An Educational Nutrition Planner Targeting Adults with Low Nutrition Literacy

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Abstract

This paper explores how a nutrition planner mobile application could be used as an effective intervention to change eating behaviours in older adults with low nutrition-literacy, through automation of the diet-creation process, and educational features. This is in light of dietary risk factors being the second leading cause of mortality in the UK, and current solutions lacking some functionalities and long-term engagement.

To do this, following a background review of relevant literature and systems, a UX prototype was created considering HCI methodology, including iterative user research and analysis.

During this process, many findings were elucidated. Primarily concerning the value of educational features, prioritising ease-of-use, and the comparing older users with other users.

This paper concludes that the prototype meets the aims, objectives and requirements set. Thus, it is proposed that further development into a functional application would reveal a valuable solution to the problem of poor dietary choices among those with low nutrition-literacy in the UK.

Declaration

I declare that this dissertation represents my own work except where otherwise stated.

Acknowledgements

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Table of Contents

1. Introduction

This section outlines motivation and rationale, aims and objectives, and ethical considerations, condensed from the "Project Proposal" - reflecting the state of the project at that time.

1.1.   Context: motivation and rationale

1.1.1. Context

In the 21st century, UK citizens have access to a wider range of more affordable nutritious food, as well as information on eating healthily through the school curriculum and online sources. Despite this, as of 2021, dietary risk factors were the second leading cause of mortality, accounting for 12.1% of total deaths in the country [1]. Furthermore, significant metabolic risk factors like systolic blood pressure (13.1%) [1] and BMI (9.1%) [1] are also influenced by diet [2] [3]. Together, this indicates a significant proportion of the population are failing to eat healthily for reasons besides accessibility of nutritious food. One explanation for this is, in demographics where diet is a leading risk for mortality (>49 years age), "Health literacy" is lacking [4]. Reasons for this could include time passed since education, and infrequent use of helpful technologies. Additionally, a barrier to formulating a healthy diet is the time and effort needed for research.

1.1.2. Problem

Solutions exist for tracking one's nutrition. Many of these technologies focus on fitness-oriented users, who want to track macronutrients for weight loss or muscle gain purposes. *MyFitnessPal* [5], which advertises as "reach your goals", combines nutrition with tracking activity and weight. Others focus on tracking nutrition with a focus on wellbeing, where details about foods are not included. In *bearable* [6] , users track their diet and mood, as well as other factors like sleep, to see correlations. The solution which is most applicable to the problem of high mortality from dietary causes in the UK is *Cronometer* [7], as this is an easy-to-use and detailed tracker of both macro and micronutrients, which could be used to assess where a user's current diet is lacking and worsening their health. However, a weakness is that it cannot generate a diet from scratch,

and educational features are hidden behind a paywall, reducing utility for the identified problem. *EatThisMuch* [8] can create a diet from scratch, however, this technology focusses on providing the user with meals rather than ingredients, which introduces accessibility issues that are implicated with cooking, and means it sometimes fails to fulfil all micronutrients.

1.1.3. Rationale

The intention is to produce a mobile application that can generate a diet from scratch, fulfilling all nutrients, and considering factors like dietary needs. An agile design approach with iterative user-testing will be utilised, to improve Human-Computer Interaction (HCI). The focus of the application is reducing risk factors for mortality and poor quality of life due to health issues caused by diet. Problems with current solutions will be addressed by combining aspects from each; like generating maintenance calories, generating a diet from scratch, and educational features.

1.2.   Target User

The target user for this project is an individual with low nutrition-literacy. Older users often have this, and also suffer more severely from the effects of poor diet.

1.3.   Aims and Objectives

For the overall aim, see the first sentence of the rationale.

1.3.1. Objectives

1. "Diet planner" functionality for the application, which provides a list of daily foods that fulfil the individual's RDAs (Recommended Dietary Allowances) for all nutrients and considers other dietary factors like allergies and dislikes.

2. Educational functionality where individuals can view their health as categories like "Joint Health" and "Eye Health", then view nutrients relevant to these components, and foods containing these nutrients.

3. To do this, program a function which looks at the CoFID [9] (Composition of Foods Integrated Dataset) dataset and procures foods that are outside the average range for a given nutrient.

4. Individuals can input their height, weight, and activity level to generate a TDEE (Total Daily Energy Expenditure) which is used to recommend calorie intake, then factored in to the "Diet planner" for specified weight loss, gain, or maintenance.

5. Ensure that the application is usable for older adults. To verify this, make sure any user-evaluation involving adults above the age of 40 includes reporting quantitative measures of usability, and ensure these are above relevant standards.

6. Use agile, participative design throughout the development process to implement the considerations of users regarding UI (User Interface) and UX (User Experience) changes through interviews, as suggested by HCI literature.

1.4.   Ethical Considerations

Before beginning the project, an ethics checklist was completed (appendix A), and ethical considerations noted.

For one, medical data could have been collected within the app, or during interviews/surveys to assess the impact of some conditions on UX design. However, the choice was made not to collect this sensitive data, and instead rely on non-sensitive data like estimates of nutrition literacy.

Another consideration was collection of identifiable personal data in user research. Regarding this, questionnaires were anonymised, personal information revealed in interviews was censored in transcripts, and recordings were deleted.

1.5.   Structure

Following this section, the process of and inferences from the background review are detailed, to be used in the subsequent process including user research and development, the results of which are then evaluated, concluding with learnings, future work, and summation.

2. Background Review

The Background Review for this project included a literature review and a "state-of-the-art" review of existing systems.

2.1.   Literature Review

Relevant literature was initially reviewed when writing the "Project Proposal," then developed for the most pertinent sources, considering *validity*, *synthesis*, and *relevance*. Additionally, a perception of the "current state of knowledge" was examined as derived from this literature - classifying certainties and uncertainties, and contrasting new and dated knowledge. An abstract

construction of "foundational blocks" was produced, where some findings were deemed foundational to the project and others supplementary, to aid prioritisation going forward (Appendix B).

2.1.1. Initial Review

The initial review consisted of ten sources. For each of these sources, the study was outlined, then its relevance to the project was assessed. The focus areas for research were: Justifying a mobile application to change nutrition behaviour, consolidating which features would aid this app's effectiveness, considering design from a HCI perspective, and investigating standards and data that could be utilised. Throughout, the target user of an older adult with low nutrition literacy was regarded.

Justifying this solution was addressed by one key paper [10], wherein Villinger *et al* covered forty-one studies of mobile interventions in nutrition behaviours and found that these interventions are effective, and not limited to certain populations or app-types. This justified a mobile application as a solution for addressing the problem of poor nutrition choices in the UK. That said, this study also found that long-term follow-up effect sizes were generally non-significant. This implies that such intervention modalities are lacking features which promote long-term engagement, raising a concern with this project; designing to increase long-term engagement is crucial.

