# Prototyping gamification of lifestyle application for prevention of obesity in young adults

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The prevalence of obesity is a problem that continues to increase for decades like an epidemic. In particular, young adults between the ages of 18 and 35 are vulnerable to weight gain, and obesity leads to various diseases, including type 2 diabetes. Therefore, to reduce the prevalence, ultimately, the prevention of obesity in overweight young adults should be prioritized in the management of obesity epidemics. However, obese patients have low willpower and poor adherence to treatment. To address these issues, gamified lifestyle apps can be key helpful tools, as gamification and the use of mobile apps help provide motivation and persistence, respectively. The purpose of this research is to prevent obesity in young adults by presenting a prototype of a gamified lifestyle app for motivation and sustainability of body fat reduction in young adults. For building a prototype, useful features of lifestyle apps for obesity prevention were investigated through a systematic literature review, usability testing was conducted, and then follow-up questions were asked, and the system usability scale (SUS) was measured for the built prototype. Based on these prototype tests, points for improvement were derived, and a second prototype was produced to provide a final high-quality prototype of the application. Therefore, this research presents a prototype of a lifestyle application that combines gamification to prevent obesity in young adults aged 18 to 35 and builds a prototype that leads to lifestyle changes in young adults and naturally prevents obesity. Also, the value of this research is valuable in that it focuses on preventing obesity with functions such as gamification, motivation, and self-monitoring that are differentiated from existing health applications.

Additional Key Words and Phrases: gamification, lifestyle application, lifestyle game, prototyping, obesity, m-health.

## 1 INTRODUCTION

The prevalence of obesity has continued to increase over the decades. Particularly, young adulthood between the ages of 18 and 35 is a vulnerable period for weight gain. As they entered adulthood, the average body mass index of the youngest generation was higher than that of the previous generation due to unhealthy eating habits. In this life stage, obesity can have a big impact on health [1]. For example, this phenomenon has been documented in the United States as the "Freshman Fifteen" phenomenon, in which young adults gain weight rapidly as they enter college [1], and the United States has seen a significant increase in obesity over the past few decades, and it has also caused type 2 diabetes and high blood pressure associated comorbidities increased significantly [18]. Therefore, the reduction of body fat mass is a factor that can greatly contribute to alleviating the prevalence of obesity, and adult diseases caused by obesity [2]. Preventing overweight young adults from becoming obese should be a priority in the management of obesity epidemics [2].

However, due to the lack of will and commitment to the treatment of obese patients, it is very difficult from the point of view of treatment in the medical field to lead to loss of body mass. Patients' lack of commitment to care is a constant concern among experts in adopting technology to motivate patients [5], and non-compliance with care is a problem for about half of most patients [13]. These challenges can help improve patient adherence to treatment through mobile apps. Mobile apps can help increase activity adoption by providing user support and motivation [13], and since most people own and use mobile phones regularly, lifestyle apps, which are mobile health technologies (mHealth), can be the right medium for powerful health behavior changes for health prevention and self-care [17]. The development of personal health-related mobile apps has increased significantly in recent years, with the most downloaded apps related to physical activity and weight management [13]. This shows that people's perceptions of using these health apps are positive. One of the major challenges in the mobile app market is to keep users from losing interest in using the app consistently over a long period of time A strategy for this is gamification, which is described as the use of game design elements in a non-gaming context [19]. Powerful and addictive gamification can help users solve problems, promote learning, explore user motivation, as well as create additional excitement in the user's experience [5].

Therefore, the purpose of this research is to go beyond a weight management app with only a step counter function, to increase the participation rate and persistence of use to prevent obesity in young adults, and to reduce body fat to induce motivation and participation in treatment for obese patients. Suggesting a prototype is to evaluate whether it can lead to disease-preventing effects in young adults. It also aims to provide further evidence that the presented lifestyle apps can be invaluable tools to help users adopt healthy lifestyles and improve their health.

Finally, the structure of the research follows the diagram below.

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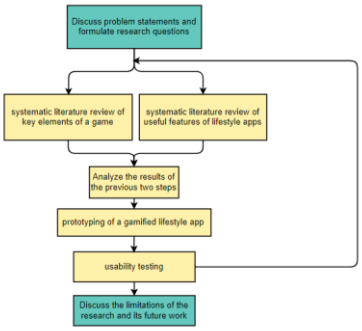



Fig. 1. Structure of research.

## 2 PROBLEM STATEMENT

Although partial mobile app research for weight loss has often been conducted [13, 10], strategies to improve motivation and support problem-solving to reduce stress were omitted because only strategies for weight loss were included [20], and research that presented a prototype of a weight loss lifestyle app for obesity including gamification function is not enough.

In addition, although obese patients can receive help from mobile health apps, usage of the app is often significantly reduced compared to the initial stage due to a lack of interest and motivation [2]. Therefore, the inclusion of an additional strategy: gamification should make the app more useful to users with motivation and persistence issues.

In general, the attitude toward gamification is generally positive, and this has a great influence on the usage of people [19]. Thus, while the literature on health management apps in the medical field and gamification in the medical field is growing, however, little attention has been paid to the combination of the two concepts. To combine the concept of lifestyle app and gamification, the important point is to identify the elements that drew people's interest in the game and essential elements of the lifestyle app, and then apply them appropriately to the lifestyle app.

To increase the motivation and continuity of lifestyle app use by young adults, this research investigates and analyzes the game elements that young adults might be interested in for gamification of apps and useful functions for preventing obesity. By combining the results of these two analyzes, we confirm whether the implemented application is effective in preventing obesity in young adults.

### 2.1 Research Question

The problem statement will lead to the following research question:

*How can we build a prototype of gamification of a lifestyle application to prevent obesity in young adults?*

The research question can be answered by the following sub-questions.

1. What are the useful functions of lifestyle apps for obese patients?
2. Could the implemented prototype motivate young adults and be functionally useful for obese patients?

## 3 METHODOLOGY

The first sub-question can be conducted by systemic literature review. The second sub-question can be conducted by prototype test with usability test, follow-up questions and system usability scale (SUS).

### 3.1 On answering RQ1

This research conducts a systematic literature review through a search strategy based on the guidelines of discussed by Wolfwinkel et al. (2013) [21]. The database that will be used to search related literature is Web of Science. Through the systematic literature review, the useful features of application for obese patients would be collected. Therefore, useful functions of lifestyle apps for young adults to prevent obesity will be established.

### 3.2 On answering RQ2

Based on the results of the systematic literature review, build an initial high-fidelity prototype using established essentials referring to the design science research methodology proposed by Peffers, K. et al (2007) [15]. Uizard program is used as a design tool for the prototype. Using the implemented prototype, prototype tests on arbitrarily young adults including a usability test, follow-up questions, and a system usability scale would be conducted. Afterward, a more advanced secondary prototype would be created based on the result of usability testing.

## 4 FIRST-SUB QUESTION

A five-stage process based on the grounded theory approach as suggested by Wolfswinkel et al. (2013), is conducted to answer first research questions, and Web of Science is used as scientific database.

### 4.1 Literature review

In order to answer the first sub-question, only recent articles within 5 years are considered, as lifestyle apps are changing rapidly. Also, only articles written in English are considered and exclusion criteria are categories not related to this research. the query "lifestyle AND app* AND obes*(title)" was searched, and the search results Web of Science provides 23 articles results. The reason for limiting the search to a title is that there were too many irrelevant articles when limiting the search to a topic that contains a title, keywords, and abstract. After selecting literature related to the current research based on the abstract from the selected papers, 5 papers [6, 7, 8, 3, 11] were selected based on the full text, and a concept matrix was added for literature review. In summary, a total of five articles were selected in the definition-search-selection phase. A conceptual matrix for the literature review is presented in Table 1 of Appendix A. The next step for a systematic literature review is the analysis phase.

