particularly if they could be tailored to their daily routine or recent behavior. Suggestions like “drink a full glass in the morning” or “avoid too much water before meals” were seen as useful, especially if framed as practical advice rather than system feedback. There was little concern among participants regarding data processing, provided that the purpose and benefit were clearly communicated.

6.3 Further Development and Research Directions

The next stage of the project should focus on the actual development of the mobile application based on the current prototype and its subsequent evaluation in real-life use. Long-term testing with older adults will be essential to assess how the app performs beyond isolated usability sessions, particularly in the context of sustained behavior change and integration into daily routines.

However, throughout the research and testing process, several adjacent directions emerged that may significantly enhance the effectiveness of the app and user engagement. These areas are recommended for future research and potential implementation:

Connectivity with wearable devices (e.g., smartwatches or fitness trackers) could support passive tracking of user activity and hydration patterns. Wearables could also deliver subtle reminders—such as haptic feedback—when the user is not near their phone, which was a frequent occurrence reported during interviews.

Participants also described daily routines where smartphones were often left behind, particularly while gardening or doing household chores. This points to the need for alternative reminder mechanisms beyond screen notifications, such as sound, light, or location-based cues.

Future development could include optional caregiver or family member interfaces to support hydration monitoring remotely. This would be particularly useful for older users with memory challenges or limited device interaction, allowing for soft supervision and encouragement from trusted individuals.

Adaptive personalization mechanisms may also improve engagement. These could include dynamically adjusting the frequency and tone of reminders based on user behavior, or providing hydration tips that align with individual consumption patterns and times of day.

Finally, longitudinal research will be necessary to assess whether app usage leads to measurable health and behavior improvements. Combining in-app analytics with periodic user interviews will help determine both sustained adoption and impact, while informing ongoing refinement.

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8 Appendix

A. Survey Questionnaire

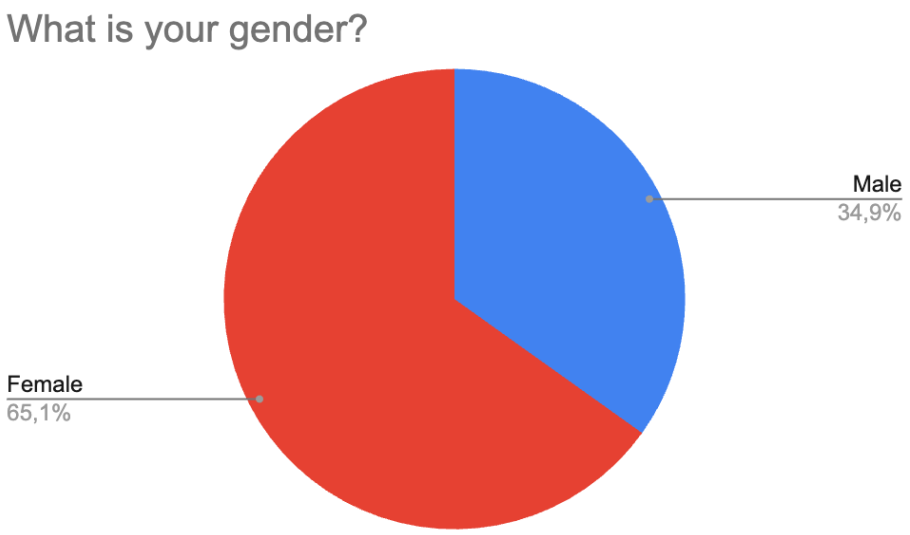


Figure A1. Respondents' gender distribution.

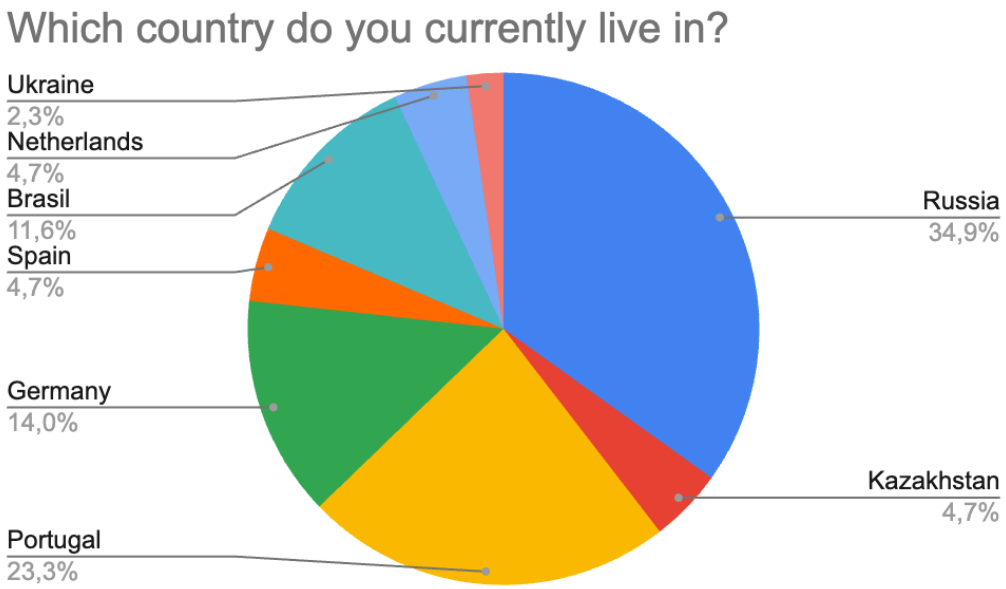


Figure A2. Country of residence.

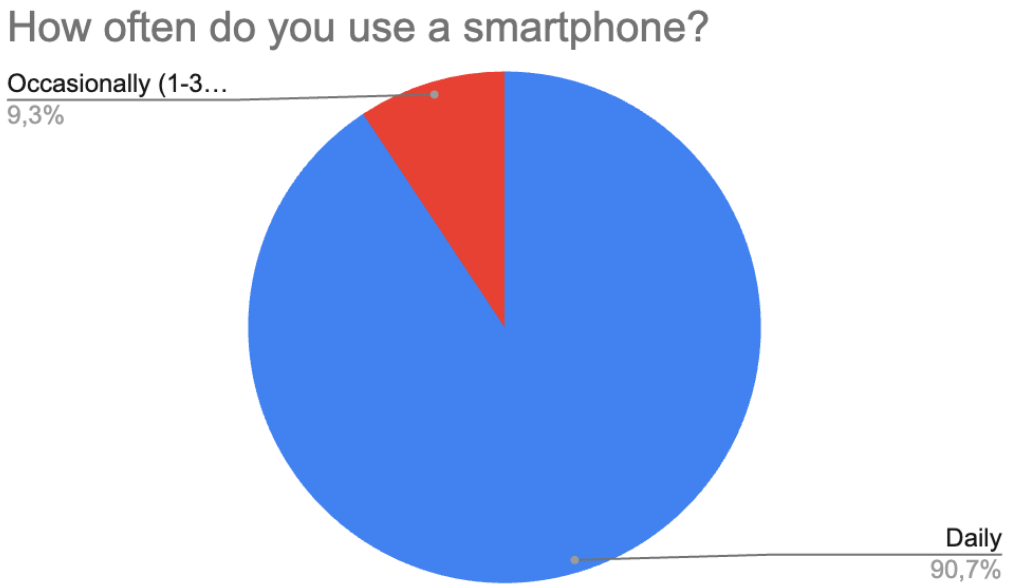


Figure A3. Frequency of smartphone use.

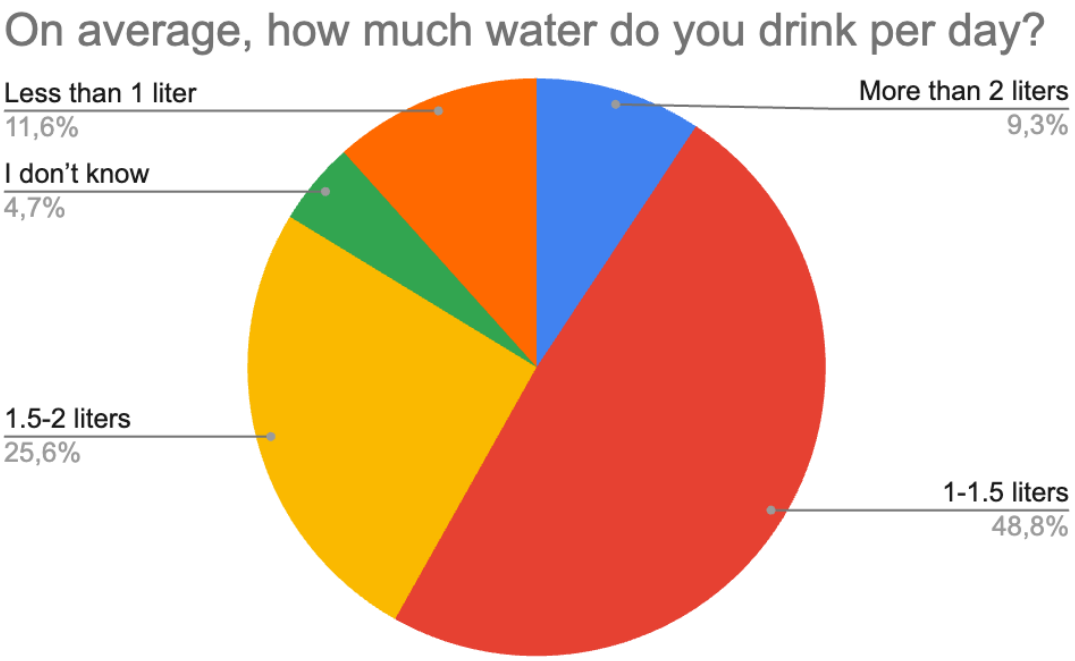


Figure A4. Average daily water consumption.