Besides those essential for the solution, features were partially determined by the literature review. Namely, two studies: *Designing Positive Behaviour Change Experiences* [11], and *The Use of Social Media in Nutrition Interventions for Adolescents and Young Adults* [12]. The former performs a sentiment analysis on the most frequent fitness and nutrition Behaviour Change Techniques (BCTs) in applications, finding the most positively perceived are Goals, Programs, Plans, Tracking, Friends, and Story. These findings precipitated the inclusion of some of these techniques within the app, particularly Programs and Plans, which were portrayed in the study as especially popular relative to their frequency of inclusion. Additionally, they write about the design implications of these BCTs, which provided insight into implementing these. The latter study reviews sixteen studies into use of social media in nutrition interventions for adolescents and young adults, finding eleven of these had significant results. This justifies the implementation of social features in the project.

Regarding design, three studies were key. Chiefly, *Design and Evaluation of Technologies for Informed Food Choices* [13] (DETIFC), wherein the researchers developed a set of 20 finalised "food literacy" heuristics to aid in design of relevant systems, after a process consulting nutritionists and HCI experts. These heuristics were highly relevant, especially to inform the development of the app's User Interface (UI), ensuring choices are supported by a robust process as in this study. *Designing Apps to Support Engagement by Older Adults* [14] used a think-aloud

methodology to get feedback from users of a dietary assessment app, finding that older adults need more support (and prefer mobile applications). Considering this, a decision was made to emphasise support, given the target user being an older adult. Finally, *Designing User Interfaces for a Wellbeing Persuasive App* [15] showcases design elements that impact on the "pleasantness and frequency of use" of these apps. These design components could be referred to as a foundation for the UI of the app.

Before development began, concrete data and established standards for similar systems had to be ascertained. For example, using *From Plate to Guide: What, Why and How for the Eatwell Model* [16] which is a detailed document on how the government developed "the Eatwell guide", improving on the "Eatwell plate". Relevantly, these advise the public on how to meet nutritional requirements without precise quantitative guidance. Detail is provided on how the old "Eatwell plate" model was confusing or unhelpful, including how consumers typically view different representations of nutritional guides. This could be used to inform decisions of how to convey information visually to increase "accessibility, engagement and understanding". *Government recommendations for energy and nutrients for males and females aged 1 – 18 years and 19+ years.* [17] provides the dietary requirements for calories and nutrients as devised by Public Health England based on various detailed enquiries. This provides a scientific foundation for guidance on daily recommendations, avoiding the ethical concern of misinformation that could arise from using less robust sources. Similarly, *McCance and Widdowson's composition of foods integrated dataset* [9] is used to inform their references for the nutrient content of the UK food supply, providing any quantitative information regarding the nutrition of various foods that may be included in the app. Again, as robust a source as can be procured.

2.1.2. Further Review

Following submission of the initial review, gaps in its comprehensiveness were identified, including a need to consider *validity and synthesis*. As such, a more in-depth evaluation was carried out as described under the "Literature review" heading.

Assessing "What we know for sure", the most pertinent findings were the following: that the 3 most effective nutrition BCT are "shaping knowledge", "goals and planning", and "social support" [10]; from the same source, that long-term follow-up effect sizes are insignificant; and that lastly that older users need more support to use apps [14]. Regarding "What we are uncertain about", Villinger *et al* also found that it is difficult to assess the effectiveness of different BCT as they are implemented differently in different studies. "Dated and Superseded" information includes the old "Eatwell plate" using photographs over icons, and lacking distinction between fats [16], whereas "New or Untested" included how to increase long-term engagement with these apps, for example by testing the effect of positively perceived BCTs on long-term user retention.

This categorisation was helpful, e.g. because the reliability of those findings in the "What we know for sure" category could be relied upon more, or because "New and Untested" information could be lined up for user research.

Following this, an abstraction of "foundations" was constructed in which the main foundation that underpins the project was the finding that app-based mobile interventions are effective in changing nutrition behaviours, whereas concepts like older adults requiring more support [14] were built on top of this. This meant a plan could be established of how to structure the project, first implementing the solid foundations then the components that build upon this.

The two studies which were reviewed in detail, given their position as foundations for the project, were Villinger *et al's* meta-analysis, and DETIFC [13].

Critically evaluating the validity of Villinger *et al*'s study revealed that Villinger themselves have published many papers with focuses on nutrition and on mobile tech, increasing this study's reliability. Additionally, they provided valid analysis that the heterogeneity of results is due to a difference in methodology between studies reviewed. Though, their assertion that mobile interventions are "essential to conquering the obesity epidemic" may be overstated if long-term effect sizes are indeed insignificant. Regarding synthesis, this paper's 229 citations include at least 2 other applications [18] [19] showing its value is apparent to developers. Additionally, their methodology utilises findings from *The CONSORT Framework* [20] showing consideration of valid sources and thus increasing value. That said, Villinger *et al*'s study was criticised by Seid [21] for a limited number of included studies; suggesting that effectiveness was indeed population dependent. Relevance-wise, it could be said that the lack of a HCI perspective in this study is a fault, however it is altogether still very relevant since it uses a thorough methodology to provide a relevant conclusion on mobile interventions being effective. As such, critically evaluating this study did not reveal any weaknesses which would hinder its usability as a foundational source for the project, though consideration was given to possible population-dependency of effectiveness, by ensuring tailoring to target users.

Critically evaluating the validity of DETIFC found two main flaws. One was that there was a lack of a clear methodology for their initial review of grocery websites, which could weaken their findings. The second was that initial heuristics were proposed through this review, with no opportunity for participants to suggest new ones. This could mean that other useful heuristics were not considered. However, neither of these particularly limit this project's usage of the findings. In terms of synthesis, the study has 0 citations, suggesting that the heuristics are untested in real-world scenarios. Additionally, there is a lack of clear methodology in their analysis of the heuristics, since participants voted on which ones to change but the decision was ultimately up to the researchers. Once again, this could weaken their findings. At this stage, it could be said that the study should not be used as a foundation for the project as it is too flawed, but the relevance was so apparent that it maintained a key-role in development. That is, the

presence of HCI *and* nutrition perspectives within the research, as well as a similar aim to improve nutrition literacy. Subsequently, this study's findings were utilised, but with a regard to consider other potential "heuristics" as well, to ensure no reliance on fragile findings.

2.2.   State-of-the-Art Review

In HCI development, it is also suggested to carry out a "state-of-the-art" review, where similar systems are evaluated. The primary method of doing this for this project was using user reviews on the Google Play Store, which allowed assessment from a user perspective. Apps reviewed were *MyFitnessPal* [5], *Bearable* [6], *Cronometer* [7]*, and *EatThisMuch* [8].

More specifically, reviews were procured with a regard to both positive and negative reviews, then quotes were lifted which target relevant features, and a thematic analysis of these was performed to elucidate two key findings.

- UI for these systems is typically described as "confusing" or in similar terms.
- Users have a strong positive perception of personalisation and customisation features.

As well as these, some less-common concerns of individual users were marked for later consideration, if they were particularly easy-to-implement or seemed to align with common-sense design principles or functionality. For example, loading bars and being able to preview features without registering.

Altogether, the background review allowed for development of a set of foundational and supplementary considerations when developing the project, considering both literature and real-world findings. These considerations were also essential to composing the structure of user research.