### 4.2 Analysis of the systematic literature review results

This section focuses on the analysis of the matrix generated in the first stage of the literature review. The matrix generated as

a result of the literature review can be found in Appendix A. According to the result of the generated matrix, the most useful functions used in lifestyle apps for people with weight problems, especially obesity, are 'physical activity tracker' and 'nutrition', in 5 out of 5 articles. The next most important features in the lifestyle app are "self-monitoring", "motivation", "stress management", "educational content (health advise)", "tracking dietary intake" and "health (interactive) communication" which mentioned in 3 out of 5 articles. Also, the third useful features is "diet recommendation" mentioned in 2 out of 5 articles. Especially, the features of "physical activity tracker" and "tracking dietary intake" means that your app cannot automatically fill in everything for you, and your app needs immediate input, such as the user's food eaten and the activity they did, in order to function properly. Table 2 below provides an overview of the three most rated concepts.

Table 2. Top 3 rating functions of lifestyle apps for obesity.

| | |
|---|---|
| I. *Physical activity tracker* | A tool to help with self-monitoring, it can track the user's physical activity. ex) step counter |
| I. N*utrition tracker* | It should be able to track nutrition that user's intake and provide recommended nutritional guidelines based on user characteristics. |
| II. *Self-monitoring* | Users should be able to easily check their changes by entering and tracking changes directly. |
| II. *Motivation* | It should include elements that give you a sense of accomplishment so that users can use the app consistently. ex) rewards, competition, interactive communication with the other users |
| II. Stress management | It should measure stress and recommend programs for managing stress. |
| II. *Educational content (health advise)* | It needs to provide from simple health advice and exercise tips to professional knowledge for users who lack professional knowledge. |
| II. *Dietary intake tracker* | It should be able to simply enter what the user ate. |
| II. *Health (interactive) communication* | There should be a place for communication between users so that users can practice self-management while feeling connected and belonging to others. |
| III. *Diet recommendation* | It should be able to recommend a diet according to the user's physical characteristics or insufficient nutrients. |

## 5 SECOND-SUB QUESTION

To answer the second sub-question, the features required for the prototype are proposed by combining the results obtained from a systematic literature review with the elements for gamification proposed by Alina Maximova (2021). The design science research methodology proposed by Peffers, K. et al. (2007) is used for answering second sub-question.

### 5.1 Prototyping

The key purpose of the prototype was to prevent obesity in young adults aged 18 to 35 years, and it was created by combining gamification to increase motivation and long-term usability. The prototype was implemented with a prototyping tool called Uizard. An image of the entire first prototype can be found in Appendix B and the main features of that prototype are following.

*5.1.1 Weight Tracker.* For self-monitoring, it has a "weight tracker: feature. A weight graph exists so that users can see changes in their weight briefly. The graph can be checked monthly, weekly, and yearly, and you can get high points if the weekly graph shows a downward trend. Moreover, in case a user made a mistake, the user can edit it and input weight so that the user can track his or her weight.

*5.1.2 Dietary intake tracker.* The app presents a dietary intake tracker in the simplest way. When a user takes a picture, uploads it to the application, or the application recognizes a barcode, the user's intake of nutrients is automatically calculated. Furthermore, in case a photo or barcode cannot be recognized, it can be entered manually through the search function. Users can check how many of the total recommended calories are consumed and view the intake ratio of the three major nutrients which are carbohydrate, protein, and fat. Users can easily check which nutrients are consumed a lot and which nutrients are consumed less.

*5.1.3 Stress measurement.* Video recordings of fingertips made using smartphone cameras and flashes contain a beating component caused by the same heart pulses present in the photoplethysmography signal [12]. By performing peak detection on the beating signal, continuous heart rate and respiration rate can be estimated [12], allowing approximate stress measurements. The app can measure stress without a wearable device through PPG measurement and recommends a stress management program according to the measured stress level of the user. In order to provide content that stabilizes the body and mind, stress management programs include breathing control methods, meditation methods, and an emotional diary where you can share your worries. When the

user completes one of the stress management programs, the user can obtain the corresponding points.

*5.1.4 Lifestyle score.* When a user enters his/her name (nickname), height, weight, date of birth, and gender, obesity is automatically calculated, and the value is stored as personal information in the database. Average exercise amount, average lifespan, stress index, and average nutrient information are automatically calculated and entered from previously recorded data from the user, and the daily lifestyle score is calculated accordingly. With the calculated lifestyle score, their recommended daily food intake and daily recommended amount of exercise to achieve a normal weight are determined. If the lifestyle score is gradually accumulated, user can check their lifestyle score trend with the lifestyle graph.

*5.1.5 Rewards system.* This app uses a point system as a reward. High points can be obtained if the nutrients consumed during the day are balanced, the user consumes adequate calories, and if the amount of exercise is appropriate. In addition, when the points obtained for a week are graphed, if there is an upward trend, the user can also obtain high points.

*5.1.6 Challenges.* When a user participates in a desired challenge for a week, the corresponding point can be obtained, and it is possible to check how many users have participated in the challenge, which further encourages the user to participate in the challenge.

*5.1.7 Community.* Users can be motivated by sharing tips, emotions, and stories with other users through the community. Also, if an article uploaded by a user is selected as the best article, the user can accumulate points.

*5.1.8 Gamification.* The elements for gamification proposed by Alina Maximova (2021) are "Entertainment/enjoyment, Social, Nature of game, Competition", the gamification used in this application is a game that harvests orange fruits. Users can use the points earned by the user to purchase items that help grow orange trees in the store to quickly grow orange trees from sprouts. Also, users can grow orange trees through random items obtained through other activities. When the orange tree has finished growing, the user can finally harvest orange fruit, and the game ranking is established based on the number of harvested orange fruits, and users can compete with other users. Through this, the four gamification factors can be satisfied and motivation through gamification is possible.

*5.1.9 Educational content.* In order to solve the lack of professional knowledge of users, health-related articles and videos can be accessed through learning contents, and useful knowledge can be saved as a bookmark function. In addition, the AI chat bot shares professional and accurate knowledge in order to immediately resolve users' questions.

## 6 EVALUATION

A prototype test was conducted to evaluate the prototype made as a result of prototyping. The prototype tests were conducted with 34 potential end-users, namely young adults aged 18-35 years. This was done to test the usability of the prototype and observe how potential users would interact with the prototype, followed by an evaluation with them.

**Setting and participants**

Through a survey using Google forms, potential users who were willing to participate in prototype testing were recruited, and in order to participate in the prototype test, participants were limited to users who had access to electronic devices such as desktop, laptop, tablet, and smartphone. For quality data collection, follow-up questions for potential users' usability testing and evaluation, and questions for SUS scale measurements will be recorded, and consent to keep records until the research is completed was also essential.

### 6.1 Usability Test

The first prototype test is to identify usability issues for that prototype and collect qualitative and quantitative data to determine product satisfaction for potential users.

**Procedure**

Recruited participants conducted a usability test using a usability testing tool called Maze. Before starting the test, the purpose of the research and procedures for prototype testing to participants were explained and obtained consent to collect and store data. During the usability test, participants were given 17 tasks to perform. The mission was divided by the main features of the application to check what first-time users would be able to do without any learning. The missions given to participants can be found in Appendix C. After that, qualitative data were collected through the observation of the participants' actions on the mission. This allowed users to understand where they made mistakes and where they did not understand certain missions.