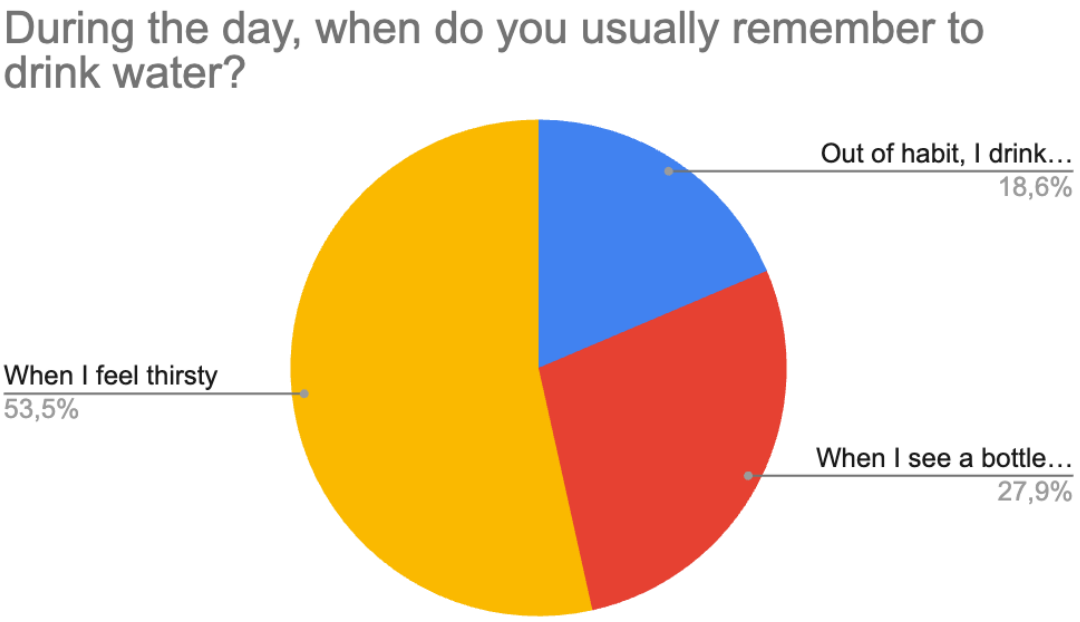


Figure A5. When respondents usually remember to drink water during the day.

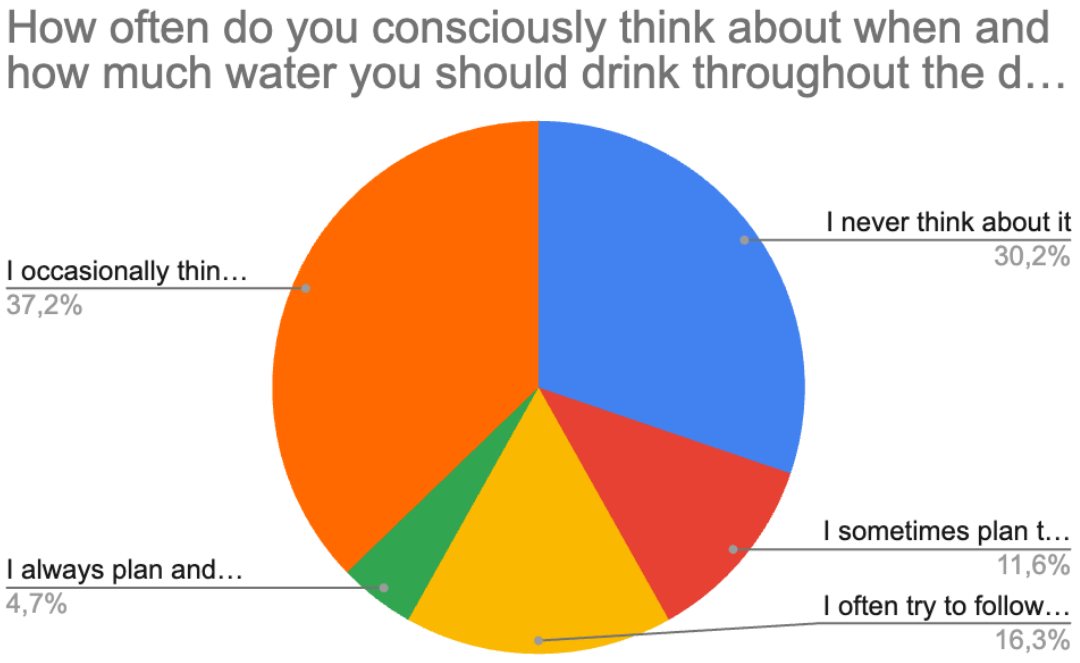


Figure A6. How often respondents consciously think about their water intake.

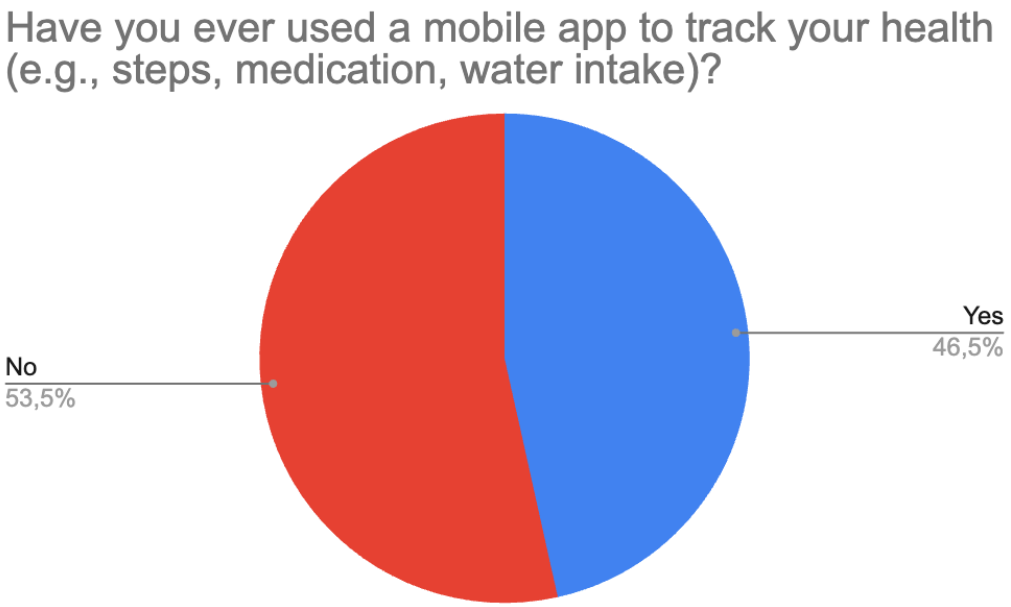


Figure A7. Use of mobile apps to track health-related metrics.

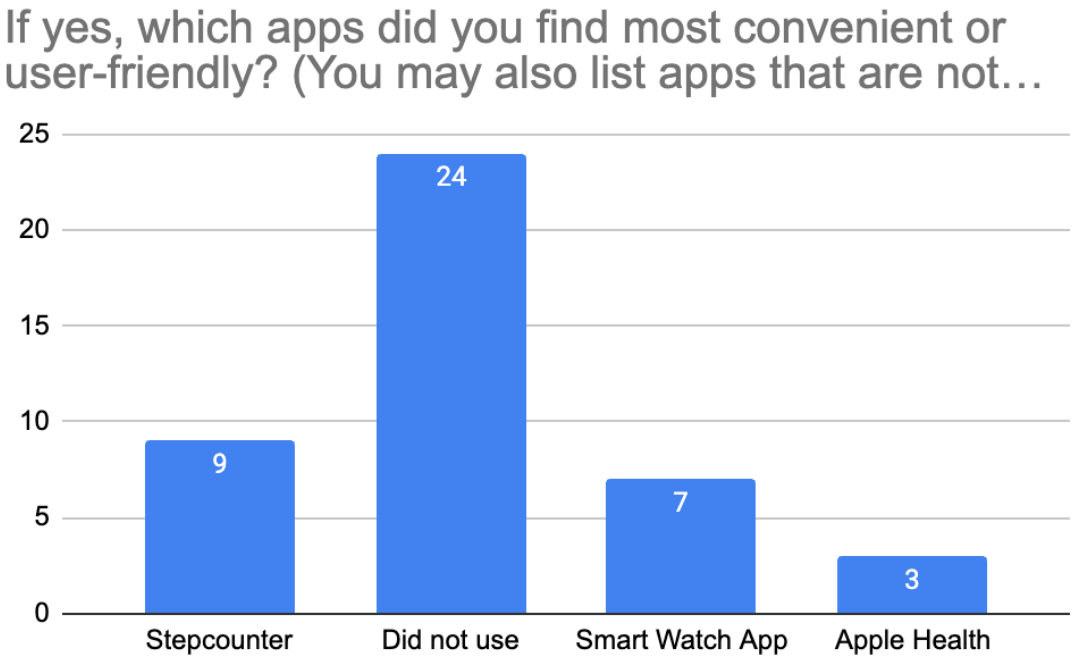


Figure A8. Most convenient or user-friendly health-related apps.