3. What Was Done and How

In this section, the development process for the project will be detailed, as the concept shifted from a full application to a UX prototype since time considerations became severe, to ensure HCI was well-developed, rather than limited. The development structure was: Prototyping, Fieldwork/User Research, Requirements, Development, Evaluation, Refinement. Notably,

prototyping came before user research, to ensure feedback on UI could be gleaned throughout, following an iterative development cycle.

3.1. Prototyping

Early prototyping of the project was based on provisional requirements derived from the context, background review, and aims and objectives.

3.1.1. Paper prototyping

To begin with, a paper prototype was sketched using simple principles:

- Project is a mobile application.

    o   Make space for android UI.

- Features include diet generation (Fig. 2), educational features (Fig. 3), social features (Fig. 4), and weight loss (Fig. 2).

- Consider target user.

    o   Add support (Fig 1)

- Simple UX concepts.

    o   Buttons, scrolling, call-to-action, mental models.

        ▪   Mental model of human body and corresponding health categories to location (Fig. 3)
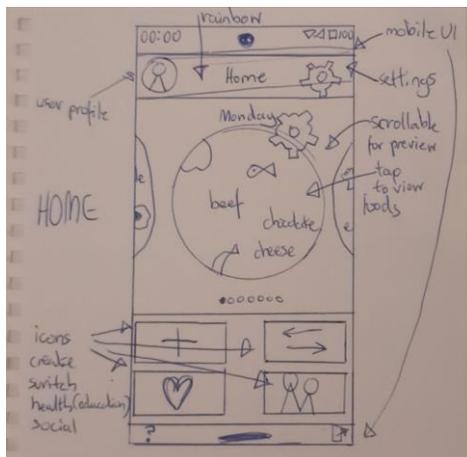
Fig. 1

Fig. 2

Fig. 3

Fig. 4

Jacob Peel 210077111
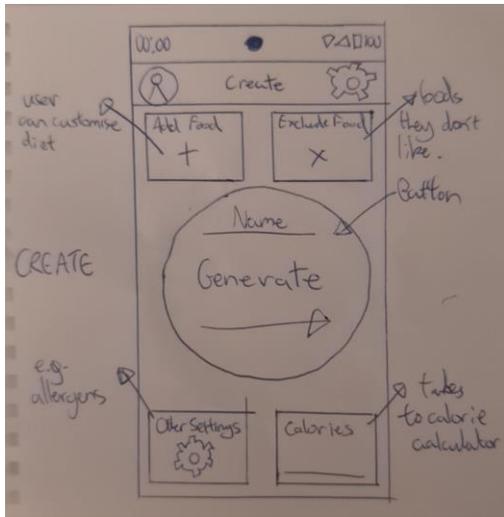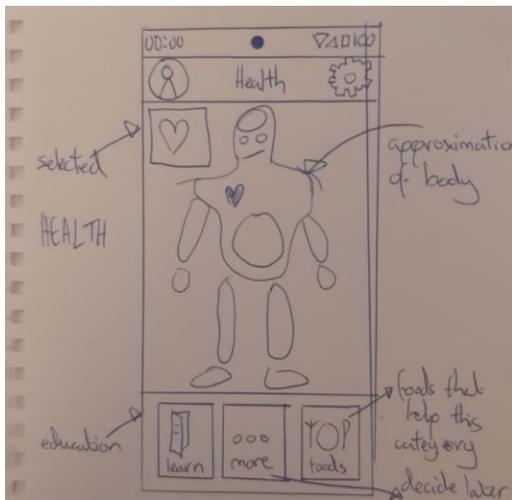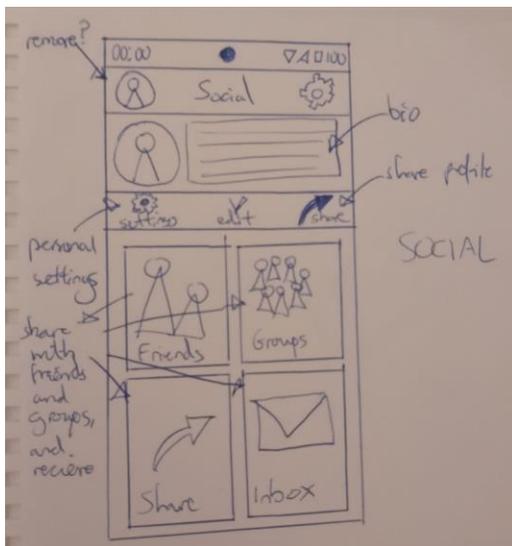
3.1.2. Wireframe

Following the paper prototype, the decision was made to use Figma to wireframe a slightly higher fidelity design.

Further considerations included:

- Spacing of elements.

- Use of colouring.

- Visualising design as closer-to-completion to assess whether UI from paper prototype still sufficient.

This resulted in the following figures:
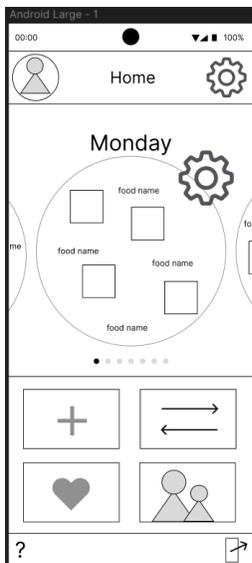
Fig. 5
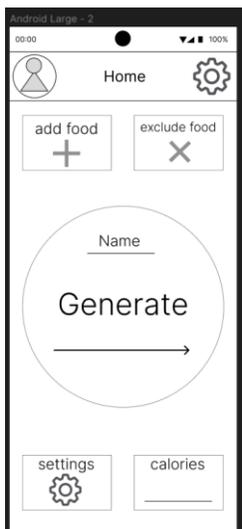
Fig. 6
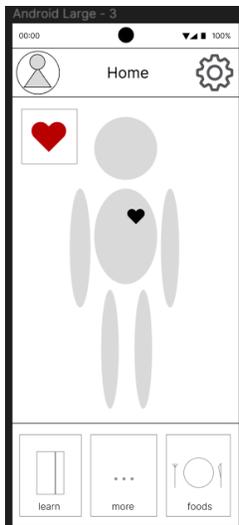
Fig. 7
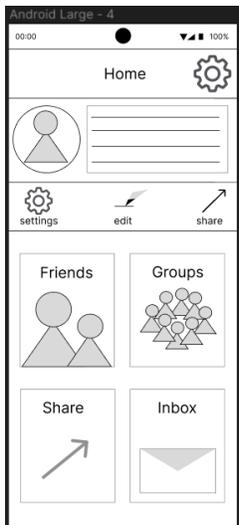
Fig. 8

3.1.3. Increasing fidelity

To increase fidelity, the following changes were planned and implemented:

- Devise a brand identity to inform motifs throughout the UI.
  - Brand name "PlanMyPlate" was arrived at.
  - From this, a motif of a plate was derived as use of ellipses throughout the design.
  - Slogan "Eat the rainbow" was based on research [22] and reflects variety of food recommended.
  - From this, a rainbow colour-scheme was derived.