### 6.2 Follow-up Questions and SUS

After completing a usability test, participants were requested follow-up questions and SUS questions to gain additional insight into the participants' initial opinions on the questionnaires. Follow-up questions have been asked to get feedback on important or missing features of the prototype, and 10 questions with the Likert scale for SUS measurements can be used to identify each user's general view of the usability of the prototype. A list of follow-up questions can be found in Appendix E, and a list of SUS questions can be found in Appendix F.

*6.2.1 Follow-up Questions.*

After all the usability tests were completed, a total of four open-ended questions were investigated through questionnaires to gain better insight into whether the application fits the user's expectations and requirements. It was requested to list three of the most valuable top features suitable for the purpose of the application and what features were missing and uncomfortable to improve the application according to the purpose.

#### *6.2.2 System Usability Scale.*

The system usability scale (SUS) is used to assess the ease of use, efficiency, learning, and satisfaction of the system, and although user measurements are inherently very complex, SUS enables simple and quick user measurements [4]. It is suggested that the SUS survey questionnaire should be conducted immediately after the usability test [4] Therefore, this research measured SUS Scale using the calculation method presented in A.A. Rain et al. (2016) to obtain quantitative data immediately after the usability test.

**Procedure**

The SUS Scale collected data through questionnaires with 10 usability items, each of which consists of a 5-point Likert scale, 1 = "strongly disagree" and 5 = "strongly agree" to calculate the SUS scale. The calculation method proposed by A.A. Rain et al. (2016) ultimately provides a score of 100 points, with 68 points as the threshold for the SUS average score, and if the score is above 68 points, the usability of the prototype is considered above the average, and if the score is below 68 points, it is considered below the average [4].

## 7 RESULTS

### 7.1 Data Collection

As mentioned in Demonstration and Evaluation, data was collected through various methods such as a usability test, follow-up questions, and measuring the system usability scale.

### 7.2 Data Analysis

As mentioned in Demonstration and Evaluation, data was collected through various methods such as a usability test, follow-up questions, and measuring the system usability scale.

#### *7.2.1 Participants.*

A total of 34 potential users aged 18 to 35 are willing to participate in this research and have access to electronic devices, and prototype tests were conducted on them. Several studies suggest that 3 to 5 users are sufficient to find 80% of software interface problems but increasing the number of test groups from 5 to 10 can significantly improve data reliability and increasing the number of test groups to 20 can result in high rates of usability testing [9]. Therefore, a total of 34 participants can say that it is sufficient for usability testing to improve the prototype of this study. Detailed tables by gender and age of participants can be found in Appendix D.

#### *7.2.2 Usability test.*

Participants' actions according to the missions collected through Maze were reviewed and analyzed in the Usability test.

For each mission, the results were recorded and analyzed according to the following categories:

- The participants accomplished the mission by themselves in 60 seconds (+)
- The participant fails to perform the mission in 60 seconds but performs the mission with one hint (o)
- The participant fails the mission in 60 seconds (-)

Appendix C provides an overview of the mission performance capabilities of each participant according to the categories. After analyzing the actions for each mission, most of the participants were able to perform the task on their own, and the "Task 6. I want to track my weight change" mission was possible on their own, but all other tasks had to be given one hint to solve the task. The mission that 17 out of 34 participants asked for hints was "Task 8. There is no information I want, so I want to ask the AI", and the mission that 9 participants needed hints was "Task 2. To check the condition, I want to measure the stress", and a total of 7 participants asked for hints was "Task 4. I want to participate in the challenge". Also, there was no mission that could not be accomplished at all. Hints were configured to return to the home screen rather than the obvious screen to perform the mission, and users were able to complete the mission after returning to the home screen.

After completing the usability test, when asked why hints were needed, most participants answered that it was difficult to know what features were located at first because they were new to the prototype, but once they understood the prototype, they were easier to do.

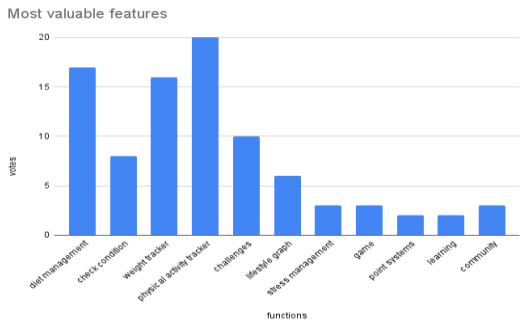
#### *7.2.3 Follow-up Questions.*

The answers to follow-up questions were analyzed through Microsoft Excel in order to improve the application for follow-up questions in the future. Exact answers to follow-up questions can be found in Appendix E. Some participants showed interest in the prototype with positive opinions such as "I really want to use it when the application is released" and "The composition is good and full".

**Most valuable features**

As a result of investigating which features of the prototype was the most valuable function for the purpose of a lifestyle app gamified to prevent obesity in young adults with 34 participants, the top 3 features were physical activity tracker, diet management, weight tracker. Firstly, 20 out of 34 participants selected the physical activity tracker as a valuable feature. In particular, 2 out of 20 participants preferred the physical activity graph, and 6 participants valued recommended exercises. Secondly, 17 out of 34 participants regarded the function of diet management as important, and 7 of them answered that the function of diet intake tracker was valuable. Among the participants who mentioned the diet management function, participant number 15 added the following mentions especially about the function of the diet tracker. "I think food is one of the most important things in life, but it is difficult to know what a food contains in terms of nutrition and health. It was nice to be able to understand and track one diet more easily." Thirdly, 16 out of 34 participants said that the weight tracker was the most valuable feature, and participant number 21 mentioned, "The fact that there is a weight tracker that I can keep objectively check my condition will be a great help in managing my weight and figuring out the direction of my exercise". In addition to that, the preference graph for the valuable features can be checked in figure 2.

Fig. 2. Most valuable Features Preference Graph.




Besides the top 3 features mentioned as useful features above, participant number 21 also mentioned "challenges" and "community" features as valuable features. For the challenges feature, obesity management is usually boring in repeating the same exercise or diet, but he mentioned the possibility of long-term use as interest is maintained through the challenge function. He said that because there are people who can go out and manage obesity together, we can motivate each other. Also, participants 4, 24, and 31 answered that it would be a useful feature for the "learning" function. Among them, participant 24 added that he was particularly impressed by the fact that he was able to directly access the text and video by clicking on a link to a related article or video. Finally, a total of 6 participants, 3, 4, 9, 15 and 23, selected the function for "the lifestyle graph" as a valuable feature. Among them, participant number 15 mentioned that the lifestyle graph is a good way to check the user's progress and be motivated by it.

**Missing features**

Most of the participants mentioned that all the necessary features were present, but a few described the features they needed but were missing for their lifestyle app. Among the missing features mentioned, there were many functions related to diet. The participant mentioned that it would be desirable to have a function that recommends a good diet to prevent obesity that can replace regular food. For example, I can recommend a diet for using erythritol instead of sugar. Also, a cooking tab with recipes that include healthy foods can be useful, because "people who grew up with bad eating habits don't know much about it, so it's very common to leave it unattended into adulthood, so this can be a valuable change." was mentioned.

In addition to functions related to diet, there some mentions that it would be good to quantify weight loss for motivation, put weight loss into the ranking system, and there may be a function to measure water intake, and statistics to motivate users. For example, for statistics, users who respect their diet for two weeks may indicate that they are 20% more likely to succeed in their goals. Finally, "it would be good to add a function to record or track various exercises" was mentioned. Except for them, all other participants did not comment on the missing features.