Figure A9. Preferred types of reminders for hydration apps (multiple responses allowed).

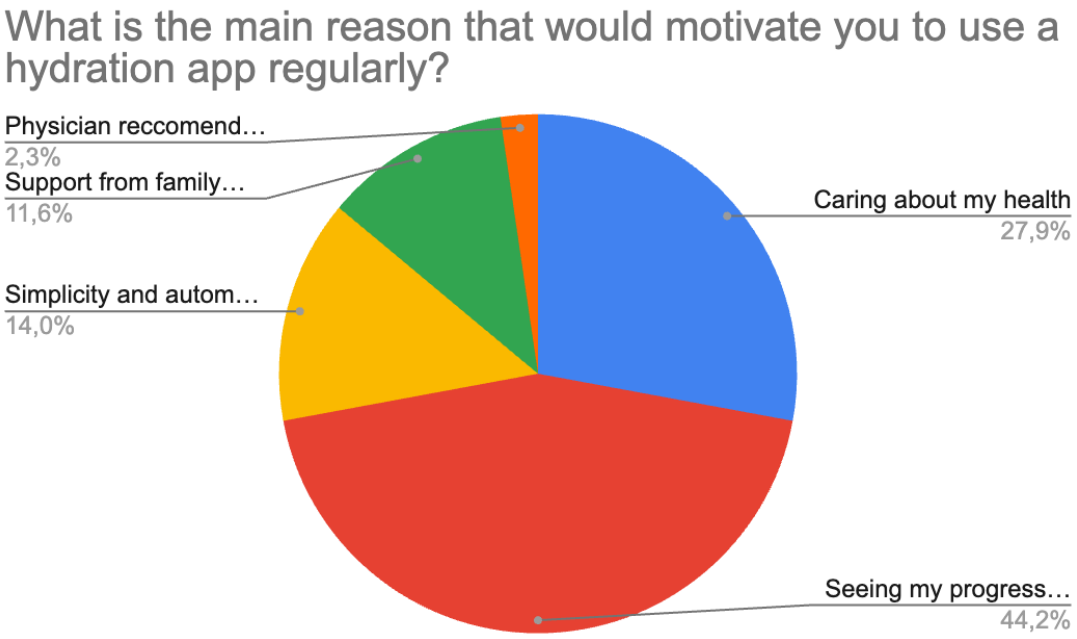


Figure A10. Main reason to use a hydration app regularly.

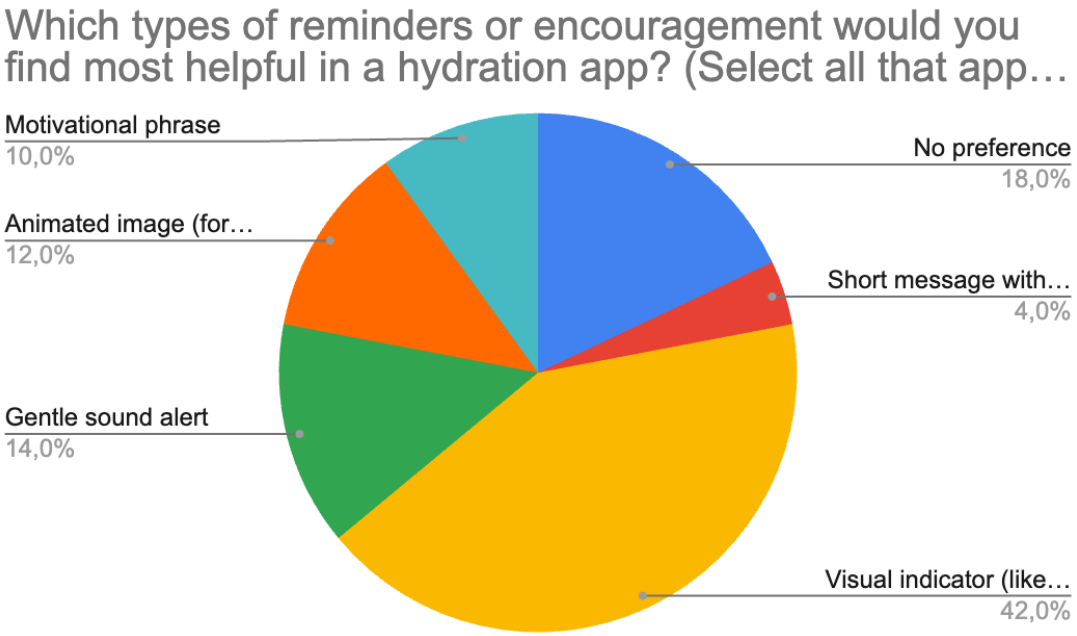


Figure A11. Preferred types of reminders or encouragement in a hydration app

(multiple responses allowed).

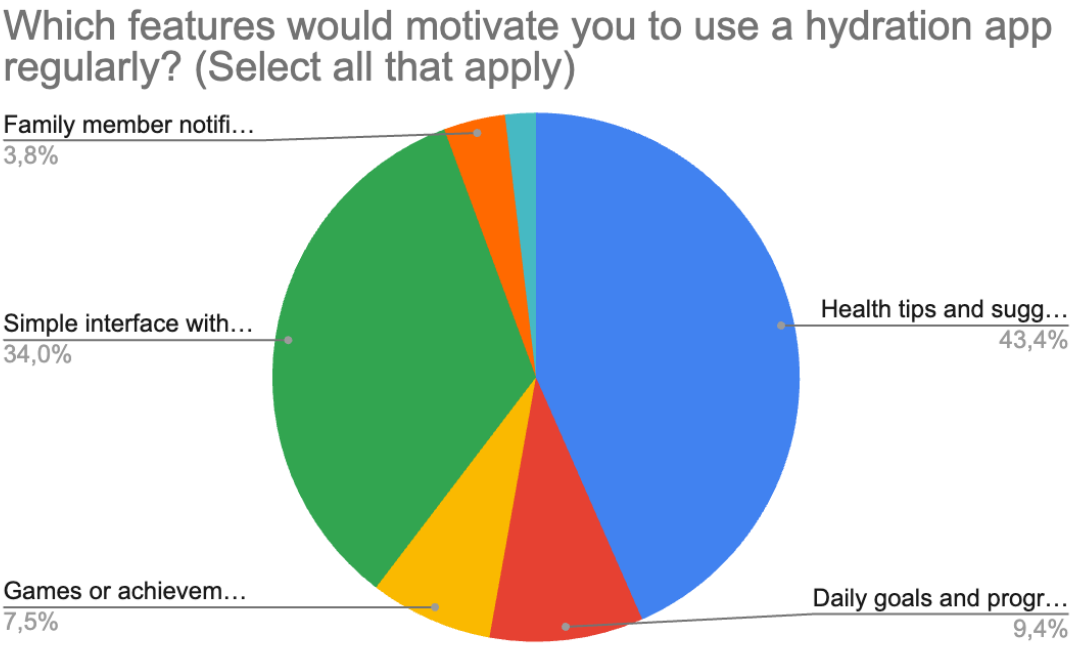


Figure A12. App features that would motivate respondents to use a hydration app regularly (multiple responses allowed).

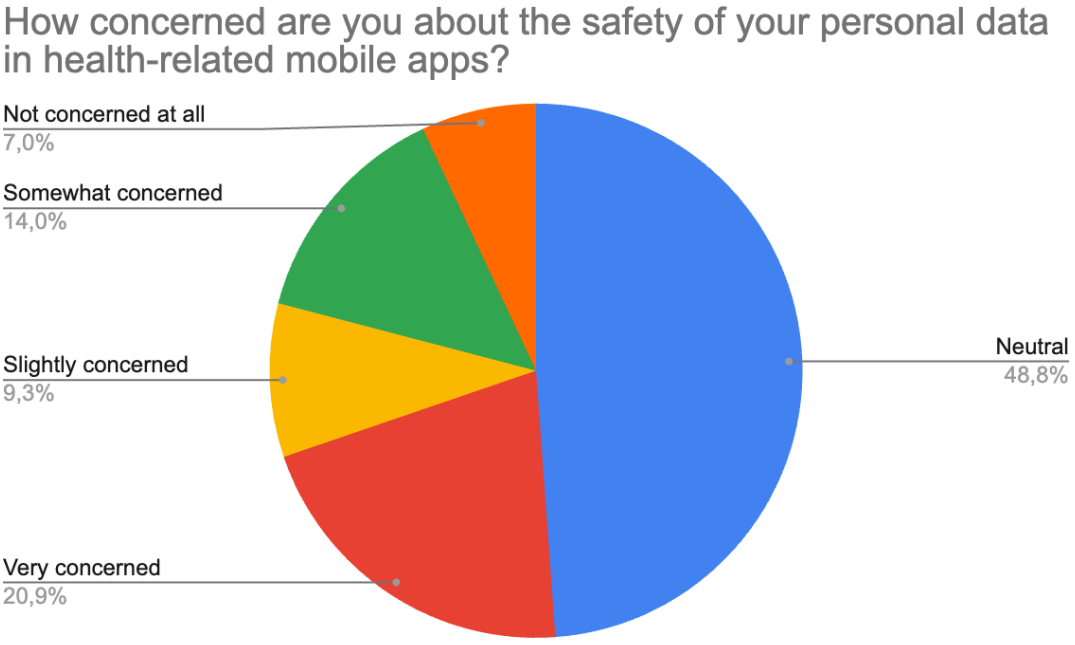


Figure A13. Level of concern about personal data safety in health-related apps.