- Add Create account/ Log in functionality, Switch diet screen, and more educational depth.

These changes arose during prototyping, through reflection:

- Design of "My Health" page should move way from human body mental model since it is too difficult to assign various health categories to particular locations e.g. skin.
- Concept of recipes devised.
- Notifications.

To create this prototype (Appendix E), two key plugins were used within Figma. Firstly, "Icons8" which allowed for access to many free icons that could be used to accompany labelling for buttons etc. given that the "Eatwell guide" research found respondents with an unhealthy diet preferred drawings to photographs. Secondly, "Type Tool" which curved typed text so it could be placed on ellipses to improve aesthetics.

3.2.   Fieldwork/ User Research

Alongside creation of this prototype, a questionnaire was researched, composed, reviewed, refined, then disseminated. Drawing from this, an interview process was formulated, reviewed, and refined.

3.2.1.   Questionnaire

Research for both the questionnaire and the interview began with reading the paper *Questionnaires, in-depth interviews and focus groups* [23], garnering numerous insights. For questionnaires, this paper firstly stressed the importance of reliability (consistent measures), and validity (measuring what is intended to be measured). These were implemented by use of Likert scales and requesting feedback respectively. In the study, emphasis was placed on convincing users of the benefit of them completing the study to aid their focus. Considering this, the questionnaire was written to include statements such as "to see how… responses were implemented…email _@email(dot)com". Additionally, other points were implemented, such as age ranges being more appealing to participants than specific age, avoiding requiring interpretation (in this case, clarification provided in descriptions under the questions) and use of grouping questions and good sequencing

Composition of the questionnaire began after considering the project's background research, as well as aims and objectives. 4 justified sections were proposed:

- *Demographics*, allowing for comparison between older and younger users, and educated vs non-educated users.
- *Nutrition and applications background,* permitting further assessment of nutrition-literacy, and to glean further insight into participants ideas about similar systems.
- *Information for development of application features*, where the importance of the various features could be assessed from a user perspective.
- *Information for development of application interaction,* wherein data about how users would prefer to interact with the application was acquired, including potential challenges and comparing importance of conflicting interaction concerns.

Next, the project's supervisor was requested to provide feedback on the questionnaire, including critiquing questions, and providing suggestions for new questions. For example, asking people how they envision the perfect nutrition planner app.

Using the feedback, the questionnaire was refined, ready for dissemination. A debriefing section was added where users could enter their email if they were happy to be contacted for interviews or evaluation.

The questionnaire was propagated through two means. Firstly, it was put on the Instagram story of a Newcastle University society. This was intended to get as many responses as achievable to gain a breadth of data. Secondly, an older woman was contacted through personal relations, and asked to distribute to friends and family of their age, allowing for a secondary demographic closely aligned with the target user, to compare with the student-oriented demographic. As such, it was possible to see where current solutions have weaknesses for the problem in question, since they are designed for the biggest market of younger users.

3.2.2. Interview

After the questionnaire was disseminated, work began on considering questions and process for an interview.

Again, Adams' paper [23] was used to inform initial decisions. A key theme in the paper is setting the interviewees at ease allowing for more valuable responses. For one, the use of pre-prepared questions, but with deviation encouraged where necessary. This makes the interview harder to analyse but avoids irritating participants by covering the same points they have already made again. Another borrowed example is using introductions and outlining permissions, including detailing confidentiality, so the user knows how their responses will be used. Outside of this, there is a stress on avoiding leading questions, which was illuminating since statements like "do you mean x" are easy to make in an interview unless actively trying not to. Lastly,

Adams' paper revealed the concept of using scenarios and personas as prompts, to target particular issues after the respondent has "let off steam".

The interview was structured as follows:

- *Context*, where the user was briefed on the background, permissions, and their expectations in the interview, and asked to sign a consent form. Then, they were informed briefly what they would be asked to prime their thinking.
- A warm-up question as suggested by Adams.
- *Nutrition knowledge and opinions*. One purpose of this was to see clarify which areas of the interviewee's nutrition knowledge were strong or lacking, and extrapolate this to a target user's hypothetical knowledge to inform development. The purpose of eliciting opinions varied question-to-question, but included investigating which aspects were outside the app's control.
- *Wellbeing/Lifestyle application experience/applications.* This section was intended to garner thoughts on similar applications the interviewee might have used in a more qualitative, in-depth format than the questionnaire. They were told to get any used applications up on their phone, if possible, to allow for accurate responses that don't rely on memory, especially UX feedback.
- *Ideas about Nutrition Planner.* In which, the interviewee is asked for their views on this specific project, to gather particularly relevant data through conversational insights.
- *Social and Educational Features.* This section asks the interviewee to consider apps they use and the educational and social features within them, how they could be improved, and how they would be adapted to a nutrition planner app.
- *Scenarios and Personas.* The user is here referred to 3 scenarios and a persona, then asked how the ideal app would support themselves in that scenario, as well as the persona. They are also asked about what then might make the app difficult to use, and how visual and interactive design could help the persona. The persona given, "John", is intended to represent the target user, and as such, valuable data can be acquired even where the interviewee does not align with this target user.
- *UI Review.* This section implements a quasi-cooperative review, wherein the user is shown the final prototype using MS Teams' "Share Screen" functionality, and walked through the Figma frames and overlays, being asked at each a short list of questions following their initial impression. The user is also encouraged to ask questions, leading myself to consider the design more deeply. This is intended to reveal any UI issues before proceeding to UX development.

This interview format was then reviewed by the project supervisor, providing feedback like including alternative questions for those who don't use any apps.

To conduct the interview, MS Teams was chosen for its auto-transcription and screen-sharing features, which removed the need to meet in-person, as this would have been logistically difficult. Of five respondents age 40+, one was available for interview. This user aligned closely enough with the target user that data gathered was predicted to be valuable.

3.2.3. User Research - Results and Evaluation

To analyse the questionnaire, both quantitative and qualitative methods were used. Firstly, the data from quantitative questions was analysed in a simple manner (e.g. comparing Likert averages), then the same was done for qualitative responses as a thematic analysis. Both analyses were then compared to any hypotheses for the various questions. Subsequently, they were reviewed and developed into speculative insights, which were further developed into requisite actions. As well as this, a group of 5 key respondents were identified based on age. Comparisons were drawn between these and other users via a spreadsheet to ascertain where requirements differ for older adults. Hypotheses, findings, insights, and consequences were then organised into the table in appendix F. Of these, the most apposite are summarised below:

- A significant majority of participants chose "Food Tasting Good" as one of their most important nutrition factors, prompting the inclusion of recipes.
- Educational features are considered much more important than social features, and so can be prioritised where necessary.
- Ease-of-use significantly valued over customisability, despite customisability being identified frequently as priority in qualitative questions. This suggests labelling and easy-to-understand explanations key.
- Participants were concerned about potential for aggravation of eating disorders, which is an ethical concern that can be addressed through "Treat allowance", reducing rigidity of diet.