**Features that could be improved**

Participants number 7 mentioned that "it would be good if in "learning", the categories were divided into various categories (diet, exercise, etc.), and if there is a corresponding quiz, the participation of the app will increase. Also, If there are mini-games in the exercises, it will serve the purpose of "gamification" better. Finally, encourage long-term use by adding a notification service. For example, when a user's friends have completed an exercise or their lifestyle score has risen, a notification is provided to the user to motivate them." Moreover, participant number 31 said that overall, it was very clear to find the features I was looking for, but it would be nice to tweak the composition of the features. For an AI feature, for example, I do not know why they put the AI feature there for training, it just looks like a chat feature, and there is no clue to identify the AI icon. Also, it would be nice to be able to add the list of challenges you want directly in the challenge. Finally, the target group is young adults and digital natives, so it would be great if the user could organize the app's features according to their needs, among many other features. I think customization is important for young adults. Also, participant number 22 mentioned the following. "It would be better if there was a function to visually compare the average value of weight and nutrition according to the age entered by the user with the value entered by the user. It would be great if it could be linked to a smartwatch to track exercise, and it will be even more motivating if you add the ability to not only share your story, but also connect with others in the community feature".

#### *7.2.4 System Usability Scale.*

Finally, the average score on SUS Scale and total SUS by the participant was also calculated through Microsoft Excel. Appendix F represents the SUS score of all participants, and the lowest score was 42.5, the highest score was 100, and the average score was about 68.6. Although the average score for that prototype is barely higher than 68 so it is in an acceptable range, the prototype requires to improve further to improve the average score.

## 8 FINAL PROTOTYPE

Based on the results derived from the evaluation, a more advanced secondary prototype was produced. All improved features were produced based on answers to follow-up questions, and the full image of the advanced secondary prototype for each feature can be found in APPENDIX G and a detailed description of the improved features can be figured out following.

### 8.1 Home screen customization

According to the answer to question 3 of follow-up question of participant number 31, a customizing function was added to make the functions included in various apps efficiently used for users. In order to make it easy for each user to access the desired function or to avoid unnecessary functions for user, it is possible to add or delete desired functions through customization. As a result, functions that were previously restricted to access can now be easily accessed from the home screen. For example, originally, the lifestyle score could only be checked after checking the condition, but now the lifestyle score can be directly checked through the home screen. That is, the item of “check lifestyle score” was added separately so that users can check the

lifestyle score measured by the user. In the case of nutrition score, there was also an error that could only be checked by entering the diet menu, but the error was corrected by customizing the function and allowing direct access from the home screen. Also, referring to the answer of participant number 27, the "Connecting with a smartwatch" category was redesigned to be able to be added to the home screen for users who have a smart watch to measure the amount of exercise in conjunction with the smart watch.

### 8.2 AI chat bot

If the AI chat bot were originally included in the learning feature, the AI chat bot was not only used for learning but a function to connect experts was added so that they could receive advice or receive advice from them according to the answer of participant number 27. Therefore, after removing the icon from the learning feature, it can be added as a separate category to the home screen.

### 8.3 Challenges

Additionally, in order to increase the user's participation rate, the challenge feature has been improved to add a challenge topic recommended by a specific user so that the user can interact with various people and enjoy the challenge more. The prototype image for this can be found in Appendix G.

### 8.4 Learning

For the learning function, learning articles and videos were divided into categories such as diet and exercise to enable users to easily learn the information they want, and a quiz function was added to learn specific articles or videos and then make users remind what they learned through a simple quiz.

### 8.5 Community

The community function originally only contained "share your story", but to expand the scope of the user's community, it is possible to add friends through User ID and to increase motivation and continuity, a competition function is added to check each other's progress with friends.

### 8.6 Notification

It encourages users to use it for a long time by adding a notification function that has not been previously available. For instance, if a user's friends have completed exercise or increased lifestyle scores, the user is motivated by the notification, and if the user has recorded water intake, the notification notifies the remaining water intake to encourage meeting the water intake. When using the competition mode with a friend, a notification is provided when the friend achieves the goal to motivate the user.

### 8.7 Activity

In order to track a greater variety of movements in the physical activity tracker function, "add more workouts" has been added, which is recommended for wearable users because the tracking function is more accurately measured when using a wearable. It is also redesigned to play mini-games and solve quizzes, by clicking one of the recommended workouts. Mini-games are provided accordingly for each workout, and it is possible to score accordingly when completing the mini-games.

## 9 CONCLUSION

In summary, the purpose of this research is to present a prototype of a gamifying lifestyle app for obesity prevention in young adults. Through systematic literature review, the useful functions of lifestyle apps for obesity prevention were investigated and then build a prototype based on the results and ask follow-up questions to find improvements and measure SUS. The most important results of a systematic literature review can be summarized as follows. Referring to Table 2, the most useful top 3 features of lifestyle apps for obesity were "Physical activity tracking, Nutrition, Self-monitoring, Motivation, Stress management, Educational content, Dietary intake tracking, Communication regarding health, Diet recommendation". In addition, the most important essential elements investigated by Alina Maximova (2021) [14] were "Entertainment/enjoyment, Social and Nature of Game, and Competition".

The result of usability test of prototypes based on these literature reviews was that users were able to complete most of the missions themselves, but required one hint for all but one mission which is TASK6, and there are no completely failed missions, and participants added that it took time to figure out the prototype because it was their first time using it, but once they identified the prototype, they would be able to carry out the mission easily.

After conducting usability tests, the result of follow-up questions showed that most of the participants already had all the necessary functions, but the main features to be improved were as follows.

- In "Learning", it would be good to classify it into various categories (diet, exercise, etc.), and if a corresponding quiz comes out, the participation of the app will increase.
- If there are mini games in "Exercise", it will be more helpful for the purpose of gamification.
- Adding "Notification" services will encourage long-term use.
- "AI chat bot" should be separated from "Learning" and placed separately, it should have not only a chat bot function but also expert advice.
- It would be nice if the users could add the desired challenge on their own.
- It would be nice if there was a customization function on the home screen that allows users to configure the functions of the app according to their needs among many functions.
- It would be better if it is possible to link it with a smartwatch and track physical activity.
- In addition to the ability to share one's story in the "Community", it will be more motivating if it possible to connect with others.

Finally, the results of the SUS scale were slightly distributed by each user with a maximum of 100 points and a minimum of 42.5, with an average score of about 68.6 points. It falls within an acceptable range, but the prototype needed further improvement.

Therefore, a systematic literature review investigated the useful features for obese patients, allowing applications to focus on obesity prevention, and usability test provided insight into user experience and opinions on prototypes, user requirements for successful improvement of prototypes, and follow-up questions to meet target users' goals and needs. SUS was also able to identify the overall preference for prototypes.

In conclusion, the prototype was improved by summing up the results of the prototype tests conducted, and through this process, the main questions of the research were successfully answered. The value of this research provides a basis for increasing the demand and preference for applications for the prevention of obesity in young adults and is valuable in that it focuses on obesity prevention with features such as gamification, motivation, and self-monitoring differentiated from existing health apps. In addition, this research will be able to serve as a pillar of the development of gamifying lifestyle apps that will attract the attention of the game industry in the future, thereby reducing unnecessary functionality and app preference survey time. However, some limitations have occurred during the research, and future work on the project must be carried out.

## 9.1 Limitations

Firstly, the systematic literature review excluded articles in various languages except for English, so it was difficult to result in sufficient and diverse results, and this research was conducted literature review only on the Web of Science, resulting in missing research papers or articles.