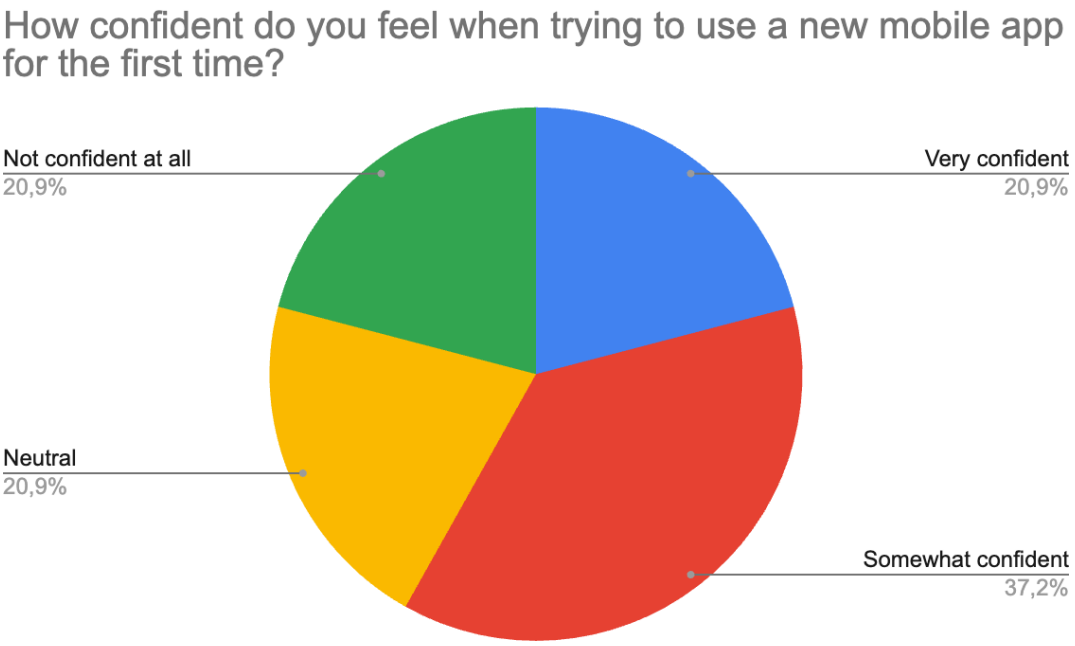


Figure A14. Confidence level when using a new mobile app for the first time.

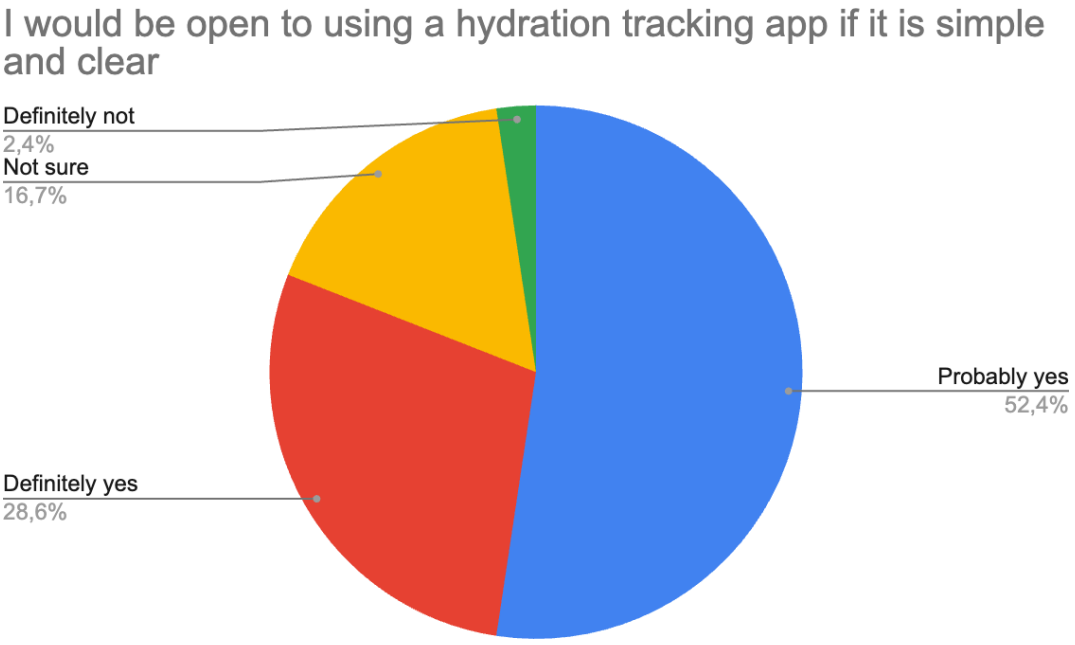


Figure A15. Openness to using a hydration tracking app if it is simple and clear.