The table in Appendix G refers to a comparative analysis of identified "key respondents" in age bracket 40+ with the rest of respondents. Key insights and consequences are as follows:

- Compared to the rest of the population, key respondents have a significant preference for dietary choices (e.g. vegetarianism) and boosting mood as important aspects. Thus, any customisability should certainly include dietary choices. Mood should be front-and-centre in "My Health".

- Key respondents have strongly negative perception of importance of social features compared to rest of population, and slightly more positive perception of educational features. This reinforces the idea educational features should be prioritised over social ones.
- Target respondents are much less concerned about weight loss. However, this may not reflect their need to lose weight, which is still important.
- All key respondents preferred the app to be easy-to-understand rather than detailed, compared to 2/3rds of other respondents. Support should thus always be available, and information conveyed using colours, symbols, and simple presentation.

As well as being noted for use in development, these findings helped inform the interview questions. For example, investigating why the biggest share of respondents never use lifestyle applications.

The recording and transcript of the interview were reviewed topic-by-topic, noting the question (including non-pre-prepared ones) and bullet pointing the key points in the interviewees answer. Then, key information was formatted into the table in appendix H. This is summarised below, the second tier of bullet points representing insight from myself.

- The user had good health-literacy.
    - So, findings may not be wholly extrapolatable.
- Dietary choices limited by supermarket selection.
    - Suggests need for "hard-to-find foods" toggle.
- Treats are "necessary".
    - Treat allowance concept reinforced.
- Doesn't use similar apps because they aren't tailored to their demographic. Nutrition info not specific to them.
    - Ensure this.
    - Personalisation of nutrition information available?
- Ceased using app in past due to lack of novelty.
    - Novelty can be maintained through depth of educational functionality.
- Thinks information should be general but go more in-depth with interaction.
    - E.g. tapping button with simple info label.
- App should be easy when busy.
    - Low time-consumption again.
- App should be customisable to age and lifestyle.
    - Personalisation functionality.
- Athletes may have different requirements.
    - Consider this. Long-distance runner = more carbs, weightlifter = more protein.

- Social features have no value to them, preferred by "younger crowd".
  - Aligns with previous findings and insights.
- Educational features should be tailored to personal qualities.
- In diet plan for shopping scenario, app should provide ideas of meals, set budget, and be able to plan for multiple people. For John, the font should be big, and app should be simple to use.
  - Recipes section.
  - Budgeting in settings.
  - Multiple users on one account for families.
  - Changeable font size.
- In scenario of educating oneself about nutrition, there should be no expectation to learn daily. John would use "foods to avoid" section for weight loss, and app should not assume knowledge of similar systems for older users.
  - No "Streak" functionality.
  - Do not base UX on typical systems without consideration of those who haven't used them.
- In scenario of sharing diet plan with close friend and relatives, social sharing with WhatsApp should be possible. John might like to share with family in particular.

The final section of the interview consisted of a UI review of the prototype (Appendix E), as represented in the following table containing key feedback:

Negative feedback	Solution
Not clear whether "diet" referring to meals or weekly plan.	Clearly label the diet as weekly.
"Custom" button not clear.	Change "custom" to "add custom button".
Elements look "greyed out" and not interactive.	Replace grey stroke with "deep green" stroke and icons with rainbow colouring.
How to access educational features not clear.	Change "My Health" icon to include book to convey access to educational features.
Not obvious main "Monday's foods" button interactive. Thought icons represented all foods for given day rather than just preview.	Condense icon imagery then add text "tap to view all".
"Join for free" confusing as term, better as "create an account".	Change to "create an account for free", so no necessity to pay still conveyed.
Should be able to add age and lifestyle	Add "personalisation" form following account creation.

The UI review marked the end of user research, allowing for development to begin using the applied insights acquired.

3.3. Requirements

Final Functional and Non-Functional requirements were devised prior to development, using all workings heretofore. Listed below are some of those which are not mentioned in the initial objectives.

Functional

- Personalisation and customisation should be implemented.
- The UI should not be confusing.
- The application should require minimal time and effort.
- Include "Recipes".
- Include "Treat Allowance"
- Ensure guidance available for older users.
- Increase long-term engagement.
- App should be aesthetically pleasing.
- Include "Shopping List"
- Include social sharing.
- Information easy-to-understand.
- Implement "Goals and Planning".

Non-functional

- Explanations should be presented in bullet points.
- Labelling should be used throughout.
- Consistent colour scheme of rainbow, dark green and light green should be used.
- Guidance available in form of tutorial and help buttons.
- Implement heuristics like traffic light colouring to represent positive and negative, and guiding stars.

3.4.   Development

The development stage, i.e. refining the initial prototype, required the bulk of time allocated for the project. This included improving the UI based on research, implementing missing functionality, and realising thorough UX design to increase fidelity. Doing this primarily used the requirements devised, as well as reflection on the background review and user research. See Appendix I for a link to the

3.4.1.   UI Development

The initial step in UI development was implementing the righthand column of the above table.

There were three main considerations from this point forwards. Firstly, any other relevant user research, secondly reflection on the prototype as development continued, and thirdly further considerations from the background review.

User research considerations were as follows:

Social features: Social Features are considered unimportant by most participants and thus should not be front-and-centre in UI. Implemented as not including share buttons throughout to avoid overwhelming users with an unpopular feature.

Ease-of-use: This was promoted over customisability through internal consistency each "ellipse" (button) component being interactive, and having a differing stroke colour to allow the user to easily glean information. For example, the traffic light nutrition system.

Information easy to understand: Detail in the UI was concealed behind easy-to-understand headlines and icons. Bullet-pointed explanations are used to aid understanding.

Labelling: Due to the target user, it was necessary to include abnormally frequent labelling to convey meaning where they are not familiar with other systems and typical icons.

As well as this, many changes and developments were made through reflectively considering the prototype during UI development:

Colouring: Scrollable elements were changed to light green to be consistent with earlier colour changes. Additionally, to improve aesthetics, the custom "rainbow" gradient fill pattern was changed from vertical to diagonal alignment.

Fidelity: Initial fidelity improvements came through UI. For example, wireframed elements which remained in the prototype like the contents of an android-phone mock-up were replaced by finalised imagery.

Overlays: Consideration revealed certain planned functionality should be implemented through Figma's overlay system. This allows for display of elements above the current screen. For example, touching the help button displays a help overlay, using a blurred background with clear spaces indicating which components the help is referring to.

Symbols: Where labelling would have compromised aesthetics, symbols were used to direct users. For example, the writing icon; placed near editable text to indicate that affordance.

Not all UI considerations from the background review had been fully implemented in the initial prototype:

Food literacy Heuristics: One heuristic relevant to UI is "H2. Interpret Nutrition Content" which advises the use of symbols and colours. This was implemented as suggested, using traffic light colours to indicate high contents of harmful nutrients and low contents of beneficial ones relative to comparable foods. "Guiding stars" show at-a-glance the overall score for a given food's breakdown. These stars were envisioned as considering all factors, with 3 stars indicating a food that is always a good choice, 2 being a good choice in moderation, 1 star having some good qualities, and 0 stars being a treat.