Secondly, the limitations of the current research were the lack of time to test the second prototype and the long-term prototype test. It may have been difficult for participants to make a clear opinion because they first encountered the prototype, and there were many mistakes at first when conducting usability tests, but there were general opinions that the more missions, the easier it was to know how to use them. Therefore, if participants are asked to use it for several days in their daily lives as an app on the markets and then conduct long-term tests, participants will be able to give clearer answers in the survey.

Thirdly, the usability test was conducted non-face-to-face using a program to prototype as many people as possible during the limited research time. It was a time benefit because the researcher and participants did not have to meet face-to-face for prototype testing, and they were able to conduct a more convenient test, however, the researcher could not observe participants' nonverbal signals namely, facial expressions and behaviors during the usability test. More detailed information can be obtained by observing signals from nonverbal communication, but the lack of these clues made it difficult to understand the exact meaning of the participant's behavior.

In addition, there is a possibility that there is a lack of sincerity or biased response in the survey measure especially the SUS conducted after the usability test. The SUS survey was based on the Likert scale of whether participants agreed or disagree with the questions, and there was an overly positive answer because participants sometimes wanted to give positive answers to the researcher rather than critical answers including 100% of their intentions. Moreover, each participant's SUS score was distributed without being driven to the calculated average score, making it difficult to generalize the results to which score to believe.

Finally, the biggest limitation of this research is that it cannot solve the problem of all generations with obesity because it targets young adults. However, lifestyle applications implemented, at least for young adults, can help people motivate and recognize situations and solve some of the problems.

## 9.2 Future works

Considering the limitations of this research, the future works proposed can be described as follows.

After a systematic literature review to establish the useful functions for obese patients, a focus group should be established and interviewed for young obese patients. In this research, functions were collected through systematic literature reviews, but interviews can determine whether the functions examined are useful for young obese patients. In addition, it is necessary to check through interviews what game elements and functions young adults find interesting, and furthermore, interviews on gamification can be conducted to people in the game industry to attract interest in the game industry. In order to produce a prototype including game elements that are interesting to young adults, efforts are needed to add interactive game elements by focusing on game functions.

Based on the results of the prototype test, another qualitative research should be done with the improved secondary prototype. Use eye tracking or think-aloud techniques face-to-face to capture signals of nonverbal communication to gain insight into the benefits and improvements of the prototype, and the participants' experience and satisfaction with it. Additionally, in order to clearly measure the SUS, the SUS should be measured after approximately 4 weeks of long-term prototype testing.

On top of that, the research did not determine whether the participants collected for testing were suffering from obesity or at risk of obesity, so it is recommended for future works to investigate and include overweight participants who are actually obese or at high risk of obesity in order to meet the big purpose of "prevent obesity. Ultimately, however, the goal should be to create lifestyle applications that are effective in preventing obesity while improving lifestyles, rather than applications that focus on weight loss and maintenance.

Lastly, since the target group of this research is a young adult, it is recommended to collect the population of different ages for lifestyle applications for all generations and carry out the process described above.

However, this research is enough to develop applications in earnest, including gamification to prevent obesity in young adults. Design and organization effectively, user-experience-driven design, and in this process, you can gain more insight by build and repeated testing of prototypes for groups including young adults as well as obese people.

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# A Appendix A

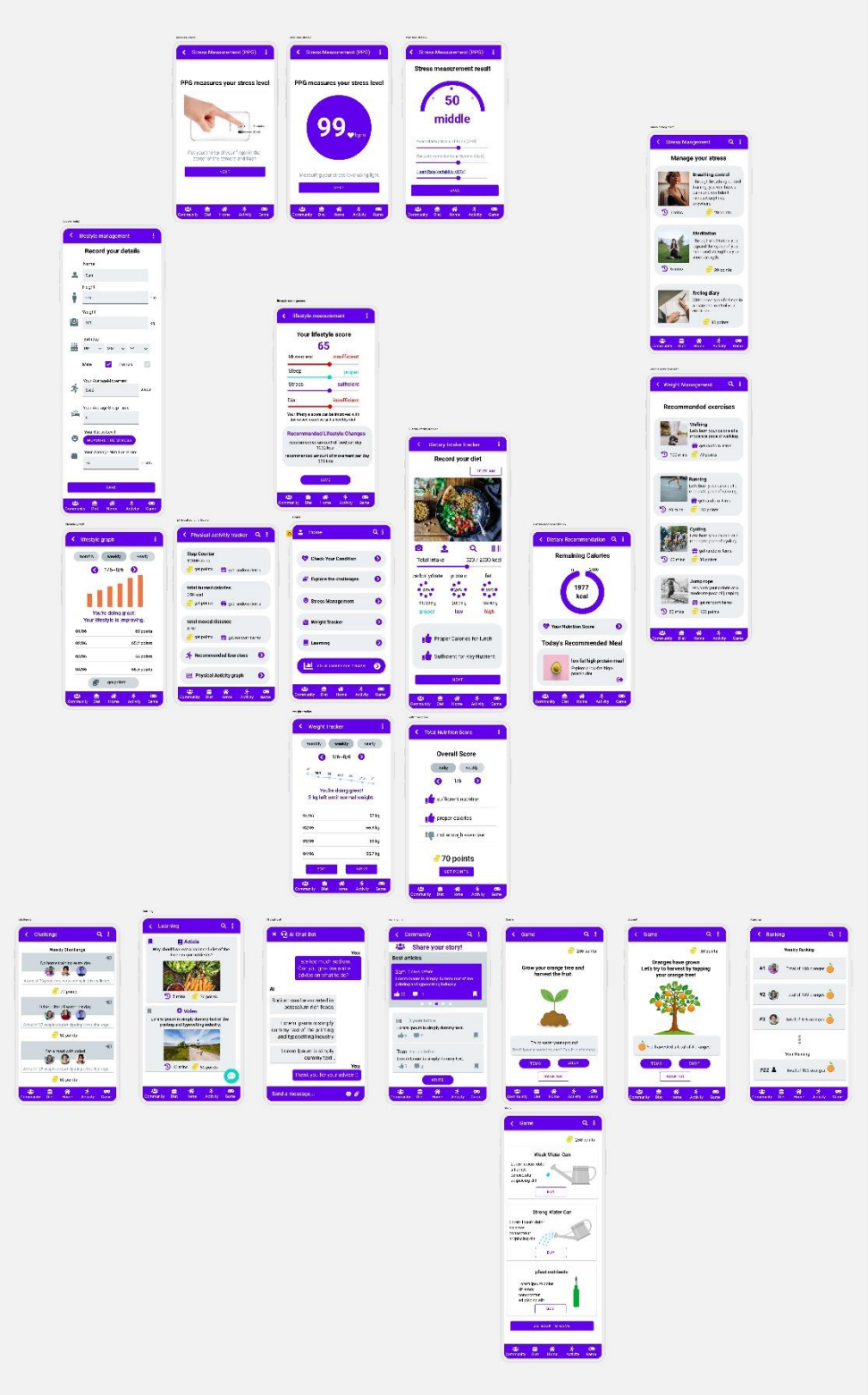
Table 1. Concept matrix for literature reviewing for sub-question three

| Article | | Chew, C. S. E. et al (2021) | Dehjan, Z et al (2020) | Dias, S. S et al (2019) | Antxon Apiñaniz, et al (2019) | Karduck, J., & Chapman-Novakofski, K. (2018) |
|---|---|---|---|---|---|---|
| Concept | Self-monitoring | X | | X | | X |
| | Motivation | | | X | X | X |
| | Physical activity tracking | X | X | X | X | X |
| | recommended nutritional guidelines (nutrition) | X | X | X | X | X |
| | Stress management | | X | X | | X |
| | Educational content s(health adivse) | | X | | X | X |
| | Reminder | | | | | X |
| | Easy to use | | | X | | |
| | tracking dietary intake | X | | | X | X |
| | calorie counter | | | | | X |
| | Health (interactive) communication | X | X | X | | |
| | Diet recommendation | X | | | X | |
| | Weight tracker | X | | | | |
| | Sleep | | | X | | |

X = concept is mentioned in the article

## B APPENDIX B

First prototype based on literature review.



