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Enhancing Physical Activity through an Evidence-Based App: A Data-Driven Approach to Healthier Lifestyles

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Abstract

Society is becoming increasingly sedentary, causing many health problems. A sedentary lifestyle is one of the main causes of the current increase in chronic diseases such as diabetes, cardiac issues, and several forms of cancer. This study describes the development process for an evidence-based activity tracker app aimed at improving physical activity levels. This research investigates determinants of physical activity and behavior change techniques. Four key determinants were identified: self-efficacy, attitude, social dynamics, and knowledge. Effective behavior change techniques for increasing physical activity include goal setting, recognition and rewards, self-monitoring, instructions on how to perform behavior, and competition. Based on these findings, a gamified activity tracker app was developed with features such as a point system, streaks, recommendations, achievements, levels, and graphical views of activity data. User interviews on the app design yielded positive feedback. However, further research is needed to refine the app's recommendation model and validate its long-term effectiveness through comprehensive field testing.

1 Introduction

Society is becoming more and more sedentary, we are spending increasing amounts of time in environments that limit physical activity (Owen et al., 2010). We are sitting more and moving less. The rise of technology has led to increased sedentary behaviors (Woessner et al., 2021), such as prolonged sitting while using smartphones, computers, or watching TV. Modern environments are often designed to promote sedentary lifestyles due to factors like long commutes, desk jobs, and limited access to green spaces for physical activity. Many jobs now require long hours of sitting at a desk, contributing to decreased physical activity levels

during the day (McCrary and Levine, 2009). Notably, the leisure activities we engage in have also become increasingly sedentary, further displacing opportunities for physical exertion.

This shift to a more sedentary lifestyle is quite abrupt compared to the time of human existence, from an evolutionary perspective humans are designed to move (Owen et al., 2010). This rapid change in lifestyle has led to several health problems. Leading a sedentary lifestyle is one of the main causes of the current increase in chronic diseases such as diabetes, cardiac issues, and several forms of cancer (Park et al., 2020). Moreover, sedentary behavior is associated with higher rates of depression, anxiety, and stress due to the lack of endorphins released during physical activity (Jiang et al., 2020; Eime et al., 2013). Additionally, insufficient physical activity can lead to decreased muscle strength, flexibility, and overall fitness levels affecting the quality of life. These points underscore the importance of regular physical activity and the significance of the current problem of modern society. Furthermore, studies have shown that physical activity can enhance cognitive function, mood regulation, and quality of sleep, leading to a better quality of life (Alnawwar et al., 2023; Mandolesi et al., 2018; Mahindru et al., 2023). Engaging in physical activities like team sports or even brisk walking can promote social interactions and a sense of community, providing emotional connections and support networks (Maslen, 2015; Eime et al., 2013). Embracing a physically active lifestyle is essential for achieving long-term health benefits and enhancing both physical and mental resilience in the face of daily challenges.

The challenges associated with transitioning to a more active lifestyle are multifaceted. Many individuals find it difficult to add physical activity into their daily routines, particularly when constrained by sedentary work or school environments and the overall demands of busy lives. Common

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self-reported reasons for not engaging in physical activity include; lack of time, lack of opportunity, not feeling competent, and lack of training companions (Carballo-Fazanes et al., 2020; Mutrie and Biddle, 2001) Another problem is a lack of awareness, as a significant portion of the population may be unaware of the severity of the problem or might be in denial about its impact on their health (Bennett et al., 2009; Ronda et al., 2001). Besides these barriers, one of the biggest causes of inactivity is the lack of motivation.

Hand in hand with this surge in sedentary lifestyle is the widespread adoption of smartphones and smartwatches. While these devices might negatively impact physical activity levels, they can also serve as powerful tools in the form of activity trackers, capturing data on crucial health metrics such as heart rate, step counts, and sleep patterns. The data gathered by these activity trackers can be used to provide real-time feedback on daily activity levels, which could be used to encourage users to be more active throughout the day. For instance, this data can be used to set and track goals such as a target for daily steps. By presenting this information, users become more aware and can make more informed decisions about their lifestyle.

This research project delves into identifying the most effective methods for presenting activity data to individuals, aiming to encourage a fundamental change in lifestyle choices. By leveraging the capabilities of activity trackers and effectively communicating the collected information through an app, this project aims to help individuals make informed decisions about their daily activities. The overarching goal is to encourage a more active and healthier way of life through strategic data presentation and motivational techniques.

The study attempts to address the research question: How can data analytics of human activity patterns be best presented or communicated in an app to individuals with varying degrees of data literacy, that leads to a structural change in lifestyle? This question is essential in bridging the gap between sedentary habits and an active, well-balanced lifestyle, thus addressing the urgent issue of rising chronic diseases within modern society.

To achieve this, the research involves a comprehensive review of the determinants of physical activity, behavior change techniques, and data presentation strategies. By understanding these elements, the project aims to develop a theory and

evidence-based motivational activity tracker app. The target group for this app consists of individuals who fall below the recommended activity levels, representing a group most in need of lifestyle interventions.

A significant aspect of this study is the exploration of behavior change techniques. For instance, this study will evaluate the effects of strategies such as goal setting, feedback, and self-monitoring on user engagement, physical activity, and motivation. Additionally, the presentation of data plays a pivotal role. Clear, intuitive, and personalized data visualizations can make complex information accessible to users with different levels of data literacy, ensuring that the app's insights are actionable and relatable

This paper describes the steps taken to develop the motivational activity tracker app. It covers the initial research phase, including literature reviews and supplementary user studies, to the design and development of the app prototype. Each stage of development is based on theoretical structures and empirical evidence, ensuring that the final product is evidence-based.

In summary, this research aims to enhance how activity data is communicated to individuals, particularly those below the recommended activity levels, to inspire long-term lifestyle changes. By combining technological innovation with behavioral science, the project sets out to create an app that not only tracks activity but also motivates and guides users to adopt a more active lifestyle.

2 Existing Solutions

There are numerous existing solutions aimed at tackling the increasing problem of sedentary lifestyles. Thousands of physical activity tracker and motivator apps are available aimed to enhance their users' physical activity levels and/or improve activity performances. These apps utilize a variety of motivational techniques, including gamification, competition, social support, and networking. In this chapter, we will explore several of these apps and the strategies they employ. We will evaluate their strengths and identify areas where they could be improved.

2.1 Fitbit

Fitbit is one of the most popular activity tracker apps available today, widely recognized for its comprehensive approach to health and fitness monitoring. The Fitbit app has a great variety of features including guided workouts, activity overviews, goal setting, health monitoring, stress and mindfulness tips. These features collectively offer users a holistic approach to managing their well-being. Numerous studies have found that the use of Fitbit is related with a significant increase in physical activity (Ringeval et al., 2020; Petersen et al., 2020; Griffiths et al., 2022) underscoring its effectiveness as a fitness tool.

One of Fitbit's standout features is its robust tracking capabilities. The app records a great number of data including calories burnt, distance walked, steps taken, active zone minutes, and much more. This constant monitoring should help users stay aware of their physical activity throughout the day, encouraging them to move more and meet their activity goals. For instance, seeing a daily step count can motivate someone to take an evening walk to hit their daily step goal, fostering a more active lifestyle (Zahrt et al., 2023).

The Fitbit app enables users to set goals in four different categories: activity, mindfulness, health, and nutrition. It allows the user to set and adjust various types of goals such as step counts, distance targets, and number of training days. Offering a wide variety of metrics and goal options for all users. To motivate users, the app provides real-time feedback and displays their progress, helping them stay on track and achieve their objectives.

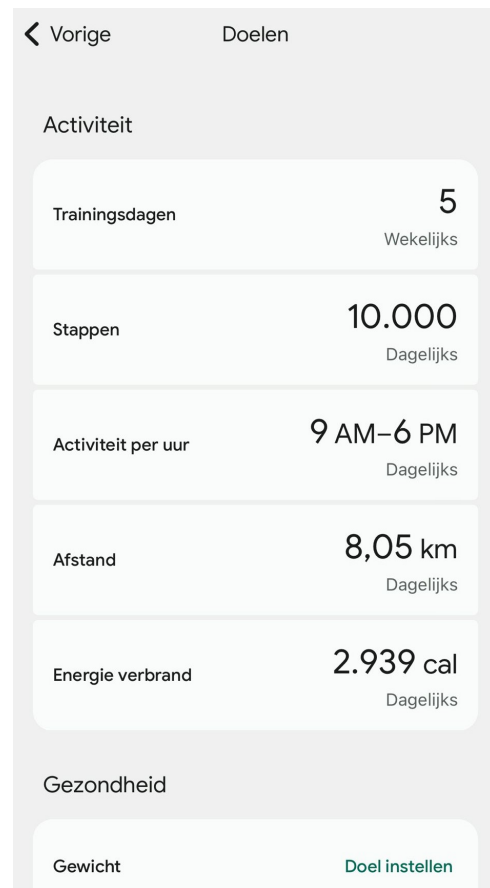


Figure 1: Fitbit's goal options

Fitbit's user interface is designed to be intuitive and user-friendly, making it accessible to people of all fitness levels. The user interface is fully customizable to the user's preferences allowing the user to select the data and metrics they want to focus on. Whether you are just trying to get started on your fitness journey or an experienced athlete aiming to optimize your performance, Fitbit's comprehensive data presentations can help the users make informed decisions about their health and fitness routines. The app's detailed graphs and charts allow users to visualize their progress over time, which can be particularly motivating and satisfying.

The app's ability to present recent activity behavior, such as the number of training days in the past week, offers users valuable feedback on their consistency and progress. This feature helps users understand their exercise patterns, identify trends, and adjust their routines accordingly. For example, if a user notices a decrease in their training days over the past week, they might decide to prioritize more workouts in the upcoming days. This continuous feedback loop can help users in maintaining motivation and ensuring long-term adherence to

activity goals.

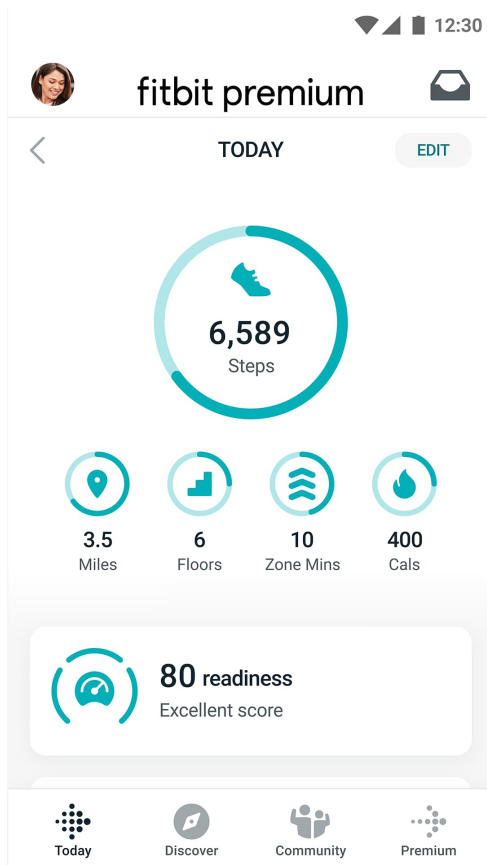


Figure 2: Fitbit's user interface

Fitbit also offers social features that enhance user engagement and motivation. The app allows users to connect with friends, join challenges, and participate in community events. These social elements introduce a sense of competition and camaraderie, making fitness more enjoyable and interactive. For instance, a user might join a step challenge with friends to see who can take the most steps in a week, adding a fun and competitive edge to their daily routine.

Another feature of the app is badges, the app has fun badges for different activity achievements. Some examples of these achievements are "getting 10000 steps in a day" or "climbing 25 stairs in a day" (see Figure 3). These badges provide a sense of accomplishment and drive motivation. The badges promote an active lifestyle and allows users to celebrate their accomplishments.

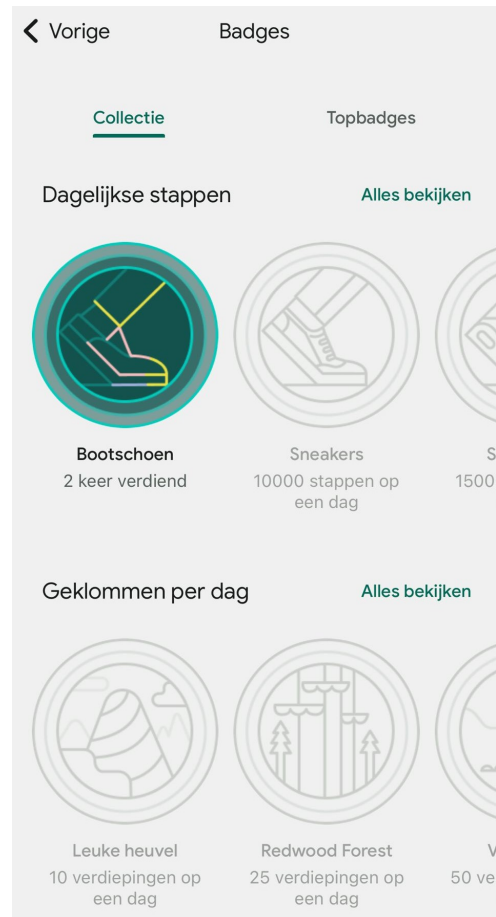


Figure 3: Fitbit's badges

Moreover, Fitbit provides users with personalized insights and recommendations based on their activity data. These insights help users understand the impact of their habits on their overall health and suggest ways to improve. For example, if the app detects that a user has been particularly sedentary, it might recommend taking short walks or stretching breaks throughout the day.

The app also has a coach page, this page provides useful information and content on a range of different topics such as sleep, stress, and fitness. It also features a great library of workout videos to a wide variety of fitness levels and interests. These videos contain full workouts and provide step-by-step instructions. This is great for people who are just starting to work out or who like working with a personal trainer. Besides these workout videos, there are also videos on other topics such as breathing and meditation exercises and much more.

Unfortunately, not all of these features are free to use. The app follows a Freemium model, offering basic features for free while more advanced features require a costly premium subscription at

\$9.99 per month. Advanced activity and sleep tracking and most content of the coach page are part of the premium features. Besides the app is designed to be used with a Fitbit device, however it still offers plenty of features without one, though it is less complete (Coombes, 2023). This is unfortunate, as many people do not own a Fitbit device. Furthermore, the app's extensive customization options and detailed data can be overwhelming for new users. The app offers an abundance of customization and different goals to aim for, the abundance of options can confuse both new users and those with lower data literacy. As these users might not be aware what metrics or goals are important to prioritize for their health goals.