Designing User Interfaces for a Wellbeing Persuasive App: Some UI findings from this were implemented initially, but others, like compliance with accessibility guidelines, were not. In the "Shopping list" screen, where text was too small to comply with guidelines for visually impaired users, the ellipses were made interactive, to open an overlay of a larger ellipse with larger text for a category. Furthermore, the attached figures in this study provided inspiration. For example, the use of emoticons to convey emotion linking to items. In this, high or low levels of good nutrients in the filter system etc.

State-of-the-art Review: The key finding in the state-of-the-art review was the UI being "confusing", "messy" or "clunky" in similar systems. To address this, particular care was taken in providing clarity. For example, arrows were added to scroll bars to ensure user recognised these as such.

3.4.2. Adding Functionality

Functionalities derived from the background review are detailed below:

Calorie Calculator:

Including calorie calculator functionality was proposed in the project's objectives, since obesity is a major health risk factor, and supported by the positive perception of "personalisation features" in the state-of-the-art review. To perform this, the user completes a form including height, weight, and activity level, as copied from an online calorie calculator [24], since TDEE is

dependent on these factors. They then select gain, maintenance, or loss and it provides a daily calorie recommendation which is applied to the given diet using the "Save" button.

Explanation:

Given "Shaping knowledge" was found by to be an effective BCT [10], it was important to further develop educational features. By navigating to a health category e.g. heart health, then a particular factor e.g., red meat, then a reason this factor impacts the category e.g. saturated fat, the user can view more detailed explanation. The explanation provided in the prototype for saturated fat's impact on heart health is drawn from Fritsche [25] and Ruuthe [26] for inflammation and LDL cholesterol respectively.

Plan:

The importance of planning was revealed in both Villinger *et al*'s study [10] and Pimenta's [11], wherein it was found planning as a BCT is both effective and positively perceived respectively. This was implemented in two main screens. Firstly, a plan for each health category based on the factors affecting this aspect of health, presented in a view consistent with the "Food library", including key foods, and an ability to add these to an individualised plan. This individualised plan is the 2nd screen, which reflects all the items from various plans the user has curated. Items in this plan are intended to influence diets generated for the user, which is an element of customisation. Icons are used for health categories to ensure the user can see at-a-glance which items in the plan are benefitting which aspects of their health. The plan is intended to incorporate *goals and planning* [11], and increase long-term engagement, which is lacking according to Villinger *et al*.

Sharing with friends:

Though user research was unfavourable towards it, Villinger *et al* found social support was an effective BCT, and Chau [12] concluded social media features like sharing were also effective. Thus, the implementation of sharing with friends. This is included throughout the prototype as an overlay when "Sharing", as well as a main "Friends" screen. This aims to allow users to inspire each-other with diets for various purposes e.g. weight loss or mood, as a form of social support. Regarding the "Friends" screen itself, only basically functionality was included due to the negative perception of social features during user research and time-constraints. The user can search friends, add new friends, and view a list of friends.

Personalisation:

Personalisation is included throughout the app, including following creation of an account, where information to personalise their experience is requested from the user. Deciding which information to request included consideration of all research. For example, requesting age was due to identification of the target user from the *context, problem, rationale* research conducted,

whereas requesting activity-type was a suggestion from the user-interview. The former was intended to customise foods suggested (e.g. more protein required [27]), and which information was front-and-centre (e.g. heart health, joint health).

Diet Breakdown:

This shows how a diet fulfils the user's nutrient requirements. It also reflects the BCT of *shaping knowledge* as mentioned by Villinger *et al.* As well as this, a breakdown is available for individual foods. Details of implementation include provision of each macronutrient in grams, and each micronutrient in an appropriate measurement e.g. milligrams. Where necessary, a further breakdown is included, for example fat into saturated and unsaturated. For micronutrients, the fulfilment of the RDA for each of these is stated as a %, or an approximation of RDA based on weekly recommended intake for those fat-soluble nutrients.

X Day's foods:

For each day of each diet, a list of foods is provided, split into categories derived from the Eatwell guide [16] such as carbs, protein, fruits and vegetables, and fats and dairy. This is an essential feature for objective 1, where it is stated, the application should "provide a list of foods split by day". These foods are intended to fulfil each nutrient requirement for the user as well as adhering to customisation. Splitting this list into categories makes the information easier to understand, and provides an educational element, where it is not always clear which group a food should belong to. As well as this, user's recipes which align with the foods for that day can be viewed at the bottom, so the user can better plan their meals.

Sort by and Filter by:

Items within the food library can be sorted and filtered, increasing the efficiency-of-use of the application. Furthermore, Bomfim [13] specify their 4th heuristic for food literacy to be "Sort by nutrition values" and their 5th is "Filter by nutrition content". Their suggested implementations are sorting from low-to-high for health-negative nutrients like sugar, and filtering based on these qualities. In the prototype, this is extrapolated to being able to search high-to-low for health-positive nutrients like unsaturated fat. This is perhaps more useful since sorting from low-to-high for sugar would reveal thousands of foods with no sugar, that aren't necessarily healthy due to other factors. Filtering includes doing so by the star breakdown of each food item, as well as the "colour" grade given to each macronutrient for the item. The sorting system increases efficiency-of-use, whereas filtering primarily supports education where the user may be curious how different filters synergise e.g. foods that are ranked 3 stars but are low calorie.

Studies

Supporting studies, viewable by the user, were planned to be included in the application from conception, to avoid ethical concerns around providing a diet or advice which is not sufficient or potentially harmful. The studies overlay for each relevant screen includes link icons indicating they can be clicked. Upon this, the final application would navigate away from the application into browser and the user could view the study.

As well as these, much functionality was developed based on the user research conducted:

Shopping List:

The need for a shopping list was revealed through the questionnaire. In this, *convenience* was ranked among the most important nutrition considerations, as well as "shopping section" and "ordering from the supermarket" being mentioned by two respondents. Given this, a shopping section was implemented using the design concept of external consistency [28]. This is explained under the later "heuristic evaluation". Addition of *strategic planning* like this is also Bomfim's 16th Heuristic, and one of their suggested implementations.

Edit Diet:

Being able to edit the diet is a key functionality which represents respondents' desire for the system to be "responsive". The "Edit diet" screen allows for adjustment of all aspects of the diet like adding and removing foods included, calories, and settings.

Food List and Library:

The food list and library are key functionalities precipitated by the popularity of educational features in user research. It was deemed insufficient to simply list the food as in the "Monday's foods" page instead, greater educational value was provided by searchable, sortable, and filterable list of food items with individual information and breakdowns. This is present in both the "Food List" for a day or diet, and the "Food library", listing all foods the app supports.

Diet Settings:

Diet settings were expanded from the simple cog in response to need for customisability. This included being able to choose a macronutrient split, as is shown to be a consideration among athletes [29], a dietary practice like vegetarianism (a concern of target respondents in questionnaire), a budget (a concern of the interviewee), and a treat allowance (a method of reducing rigidity and addressing eating-disorder concerns).