# C APPENDIX C

Overview of participants' mission performance

| Task # | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Participant # | | | | | | | | | | | | | | | | | |
| 1 | (+) | (+) | (+) | (o) | (+) | (+) | (+) | (o) | (+) | (+) | (o) | (+) | (+) | (+) | (o) | (o) | (o) |
| 2 | (o) | (+) | (+) | (o) | (+) | (+) | (+) | (o) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) |
| 3 | (o) | (+) | (+) | (+) | (+) | (+) | (+) | (o) | (+) | (+) | (o) | (+) | (+) | (+) | (+) | (+) | (+) |
| 4 | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) |
| 5 | (+) | (+) | (+) | (+) | (o) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) |
| 6 | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (o) | (+) | (+) | (+) | (o) | (+) | (+) | (+) | (+) | (o) |
| 7 | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) |
| 8 | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) |
| 9 | (+) | (+) | (+) | (o) | (+) | (+) | (+) | (+) | (o) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) |
| 10 | (+) | (o) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) |
| 11 | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (o) | (+) | (+) | (+) | (+) | (+) | (o) | (+) | (+) | (+) |
| 12 | (+) | (o) | (+) | (+) | (+) | (+) | (+) | (o) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (o) |
| 13 | (+) | (o) | (+) | (+) | (o) | (+) | (o) | (+) | (+) | (o) | (+) | (+) | (+) | (+) | (+) | (o) | (+) |
| 14 | (+) | (o) | (+) | (+) | (+) | (+) | (+) | (o) | (+) | (+) | (+) | (o) | (+) | (+) | (+) | (o) | (+) |
| 15 | (+) | (+) | (o) | (+) | (+) | (+) | (+) | (o) | (+) | (+) | (o) | (+) | (+) | (+) | (+) | (+) | (+) |
| 16 | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (o) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) |
| 17 | (o) | (o) | (+) | (+) | (o) | (+) | (+) | (o) | (o) | (o) | (+) | (+) | (+) | (+) | (+) | (+) | (+) |
| 18 | (+) | (+) | (o) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) |
| 19 | (o) | (o) | (+) | (o) | (+) | (+) | (+) | (+) | (+) | (o) | (o) | (+) | (+) | (+) | (o) | (+) | (o) |
| 20 | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (o) | (+) |
| 21 | (+) | (+) | (+) | (o) | (+) | (+) | (+) | (+) | (+) | (+) | (o) | (+) | (o) | (+) | (+) | (+) | (+) |
| 22 | (+) | (+) | (o) | (+) | (+) | (+) | (+) | (o) | (o) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) |
| 23 | (+) | (o) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) |
| 24 | (+) | (o) | (o) | (+) | (+) | (+) | (+) | (o) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) |
| 25 | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) |
| 26 | (+) | (+) | (+) | (o) | (+) | (+) | (o) | (o) | (+) | (+) | (+) | (+) | (+) | (+) | (o) | (+) | (+) |
| 27 | (+) | (o) | (+) | (+) | (o) | (+) | (o) | (o) | (o) | (o) | (o) | (o) | (o) | (o) | (o) | (o) | (o) |
| 28 | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) |
| 29 | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) |
| 30 | (+) | (+) | (o) | (+) | (+) | (+) | (+) | (+) | (o) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) |
| 31 | (+) | (+) | (+) | (o) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) |
| 32 | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (o) | (+) | (o) | (+) | (o) | (o) | (+) | (+) | (+) | (+) |
| 33 | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (o) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) |
| 34 | (+) | (+) | (+) | (+) | (+) | (+) | (o) | (o) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) | (+) |
| 1 Hint Required | 4 | 9 | 5 | 7 | 4 | 0 | 4 | 17 | 5 | 5 | 6 | 4 | 3 | 2 | 4 | 5 | 5 |

**Usability Test Missions List**

1. I want to check today's condition
2. To check the condition, I want to measure the stress
3. After the stress measurement is complete, I want to check the total score of the lifestyle
4. I want to participate in the challenge
5. After checking the lifestyle score, I want to manage my stress
6. I want to track my weight change
7. I want to learn expertise to improve my lifestyle
8. There is no information I want, so I want to ask the AI
9. I want to check my lifestyle graph
10. I want to keep a record of my diet
11. I want to check my nutrient score
12. I want to check community
13. I want to check the amount of physical activity today
14. I want to check recommended exercises
15. I want to play games
16. I want to purchase items for the game
17. I want to check my ranking of game
18. For missions that required hints, why did you need hints?