In conclusion, Fitbit stands out as a comprehensive and effective tool for health and fitness monitoring, offering a wide array of features that cater to various aspects of well-being, including activity tracking, goal setting, mindfulness, and personalized insights. Its robust tracking capabilities and user-friendly interface make it useful to individuals of all fitness levels, providing detailed data that can help users make informed decisions about their health routines. The app's social features and achievement badges add an element of fun and motivation, encouraging users to stay active and engaged. However, the extensive customization options and abundance of data points can be overwhelming and confusing for new users.

2.2 Ommetje

Ommetje is an innovative physical activity tracker app developed by the Dutch brain health foundation called "Hersenstichting". The app is designed to enhance brain health by encouraging users to incorporate more movement into their daily routines. The core objective is to motivate users to move more during the day and to break the pattern of prolonged sitting by engaging in regular physical activity, thereby fostering overall well-being. The app has been shown to increase physical activity levels and motivate its users (D&B). More than 50% of the users have increased their activity levels thanks to the app and 30% of all users have made walking a habit showing its ability to foster long-term behavior change (Hersenstichting, 2023).

The app emphasizes the benefits of daily physical activity, particularly in relation to brain health. For instance, engaging in consistent physical exer-

cise has been shown to offer significant protection against cognitive decline, reducing the risk of developing various brain-related conditions such as dementia, stroke, and depression (Hersenstichting, 2023). These conditions not only affect individuals' quality of life but also place a substantial burden on healthcare systems and families.

Ommetje encourages its users to take short, frequent walks, known as "ommetjes" in Dutch to enjoy these health benefits. The concept of the app is simple: rather than committing to long, strenuous exercise sessions, users are encouraged to integrate brief walks into their daily schedules. The goal of this approach is to make it easier for people to stay active without feeling overwhelmed or having to make significant changes in their routines.



Figure 4: Main screen of Ommetje app

The app employs a variety of gamification techniques to motivate its users to stay active and engaged with the app. Firstly, Ommetje incorporates an XP (Experience Points) system, where users earn XP for every walk they complete, incentivizing regular activity. Users must use the app to track their walks, ensuring they monitor their progress and remain engaged with the platform. The app records walking time and distance, and after each walk, it provides feedback on how this regular ac-

tivity benefits brain health. Additionally, Ommetje uses "streaks" to promote consistency, a "streak" is a count of the number of consecutive days the user recorded a walk of at least 20 minutes, rewarding an extra 3 XP for each walk that continues the streak.

Furthermore, Ommetje allows users to set personal weekly goals for the number of walks they aim to take. These goals can range from one to fourteen walks per week, including a maximum goal ensures the app does not promote over-training which could have a negative health impact. Allowing users to set and adjust their goals accommodates users of all activity levels, from beginners to more advanced walkers, and helps them stay motivated by providing a clear, achievable weekly target.

Ommetje also features a tiered leveling system to recognize and encourage user activity. The levels include "Starter", "Doorbijter" (Go-Getter), "Volhouder" (Perseverer), "Semi Professional", and "Professional" as shown in Figure 5. Each level represents a positive acknowledgment of the user's dedication and progress. Advancing through these levels not only provides a sense of accomplishment but also serves as a motivational tool, encouraging users to strive for higher levels and set new goals.



Figure 5: Levels in Ommetje app

In addition, the app awards medals as a form of recognition and reward for user accomplishments as can be seen in Figure 6. These medals also serve as additional goals, motivating users to engage in more walks. Examples of medals include "Start

the Day Right: Walk before 9 AM 25 times" and "Consistent Walker: Walk for at least 20 minutes for 15 consecutive days". Each medal category has different levels, from beginner to advanced, adding an extra layer of challenge and reward. Importantly, the medals are frequency-based rather than performance-based, rewarding a certain number of walks rather than long or intensive sessions.

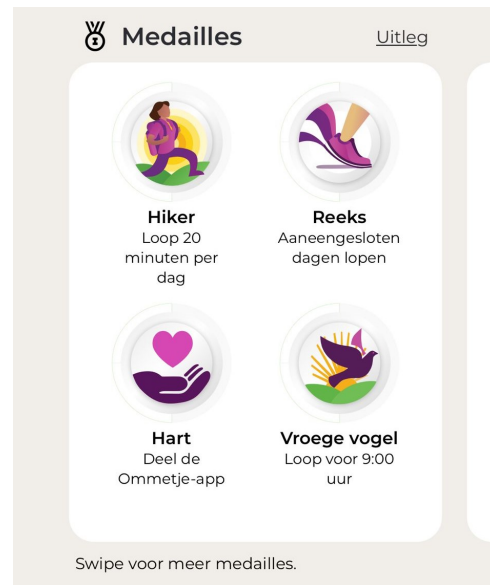


Figure 6: Medals in Ommetje app

Furthermore, Ommetje allows friends and colleagues to form teams and compete on XP points earned, enhancing the app's social and motivational aspects. The app displays a simple ranking of all team members, fostering friendly competition. This feature not only motivates users to stay active through competition but also leverages social pressure, as seeing friends and colleagues going on walks can encourage others to join in. By combining competitive motivation with social influence, Ommetje makes physical activity more engaging and enjoyable, encouraging users to achieve their fitness goals.

Beyond these gamification elements, Ommetje also provides some simple statistics about the user's activity, such as the number of walks per month and the total time spent walking (see Figure 7). These insights allow users to track their progress over time and see the tangible results of their efforts. However, these statistics are relatively limited compared to other apps such as Fitbit.



Figure 7: Statistics in Ommetje app

Although Ommetje has lots of amazing features it also has its limitations. The primary limitation is that Ommetje is exclusively designed for walking, meaning it does not track or support any other types of physical activity, such as daily steps, cycling, swimming, or gym workouts. While Ommetje’s motivational features are effective, its focus solely on walking may not meet the needs of users looking for a more comprehensive fitness tracking solution. The issue with this singular focus is that it fails to acknowledge the benefits of other forms of exercise, which can be just as healthy and beneficial as walking. For example, a user might spend an hour cycling, which is great for overall health. However, because this activity is not walking, it won’t be recognized or logged in the Ommetje app, and the users are not encouraged to engage in these activities. Consequently, users who diversify their physical activities might feel undervalued, as their efforts in these other activities are not reflected in their app progress.

In summary, Ommetje stands out as an innovative app designed to promote brain health through regular physical activity, particularly walking. Its numerous features, such as the XP system, streaks, weekly goals, tiered leveling, and social competi-

tion, effectively motivate users to stay active and make integrating brief walks into their daily routines easier. The app’s emphasis on gamification and community support enhances user engagement and helps foster long-term healthy habits. However, Ommetje’s exclusive focus on walking may limit its appeal to those who engage in a variety of physical activities. While it excels at promoting regular walking, users looking for a more comprehensive fitness tracking solution may find its limitations restrictive.

2.3 Strava

Strava is a highly popular fitness app known for its powerful tracking capabilities and strong social components, making it a favorite among both amateur and professional athletes. Strava offers an extensive array of features designed to enhance the training experience, track physical activity, and foster a sense of community among users. Research has shown that using Strava positively impacts physical activity engagement and motivation (Petersen et al., 2020; Franken et al., 2023; Williams, 2012).

One of Strava’s standout features is its exceptional tracking ability. The app accurately records a wide range of metrics such as distance, pace, elevation gain, and calories burned, providing users with detailed insights into their workouts (see Figure 8). This accurate tracking is of great value for users who want to monitor their activities and optimize their performance. For instance, cyclists and runners can rely on Strava to track their routes, speeds, and splits, helping them understand their strengths and areas for improvement. This tracking ability encourages the users to improve their performance and ultimately motivates them to enhance their activity levels.

Strava also provides detailed feedback on performance, helping users analyze their workouts and track their progress over time. The app’s in-depth analysis tools include performance graphs, personal records, and comparisons with previous activities. This feedback is crucial for athletes looking to improve, as it allows them to identify trends and make data-driven adjustments to their training. For instance, a runner can review their pace and heart rate data to determine the effectiveness of their interval training sessions.

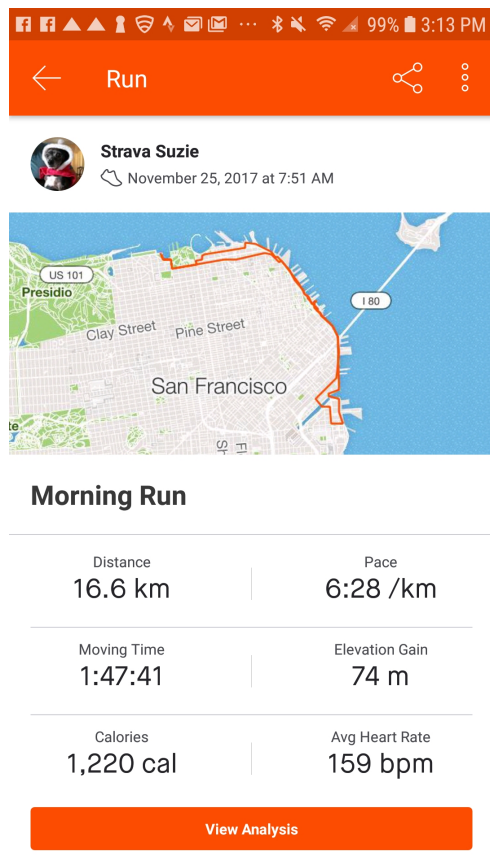


Figure 8: Example of tracking abilities of Strava

While Strava is mostly known for its use in cycling and running activities, it is not limited to these sports. The app supports over 30 different activities, including swimming, hiking, and yoga. This multi-sport capability ensures that Strava meets the diverse needs of its user base, making it a valuable tool for a wide range of people.

The app's strong community aspect is one of its defining features. Strava's social network allows users to share activities, follow friends, join clubs, and participate in group challenges, fostering a sense of support and competition. The ability to share workouts and achievements with others adds a motivational element, encouraging users to stay committed to their activity goals. For example, cyclists can discover new routes by following other users and exploring the segments they have created, making it easy to find new and exciting paths to ride. The communities and social networking features in Strava facilitated significantly greater engagement in physical activity (Petersen et al., 2020; Franken et al., 2023).

Competition is a significant aspect of Strava, adding an extra layer of motivation for users. The app features leaderboards for various segments of

routes, allowing users to compete for the best times and earn titles such as "King of the Mountain" (KOM). This gamification aspect can be particularly motivating for competitive individuals who thrive on setting and achieving goals. For example, a cyclist might push themselves harder on a climb to secure the KOM title, adding a fun and challenging dimension to their rides. It could also increase motivation to work out more often to improve performance in the long run.

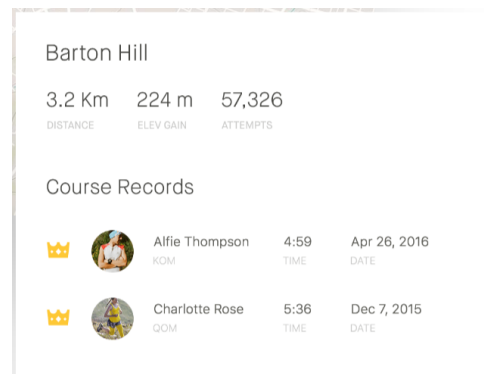


Figure 9: Leaderboards of Strava

Despite its many advantages, Strava does have some drawbacks. Strava's heavy focus on performance and social aspects can also have a negative impact on some people as it can result in social pressure and self-presentation that could influence mental or physical health (Batterbee, 2021; Russell et al., 2023). The emphasis on competition and public sharing of workouts might not appeal to everyone, particularly those who prefer a more private and self-focused approach to their fitness journey and do not want to be confronted with other people's performances. The pressure to perform and share achievements can sometimes negatively impact the intrinsic enjoyment of exercise, it can be too intimidating and demotivating. A rather famous quote in the Strava is "If it's not on Strava, it didn't happen" which is a perfect example of the obsession that can arise from this strong community.

Another downside is the cost associated with its premium features. While the basic version of Strava is free, users must subscribe to Strava Summit to access advanced features such as detailed performance analysis, route exploration, live tracking, and many of its competition features (Strava, 2024). This subscription model may be a barrier for some users who are unwilling or unable to pay for the premium service.

In conclusion, Strava excels in offering a powerful and engaging fitness solution for people who want to improve their activity levels and enjoy the social aspects. Its powerful tracking capabilities, multi-sport support, and strong community aspects make it a valuable tool for monitoring performance, discovering new routes, and staying motivated. However, the costs associated with premium features and the app's strong focus on performance and social interaction may not be suitable for everyone. The performance and competition focus can be intimidating and may not be the ideal solution for individuals who are solely focused on improving their health.

2.4 Nike Training Club

Nike Training Club is one of the most used fitness apps in the world, earning the top spot as the best free fitness app according to Forbes Health (Alena Hall, 2024). This app brings the benefits of personal training to users without the high costs typically associated with hiring a personal trainer. By offering multi-week training programs tailored to different fitness goals, Nike Training Club makes high-quality fitness guidance accessible to everyone for free. While there are no direct studies on the app's impact on increasing physical activity, one study found that using the app improved workout adherence and enhanced aerobic endurance (Malabed, 2023).

The programs within the app consist of comprehensive workout videos that guide users through each exercise with clear, step-by-step instructions. These videos are particularly beneficial for beginners, as they demonstrate proper form and technique, reducing the risk of injury and boosting confidence. For example, a beginner learning how to do a squat can follow along with the video to ensure they are performing the movement correctly, which is crucial for preventing injuries and maximizing the effectiveness of the exercise.

One of the app's standout features is its versatility, accommodating users of all fitness levels. Whether you're a beginner just starting your fitness journey or an experienced athlete looking to enhance your routine, there's a program suited to your needs. Many of these programs require no equipment, which ensures that anyone can participate, regardless of their access to a gym or workout equipment. This inclusivity helps lower barriers to physical activity, making fitness more accessible to

a wider audience.

The wide variety of workout programs with a range of intensity, required time, and fitness goals time is another significant advantage. Users can choose programs that fit into their weekly schedules, whether they have 20 minutes or an hour to spare. This adaptability ensures that even the busiest individuals can find time for exercise, making it easier to maintain a consistent fitness routine.