Health overview per category:

Since respondents were concerned about easy-to-understand information, and the app being too time-consuming, it was important to add overviews. Each health category has its own overview viewable directly from its main page. This overview consolidates each main factor affecting the category and their explanations, providing broad, but easy-to-digest information. The user can apply this info themselves or use the action plan prompt for advice derived from it.

Tutorial Overlay

A tutorial overlay was already considered given older users need more support by Kelly [14], and further concern from the interviewee confirmed this direction, stressing "straightforward instructions" and "not understanding borrowed principles". This tutorial can be accessed through choosing this from the help overlay which also suggests support (e.g. a chatbot), after tapping the help button on the bottom tab of any screen. It guides the user through each element of that screen, explaining the functioning of them. "Next" or "Previous" can be pressed to navigate the elements in order of position on screen. The intention was to make there are no unexplained elements, to ensure ease-of-use for target users.

Recipes

Inclusion of recipes was not initially planned due to technical limitations, but this was reviewed as the project evolved to a UX prototype rather than an app, especially given the focus from respondents around "meals" in user research. Indeed, the interviewee stressed the app should "tell you what to buy based on meals". In the recipes screen, the user can view a list of recipes they have created (or have had shared with them) and interact with these to view ingredients and method. The ingredients are added from the food library, allowing for a breakdown for each recipe based on this, whereas the method is simply a set of text inputs representing steps in the recipe. This also draws from Bomfim's 16th heuristic "Support strategic planning", which suggests a meal plan is a useful food-literacy tool.

3.4.3. UX Development

Following UI adjustments and implementation of functionality, UX was considered more deeply; implementing navigation, prototyping interaction, and other requisite additions for this.

Navigation and overlays

Each screen was considered, and a natural navigation link from an element on another screen was identified, then any additional links that could increase efficiency-of-use were investigated. For example, the "Edit diet" screen should naturally be navigated to using the edit cog on the home page, and a possibility to navigate here from the "Switch diet" screen was added as well.

After this assessment, these navigation paths were developed. Figma's inbuilt "interaction" functionality, specifically a "Tap" interaction triggering navigation, was used to link between the relevant element and screen.

Regarding overlays, elements were assigned a "tap to open overlay" interaction. Furthermore, the overlays themselves were given a "back" button, which closed the overlay, as well as giving the blurred background the same interaction to increase flexibility. Some overlays also were given "switch overlay" interactions such as the dialogue where the help button is tapped to open the "Help" overlay, then the "Tutorial" button is tapped to switch to the tutorial overlay.

Interactivity:

Further use of Figma's interaction prototyping was required to increase the fidelity of the project. For one, any forms, for example Personalisation, should include an ability to interact with buttons and fill in fields. This was done using *components*, not to be confused with the general term as used previously. In Figma, components refer to design elements that can be reused within your project. As well as being reusable, which aided in elements shared between screens like the bottom icons bar, Figma supports "variants". These variants allow for special interactions where a component can change variant depending on an event. In this project, to implement button pressing a "Tap" interaction changed that button (a component) to a "selected" state (variant) indicated through UI via a rainbow stroke and inner shadow.

Another increase in interactivity was allowing horizontal scrolling within a frame. In the Home page, the user can swipe through the days of the week for their diet, viewing a preview in the interactive button for that day. In the Start screen, the user can preview different features before creating an account, as mentioned in the state-of-the-art review. To do this, multiple frames were added to a group with multiple times the width of the prototype. This group was added to the relevant Screen and its variation, independently manipulating its x coordinate. Using Figma's "smart animate" feature, a "drag" interaction was added to an element in this group to allow navigation between these screens, where Figma automatically doesn't drag the matching elements between them like the bottom bar, only non-matching elements like the aforementioned group. This implementation increases pleasantness-of-use, proposed by Buzzi [15] as a UX consideration affecting frequency-of-use, tackling the problem of long-term engagement.

A final example of interactivity improvement was in increasing the responsiveness of the prototype. This was done by implementing 1 example of various features to be previewed. These include, filtering (by alphabet), removing foods from a list, a tutorial for the "custom button" functionality, and adding and sharing responsiveness through a "added successfully" or "shared successfully" overlay. Altogether, these increase the fidelity of the prototype and allow better analysis as the actual prototype can be analysed rather than speculation about how a complete application would look.

Other Additions

Requisite screens like the "Switch diet after deletion" frame:

When implementing interactivity of the diet deletion button, it was realised such a page is necessary, to ensure the user is always following a diet. This improves user experience because they are directed automatically to a solution to this issue, instead of having to find out how to fix it themselves.

The Home Button

The bottom bar had consisted of help, recipes, and settings. However, the need for general "Settings" was not justifiable given all settings are specific to diet or personalisation, and, in many situations, the user would have to click back multiple times to get to the home page. Thus, a home button was added to improve efficiency-of-use.

By combining the initial prototype with these changes, a second prototype was produced, ready for analysis.

3.5.   Analysis

After some deliberation, three methods were chosen to analyse the second prototype. Firstly, a cooperative evaluation, secondly a System-Usability-Scale (SUS) questionnaire [30] , and thirdly a heuristic evaluation.

Once these had been conducted, the following methodology was used to elicit final refinements.

1) For each screen, all changes derived from the analysis were written.
2) The importance of each change as a score out of 5 was then determined either by
    a. Combining an estimation of the interviewee's strength of opinion regarding this change and my own.
    b. Taking a score out of 4 that was given to each screen for each heuristic in the evaluation and subtracting this from 5.
3) The SUS survey results were analysed to glean any usability weaknesses.
4) Each change with a score above 2 was added to a shortlist.
5) Each change in this shortlist was given an "expected time required for implementation" in minutes.
6) Considering the above factors, final refinements were listed out.

3.5.1. Cooperative Evaluation

In a cooperative evaluation, the user is encouraged to see themselves as a collaborator rather than a participant [31]. The user can ask questions of the evaluator and vice-versa, increasing clarification and elucidating problems. They are encouraged to criticise the system. In this evaluation, interviewing the same interviewee as in the user research, a small set of questions were prepared to be repeated for each screen in the prototype. however, the decision was made to cease these quickly, since enough evaluation was being elicited without them and it was interrupting the flow of the dialogue. Listed below are the key criticisms for each screen, their solution, and the score of that solution out of 5, for its importance as a final refinement.