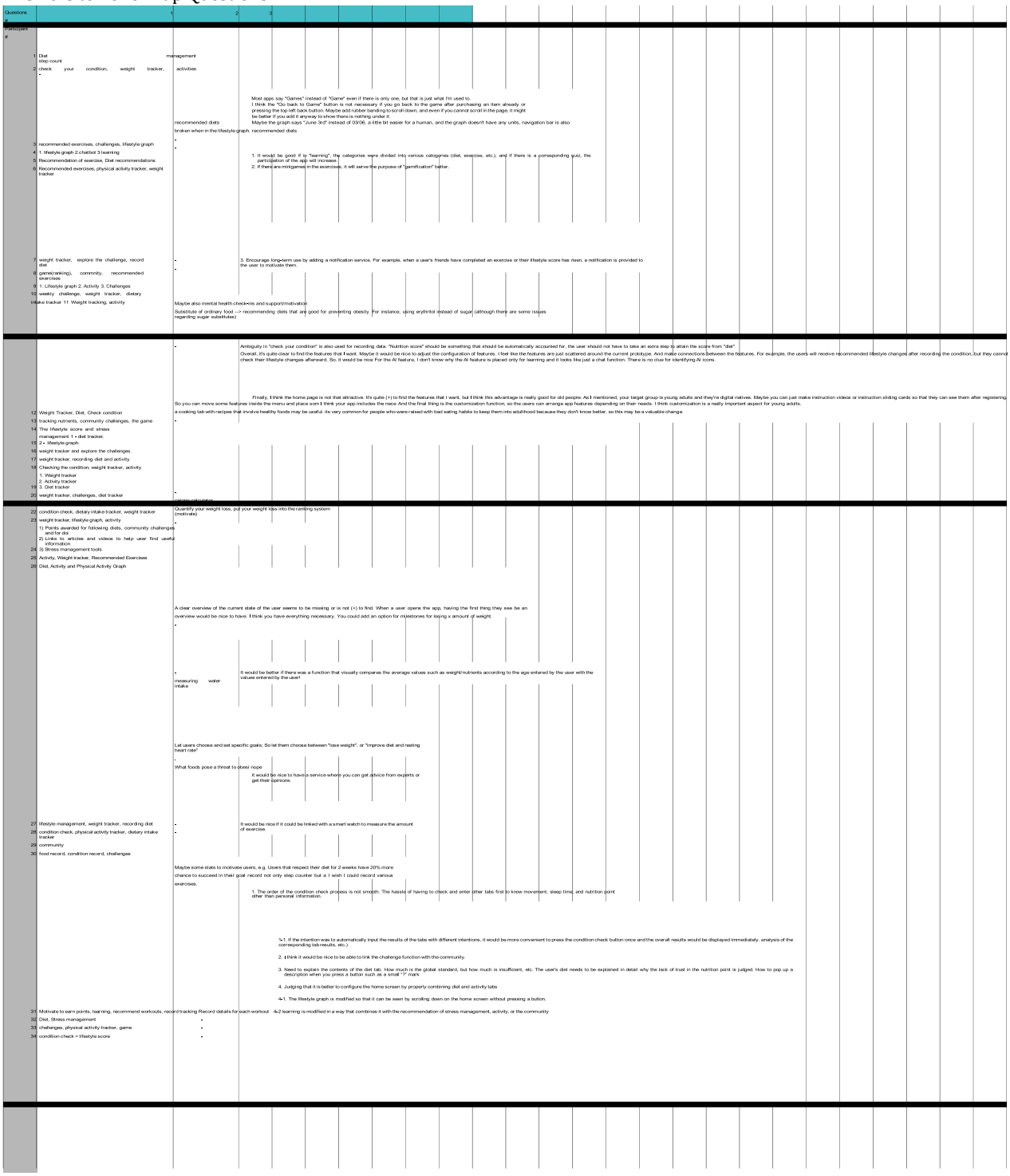
## D APPENDIX D

Table by gender and age of participants

| Participant # | Gender | Age |
|---|---|---|
| 1 | Female | 33 |
| 2 | Male | 21 |
| 3 | Male | 19 |
| 4 | Male | 20 |
| 5 | Male | 23 |
| 6 | Female | 23 |
| 7 | Female | 22 |
| 8 | Female | 23 |
| 9 | Female | 19 |
| 10 | Female | 19 |
| 11 | Male | 23 |
| 12 | Female | 26 |
| 13 | Female | 20 |
| 14 | Female | 20 |
| 15 | Male | 20 |
| 16 | Male | 25 |
| 17 | Male | 21 |
| 18 | Female | 20 |
| 19 | Male | 20 |
| 20 | Female | 21 |
| 21 | Male | 26 |
| 22 | Female | 21 |
| 23 | Female | 22 |
| 24 | Male | 21 |
| 25 | Male | 20 |
| 26 | Male | 22 |
| 27 | Male | 27 |
| 28 | Female | 22 |
| 29 | Male | 20 |
| 30 | Female | 24 |
| 31 | Male | 27 |
| 32 | Male | 29 |
| 33 | Male | 28 |
| 34 | Female | 24 |

# E APPENDIX E

## Answers to Follow-up Questions



| Questions # | 1 | 2 | 3 |
|---|---|---|---|
| Participant # | | | |
| 1 | Diet | management | |
| 2 | check your condition, weight tracker, step-count | activities | - |
| 3 | recommended exercises, challenges, lifestyle graph | recommended diets | Most apps say "Games" instead of "Game" even if there is only one, but that is just what I'm used to.<br>I think the "Go back to Game" button is not necessary if you go back to the game after purchasing an item already or pressing the top left back button. Maybe add rubber banding to scroll down, and even if you cannot scroll in the page, it might be better if you add it anyway to show there is nothing under it.<br>Maybe the graph says "June 3rd" instead of 03/06, a little bit easier for a human, and the graph doesn't have any units, navigation bar is also broken when in the lifestyle graph. recommended diets |
| 4 | 1. lifestyle graph 2.chatbot 3.learning | - | - |
| 5 | Recommendation of exercise, Diet recommendations | | |
| 6 | Recommended exercises, physical activity tracker, weight tracker | | 1. It would be good if in "learning", the categories were divided into various categories (diet, exercise, etc.), and if there is a corresponding quiz, the participation of the app will increase.<br>2. If there are minigames in the exercises, it will serve the purpose of "gamification" better. |
| 7 | weight tracker, explore the challenge, record diet | - | 3. Encourage long-term use by adding a notification service. For example, when a user's friends have completed an exercise or their lifestyle score has risen, a notification is provided to the user to motivate them. |
| 8 | game(ranking), commnity, recommended exercises | - | - |
| 9 | 1. Lifestyle graph 2. Activity 3. Challenges | | |
| 10 | weekly challenge, weight tracker, dietary intake tracker 11 Weight tracking, activity | Maybe also mental health check-ins and support/motivation<br>Substitute of ordinary food --> recommending diets that are good for preventing obesity. For instance, using erythritol instead of sugar (although there are some issues regarding sugar substitutes) | |
| | | - | Ambiguity in "check your condition" is also used for recording data. "Nutrition score" should be something that should be automatically accounted for, the user should not have to take an extra step to attain the score from "diet".<br>Overall, it's quite clear to find the features that I want. Maybe it would be nice to adjust the configuration of features. I feel like the features are just scattered around the current prototype. And make connections between the features. For example, the users will receive recommended lifestyle changes after recording the condition, but they cannot check their lifestyle changes afterward. So, it would be nice For the AI feature, I don't know why the AI feature is placed only for learning and it looks like just a chat function. There is no clue for identifying AI icons. |
| | | | Finally, I think the home page is not that attractive. It's quite (+) to find the features that I want, but I think this advantage is really good for old people. As I mentioned, your target group is young adults and they're digital natives. Maybe you can just make instruction videos or instruction sliding cards so that they can see them after registering. So you can move some features inside the menu and place som I think your app includes the nece And the final thing is the customization function, so the users can arrange app features depending on their needs. I think customization is a really important aspect for young adults. |
| 12 | Weight Tracker, Diet, Check condition | a cooking tab with recipes that involve healthy foods may be useful. Its very common for people who were raised with bad eating habits to keep them into adulthood because they don't know better, so this may be a valuable change. | |
| 13 | tracking nutrients, community challenges, the game | - | |
| 14 | The lifestyle score and stress management 1 - diet tracker. | | |
| 15 | 2 - lifestyle graph. | | |
| 16 | weight tracker and explore the challenges. | | |
| 17 | weight tracker, recording diet and activity | | |
| 18 | Checking the condition, weight tracker, activity | | |
| 19 | 1. Weight tracker<br>2. Activity tracker<br>3. Diet tracker | | |
| 20 | weight tracker, challenges, diet tracker | - | |
| 22 | condition check, dietary intake tracker, weight tracker | Quantify your weight loss, put your weight loss into the ranking system (motivate) | |
| 23 | weight tracker, lifestyle graph, activity | - | |
| 24 | 1) Points awarded for following diets, community challenges and for dai<br>2) Links to articles and videos to help user find useful information<br>3) Stress management tools | | |
| 25 | Activity, Weight tracker, Recommended Exercises | | |
| 26 | Diet, Activity and Physical Activity Graph | | |
| | | A clear overview of the current state of the user seems to be missing or is not (+) to find. When a user opens the app, having the first thing they see be an overview would be nice to have. I think you have everything necessary. You could add an option for milestones for losing x amount of weight. | |
| | | - | |
| | | measuring water intake | It would be better if there was a function that visually compares the average values such as weight/nutrients according to the age entered by the user with the values entered by the user! |
| | | Let users choose and set specific goals; So let them choose between "lose weight", or "Improve diet and resting heart rate" | |
| | | What foods pose a threat to obesi nope | It would be nice to have a service where you can get advice from experts or get their opinions. |
| 27 | lifestyle management, weight tracker, recording diet | - | It would be nice if it could be linked with a smart watch to measure the amount of exercise. |
| 28 | condition check, physical activity tracker, dietary intake tracker | - | |
| 29 | community | | |
| 30 | food record, condition record, challenges | | |
| | | Maybe some stats to motivate users, e.g. Users that respect their diet for 2 weeks have 20% more chance to succeed in their goal record not only step counter but a I wish I could record various exercises. | |
| | | | 1. The order of the condition check process is not smooth. The hassle of having to check and enter other tabs first to know movement, sleep time, and nutrition point other than personal information. |
| | | | 1-1. If the intention was to automatically input the results of the tabs with different intentions, it would be more convenient to press the condition check button once and the overall results would be displayed immediately. analysis of the corresponding tab results, etc.)<br>2. I think it would be nice to be able to link the challenge function with the community.<br>3. Need to explain the contents of the diet tab. How much is the global standard, but how much is insufficient, etc. The user's diet needs to be explained in detail why the lack of trust in the nutrition point is judged. How to pop up a description when you press a button such as a small "?" mark<br>4. Judging that it is better to configure the home screen by properly combining diet and activity tabs<br>4-1. The lifestyle graph is modified so that it can be seen by scrolling down on the home screen without pressing a button. |
| 31 | Motivate to earn points, learning, recommend workouts, record tracking | Record details for each workout | 4-2 learning is modified in a way that combines it with the recommendation of stress management, activity, or the community |
| 32 | Diet, Stress management | - | |
| 33 | challenges, physical activity tracker, game | - | |
| 34 | condition check > lifestyle score | - | |