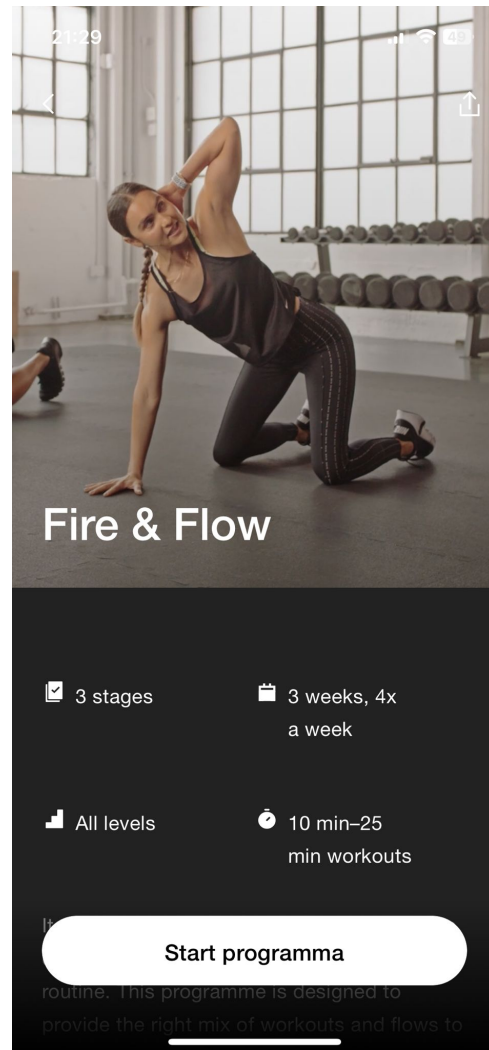


Figure 10: Example of a program in the Nike app

The Nike Training Club app extends beyond just fitness programs, the app features a rich collection of articles related to nutrition, wellness and fitness advice, educating and motivating people to adopt a healthier lifestyle as can be seen in Figure 11. These articles cover a wide range of topics, namely movement, nutrition, rest, and mindfulness. For instance, users can find articles that explain the benefits of a balanced diet, offer recipes for nutritious meals, and provide insights into importance of rest

and recovery.

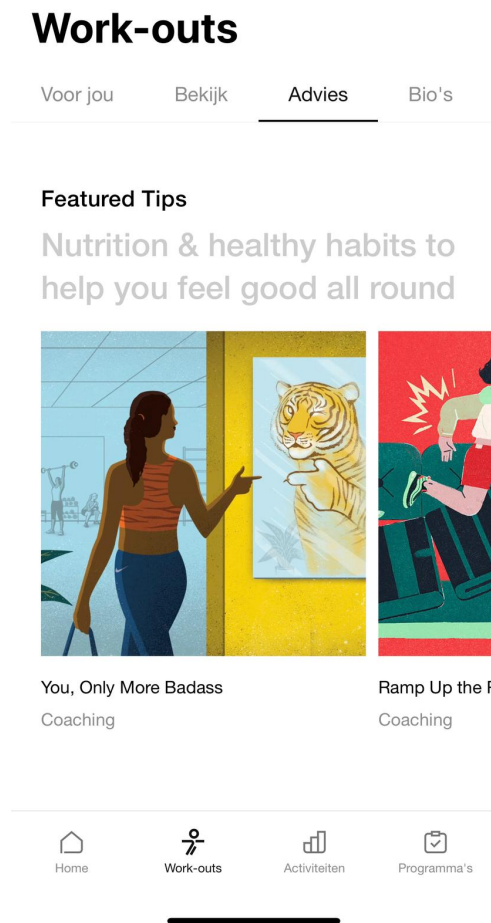


Figure 11: Featured tips in the Nike app

To further motivate and engage users, Nike Training Club includes a feature for earning in-app trophies as shown in Figure 12. These trophies serve as recognition and rewards for various fitness achievements, such as completing a certain number of workouts, hitting personal bests, or sticking to a workout routine for a specified period. For example, a user might earn a trophy for finishing their first 10 workouts or for completing a challenging training program. These virtual rewards provide a sense of accomplishment and encourage users to stay committed to their fitness journey. These trophies can be particularly motivating for those who thrive on setting and achieving goals.

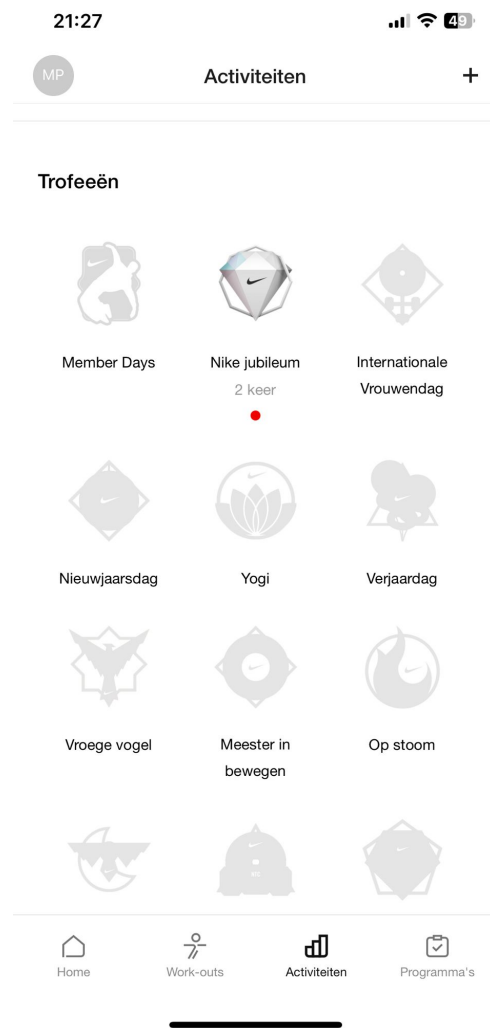


Figure 12: Trophies in the Nike app

The Nike Training Club app offers numerous impressive features designed to motivate users to integrate more physical activity into their daily routines. However, there are some drawbacks to the app. One major downside is the lack in tracking of physical activity. The app does not automatically track activity; instead, it requires users to manually input their workout data. This manual entry can be seen as cumbersome and time-consuming, leading some users to abandon the app altogether (Schroé et al., 2022). The inconvenience of having to enter data themselves detracts from the user experience, on top of that manual entry allows for the users to cheat themselves and exaggerate their workout times for example (Simons et al., 2018). While it excels in guiding users through various workouts, it does not monitor daily steps, cycling to work, or other forms of physical activity that users might engage in throughout the day. This lack of comprehensive tracking means the app cannot serve as

an all-encompassing physical activity tracker. For those aiming to increase their overall activity levels and wishing to monitor all their activities in one place, this can be a significant shortcoming.

Additionally, the Nike Training Club app focuses solely on indoor exercises such as yoga, fitness, and strength workouts. While these might be great forms of physical activity with lots of benefits, they may not appeal to everyone. Many individuals looking to adopt a more active lifestyle may prefer outdoor activities like running, cycling, hiking, or swimming. The app's limited scope in terms of activity variety means it may not meet the needs of those who enjoy or seek a broader range of exercise options. Furthermore, this article ([Choi, 2019](#)) on user pains found that one drawback was that users cannot create their own personal workout routine. Although the app offers many different programs it does not enable its users to create their own programs from the videos and instructions the app already provides. The research states that users would like the ability to make their own workouts and programs according to their wants and needs.

In conclusion, the Nike Training Club app offers numerous benefits, making high-quality fitness guidance accessible to a broad audience for free. Its multi-week training programs, comprehensive workout videos, and versatility cater to users of all fitness levels, ensuring that even beginners can exercise safely and effectively. The app's adaptability, inclusivity, and additional resources on nutrition and wellness further enhance its appeal. However, the app does have some limitations. The lack of automatic activity tracking and its focus on indoor exercises may not suit everyone, particularly those who prefer outdoor activities or desire a comprehensive activity tracker.

3 Methodology

This chapter will describe the methods used to develop a motivational physical activity tracker app. The methodology is structured into 6 essential steps, each contributing incrementally to the main objective of developing an evidence and theory-based motivational physical activity tracker app. By employing a combination of literature review, user interviews, and iterative development, this study ensures a comprehensive understanding of both theoretical frameworks and practical user needs.

The initial step involved extensive research into existing solutions to the problem of leading a sedentary lifestyle. This phase aimed to gain a better understanding of current app functionalities by exploring the leading physical activity tracker apps and analyzing user experiences with those apps. This step is important to better understand the problem and limitations of existing solutions. To develop a new app, it is essential to understand what has already been done and how these solutions perform.

The second step consisted of an extensive literature review to identify the determinants of an active lifestyle. This research was crucial in understanding the various factors that influence physical activity, providing a theoretical basis for the following stages. The third step extended this literature review to researching behavior change techniques aimed at influencing these determinants. To identify strategies that could effectively motivate users to increase their physical activity levels which can be incorporated in an app.

The fourth step was exploring possible app features and ideas incorporating these behavior change techniques and conducting interviews with a small group of potential users. These interviews were designed to gather insights and responses to the identified determinants, behavior change techniques, features, and to find app preferences directly from the potential users.

The fifth step focused on the designing and actualization of the app. This phase involved translating the theoretical and empirical findings into a functional and effective app design. Designing features based on the identified determinants and behavior change techniques. This design was then implemented into a web application as an app prototype.

Finally, the sixth step involved conducting a second round of interviews with potential users to evaluate their first responses to the developed app.

Using the results of these interviews the app prototype was updated slightly to better meet the needs and expectations of its potential users.

Overall, this methodology chapter outlines the systematic and iterative process followed to develop a motivational physical activity tracker app, emphasizing the integration of theoretical research, user interviews, and practical development. The following sections will provide detailed descriptions of the user interviews.

It is important to note that while this methodology draws on a comprehensive review of existing literature and case studies supplemented by user interviews, the potential long-term reliability and usability of the app might be uncertain due to limited time and resources. There was not enough time to test and evaluate the app's effectiveness and acceptance in practical settings. Therefore the findings only offer insights into initial responses.

3.1 Interview Running Group

To test some of the findings and new hypotheses there was a small interview of some potential app users. The main objective of these user interviews was to gather qualitative and quantitative data on user preferences and motivational factors related to physical activity and the potential use of an app to enhance motivation. Specifically, the interviews aimed to explore users' current workout habits, motivational challenges, and their responses to various app features that could potentially enhance their motivation.

The interview participants were all members of a running group, meaning they were already engaged in regular physical activity. As a result, they did not perfectly match the app's target audience, which is people below the recommended activity levels. Despite this, it was still valuable to get responses to initial ideas. The interviews took place in a cafe after a running session and followed a semi-structured format. This allowed for flexibility in the conversation while ensuring that all key questions were covered. Some interviews were conducted in groups, while others were one-on-one. Participants were informed of the study's purpose and provided consent to participate and have their responses recorded for analysis.

The interview questions were divided into two categories: baseline questions and main questions. The baseline questions aimed to gather general information about the participants' workout

habits and motivational tendencies. The main questions focused on participants' reactions to specific features of a proposed app that gamifies physical activity tracking. Participants answered the questions on a scale of 1 to 5 when possible and provided an explanation of their answers. This approach aims to gain a better understanding of their thought processes and these explanations are often very valuable to understand their rating.

Baseline questions

1. How often do you work out? (go for walks/runs or other)
 - Purpose: To establish participants' current level of physical activity.
2. Have you been working out your whole life?
 - Purpose: To understand participants' long-term engagement with physical activity.
3. Do you find it easy to motivate yourself to work out?
 - Purpose: To determine participants' intrinsic motivation levels, and understand what motivates them.
4. Do you like to set goals for yourself?
 - Purpose: To assess whether goal-setting is a common motivational strategy for participants.
 - Scale: 1 (Do not like) to 5 (Likes very much)

Main questions

1. Would you be interested in an app that gamifies physical activity?
 - Purpose: To determine initial interest in the concept of a gamified physical activity app. Note that the idea of a gamified physical activity app was first explained to the participants.
 - Scale: 1 (Not interested) to 5 (Very interested)
2. How motivated would you be by getting points rewarded for activities?
 - Purpose: To evaluate the potential effectiveness of a points-based reward system.

- Scale: 1 (Not motivated) to 5 (Very motivated)
3. How motivated would you be by personalized workout goals in an app? For example a 5 km walk.
 - Purpose: To assess interest in personalized goal-setting features inside an app.
 - Scale: 1 (Not motivated) to 5 (Very motivated)
 4. How motivated would you be by having a visual representation of your recent activities (e.g., a calendar or progress chart)?
 - Purpose: To explore the potential impact of visual progress tracking on motivation.
 - Scale: 1 (Not motivated) to 5 (Very motivated)
 5. Would you like the ability to compare and/or compete with friends or random users?
 - Purpose: To determine the appeal of social and competitive features and assess preference in friends or random users.
 - Scale: 1 (Do not like) to 5 (Like very much)
 6. How motivated will you be by suggestions and prompts for exercises/workouts?
 - Purpose: To evaluate the effectiveness of suggested activities in motivating users and if this could decrease perceived barriers.
 - Scale: 1 (Not motivated) to 5 (Very motivated)
 7. How motivated would you be to keep a streak of daily activity levels?
 - Purpose: To assess the motivational impact of maintaining activity streaks.
 - Scale: 1 (Not motivated) to 5 (Very motivated)

3.2 Interview Vestingloop 's-Hertogenbosch

This second round of interviews with potential app users was conducted towards the end of the project. The primary objective of this second round of interviews was to gather user feedback on the motivational physical activity tracker app idea and

features. The interviews aimed to evaluate user responses to specific app features, presented through screenshots and descriptions, to determine their motivational impact and overall appeal.

The interview took place at the "Vestingloop 's-Hertogenbosch" which is a walking and running event. This is a large event, so there are people with a large variety of walking and running experience and an audience. The interviews followed a semi-structured format allowing for flexibility in the conversation while ensuring that all key questions were covered. Some interviews were conducted in groups, while others were one-on-one. All participants were informed of the study's purpose and provided consent to participate and have their responses written down for analysis. In total 14 people were interviewed of which 4 runners, 2 walkers, and 8 people from the audience.

The interview remained in the same structure as the first one, with baseline questions and main questions. The baseline questions aimed to gather general information about the participants' workout habits, motivational tendencies, and prior experience with motivational physical activity tracker apps. The main questions focused on specific features of the developed app and their potential to motivate users. To help participants understand the app features, they were shown some screenshots of the developed app. Participants were asked to rate their responses on a scale of 1 to 5 when possible and provide explanations. This approach seeks to gain a deeper understanding of their thought processes, as these explanations are often very valuable for interpreting their ratings.

Baseline questions

1. How often do you work out? (go for walks/runs or other)
 - Purpose: To establish participants' current level of physical activity.
2. Have you been working out your whole life?
 - Purpose: To understand participants' long-term engagement with physical activity.
3. Do you find it easy to motivate yourself to work out?
 - Purpose: To gauge participants' intrinsic motivation levels, and what motivates them.