B. Screenshots of Prototype

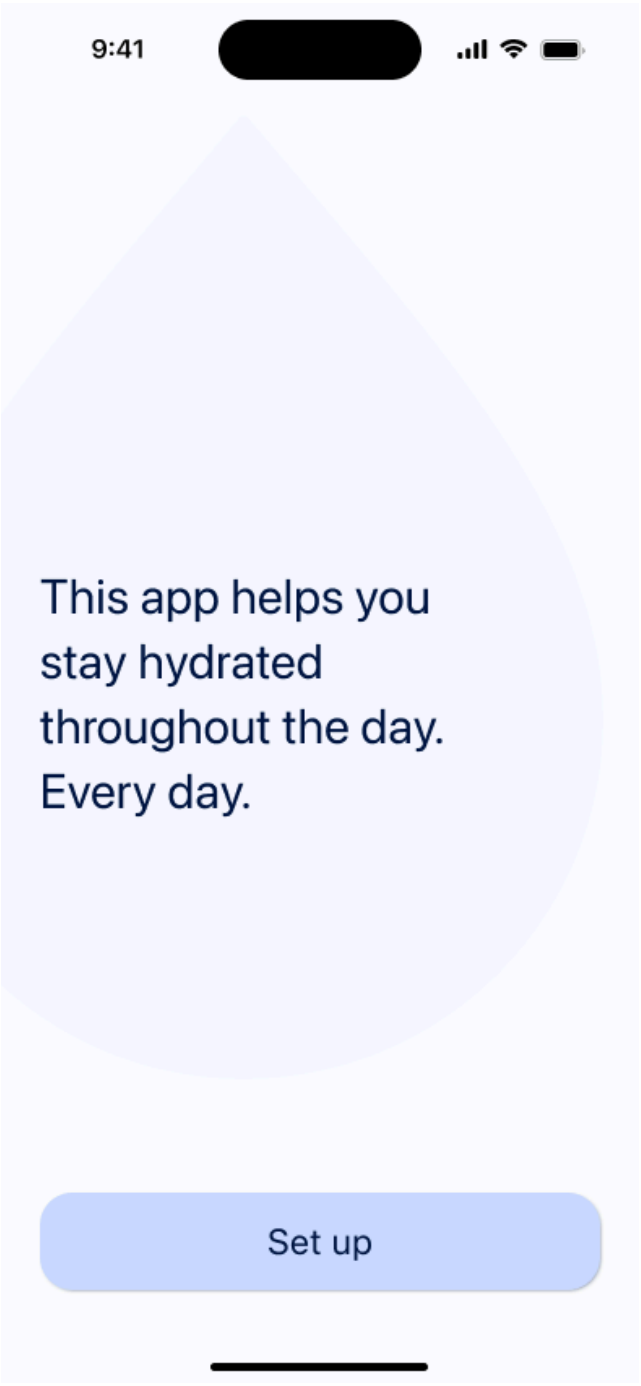


Figure B1. Onboarding – Welcome message

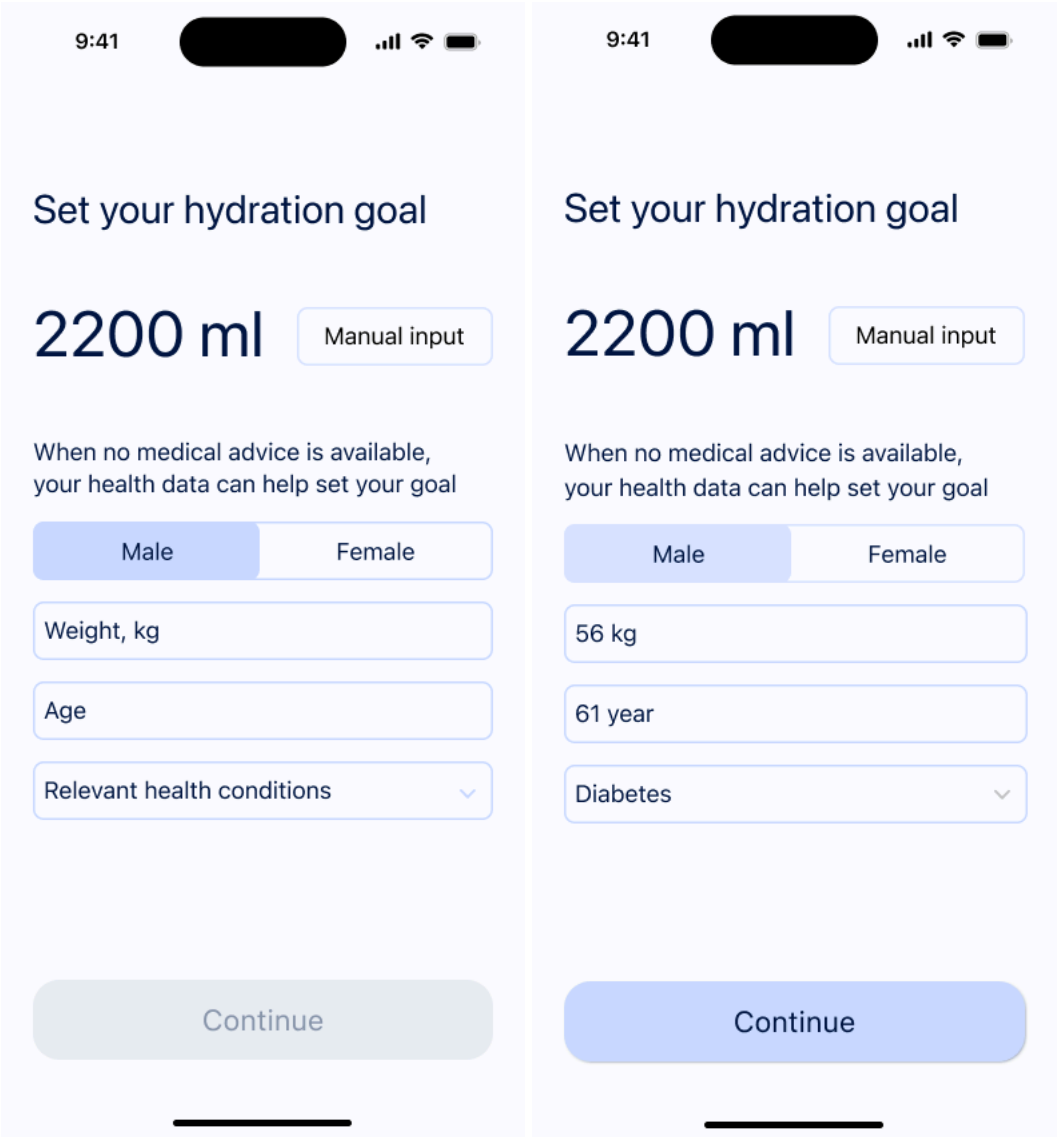


Figure B2. Onboarding – Set hydration goal

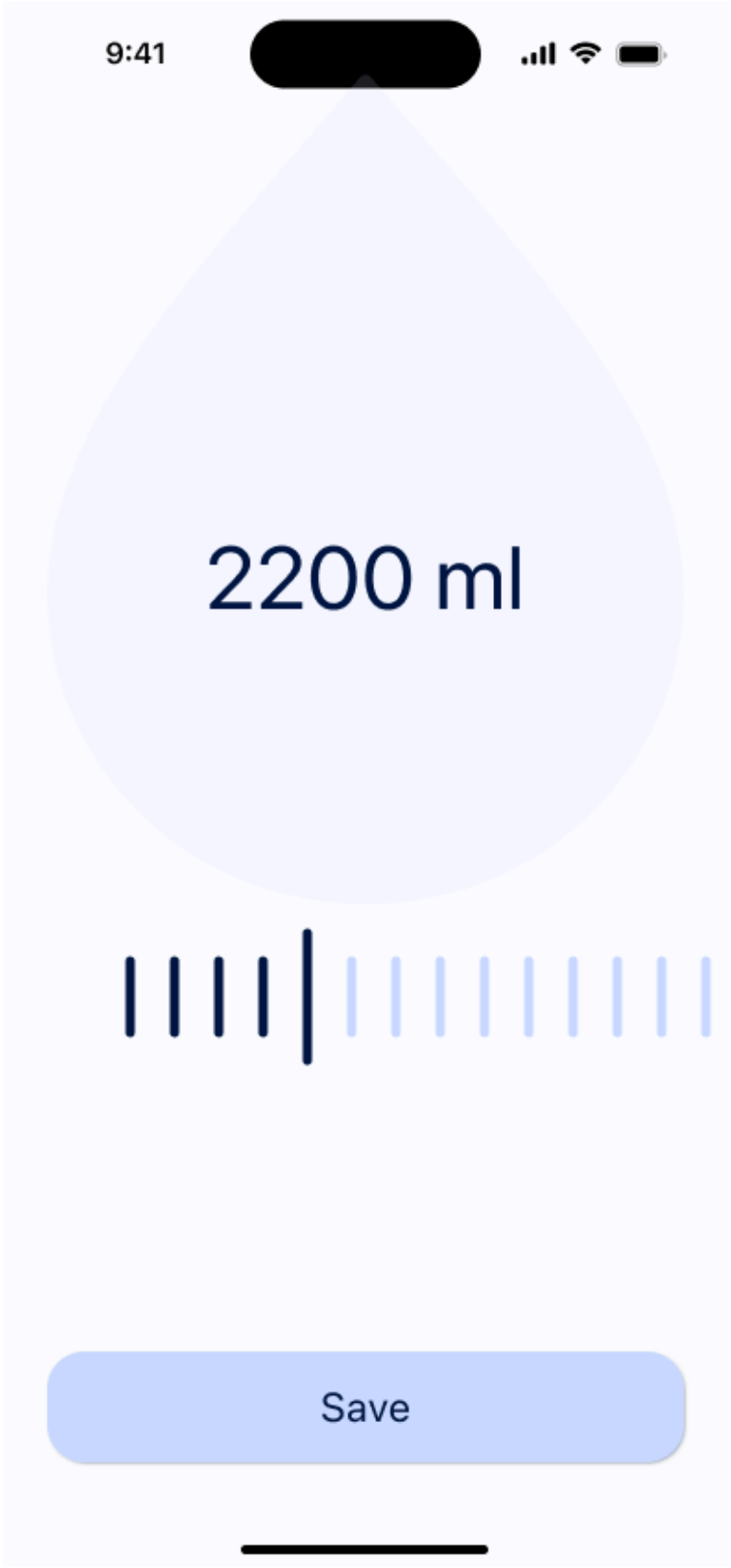