**Follow-up Questions**

1. What are the most valuable “this app” features for improving or maintaining a lifestyle for obesity prevention? (Top 3, if any)
2. Are there any missing “this app” features to help you improve your lifestyle to prevent obesity?
3. If there is a feature that could be improved, please write it here. It is very helpful for app development.

# F APPENDIX F

SUS Score for each user and the average score of the total SUS Scores

| - | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | X | Y | SUS SCORE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Participant 1 | 4 | 2 | 2 | 5 | 5 | 2 | 5 | 1 | 1 | 2 | 12 | 13 | 62.5 |
| Participant 2 | 3 | 4 | 4 | 1 | 5 | 4 | 3 | 4 | 3 | 4 | 13 | 8 | 52.5 |
| Participant 3 | 3 | 2 | 4 | 1 | 3 | 4 | 4 | 2 | 3 | 1 | 12 | 15 | 67.5 |
| Participant 4 | 2 | 2 | 3 | 3 | 4 | 3 | 3 | 2 | 3 | 3 | 10 | 12 | 55 |
| Participant 5 | 4 | 3 | 3 | 3 | 4 | 4 | 2 | 4 | 3 | 4 | 11 | 7 | 45 |
| Participant 6 | 4 | 4 | 4 | 5 | 4 | 1 | 4 | 2 | 2 | 1 | 13 | 12 | 62.5 |
| Participant 7 | 4 | 2 | 5 | 2 | 5 | 2 | 5 | 1 | 5 | 1 | 19 | 17 | 90 |
| Participant 8 | 4 | 3 | 2 | 2 | 5 | 1 | 4 | 2 | 4 | 3 | 14 | 14 | 70 |
| Participant 9 | 3 | 2 | 3 | 1 | 3 | 2 | 4 | 2 | 3 | 2 | 11 | 16 | 67.5 |
| Participant 10 | 3 | 4 | 2 | 2 | 4 | 2 | 5 | 2 | 4 | 1 | 13 | 14 | 67.5 |
| Participant 11 | 3 | 4 | 4 | 3 | 4 | 4 | 4 | 2 | 4 | 3 | 14 | 9 | 57.5 |
| Participant 12 | 3 | 3 | 4 | 1 | 4 | 3 | 4 | 1 | 5 | 1 | 15 | 16 | 77.5 |
| Participant 13 | 3 | 2 | 4 | 2 | 5 | 2 | 5 | 2 | 4 | 2 | 16 | 15 | 77.5 |
| Participant 14 | 4 | 1 | 5 | 1 | 4 | 1 | 4 | 1 | 5 | 1 | 17 | 20 | 92.5 |
| Participant 15 | 1 | 2 | 3 | 1 | 4 | 2 | 3 | 4 | 4 | 1 | 10 | 15 | 62.5 |
| Participant 16 | 3 | 2 | 4 | 1 | 4 | 1 | 5 | 1 | 5 | 1 | 16 | 19 | 87.5 |
| Participant 17 | 4 | 2 | 5 | 1 | 4 | 2 | 4 | 2 | 5 | 1 | 17 | 17 | 85 |
| Participant 18 | 5 | 1 | 4 | 1 | 5 | 1 | 5 | 1 | 5 | 1 | 19 | 20 | 97.5 |
| Participant 19 | 3 | 4 | 2 | 1 | 2 | 4 | 2 | 4 | 2 | 1 | 6 | 11 | 42.5 |
| Participant 20 | 5 | 2 | 4 | 1 | 4 | 2 | 4 | 2 | 4 | 1 | 16 | 17 | 82.5 |
| Participant 21 | 4 | 1 | 5 | 2 | 5 | 1 | 5 | 1 | 5 | 1 | 19 | 19 | 95 |
| Participant 22 | 2 | 5 | 3 | 2 | 3 | 4 | 4 | 3 | 3 | 4 | 10 | 7 | 42.5 |
| Participant 23 | 2 | 4 | 3 | 1 | 4 | 1 | 3 | 3 | 3 | 4 | 10 | 12 | 55 |
| Participant 24 | 4 | 3 | 4 | 2 | 3 | 2 | 4 | 2 | 3 | 1 | 13 | 15 | 70 |
| Participant 25 | 3 | 1 | 4 | 1 | 4 | 1 | 3 | 2 | 5 | 1 | 14 | 19 | 82.5 |
| Participant 26 | 3 | 1 | 4 | 5 | 4 | 1 | 4 | 1 | 5 | 3 | 15 | 14 | 72.5 |
| Participant 27 | 1 | 4 | 2 | 1 | 4 | 3 | 4 | 3 | 4 | 3 | 10 | 11 | 52.5 |
| Participant 28 | 3 | 4 | 4 | 2 | 4 | 3 | 5 | 2 | 4 | 1 | 15 | 13 | 70 |
| Participant 29 | 3 | 2 | 4 | 1 | 4 | 3 | 5 | 1 | 5 | 1 | 16 | 17 | 82.5 |
| Participant 30 | 5 | 4 | 3 | 3 | 3 | 4 | 4 | 3 | 3 | 3 | 13 | 8 | 52.5 |
| Participant 31 | 2 | 4 | 2 | 2 | 2 | 4 | 4 | 4 | 4 | 3 | 9 | 8 | 42.5 |
| Participant 32 | 3 | 4 | 5 | 4 | 3 | 4 | 3 | 2 | 5 | 4 | 14 | 7 | 52.5 |
| Participant 33 | 2 | 4 | 2 | 1 | 3 | 4 | 4 | 2 | 5 | 1 | 11 | 13 | 60 |
| Participant 34 | 5 | 1 | 5 | 1 | 5 | 1 | 5 | 1 | 5 | 1 | 20 | 20 | 100 |

X = (sum of scores of odd numbers) - 5

Y = 25 - (sum of scores of even numbers)

SUS SCORE = (X + Y) * 2.5

**Average SUS Score = 68.60294118**

System Usability Scale Questions

1. I think that I would like to use this system frequently.
2. I found the system unnecessarily complex.
3. I thought the system was easy to use.
4. I think that I would need the support of a technical person to be able to use this system.
5. I found the various functions in this system were well integrated.
6. I thought there was too much inconsistency in this system.
7. I would imagine that most people would learn to use this system very quickly.
8. I found the system very cumbersome to use.
9. I felt very confident using the system.
10. I needed to learn a lot of things before I could get going with this system.

# G APPENDIX G

Secondary prototype based on prototype test