4. Would you be interested in a motivational physical activity tracker app or do you use one already?

- Purpose: To determine participants' view on motivational physical activity tracker apps and past experience with these apps.

Main questions

1. How motivated would you be by getting points rewarded for activities based on steps and calories burnt?
 - Purpose: To evaluate the motivational impact of a point-based reward system.
 - Purpose: To evaluate participants' view on a point system based on steps and calories burnt.
 - Scale: 1 (Not motivated) to 5 (Very motivated)
2. How motivated would you be to keep a streak of daily activity levels which requires 30 points or 3000 steps?
 - Purpose: To assess the effectiveness of a streak on motivation.
 - Purpose: To get feedback on the proposed daily activity requirement (of 30 points) for maintaining a streak.
 - Scale: 1 (Not motivated) to 5 (Very motivated)
3. How motivated would you be by getting in-app medals for workout achievements?
 - Purpose: To determine the appeal and motivational value of achievement-based rewards.
 - Scale: 1 (Not motivated) to 5 (Very motivated)
4. How motivated would you be by having a visual representation of your recent activities?
 - Purpose: To explore the potential impact of visual progress tracking on motivation.
 - Scale: 1 (Not motivated) to 5 (Very motivated)
5. How motivated will you be by personalized suggestions and push notifications for exercises/workouts?

- Purpose: To determine the motivational impact of personalized suggestions and push notifications.
 - Scale: 1 (Not motivated) to 5 (Very motivated)
6. How motivated will you be by levels based on points per week?
- Purpose: To determine the motivational impact of levels based on points per week.
 - Scale: 1 (Not motivated) to 5 (Very motivated)
7. Would you be interested in a motivational physical activity tracker app with these gamification elements?
- Purpose: To assess participants' overall interest in motivational physical activity tracker app with gamification elements after learning more about its features and capabilities.
 - Scale: 1 (Not interested) to 5 (Very interested)

4 Results

This chapter presents the findings of the study, focusing on the literature review and interview findings. The results are organized into several key sections, starting with an exploration of the psychological determinants of an active lifestyle. Next, it reviews various behavior change techniques related to physical activity. The findings from the first round of user interviews are then presented, providing insights into user responses to behavior change techniques and proposed app features. Following this, the chapter details the app design, which is based on the study's findings. Finally, the chapter concludes with the second and final round of user interviews, aimed at gathering initial feedback on the app's features. Each section is structured to summarize and analyze the data, highlighting common themes and key findings.

4.1 Determinants of an active lifestyle

Understanding the determinants of an active lifestyle is crucial for developing effective interventions aimed at promoting physical activity. This section explores the key factors that influence an individual's likelihood to engage in physical activity. These determinants encompass a complex interplay of psychological, social, and environmental elements. The focus of this study is on psychological determinants as these can be best influenced by an app. Comprehensive insights into these factors are essential for designing motivational strategies and tools, such as a physical activity tracker app, to encourage a more active and healthier lifestyle.

4.1.1 Self-efficacy

One of the most important determinants is self-efficacy (Short et al., 2014; Bauman et al., 2012; Trost et al., 2002; Lugones-Sanchez et al., 2021). Individuals with high self-efficacy are more likely to initiate and sustain physical activity behaviors, even in challenging circumstances. Self-efficacy, as defined by Bandura (Bandura, 1997), is an individual's belief in their ability to complete a task or achieve a goal. According to Bandura, self-efficacy has four major sources: mastery experiences, social modeling, social persuasion, and psychological responses.

"The most effective way of developing a strong sense of efficacy is through mastery experiences," according to Bandura. Positive and negative experiences can significantly impact an individual's

motivation to perform a task. For instance, if someone has performed well at a particular activity, they are more likely to repeat that activity or engage in related activities. On the contrary, this also works the other way, if one has had negative experiences with physical activity they are less likely to engage in physical activity in the future.

The second source of self-efficacy, social modeling, occurs when individuals observe others successfully completing a task. Witnessing someone similar to oneself accomplish a task effectively increases the belief in one's own capabilities to perform that task, thereby increasing the likelihood of doing it. If people see other people similar to them, like their friends or coworkers, engage in an activity they are more inclined to engage in physical activity themselves.

Thirdly, social persuasion involves convincing individuals that they possess the skills to successfully perform a task. Receiving positive and encouraging feedback from others boosts the chances of overcoming self-doubt and fosters a willingness to tackle a task. For example, when someone gives you positive feedback and compliments while you are performing a sport can increase self-efficacy.

Lastly, psychological responses, including our reactions and emotional responses to situations, play a pivotal role in self-efficacy. Mood, emotional state, physical reactions, and stress levels all influence how individuals perceive their abilities in specific situations. For instance, a person who feels extremely uncomfortable about working out in a group may develop a weak sense of self-efficacy in these situations.

4.1.2 Attitude

Attitudes towards physical activity, which include perceived benefits and barriers, significantly influence individuals' willingness to engage in regular exercise (Yen and Li, 2019; Saylor, 2006; Simons et al., 2014; Salmon et al., 2003). These studies identified various perceived benefits and barriers that play a significant role in shaping attitudes toward physical activity.

Important perceived benefits of physical activity are improvements in both physical and psychological health, fitness, enjoyment, relaxation, social contact, and body image these can positively impact attitudes towards physical activity. These perceived benefits can motivate individuals to engage in activities. Conversely, perceived barriers such as lack of time, lack of motivation, lack of suit-

able facilities, fear of injury, or lack of training companions may hinder engagement. All these perceived benefits and barriers influence one's attitude towards physical activity, this attitude determines whether people want to engage in some kind of activity or not. Therefore understanding and addressing these attitudes is crucial in promoting a more active lifestyle.

These perceived benefits and barriers together influence someone's attitude toward physical activity. Someone who recognizes the health benefits and likes the social interaction that comes from physical activity may develop a positive attitude towards physical activity and is thus motivated to engage in activity behavior. Someone who finds activity to be very time-consuming, does not like sweating and feeling fatigued may develop a negative attitude towards physical activity which can cause

4.1.3 Social dynamics

Research has consistently highlighted the significant influence of social dynamics on individuals' engagement in physical activity (Yen and Li, 2019; Bauman et al., 2012; Simons et al., 2014). Within the complex network of social interactions, both positive reinforcement and social pressure play pivotal roles in shaping behaviors.

Positive reinforcement from friends, family, or peers can provide encouragement and motivation to engage in physical activity. This positive reinforcement is often amplified when the relationships are characterized by closeness and mutual support (Mutrie and Biddle, 2001). For instance, a person is more likely to engage in physical activity when their spouse encourages them to do so. Leveraging social networks and support systems can enhance individuals' commitment to maintaining an active lifestyle.

Conversely, social pressure and norms can either facilitate or hinder participation in exercise (McNeill et al., 2006). While some social circles may have an environment that promotes and encourages physical activity, others could discourage it. For example, a workplace where everyone sits at their desk the whole day and nobody goes outside during breaks can create an environment with higher barriers to physical activity than a workplace where everyone goes for a walk together in their coffee break. Understanding these nuances within social contexts is crucial for designing effective interventions aimed at promoting a more active lifestyle.

It is important to know that not all social in-

teractions will have a positive impact on physical activity. In some cases, social interactions can also hinder it. Negative social influences and a lack of active people around you can discourage individuals from engaging in physical activity. However, leveraging social networks and support systems the right way can enhance individuals' commitment to maintaining an active lifestyle.

4.1.4 Knowledge

Another determinant of physical activity is knowledge. Research indicates that having knowledge about the health consequences of being (in)active can strongly influence how much physical activity individuals engage in (Ferkel et al., 2014; Rothman, 2000). Although it is widely known that physical activity is good for your health, people vary greatly in their understanding of its benefits and risks (Fredriksson et al., 2018).

One important factor in knowledge highlighted in (Fredriksson et al., 2018) is the understanding of diseases linked with a sedentary lifestyle. In this study, participants could only identify 13.8 out of 22 diseases associated with physical inactivity and more than half of the participants did not know the recommended amount of physical activity. It found that participants who could correctly identify more diseases resulting from inactivity were significantly more active. Knowledge of physical activity behavior guidelines is associated with higher levels of physical activity engagement (Abula et al., 2018; Onyeaka et al., 2022). Additionally, it was found that people who are aware of the mental health benefits, including decreased anxiety and depression symptoms, are more likely to live an active lifestyle (Onyeaka et al., 2022).

Conclusion

So to conclude this research into the determinants of an active lifestyle, four main determinants were identified. These factors can explain most of the variance in people's physical activity. Understanding and addressing these factors are essential in promoting physical activity engagement and fostering a healthier society. By targeting these determinants through personalized interventions, education, and support systems, efforts to promote an active lifestyle can be more effective and sustainable.

1. Self-efficacy
2. Attitude (perceived barriers and perceived ben-

efits)

3. Social dynamics
4. Knowledge

4.2 Behavior Change Techniques

Understanding and applying effective behavior change techniques is crucial when developing an intervention tool aimed at increasing physical activity levels. This section delves into various strategies that can influence individuals' determinants of physical activity levels. The insights of behavioral and psychological science can be used to identify and correctly implement techniques that encourage positive changes in lifestyle choices. This section will evaluate the effectiveness of goal setting, recognition and rewards, self-monitoring, and providing instructions on how to perform specific behaviors.

4.2.1 Goal setting

Goal setting plays a significant role in encouraging a change to a more active lifestyle by providing individuals with clear targets and indicators for progress, goal setting is shown to be an effective tool to increase activity levels (Consolvo et al., 2006; Chase et al., 2018; Greaves et al., 2011; Williams and French, 2011a).

According to Locke and Latham's Goal Setting Theory there are 5 main principles to goal setting being; clarity, challenge, commitment, feedback, and task-complexity (Locke and Latham, 1990). Firstly goals should be clear and easy to understand, ambiguous or complex goals are harder can cause confusion and this decreases motivation. Secondly, goals have to be challenging to the right extent, they should not be too easy or too difficult. Easy goals do not give a sense of accomplishment and thus will not be motivating, too difficult goals will feel out of reach of the individual which could cause them to give up before even trying.

Thirdly, goals are more effective if there is a commitment by the individual, just proposing a goal to someone does not mean that the individual accepts it. Goal acceptance can occur in different ways for example by actively agreeing to a proposed goal or by helping define the goal themselves. Fourthly, individuals need feedback to understand how they are performing in relation to the goal, people get motivated if they see progress. This feedback can be in different forms, including metrics, data, or feedback from others. The feedback has to be accurate and timely to be motivating, since a deflated

step count for example can negatively impact the motivation of an individual (Zahrt et al., 2023). Finally, goals should be set at the right complexity, if goals are too complex and require too many steps they tend to be less effective. This shows the importance of breaking down larger more complex goals into smaller comprehensible tasks.

4.2.2 Recognition and rewards

Forms of recognition and rewards can have a positive impact on physical activity levels (Chung et al., 2023; Williams and French, 2011a,b). Even simple gestures of recognition for active behavior can serve as powerful motivators for individuals (Consolvo et al., 2006). Recognition serves as positive reinforcement for active behavior. When individuals receive recognition for their physical activity achievements, whether it's reaching a fitness milestone or consistently participating in exercise routines, they feel a sense of accomplishment and validation. This recognition boosts their self-efficacy and motivates them to continue their active pursuits.

Rewards provide additional incentives that further encourage physical activity. In a recent study by (Plangger et al., 2022), researchers investigated the efficacy of employing new data analytics and health gamification techniques to incentivize increased physical activity. Their findings emphasized the significant impact rewards can have on individuals' engagement in physical activities. By offering rewards such as points for engaging in active behavior, participants demonstrated notably increased levels of physical activity. Acknowledging and rewarding individuals for their efforts not only incentivizes immediate engagement but also enables long-term commitment to regular exercise and overall well-being. This highlights the importance of incorporating recognition and reward systems into health promotion apps to encourage physical activity participation.

4.2.3 Self-monitoring and increasing awareness

Self-monitoring has been shown to have a positive impact on activity levels. Self-monitoring can take many different forms. For instance, regular updates on daily step counts have been demonstrated to significantly improve self-efficacy and increase physical activity levels (Zahrt et al., 2023). In another study by (Consolvo et al., 2006) it was found that individuals liked being able to see their history

of past behavior, current status, and activity level performance. The visibility into past behaviors motivated individuals to strive for more activity, particularly if they perceived their previous efforts as insufficient. Consequently, heightened awareness through self-monitoring served as a motivational impulse for greater physical engagement.

Furthermore, the introduction of activity trackers prompted a realization among users: the tendency to overestimate one's activity levels. Many individuals frequently reported engaging in longer walks or more intense exercises than they actually performed. However, through the implementation of self-monitoring mechanisms, individuals could address these discrepancies, resulting in a more accurate understanding of their activity levels and, consequently, increasing their motivation. (Chung et al., 2023).

4.2.4 Instructions on how to perform behavior

Instructions on how to perform behavior, decision prompts, recommendations, and cues to action are also great motivators (Williams and French, 2011a; Saylor, 2006). The study from (Williams and French, 2011a) found that creating a detailed plan on when and how to perform physical activity and providing instructions and information was effective at creating a positive change in self-efficacy and improving physical activity behavior. Providing these instructions decreases perceived barriers and increases knowledge which are both strong determinants of physical activity. Decision prompts and nudging have also been found to be effective, this study from (Saylor, 2006) noted that a simple decision prompt to take the stairs instead of an elevator or escalator resulted in a median rise in stair use of 54%. This is a significant increase and shows the power of decision prompts and simple cues to action/reminders. These decision prompts increased awareness and promote physical activity, motivating people to engage in physical activity.

4.2.5 Competition

Forms of competition have been shown to increase motivation and physical activity engagement (Johannesson et al., 2010; Reeve, 2023). Competition provides a goal to aim for and encourages individuals to push themselves. For instance, when seeing others/friends engage in a certain amount of physical activity it can motivate you to meet or exceed those levels. However, competition can also negatively impact physical activity levels and mental

health (Batterbee, 2021; Russell et al., 2023). It can introduce a fear and pressure to perform which could negatively impact physical activity engagement (Reeve, 2023). Therefore, competition can be a double-edged sword and should be used with care and thoughtfulness to minimize negative effects.

Strava is a prime example of the application of competition in an activity tracker app, Strava has a heavy focus on competition and performance appreciated by many users. Comparing oneself with others, and striving to climb up leaderboards can drive individuals to new heights and improve on themselves. This constant comparing of their performance to others can also be intimidating and demotivating for some individuals (see section 2.3).