Figure B3. Onboarding – Manual input of a hydration goal

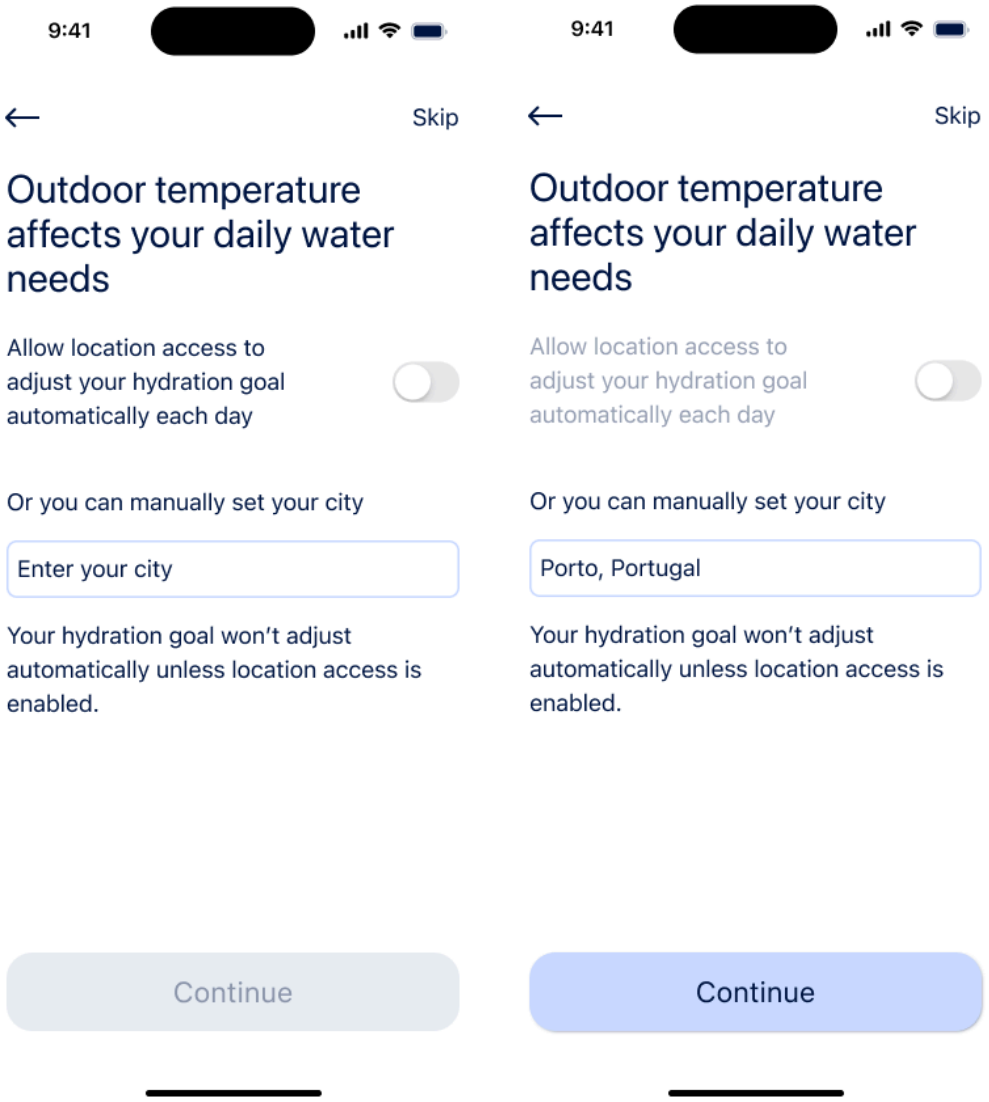


Figure B4. Onboarding – Location request

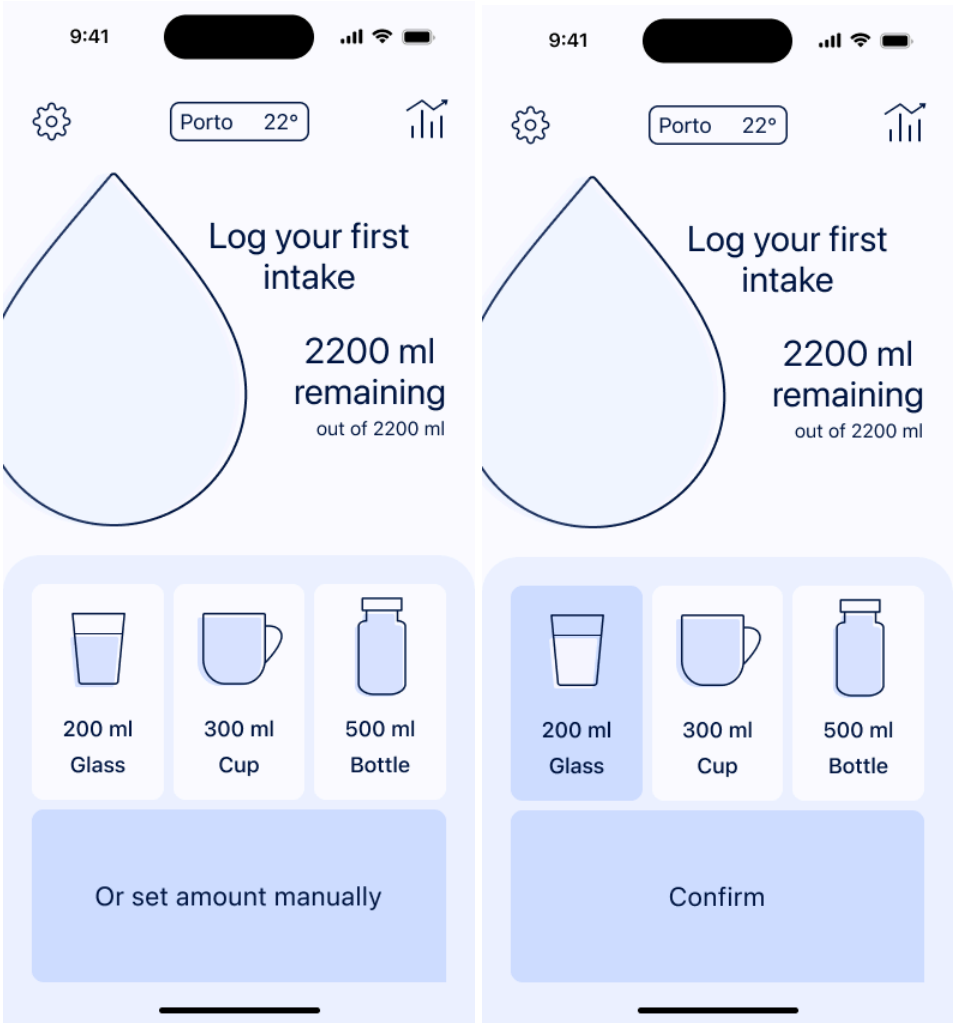


Figure B5. Main screen, logging first intake

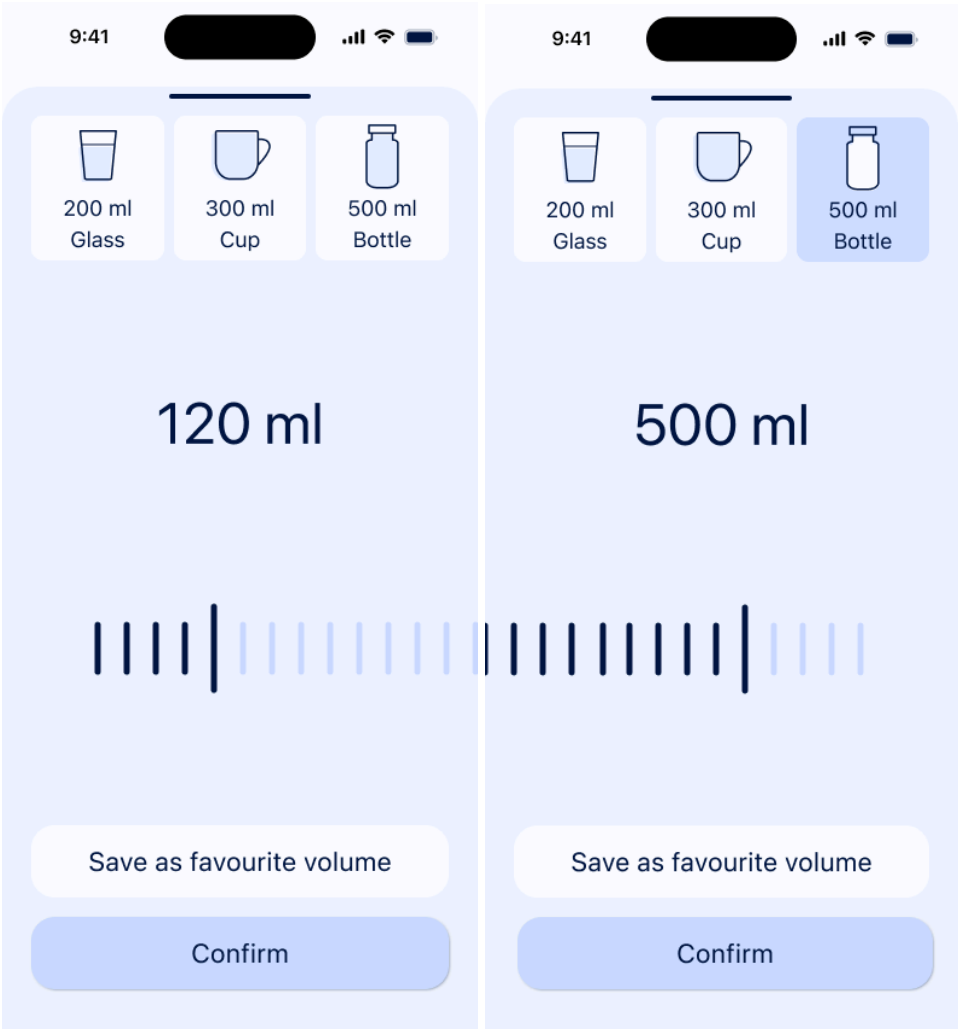


Figure B6. Manual input of a first intake

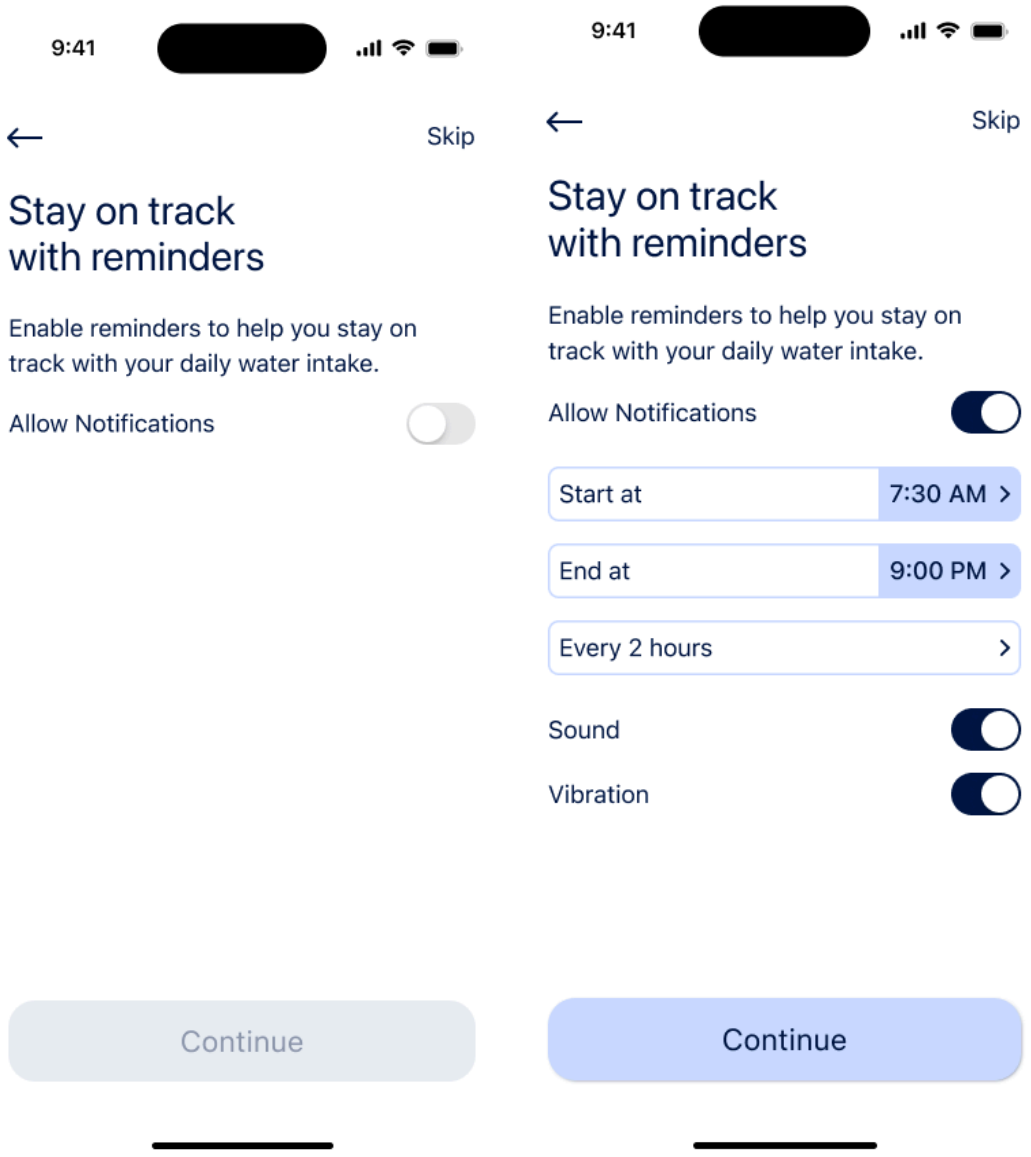


Figure B7. Onboarding 2 – Reminders

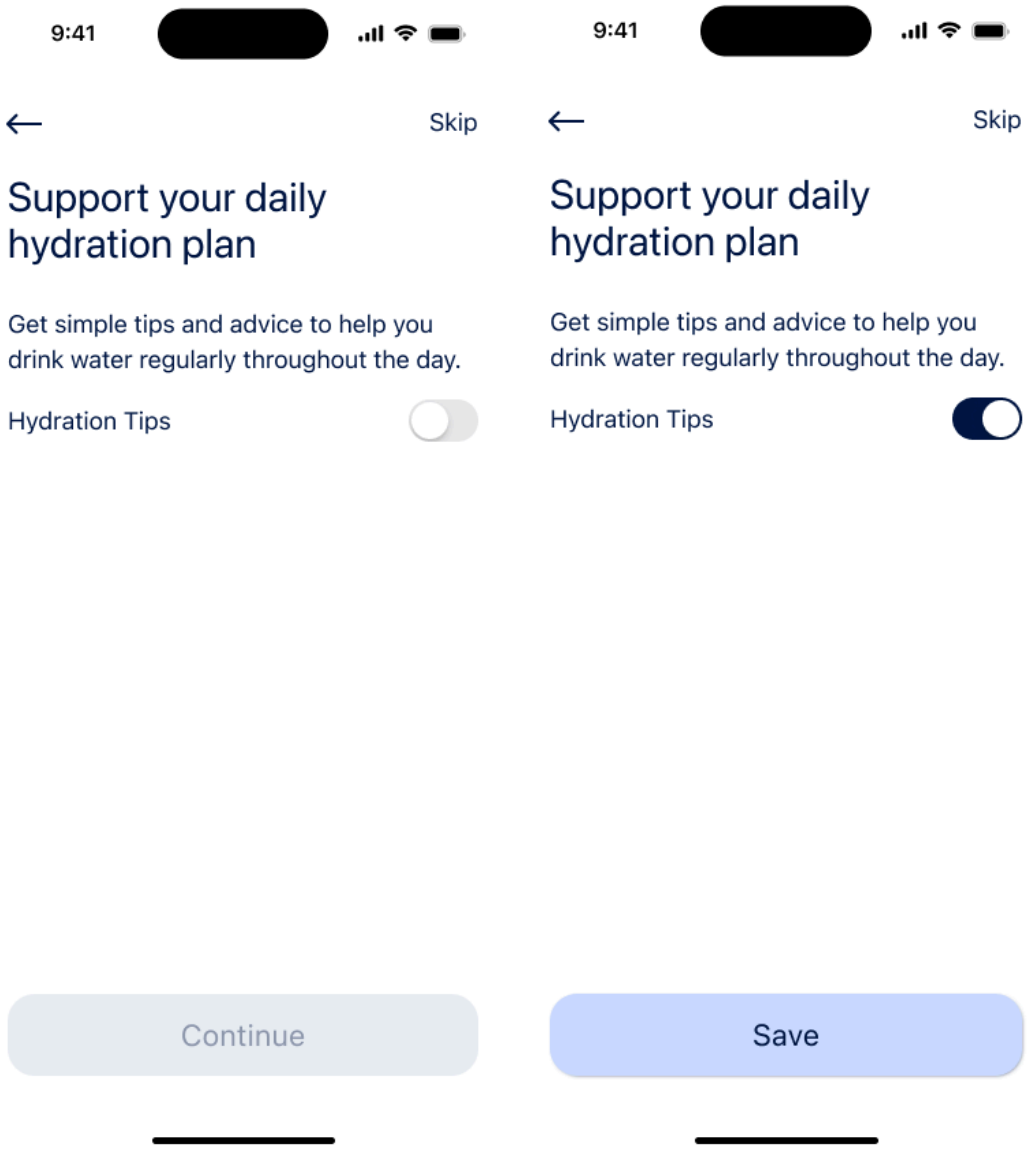


Figure B8. Onboarding 2 – Reminders Tips

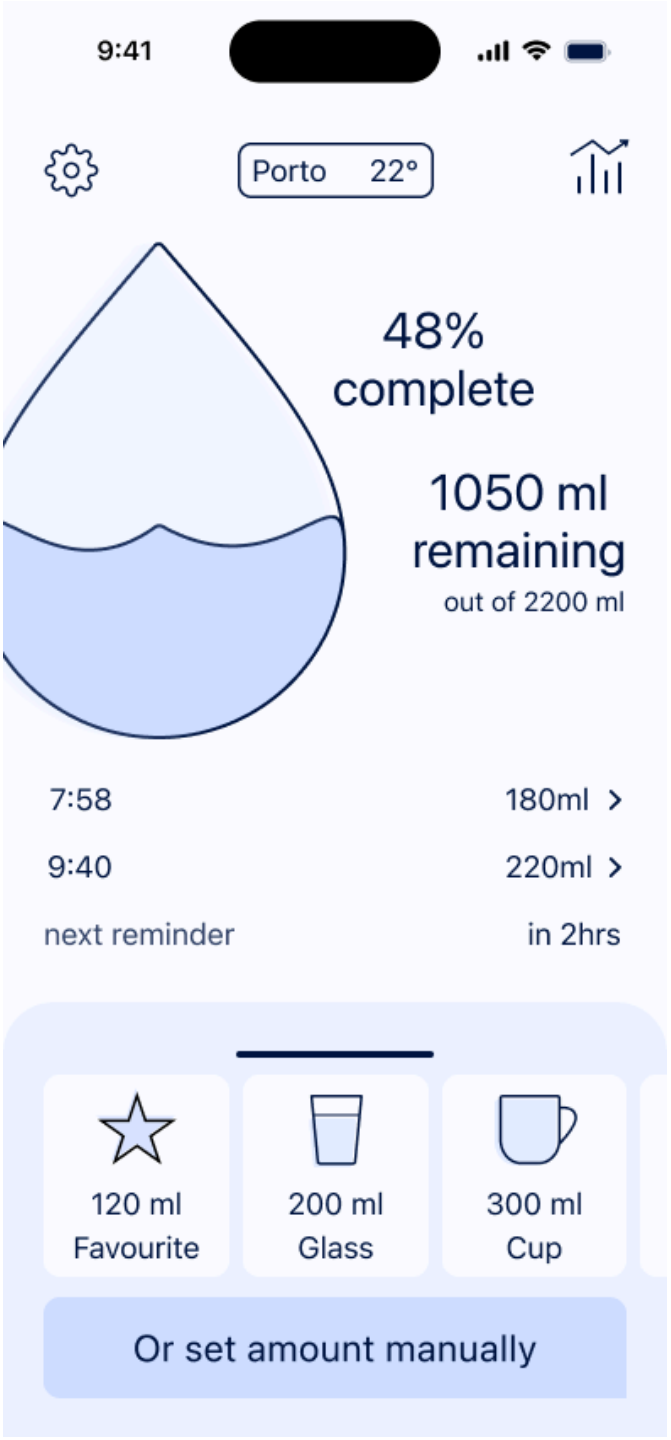


Figure B8. Main screen