Conclusion

In conclusion, there are many behavior change techniques that effectively promote an active lifestyle. By setting clear and achievable goals, recognizing and rewarding progress, monitoring activity levels, providing detailed instructions, and using competition, individuals can significantly improve their engagement in physical activities. The effectiveness of these techniques highlights the importance of a structured approach in designing intervention tools aiming to increase physical activity.

4.3 Interview Running Group

This section presents the results of the user interviews conducted to gather insights into the factors that motivate individuals to engage in physical activity and their responses to various features proposed for a motivational physical activity tracker app. The baseline questions were used to understand participants' current workout habits, lifelong engagement in physical activity, and intrinsic motivation levels. These responses provide a context against which the more detailed main questions are analyzed. The main questions focused on evaluating participants' interest in and potential motivation derived from specific app features, such as gamification elements, personalized workout goals, visual progress tracking, social comparison, and streak maintenance. The results are presented in a structured manner, with each question's answers summarized and analyzed to identify common themes and key insights.

Baseline questions

1. How often do you work out? (go for walks/runs or other)
 - Most participants stated that they work out around 2 to 3 times a week.
2. Have you been working out your whole life?
 - Most participants stated that they have been working out their whole life, most of them in different sports throughout their lifetime.
3. Do you find it easy to motivate yourself to work out?
 - Most of the participants found it relatively easy to motivate themselves to work out. Some factors stated why they found it easy were, it was a habit for a long time, the accountability of participating in group sessions such as a running group.
 - Some participants stated that when there was bad weather or when they were busy at work it was a lot harder to motivate themselves.
4. Do you like to set goals for yourself?
 - Most participants like working with goals and do set them for themselves other participants mentioned they want to keep it casual and feel no need for goals.
5. Most participants really like working with goals however, they should be personalized and designed to help the individual reach a larger goal.
4. How motivated would you be by having a visual representation of your recent activities (e.g., a calendar or progress chart)?
 - Being able to see progression, past activity behavior and performance is found to be really nice and motivating by nearly all participants.
5. Would you like the ability to compare and/or compete with friends or random users?
 - The view on competition with others was really divided into 2 groups, some find it pretty motivating and fun while others are not interested in it at all because they only want to focus on themselves
6. How motivated will you be by suggestions and prompts for exercises/workouts?
 - Suggestions for workouts should be really personalized and adjusted to a person's situation and past behavior (injury, illness, work, etc.).
 - Suggestions for workouts should also include rest and never promote over training.
7. How motivated would you be to keep a streak of daily activity levels?
 - Although the participants did not think they would be motivated by a streak because they found themselves to engage in enough physical activity some could see how it could be motivating to others who might not be so active. These participants emphasized they thought the streaks should only require a minimal level of daily physical activity.

Main questions

1. Would you be interested in an app that gamifies physical activity?
 - The participants stated as they are happy with the amount of physical activity they engage are not interested in a gamified activity tracker app. (or no app at all)
2. How motivated would you be by getting points rewarded for activities?
 - Most of the participants stated they wouldn't be motivated by getting points rewarded for activities.
3. How motivated would you be by personalized workout goals in an app? For example a 5 km walk.

4.4 App Design

The app is primarily designed to employ various gamification techniques to enhance user motivation by boosting self-efficacy, improving attitudes toward activity, and providing knowledge. Research has consistently shown that gamification increases motivation, enjoyment, and engagement in fitness and other fields (Mitchell Shortt and Akinkuolie,

2023; Woessner et al., 2021; Mazeas et al., 2022). For instance, the app draws inspiration from successful applications like Duolingo and Ommetje, both of which utilize gamification to motivate users to adopt positive behaviors.

Duolingo, renowned for its success in language learning, demonstrates the power of gamification. Its use of hearths, streaks, levels, and other features keeps users engaged and motivated to continue learning (Mitchell Shortt and Akinkuolie, 2023; Hojjat Dehghanzadeh and Noroozi, 2021). This success highlights the potential of incorporating similar features into an app to promote physical activity. Ommetje, on the other hand, translates these gamification techniques to the fitness and health industry. By encouraging users to take regular walks and rewarding them for their consistency, Ommetje has proven the effectiveness of these methods in promoting healthier lifestyles as discussed in section 2.2.

The app, inspired by these precedents and prior research described in previous chapters of this paper, includes several key features: points, streaks, personalized cues to action, achievements, and visualization with graphs. Each of these features taps into different behavior change techniques, creating a compounded effect on motivation.

4.4.1 Points

The app will include a comprehensive point system where users earn points for the activities they engage in. This system is designed to motivate users by providing recognition and rewards for their efforts (Plangger et al., 2022). Points serve as a tangible representation of their activities, making their efforts visible and measurable. To ensure simplicity and ease of understanding, the point system will be based on calories burnt during exercise and daily steps.

The choice of calories burned over other metrics, such as distance or average speed, is strategic. Calories burned is a universal metric that applies to any type of exercise, whether it's walking, playing football, or swimming. It provides a consistent indicator of overall energy expenditure during the activity making it a useful metric for gauging physical activity levels. This universality allows users to engage in a variety of activities while still earning points in a comparable manner.

To prevent overtraining, there will be a maximum on number of points a user can achieve in a day. This safeguard encourages users to maintain

a healthy balance in their physical activities. The app will also show the total number of points a user achieved since using the app. The cumulative points represent the total value of activities the user has engaged in recognizing the user's effort and accomplishments. As this saving of points aligns with Reiss' basic desires it should motivate users to increase their physical activity (Reiss, 2000). This cumulative score not only tracks progress but also serves as a motivational tool by showcasing the user's long-term commitment and achievements.

Within the app, users can set a daily goal for the number of points they aim to achieve as goal setting is an effective motivator for increasing physical activity (see section 4.2.1). This goal-setting feature will adhere to Locke and Latham's goal-setting theory (Locke and Latham, 1990), emphasizing clarity, challenge, and commitment to maximize its effectiveness. By setting a specific number of points as their goal, users have a clear and straightforward target to aim for. They can adjust this goal to ensure it is challenging yet attainable, fostering a sense of ownership and commitment as they tailor the goal to their personal fitness levels and aspirations.

The app's main screen will prominently display the daily points, step count and progress towards the daily goal. This allows for self-monitoring through daily steps and the daily number of points which has a positive impact on activity levels (see section 4.2.3). Providing immediate feedback on the progress towards a goal is essential for the motivational effect, as people get motivated if they see they are making progress (see section 4.2.1). This visibility keeps users engaged and focused on their objectives. The daily goal, being a manageable task, does not require a further breakdown, thus maintaining its simplicity and making it easier for users to stay on track.

Incorporating these features, the app leverages the motivational power of immediate feedback, clear goal setting, and easy monitoring. By translating physical activities into a straightforward point system, users can easily understand and track their efforts, ultimately leading to increased motivation and sustained engagement in their fitness journey.

4.4.2 Streaks

The app will use streaks, a common method to promote consistency seen in apps like Ommetje, Duolingo, and many others. The concept of a streak is straightforward: it represents the number of consecutive days a user engages in a specific behav-

ior—in this case, maintaining a certain level of physical activity. Streaks are known to be powerful motivators, as they tap into several psychological principles (Weathers and Poehlman, 2024; Sharp, 2024). Streaks encourage users to engage in physical activity regularly, fostering habit formation.

The streak allows the user to visibly track their commitment to a more active lifestyle. It increases their awareness of their past behavior, reinforcing the positive habit. The streaks motivate the user through self-monitoring and increasing awareness (see section 4.2.3). Streaks also create a sense of accomplishment over time, seeing a long streak can be incredibly motivating as the streak functions as a form of recognition and reward for the user's effort and commitment which has a positive impact on physical activity levels (see section 4.2.2). The power of loss aversion also plays a significant role in the effectiveness of streaks. Users are often driven by the fear of losing their progress. The thought of breaking a streak can be a powerful motivator, encouraging users to maintain their activity levels to avoid losing their streak (Sharp, 2024).

The design of streaks in the app will be based on daily points, with a low barrier to entry. It is crucial that the streaks do not encourage over-training or deny users necessary rest days, as this can be unhealthy. Therefore the users are allowed to miss the goal of daily activity once a week while remaining the streak. This way users earn streak points for achieving a modest daily activity level that is sustainable and health-promoting. This approach was supported by findings from user interviews (see section 4.3), emphasizing the importance of balancing motivation with health considerations.

By integrating streaks, the app leverages recognition and psychological incentives to promote consistency. Users are motivated not just by the accumulation of points but by the desire to maintain their streaks, which serve as a testament to their ongoing commitment to physical activity.

4.4.3 Levels

The app will feature a levels system, where points earned through daily activities are linked to weekly levels. This system serves as a series of incremental goals that provide users with tangible milestones to strive for each week. By establishing weekly levels, the app aims to enhance user motivation, offering consistent targets that encourage ongoing engagement and effort.

Weekly levels operate as both goals and rewards,

providing a dual function that significantly boosts motivation (see sections 4.2.1 and 4.2.2). As users accumulate points throughout the week, they advance to higher levels, which not only serve as recognition of their efforts but also offer a sense of accomplishment. For instance, a user who consistently reaches higher levels each week can see tangible proof of their commitment and improvement in physical activity.

This feature motivates users through self-monitoring and increasing awareness (see section 4.2.3). The app will display users' previous levels and weekly points, allowing for personal progression tracking and self-comparison. This feature is particularly motivating as it highlights individual growth over time and allows users to self-monitor their weekly activity levels. For example, a user who sees their levels steadily increasing week after week will feel a sense of pride and motivation to maintain or even improve their performance. This historical tracking serves as a powerful reminder of how far they have come, reinforcing their dedication and encouraging continued effort.

By incorporating levels, the app leverages the principles of goal-setting and positive reinforcement. Levels provide clear, attainable weekly goals that users can aim for, making the larger objective of maintaining a healthy lifestyle more manageable. This structured approach helps break down the long-term goal into smaller, achievable tasks, making it easier for users to stay motivated and committed (Locke and Latham, 1990).

4.4.4 Recommendations

The app will also feature personalized cues to action on suitable forms of exercise called challenges. These personalized prompts are designed to reduce barriers to exercise and enhance self-efficacy as this can improve physical activity behavior (see section 4.2.4). By leveraging a user's past activity data, the app can offer relevant and timely suggestions that align with the user's habits and preferences, making it easier for them to stay active.

For instance, if a user typically goes for walks on Tuesday evenings, the app will send a notification around this time and day to encourage them to go for a walk again. This form of personalization ensures that the reminders are not only timely but also contextually relevant, increasing the likelihood of the user following through. Personalized cues enhance the app's relevance and user engagement. When users receive recommendations that are tai-

lored to their unique circumstances, they perceive the app as more valuable and supportive. This sense of personalization can significantly boost user satisfaction and adherence to the suggested activities (Simons et al., 2018).

To maximize effectiveness, these personalized cues and advice will require the user to accept them, this comes from the goal-setting theory (Locke and Latham, 1990). Individuals are more likely to act when they actively accept the goal or activity in this occasion. On top of that the users will receive additional points when following through on this accepted challenge, this serves as an additional reward and incentive.

4.4.5 Achievements

The app will feature an achievements page, which will include a great library of accomplishments to cater to all users. This page will showcase achievements across various sports as well as general activity milestones, such as daily steps. By providing rewards for reaching specific goals and milestones, the app offers a form of positive reinforcement, recognizing and celebrating users' activity achievements.

Achievements motivate users to engage in physical activity through goal setting (see section 4.2.1). The achievements should be on a wide variety of activities and have different degrees of difficulty. This ensures there are attainable and challenging achievements for all users. The goals should be simple like "10.000 steps in a day" or "Run a 5k 10 times", ensuring they are clear and easy to understand. Their should also be feedback on the progress towards the goals, the app should allow the users to quickly track their progress towards these achievements. These criteria ensure maximal effectiveness of the achievements (Locke and Latham, 1990). The achievements of these activity milestones will be rewarded with some kind of in-app trophies, motivating the users with recognition and rewards (see section 4.2.2).

The app's achievements system also taps into the psychological principle of collection. Users can be driven by the desire to collect all available achievements in their desired activities, which aligns with the basic desire of Saving from Reiss' 16 basic desires (Reiss, 2000).

4.4.6 Graphs

The app will also include a dedicated page with graphs and statistics detailing users' activity levels.

Feedback from user interviews indicated that this feature is highly appreciated and motivating, as users enjoy tracking their progress and reviewing their past activity behaviors (see section 4.3).

Moreover, these graphs facilitate self-monitoring and self-reflection which has a positive impact on physical activity levels (see section 4.2.3). By reviewing their past behaviors, users can reflect on their achievements and identify patterns in their activity levels. For instance, a user might notice that they are more active on weekends than on weekdays. This insight allows them to make informed adjustments to their routines, such as incorporating more physical activity during the week. By understanding these patterns, users can set more realistic and effective goals, further boosting their motivation to stay active.

For example, a user can see their increasing daily step count over several weeks, making the progress tangible and motivating. This clear depiction of progress can be especially encouraging for users, as it provides immediate, visual evidence of their hard work and dedication.

Conclusion

Incorporating these features into the app creates a comprehensive motivational app that encourages users to adopt and maintain a more active lifestyle. By leveraging the psychological principles behind gamification, the app can transform the often difficult task of increasing physical activity into an engaging and rewarding experience.

This app design is compatible with all forms of activity ensuring it suffices every users' tracking needs. The app uses a simple point system to allow for easy comprehensive tracking of all activities not requiring high data literacy. The app should be free to use to be accessible to all individuals.

4.5 Interview Vestingloop 's-Hertogenbosch

This section presents the results from the second round of user interviews, which aimed to gather feedback on the features of the designed motivational physical activity tracker app. The baseline questions were designed to collect general information about participants' workout habits, motivational tendencies, and prior experience with physical activity tracker apps, providing context for the analysis of the main questions. The main questions focused on evaluating the potential motivational impact of features included in the app

design. The results are presented in a structured manner, with each question's answers summarized and analyzed to identify common themes and key insights.

Baseline questions

1. How often do you work out? (go for walks/runs or other)

- Most participants reported working out 1 to 3 times per week. Exceptions included two participants who did not work out and two who exercised 4 and 7 times per week.

2. Have you been working out your whole life?

- All participants who currently worked out stated they have been working out their entire lives.

3. Do you find it easy to motivate yourself to work out?

- Most participants rated their motivation between 3 and 5 on a scale of 1 to 5, where 5 is very easy and 1 is very hard.
- Common obstacles included lack of time, laziness, and occasional dislike for exercising.

4. Would you be interested in a motivational physical activity tracker app or do you use one already?

- Half of the participants currently used an app, primarily Strava. They appreciated Strava's tracking capabilities, statistics, and competitive features with friends.

Main questions

1. How motivated would you be by getting points rewarded for activities based on steps and calories burnt?

- Nearly half the participants rated this motivation as 3 or 4 out of 5, stating that they liked the ability to track their activity levels with a number.
- The other half of the participants found it un motivating unless the points were linked to something else like in-app purchases or competition.

2. How motivated would you be to maintain a streak of daily activity levels requiring 30 points or 3000 steps?

- Most participants rated this 1 or 2 out of 5, indicating low motivation from streaks. However, a few rated it 5, finding it highly motivating.

3. How motivated would you be by getting in-app medals for workout achievements?

- The responses varied a lot ranging from 1 to 5.
- Some participants noted that medals would be motivating if they facilitated progressive improvement in their chosen sport.

4. How motivated would you be by having a visual representation of your recent activities?

- This feature received the highest ratings, with nearly all participants scoring it 4 or 5 out of 5
- Participants liked the ability to track and see their progress, and mentioned they found it motivating to see statistics about their activities such as distance walked.

5. How motivated will you be by personalized suggestions and push notifications for exercises/workouts?

- Participants rated this between 3 and 5, finding it motivating if suggestions were personalized.
- A couple of participants stated generic suggestions were seen as counterproductive.

6. How motivated will you be by levels for points per week?

- Most participants rated this feature between 1 and 3, indicating low motivation.
- However, some participants suggested levels could be more motivating if they reflected activity milestones, such as meeting health guidelines.

7. Would you be interested in a motivational physical activity tracker app with these gamification elements?

- Nearly half the participants expressed interest in an app with gamification features.
- Participants stated they would be even more interested if the app included competitive elements.

5 Implementation

This chapter outlines the implementation of the app prototype. The following sections provide an in-depth analysis of each feature, detailing the techniques used during the implementation process. Each feature from step counting to achievements was designed to improve users' motivation to engage in physical activity. The features' implementation is based on the app design and principles explained in section 4.4. For a larger version of the figures shown in this chapter see Appendix A.

The app prototype was developed using Python in Microsoft Visual Studio Code and was built on the Django framework. Django was chosen for its robust framework that allows for rapid development and clean, practical design (Mashutin, 2023; Ryabtsev, 2024). Its built-in features, such as an admin interface, authentication, and a secure framework, provide a strong foundation for building scalable and maintainable apps. The extensive library support and active developer community further contribute to the ease of implementing and extending functionalities, ensuring that the app can evolve and adapt to future requirements.

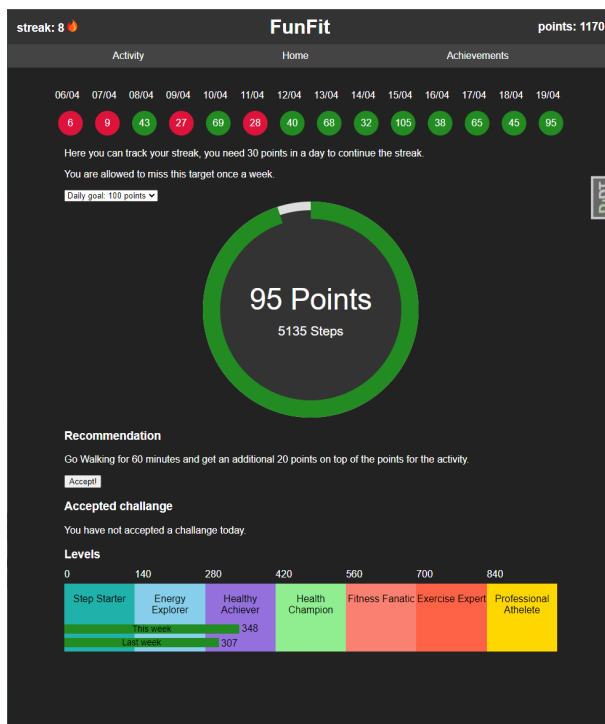


Figure 13: Home page of the app

5.1 Data preparation

In this study a Xiaomi smart band was used to collect the data for the app prototype, this data is used

to test the features on real data. The Zepp Life app was used to export the data from the smart band. This extraction provided a couple of files with activity data including an "ACTIVITY" and "SPORT" file. The "ACTIVITY" file contains daily data on steps, distance, run distance, and calories burnt. The "SPORT" file contains the type, startTime, sportTime (s), maxPace (/meter), minPace (/meter), distance (m), avgPace(/meter), and calories. These two files are both uploaded to the SQLite database of the app. The data from the files did not require data cleaning as the data was complete and in a structured format.

An SQLite database with 5 different tables was created to store all the data required for the app's functionality. A further breakdown of the different tables and variables can be seen below.

Achievement

- Name: string value with the name of the achievement.
- Sport: string value with the type of sport or activity.
- Type: string value with the metric of the achievement e.g. steps.
- Condition: integer value of the metric that has to be reached.

Activity

- Date: Datetime object with the date.
- Steps: integer value of the step count of that date.
- Distance: integer value of the walked distance in meters of that date.
- RunDistance: integer value of the ran distance in meters of that date.
- Calories: integer value of burnt calories on that day.

Challenge

- Sport: string value with the type of sport or activity.
- Condition: integer value of the metric that has to be reached.
- Date: Datetime object with the date.

- Points: integer value of the points rewarded for completing the challenge.

Level

- LevelName: string value of the name of the level.
- Condition: integer value of the number of points required for the level.
- Rank: integer value of the rank of the level ranging from 1 to 7.

Workout

- Type: string value with the type of sport or activity.
- StartTime: Datetime object with the date and time when the workout started.
- Duration: integer value of the length of the workout in seconds.
- MaxPace: integer value of the minimum pace during the workout.
- MinPace: integer value of the maximum pace during the workout.
- Distance: integer value of the distance covered in meters during the workout.
- AvgPace: integer value of the average pace during the workout.
- calories: integer value of the calories burnt during the workout.

5.2 Points

The point system was designed to be simple and user-friendly. The computation of the points should not be too complicated because this could result in the users not understanding what the points mean and it would lose its value. Points are awarded for 3 aspects of physical activity, and a maximum of 150 points per day can be earned.

1. Steps: for every 100 steps, 1 point is counted.
2. Workouts: for every 10 calories burnt during a workout, 1 point is counted.
3. Challenges: additional points are awarded for challenges, the number of points is based on the duration of the challenge, with 5 points per 15 minutes awarded.

Points are displayed in several ways:

- Daily Points: Displayed prominently in the center of the home screen, providing immediate feedback on daily activity levels.
- Total Points: Shown in the top right corner of the screen, representing the total number of points the user has earned while using the app.
- Historical Points: To provide an overview of the past behavior the number of points per day of the last 2 weeks is shown on top of the main page.

On the home screen, the user can set a daily goal for the number of points. The progress can easily be tracked using the green progression circle chart which is shown prominently in the center of the home screen and can be seen in Figure 14.

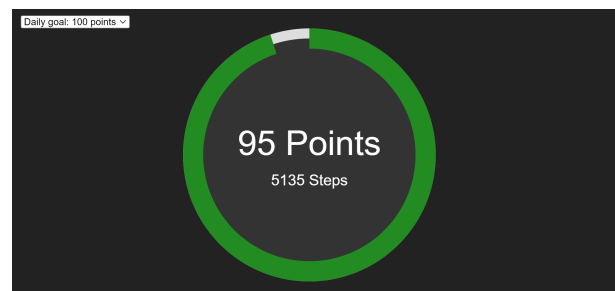


Figure 14: Daily goal in the app

5.3 Streak

Streaks are based on daily points. Users must achieve a daily requirement of 30 points (equivalent to 3000 steps or 300 calories burned during exercise) to maintain their streak. This requirement promotes a modest level of activity.

Users earn "spare days" for maintaining streaks. For every six days of meeting the activity requirement, they earn one spare day, allowing them to miss a day without breaking their streak. This system encourages consistency while providing flexibility. If the streak is broken the spare days are set back to zero.

Streaks are displayed prominently at the top-left of the screen, ensuring constant visibility. The home page also shows points per day for the last 14 days displayed in small circles, with colors indicating whether the daily requirement was met as can be seen in Figure 15. Green indicates the requirement was met, red indicates the requirement

was not met, and blue means the requirement was not met but a spare day was used to continue the streak.

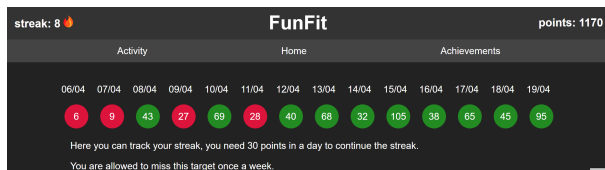


Figure 15: Streaks in the app

5.4 Recommendations

The aim of this feature was to create a model that would recommend activities based on the user’s past behavior and would encourage the user to improve on this behavior. However, due to the lack of time and data, this was deemed very hard therefore a placeholder model was implemented.

A model was created that takes the user’s activity data and a small hand-made dataset of some basic activities like walking, running, and cycling with different durations such as 15 minutes and 30 minutes. This hand-made dataset was created because there is no user database from which these activities would ideally be extracted. These two datasets of activities are combined, to prevent over-training and promote variety all the activities of the same type as the activity performed the day before are removed. So for instance, if the user went running the day before the model would not recommend going running again the next day.

So the dataset now contained past activities excluding the most recent activity type and some common activities. To clarify the dataset contains activities, not activity types so if the user went on a walk 10 times then this activity would be in the dataset 10 times. The duration of the activities is rounded to the nearest quarter-hour to avoid recommending unusual times like 35 minutes and 23 seconds. To select the recommended activity a random activity from this dataset is drawn, with activities performed more frequently thus having a higher likelihood of being chosen because they appear more often in the dataset. This model will give recommendations that closely resemble the user’s past activities while also introducing a variety and new activities.

The user can then accept this recommendation as a challenge which they have to complete that day to receive the additional points. The number of additional points they get from this challenge is

based on the length of the activity with 5 points per quarter, so an activity of 45 minutes is 15 points. These points are on top of the points the user gets from calories burnt during the activity. If the user accepts the recommendation it will be shown on the home page at ‘Accepted challenge’ as can be seen in Figure 16.

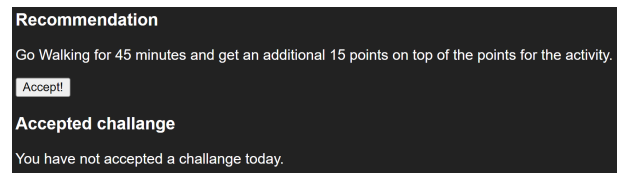


Figure 16: Recommendations in the app

5.5 Levels

For the levels a table in the database was created, each level had the features: name, requirement, and rank as shown in section 5.1. The names are designed to give a positive reinforcement for each level you can see the names in Figure 17. There are 7 levels with incremental requirements for each level, starting at 0 points for level 1 ‘Step Starter’ and ending at 840 for level 7 ‘Professional Athlete’ making jumps of 140 points which equals 20 points per day. The last level requires 840 which comes down to an average of 120 points per day. The levels are shown at the bottom of the home page so they are easily visible to the user.

The levels also have 2 progression bars with the number of points for the current week and last week. It shows at which level you are with the number of points and the ‘distance’ to the next level. It allows for immediate feedback and easy comparison with the last week. The week points are the cumulative points of the days Monday through Sunday and for the current week Monday to the current day.

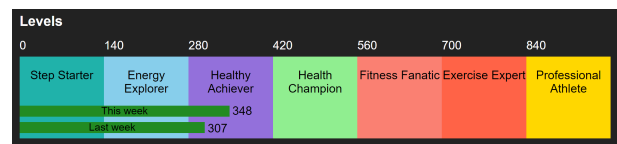


Figure 17: Levels in the app

5.6 Achievements

For the achievements, a table was created in the database with 4 variables as shown in section 5.1. The achievements are presented on a separate page. On this page, the achievements are ordered by sport

or activity and sorted on the condition from low to high. Each separate achievement is represented by a box with the name of the achievement on the upper side and the progress and condition below. This way the users can easily see their progress towards each achievement and see what they need to do to achieve it. If they have completed the achievement it turns bright gold, this represents a trophy, this way users can easily see which achievements they completed.

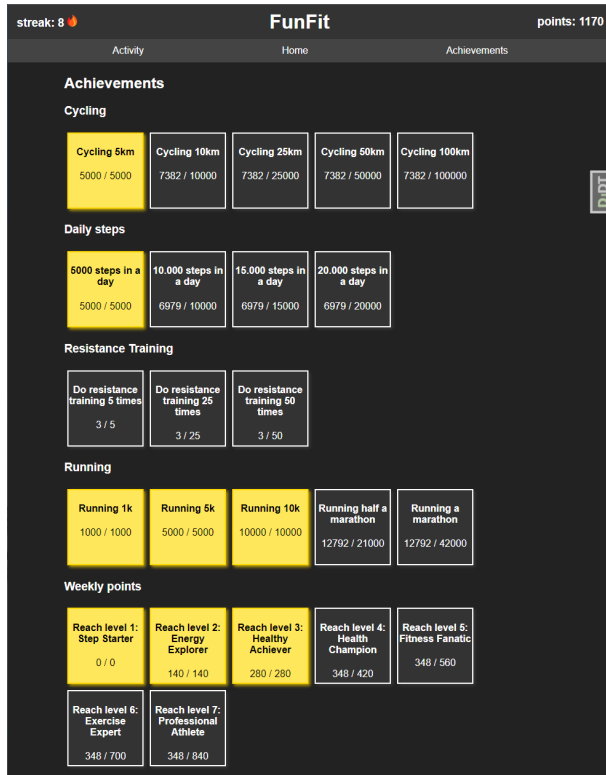


Figure 18: Achievements page of the app

5.7 Graphs

The graphs are shown on the activity page, which is a separate page for more detailed visuals of the user's activity levels (see Figure 19). Four interactive graphs were created using the Plotly module, which allows users to interact with the graphs by selecting data points, zooming, and comparing values. These graphs provide users with tools for self-monitoring, enabling them to track progress and adjust their activities accordingly.

- Steps per Day: A line graph showing daily step counts, emphasizing trends over time.
- Minutes Worked Out per Week: A bar chart showing weekly workout minutes for the last seven weeks.

- Points per Week: A bar chart presenting the total points earned per week over the last seven weeks.
- Points per Day: A bar chart presenting daily points over the last seven days.