Appendix



Figure B9. Main screen — input

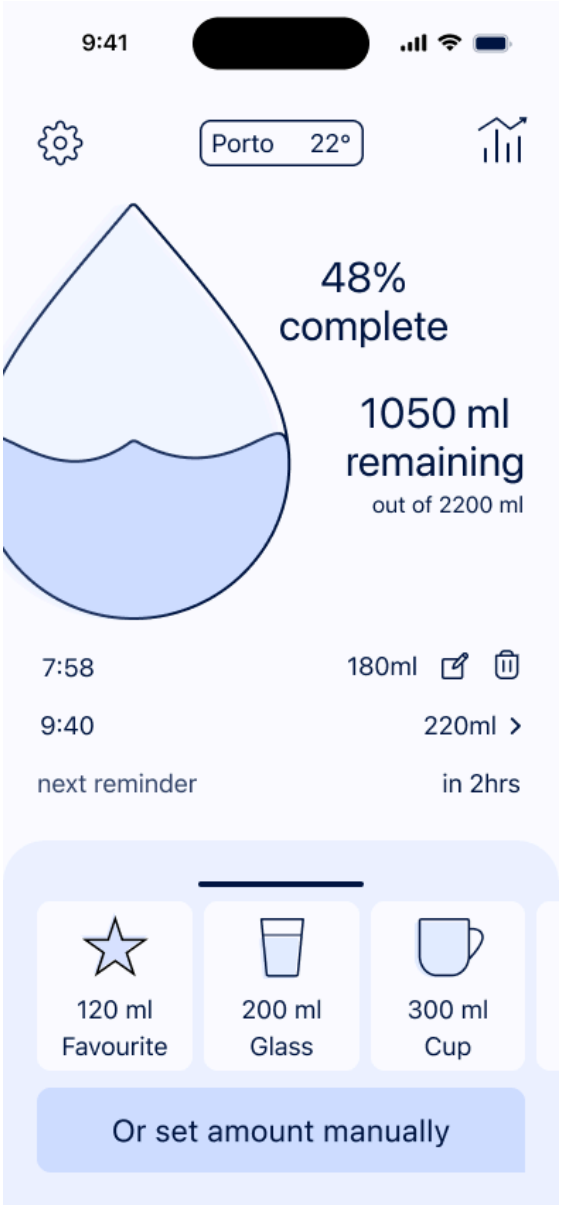


Figure B10. Main screen — Edit inputs

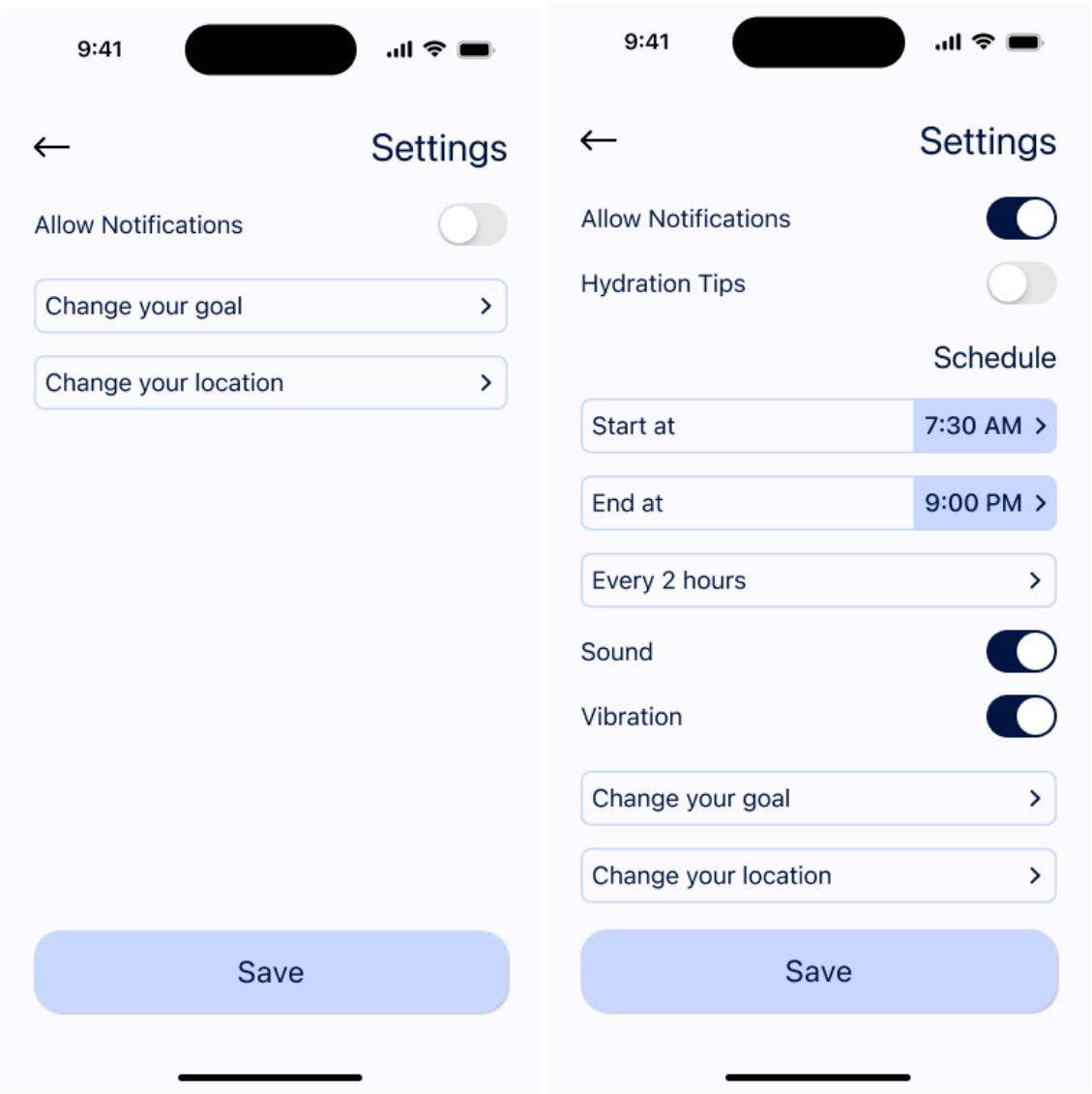


Figure B11. Notifications

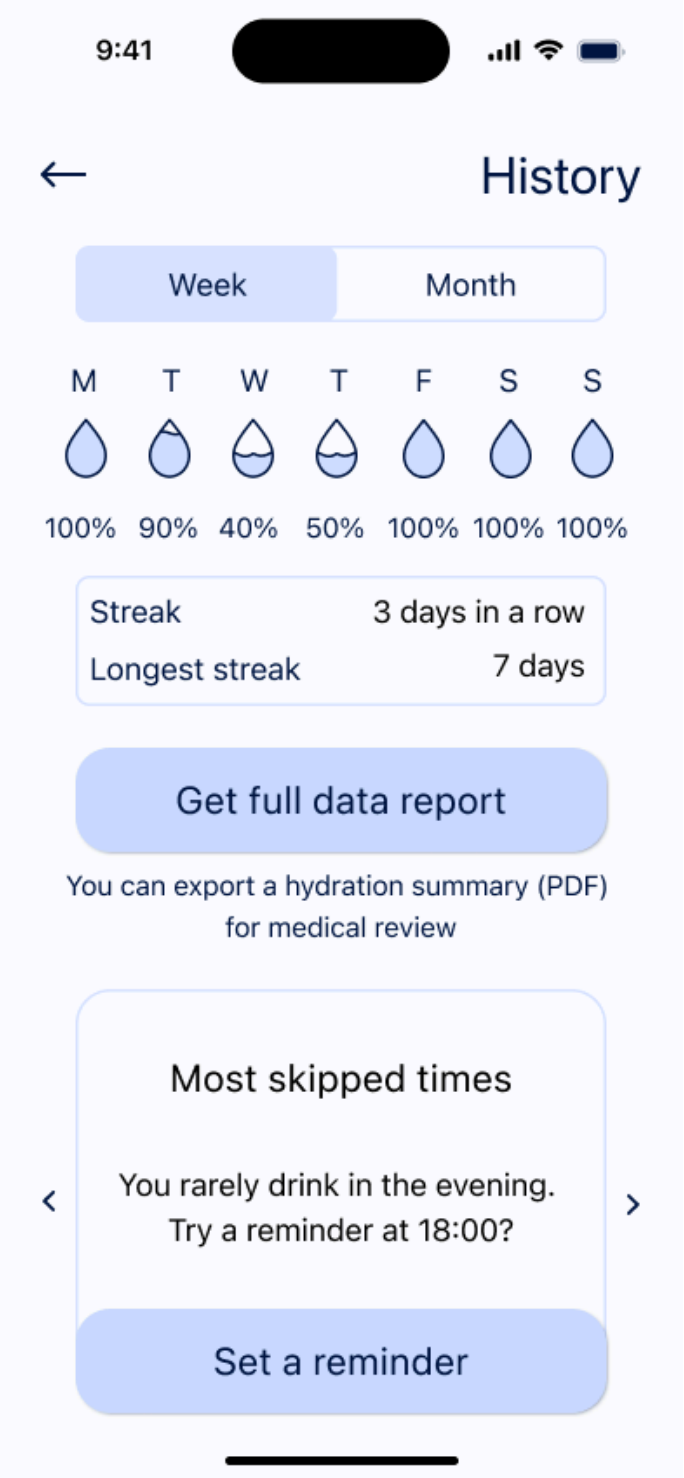


Figure B12. History