Figure 19: activity page of the app

6 Discussion

The objective of this study was to develop an evidence and theory-based physical activity tracker app that motivates users to engage in more physical activity. This chapter discusses the key findings from this study and the implications and limitations that need to be considered. It will also suggest further research.

Through an extensive literature review and supplemental user interviews, this study identified four main determinants of physical activity: self-efficacy, attitude, social dynamics, and knowledge. These four factors can explain most of the variance in people's physical activity levels. Understanding these factors is essential in developing a tool that not only improves activity levels in the short term but fosters sustainable behavior change. By addressing these factors we can design effective behavior change techniques that promote long-term engagement in physical activity (see section 4.1).

Additionally, the study explored the effectiveness of different behavior change techniques it identified five effective techniques: goal setting, recognition and rewards, self-monitoring, instruction on how to perform behavior, and competition (see section 4.2). While the study highlighted these five techniques, it does not claim they are the only effective methods. An understanding of these techniques is essential to ensure a structured approach for designing intervention tools to increase physical activity effectively. These findings formed the core of the app's design.

The app was designed with a focus on gamification elements, incorporating various features based on the identified determinants and behavior change techniques, as described in section 4.4. These features include a point system for tracking activities, streaks, levels, recommendations, achievements, and graphs for more detailed tracking.

The app is designed to provide a comprehensive tracking solution of all activities, the point system provides a simple tangible number to track overall activity levels providing a solution for individuals with different degrees of data literacy. The app is not limited to one activity as the point system is compatible with all activities from daily steps to weight lifting. The app employs many different evidence-based techniques for promoting physical activity such as goal-setting and achievements.

However, the app also has some limitations. Firstly, the app has no social elements to it although

social dynamics is one of the most significant determinants of physical activity (see section 4.1.3). Competition and social support are proven to increase physical activities (see section 4.1.3 and 4.2.5). The participants of the second user interview also indicated that they would greatly appreciate social features such as competition in the app, stating that this would increase the motivational value of the app (see section 4.5). Further research is required on how to best implement these social aspects into the app.

Furthermore, the app does not educate the users on the impact of physical activity levels and the health consequences of (in)active behavior while this is one of the most significant determinants of an active lifestyle (see section 4.1.4). The app contains levels based on weekly points to set goals for weekly activity but the app does not indicate the recommended activity levels for a healthy lifestyle. This topic requires health and fitness expertise and further research on how to best implement this in the app.

Due to time and resource constraints, this study failed to develop a sophisticated model to recommend activities to the users. The app prototype uses a placeholder model for the recommendation as described in section 5.4. However, as found in both the interviews and literature study (see section 4) the recommendations have to be tailored to individuals' needs and behaviors to ensure effectiveness. Further research is needed to develop a model that recommends activities based on users' past behavior, the recommendations should also encourage the user to increase their activity levels.

The methodology employed in this study is based on a comprehensive review of existing literature and case studies supplemented with small-scaled user interviews. Although the study resulted in an evidence-based app design and prototype the long-term reliability and usability is uncertain due to the lack of robust testing. The app has not been tested in practical scenarios, and thus, there are no empirical observations on the effectiveness of the app. A prolonged field study needs to be performed to evaluate the long-term effectiveness of the app on physical activity engagement and user experiences.

7 Conclusion

lifestyles in society.

The main purpose of this study was to answer the research question: How can data analytics of human activity patterns be best presented or communicated in an app to individuals with varying degrees of data literacy, that leads to a structural change in lifestyle? This subject is especially important since society is becoming more and more sedentary as people are moving less and less which has led to several health problems (Owen et al., 2010; Woessner et al., 2021). A sedentary lifestyle is one of the main causes of chronic diseases such as diabetes, cardiac problems, and several forms of cancer (Park et al., 2020). There are various apps designed to address this increasing problem but these have their limitations. These limitations include high costs, lack of motivation features, being limited to a small variety of activities, being too competitive and performance-focused, and being too complicated (see section 2).

An app was designed with a focus on gamification elements as this is shown to increase enjoyment and engagement (Mitchell Shortt and Akinkuolie, 2023; Woessner et al., 2021; Mazeas et al., 2022), it employs several features based on the determinants and behavior change techniques found in this study as described in section 4.4. These features include; a point system for activity tracking, streaks, levels, challenges, achievements, and graphs for detailed tracking. This app design motivates users through different psychological elements and is compatible with all activities. The point system provides a simple tangible number to track all activity data ensuring it can be used by individuals with varying degrees of data literacy. This results in a comprehensive motivational app accessible to individuals of different activity preferences and experience levels. The app design was implemented as described in section 5.

In conclusion, this study has provided valuable insights into key determinants and effective techniques for promoting physical activity through an app. By leveraging these findings and using gamification elements an app was developed that has the potential to significantly increase physical activity engagement. Further research is needed to address the limitations as discussed in section 6. The findings of this study contribute to knowledge on motivational activity tracker apps, the development of such apps represents a promising solution for addressing the growing problem of sedentary

References

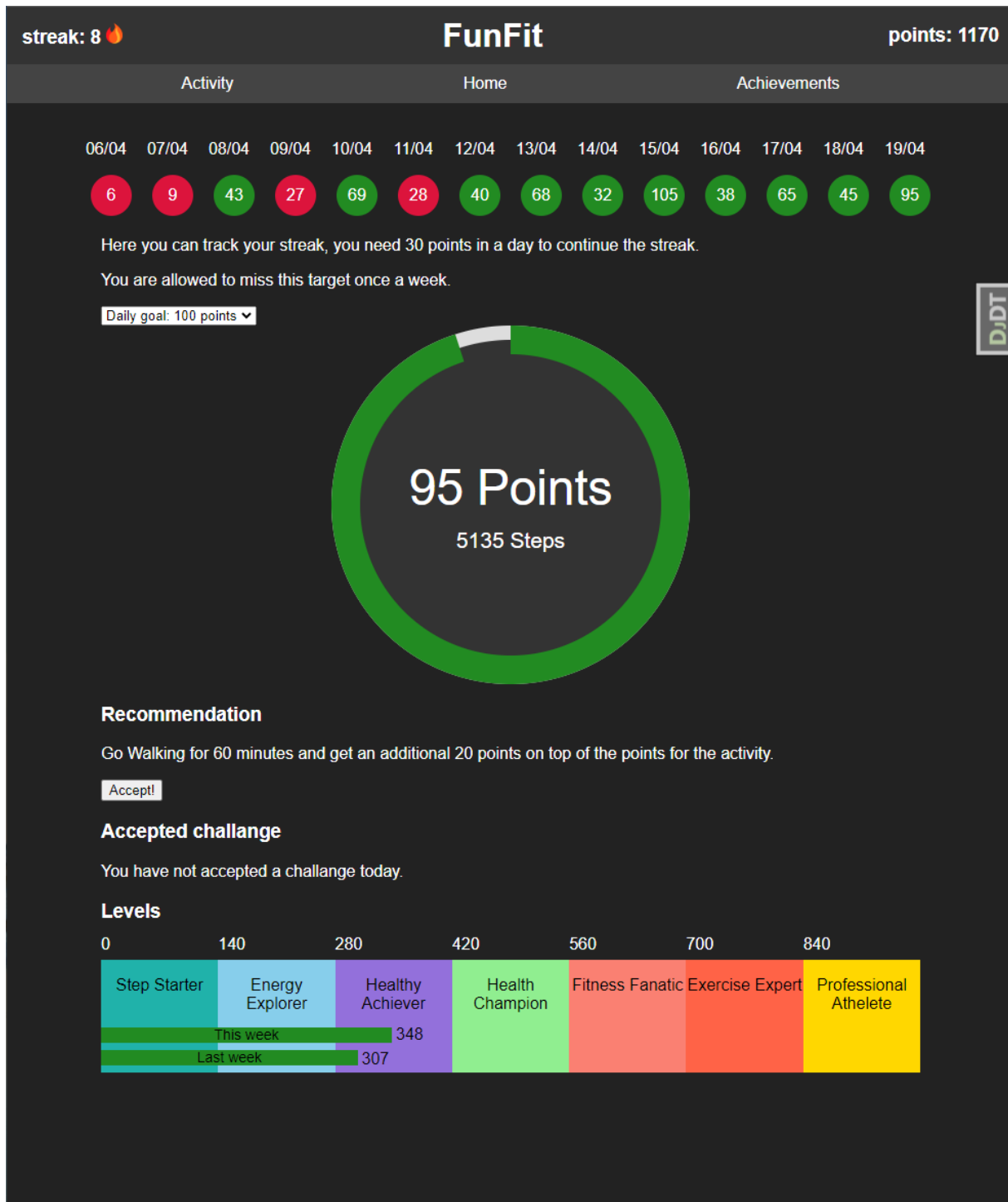
- Kahar Abula, Peter Gröpel, Kai Chen, and Jürgen Beckmann. 2018. Does knowledge of physical activity recommendations increase physical activity among chinese college students? empirical investigations based on the transtheoretical model. *Journal of Sport and Health Science*, 7(1):77–82.
- Jessica Lester Alena Hall, Meaghan Harmon. 2024.
- Mohammed A Alnawwar, Mohammed I Alraddadi, Raghad A Algethmi, Ghaida A Salem, Maha A Salem, and Abdulaziz A Alharbi. 2023. The effect of physical activity on sleep quality and sleep disorder: A systematic review. *Cureus*, 15(8):e43595.
- Albert Bandura. 1997. *Self-efficacy: The exercise of control*. W H Freeman/Times Books/Henry Holt Co.
- Sinead Batterbee. 2021. Training apps motivational or mentally harmful.
- Adrian E Bauman, Rodrigo S Reis, James F Sallis, Jonathan C Wells, Ruth JF Loos, Brian W Martin, and Lancet Physical Activity Series Working Group. 2012. Correlates of physical activity: why are some people physically active and others not? *The Lancet*, 380(9838):258–271.
- Gary G Bennett, Kathleen Y Wolin, Elaine M Puleo, Louise C Mâsse, and Audie A Atienza. 2009. Awareness of national physical activity recommendations for health promotion among us adults. *Medicine and science in sports and exercise*, 41(10):1849–1855.
- Aida Carballo-Fazanes, Javier Rico-Díaz, Roberto Barcala-Furelos, Ezequiel Rey, José E. Rodríguez-Fernández, Cristina Varela-Casal, and Cristian Abelairas-Gómez. 2020. Physical activity habits and determinants, sedentary behaviour and lifestyle in university students. *International Journal of Environmental Research and Public Health*, 17(9).
- Benjamin Chase, Morgan Hall, and Timothy A. Brusseau. 2018. Impact of goal setting on physical activity in physical education. *Journal of Physical Education and Sport*, 18(2):757–761.
- Eunice Choi. 2019. Ux case study: Nike training club.
- Jiyeon Chung, Hannah R. Brakey, Blaine Reeder, Olivia Myers, and George Demiris. 2023. Community-dwelling older adults' acceptance of smartwatches for health and location tracking. *International Journal of Older People Nursing*, 18(1):e12490.
- Sunny Consolvo, Katherine Everitt, Ian Smith, and James A. Landay. 2006. Design requirements for technologies that encourage physical activity. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, page 457–466, New York, NY, USA. Association for Computing Machinery.
- Lloyd Coombes. 2023. Fitbit premium review: Still a first-class premium fitness app.
- Onderzoeksbureau D&B. Verbeterde versie van populaire ommetje-app.
- Rochelle M. Eime, Janet A. Young, Jack T. Harvey, Melanie J. Charity, and Warren R. Payne. 2013. A systematic review of the psychological and social benefits of participation in sport for children and adolescents: informing development of a conceptual model of health through sport. *International Journal of Behavioral Nutrition and Physical Activity*, 10(1):98.
- Rick C Ferkel, Lawrence W Judge, David F Stodden, and Kent Griffin. 2014. Importance of health-related fitness knowledge to increasing physical activity and physical fitness. *Physical Educator*, 71(2):218–233.
- Rob Franken, Hidde Bekhuis, and Jochem Tolsma. 2023. Kudos make you run! how runners influence each other on the online social network strava. *Social Networks*, 72:151–164.
- Susanne V Fredriksson, Stephanie J Alley, Amanda L Rebar, Melanie Hayman, Corneel Vandelanotte, and et al. 2018. How are different levels of knowledge about physical activity associated with physical activity behaviour in australian adults? *PLOS ONE*, 13(11):e0207003.
- Colin J. Greaves, Kate E. Sheppard, Charles Abraham, and et al. 2011. Systematic review of reviews of intervention components associated with increased effectiveness in dietary and physical activity interventions. *BMC Public Health*, 11(1):119.
- Chris Griffiths, Ksenija Maravic da Silva, Farah Hina, Sue Jugon, Gemma Willis, Samantha Yardley, Jonathon Walker, and Marlene Kelbrick. 2022. Effectiveness of a fitbit based sleep and physical activity intervention in an early intervention psychosis (eip) service. *Open Journal of Psychiatry*, 12:188–202.
- Hersenstichting. 2023. Ommetje-app brengt mensen in beweging.
- Javad Hatami Ebrahim Talaei Hojjat Dehghanzadeh, Hashem Fardanesh and Omid Noroozi. 2021. Using gamification to support learning english as a second language: a systematic review. *Computer Assisted Language Learning*, 34(7):934–957.
- Lin Jiang, Yang Cao, Shuang Ni, Xiaoyu Chen, Min Shen, Hao Lv, and Jie Hu. 2020. Association of sedentary behavior with anxiety, depression, and suicide ideation in college students. *Frontiers in psychiatry*, 11:566098.
- Magnus Johannesson, Robert Å–stling, and Eva Ranehill. 2010. The effect of competition on physical activity: A randomized trial. *The B.E. Journal of Economic Analysis Policy*, 10:91–91.
- Edwin A. Locke and Gary P. Latham. 1990. *A theory of goal setting & task performance*. Prentice-Hall, Inc.

- Cristina Lugones-Sanchez, Rik Crutzen, Jose I. Recio-Rodriguez, and Luis Garcia-Ortiz. 2021. [Establishing the relevance of psychological determinants regarding physical activity in people with overweight and obesity](#). *International Journal of Clinical and Health Psychology*, 21(3):100250.
- A. Mahindru, P. Patil, and V. Agrawal. 2023. [Role of physical activity on mental health and well-being: A review](#). *Cureus*, 15(1):e33475.
- Cheryll Didi Nellie N. Obra; Agatha Camille S. Quidilla; Rome Justine B. Cajigal; Jannah Kris A. Jerez; Shiela Mae A. Ramos; Reyma Jamelia C. Malabed. 2023. [Effectiveness of using exercise app in improving exercise adherence and aerobic endurance of football players](#). 2.
- Laura Mandolesi, Amedeo Polverino, Serena Montuori, Francesca Foti, Gianluca Ferraioli, Pierpaolo Sorrentino, and Giuseppe Sorrentino. 2018. [Effects of physical exercise on cognitive functioning and well-being: Biological and psychological benefits](#). *Frontiers in psychology*, 9:509.
- Denis Mashutin. 2023. [Django vs flask: Which is the best python web framework?](#)
- Paige Maslen. 2015. [The social and academic benefits of team sports](#). *edutopia*.
- Alexandre Mazeas, Martine Duclos, Bruno Pereira, and Aina Chalabaev. 2022. [Evaluating the effectiveness of gamification on physical activity: Systematic review and meta-analysis of randomized controlled trials](#). *J Med Internet Res*, 24(1):e26779.
- Stephanie K McCrady and James A Levine. 2009. [Sedentariness at work: how much do we really sit?](#) *Obesity (Silver Spring, Md.)*, 17(11):2103–2105.
- Lorna Haughton McNeill, Matthew W. Kreuter, and S.V. Subramanian. 2006. [Social environment and physical activity: A review of concepts and evidence](#). *Social Science Medicine*, 63(4):1011–1022.
- Irina Kuznetcova Bethany Martens Mitchell Shortt, Shantanu Tilak and Babatunde Akinkuolie. 2023. [Gamification in mobile-assisted language learning: a systematic review of duolingo literature from public release of 2012 to early 2020](#). *Computer Assisted Language Learning*, 36(3):517–554.
- Nanette Mutrie and Stuart JH Biddle. 2001. *Psychology of Physical Activity: Determinants, Well-Being and Interventions*. Routledge.
- Henry Onyeaka, Juliana Zambrano, Hannah Szlyk, Christopher Celano, Philip Baiden, Chioma Muoghalu, Valentine Enemuo, Esther Ayisire Oghenetega, Jeff. C Huffman, John Torous, and Joseph Firth. 2022. [Is engagement in physical activity related to its perceived mental health benefits among people with depression and anxiety? a population-scale survey study](#). *American Journal of Lifestyle Medicine*, page 15598276221116081.
- Neville Owen, Phillip B Sparling, Genevieve N Healy, David W Dunstan, and Charles E Matthews. 2010. [Sedentary behavior: emerging evidence for a new health risk](#). *Mayo Clinic proceedings*, 85(12):1138–1141.
- Ji Hye Park, Ji Hyun Moon, Hyun Joo Kim, Min-Ho Kong, and Yun Hwan Oh. 2020. [Sedentary lifestyle: Overview of updated evidence of potential health risks](#). *Korean journal of family medicine*, 41(6):365–373.
- J. M. Petersen, E. Kemps, L. K. Lewis, and I. Prichard. 2020. [Associations between commercial app use and physical activity: Cross-sectional study](#). *Journal of Medical Internet Research*, 22(6):e17152.
- Kirk Plangger, Colin Campbell, Karen Robson, and Matteo Montecchi. 2022. [Little rewards, big changes: Using exercise analytics to motivate sustainable changes in physical activity](#). *Information Management*, 59(5):103216. Big Data Analytics for Sustainability.
- Johnmarshall Reeve. 2023. [165 Competition Can Enhance Motivation—But Typically Undermines It](#). In *Motivation Science: Controversies and Insights*. Oxford University Press.
- S. Reiss. 2000. *Who Am I?: The 16 Basic Desires that Motivate Our Behavior and Define Our Personality*. Jeremy P. Tarcher/Putnam.
- M. Ringeval, G. Wagner, J. Denford, G. Paré, and S. Kit-siou. 2020. [Fitbit-based interventions for healthy lifestyle outcomes: Systematic review and meta-analysis](#). *Journal of Medical Internet Research*, 22(10):e23954.
- Gaby Ronda, Patricia Van Assema, and Johannes Brug. 2001. [Stages of change, psychological factors and awareness of physical activity levels in the Netherlands](#). *Health Promotion International*, 16(4):305–314.
- Alexander Rothman. 2000. [Toward a theory-based analysis of behavioral maintenance](#). *Health Psychology*, 19:S64–S69.
- Hayley C. Russell, Charlie Potts, and Emma Nelson. 2023. [“if it’s not on strava it didn’t happen”](#): Perceived psychosocial implications of strava use in collegiate club runners. *Recreational Sports Journal*, 47(1):15–25.
- Alex Ryabtsev. 2024. [Top 14 pros of using django for python web development](#).
- J. Salmon, N. Owen, D. Crawford, A. Bauman, and J. F. Sallis. 2003. [Physical activity and sedentary behavior: A population-based study of barriers, enjoyment, and preference](#). *Health Psychology*, 22(2):178–188.
- C.P. Saylor. 2006. *Weight Loss, Exercise and Health Research*. Nova Science Publishers.

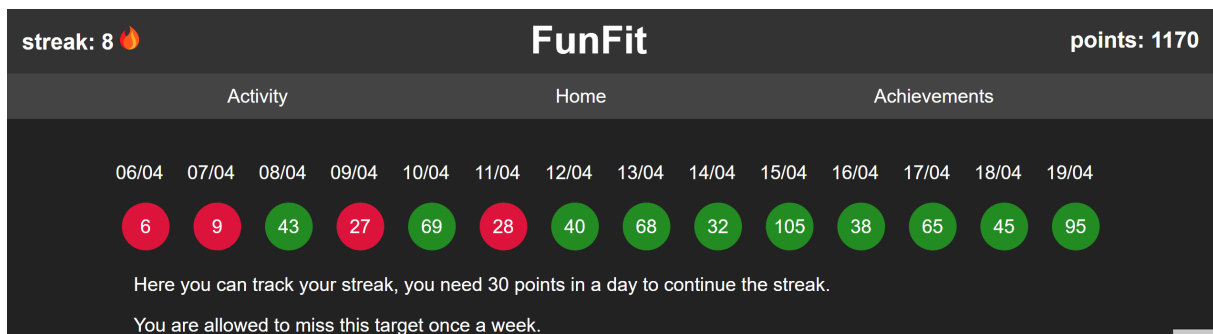
- Helene Schro e, Geert Crombez, Ilse De Bourdeaudhuij, and Delfien Van Dyck. 2022. [Investigating when, which, and why users stop using a digital health intervention to promote an active lifestyle: Secondary analysis with a focus on health action process approach–based psychological determinants](#). *JMIR Mhealth Uhealth*, 10(1):e30583.
- Andrew Sharp. 2024. [How streaks motivate us](#).
- Camille E Short, Corneel Vandelanotte, Amanda Rebar, and Mitch J Duncan. 2014. [A comparison of correlates associated with adult physical activity behavior in major cities and regional settings](#). *Health Psychology*, 33(11):1319–1327.
- Dorien Simons, Peter Clarys, Ilse De Bourdeaudhuij, Bas de Geus, Corneel Vandelanotte, and Benedicte Deforche. 2014. [Why do young adults choose different transport modes? A focus group study](#). *Transport Policy*, 36(C):151–159.
- Dorien Simons, Ilse De Bourdeaudhuij, Peter Clarys, Katrien De Cocker, Corneel Vandelanotte, and Benedicte Deforche. 2018. [A smartphone app to promote an active lifestyle in lower-educated working young adults: Development, usability, acceptability, and feasibility study](#). *JMIR Mhealth Uhealth*, 6(2):e44.
- Strava. 2024. [Strava subscription features](#).
- Stewart Trost, Neville Owen, Adrian Bauman, James Sallis, and Wendy Brown. 2002. [Correlates of adults’ participation in physical activity: review and update](#). *Medicine and science in sports and exercise*, 34(12):1996–2001.
- D. Weathers and T. A. Poehlman. 2024. [Defining, and understanding commitment to, activity streaks](#). *Journal of the Academy of Marketing Science*, 52:531–553.
- Alison M. Williams. 2012. [King of the mountain: A rapid ethnography of strava cycling](#).
- Stefanie Williams and David French. 2011a. [What are the most effective intervention techniques for changing physical activity self-efficacy and physical activity behavior - and are they the same?](#) *Health education research*, 26:308–22.
- Stefanie L. Williams and David P. French. 2011b. [What are the most effective intervention techniques for changing physical activity self-efficacy and physical activity behaviour—and are they the same?](#) *Health Education Research*, 26(2):308–322.
- M. N. Woessner, A. Tacey, A. Levinger-Limor, A. G. Parker, P. Levinger, and I. Levinger. 2021. [The evolution of technology and physical inactivity: The good, the bad, and the way forward](#). *Frontiers in Public Health*, 9:655491.
- Hsin-Yen Yen and Chia Li. 2019. [Determinants of physical activity: A path model based on an ecological model of active living](#). *PLOS ONE*, 14(7):e0220314.
- Octavia Hedwig Zahrt, Kristopher Evans, Elizabeth Murnane, Erik Santoro, Michael Baiocchi, James Landay, Scott Delp, and Alia Crum. 2023. [Effects of wearable fitness trackers and activity adequacy mindsets on affect, behavior, and health: Longitudinal randomized controlled trial](#). *J Med Internet Res*, 25:e40529.

A Appendix

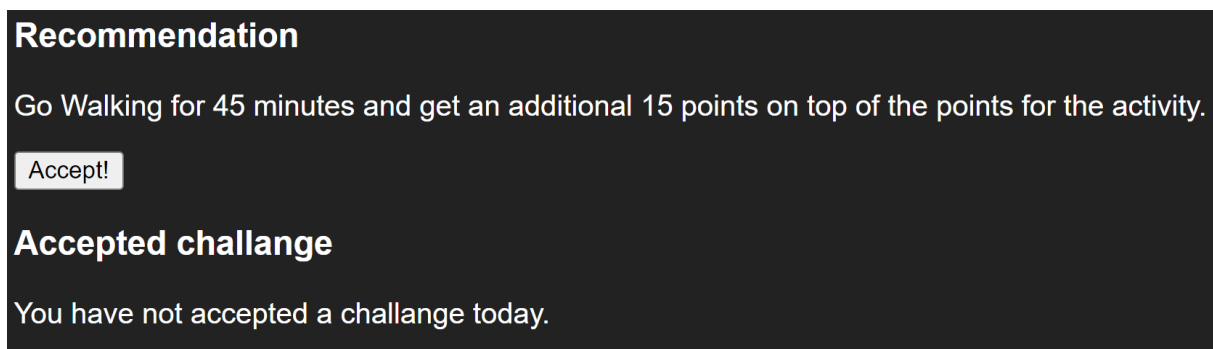
A.1 Full-Size Figure 13



A.2 Full-Size Figure 15



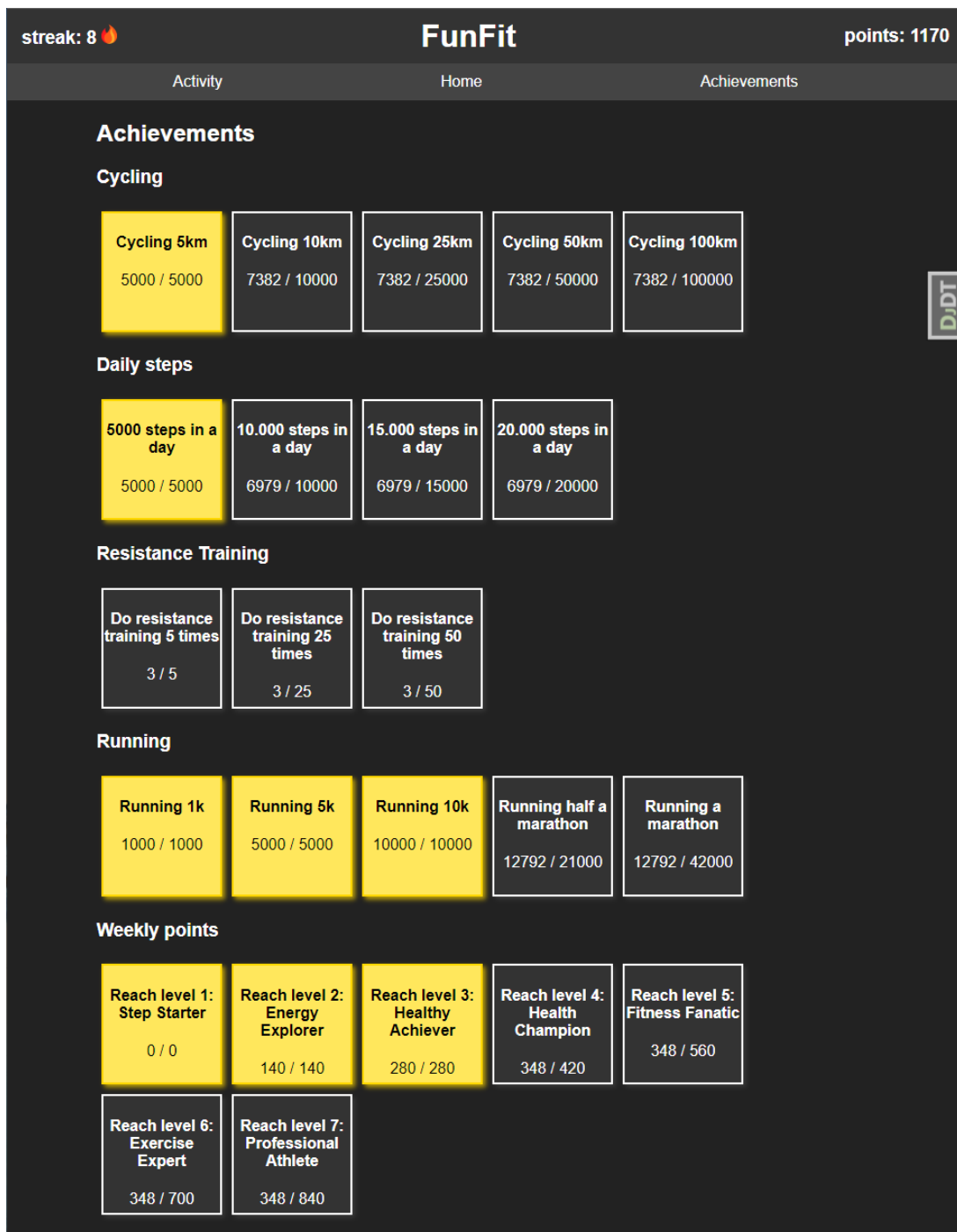
A.3 Full-Size Figure 16



A.4 Full-Size Figure 17



A.5 Full-Size Figure 18



A.6 Full-Size Figure 19