Start Screen:

Criticism	Solution	Score
Wouldn't expect anything to happen when swiping on picture or phone.	Add "swipe" call-to-action.	3
Stock photo of man-eating looks "unhappy" and "in pain".	Replace this.	2

Personalisation:

Criticism	Solution	Score
Doesn't understand what "bio" means and thinks it should be clearer what information goes in box.	Reword to make clearer for target users, consider adding label for suggested info.	2
Not clear whether "activity" refers to current activity or activity user wants to start.	Change to "current activity".	2
Didn't see "help" buttons	Make help buttons bigger or stand out more.	2

Monday's Foods:

Criticism	Solution	Score
Breakdown button is confusing because it looks like the pie chart icon applies to the categories surrounding it e.g. carbs.	Change icon or change categories so pie chart can represent them.	3

Term "Breakdown" not clear.	Replace with "nutritional info".	2

Breakdown:

Criticism	Solution	Score
Thought buttons like "protein" were interactive.	Make them interactive.	4
"Settings" should take you to actual settings page, rather than edit diet.	Label settings cog with "edit diet".	2

Diet Settings:

Criticism	Solution	Score
Doesn't know what "macro split" means.	Could change wording to "% of cals".	3
"Rare ingredients" is confusing.	Rename "hard-to-find in your country".	2

Food List:

Criticism	Solution	Score
Layered effect for multiple of same food looks weird.	Represent this differently e.g. indicate using numbers.	2

My Plan:

Criticism	Solution	Score
Doesn't understand difference between "diet" and "plan".	This will be addressed when tutorial finalised.	1
Older users may be confused which features are mandatory and which are supplementary.	Stress which features are supplementary e.g. in tutorial	2

Recipes:

Criticism	Solution	Score

Didn't understand "super porridge" was a recipe because it didn't have recipe and methods underneath it.	This would be clearer in final application where user creates their own recipes.	1
"+" buttons not clear for adding new recipes. Furthermore, expects "+" means the app has found them a recipe online and it is notifying them.	Label these buttons. Stress creation rather than notification.	3
Should be able to fetch recipes from online.	There would be copyright concerns with this.	1

Switch Diets:

Criticism	Solution	Score
"New diet" not obvious enough label, makes user think new diet is available rather than creatable.	"Create diet" better.	3

Filter by and Sort:

Criticism	Solution	Score
Food library term not clear, since library normally list of items you have curated in similar systems.	Change term	1
Should be able to sort saturated fat from low-to-high.	Implement, but this is pointless because so many foods have 0g.	1

Shopping List

Criticism	Solution	Score
Information is presented in "overwhelming" way, as measures are so precise.	As suggested, change measures to be more representative of real-world e.g. large pot. specific measurements in brackets.	3

3.5.2. System Usability Scale Questionnaire

Once 3 key respondents who were available were identified, they were given a document instructing them to "play around" with the prototype, "trying to interact with everything possible", then fill in a Google form.

The System Usability Scale is ten-item Likert scale which is used to glean usability score and compare with the industry standard. Here, it was also used to analyse below-par areas, by deeming 3/6 as neutral.

All aspects were positively perceived apart from *confidence while using* and *unnecessary complexity* which were neutral. These two elements were noted down and considered when deciding which changes to add to the final refinement plan.

The system usability score was calculated as 74.2. Sauro [32] states this is above the average score for all systems of 68, a hypothetical "B" grade, and suggestive users would be passive, rather than recommending/discouraging the system. Furthermore, this is considered "acceptable", rather than unacceptable [33].

3.5.3. Heuristic Evaluation

The Heuristic Evaluation was performed by going through each screen in the interface and giving it a justified score out of 4 for every element in "Nielsen's 10 Usability Heuristics for User Interface Design" [34]. The scores were devised as: 1 = Poor, 2 = Not adequate, 3 = Not adequate unless due to conflicting Heuristic or other reason, and 4 = adequate.

Below are writings regarding pertinent or prevalent findings for each heuristic:

Visibility of System Status:

This heuristic includes conveying state, and responsive feedback to user actions that change this.

- Throughout the design, system state is typically visible, and feedback responsive. For example, displayed information is instantly updated when edited, such as the calories.
- Deletion of foods from "Food list" is not responsive since it doesn't reflect replacement of the food.
- It is not clear in the "Friends" screen that a friend request has been received.

Match between System and the Real World:

This heuristic includes providing meaning without definition, and use of mental models.

- Many terms throughout not clear without further explanation, like "Breakdown".
- Users' mental model of macro and micronutrients being split in the "Breakdown"; however, sugar is included in the micronutrients, which breaks this.
- The mental model of a "Plan" suggests step-by-step behaviours that can be completed. It should either be implemented as such or redesigned as a different mental model like "Goals" conveying they're more long-term and less sequential.
- "Shopping List" reflects real-world layout of a supermarket.

User Control and Freedom:

Allowing the user to undo-and-redo, cancel, exit etc.

- Consistent presence of "Back" and "Home" buttons in same position easily allows for this.
- No sign-out functionality reduces this.
- Lack of "Undo" prompts throughout, e.g. when editing diet.
- "Go to top" button should be implemented for scrollable screens.

Consistency & Standards:

Includes internal consistency between components of the prototype, and external consistency with other systems and industry standards.

- Lack of internal consistency with "ellipse" components, where majority are interactive, but some just structure information. Should all be interactive in some respect.
- Consideration of a specific set of standards during development could have improved external consistency.
- Internal consistency of scrollable interfaces poor. Some use scrollbars whereas others use ellipses to indicate pagination.
- "+" buttons not always labelled.
- Back button is not consistent with typical position of top-left in similar systems. Though, this was done to consider one-handed usage, as user's thumb can easily reach it.

Error prevention:

Prevent the user from making "slips" (unconscious errors) and "mistakes" (conscious errors) arising from mismatch between perception and reality of how system works)

- Many screens do not have any errors the user can make.
- System should warn user if they are removing or excluding too many foods, it may struggle to replace them and still fulfil requirements.
- "Create account" and "Log in" buttons should be greyed out until user puts in valid details, so they do not try and log in without matching passwords etc.
- Nothing stopping user from manually inputting an unsuitable number for calories.
- User should not be able to interact with the "Save" button on the calorie calculator until they have filled in all requisite details.
- User may make conscious error of thinking they must add all foods for that diet, rather than generation being automated.

Recognition Rather than Recall:

Components should be self-explanatory, and help given should be contextual. Users should not have to remember lots of information.

- Use of labelling throughout means that users do not have to remember symbols for components.
- In "Switch diets", it may be better to label which diet is currently selected to avoid recall necessity.
- User must recall what "+" symbol means currently.
- Contextual help is given for each element, though a tutorial is available.

Flexibility and Efficiency of Use

The system should include shortcuts, personalisation, and customisation.

- Flexibility in that many screens have multiple methods of navigating to them. And actions can be carried out from alternative screens e.g. sharing.
- Customisation and personalisation are implemented throughout. The level of these is chosen by user, which improves flexibility – A user can choose to customise their diet thoroughly or not at all.
- Screens that are accessed from the profile do not have many shortcuts to them.
- User should be able to view list of all available plan items using search button from "My plan" screen, rather than having to navigate into each specific "Action plan" page.
- Searching functionality should be added to Help, so user does not have to repeatedly click "Next" or "Previous". This could be done by tapping on components behind blurred background to bring them into focus.
- "Search" in food library increases efficiency.

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Aesthetic and Minimalist Design:

Self-explanatory; also means that content and features which support primary goals should be prioritised.

- Per user analysis, design is aesthetically pleasing throughout.
- Often, minimalism can only be increased by sacrificing other heuristics or functionality.
- Pages like "Profile" and "Monday's foods" which contain a scrollable bottom tab are weak regarding this.
- Button presses could have animation.
- Calorie calculator has a redundant help button.
- Friends could be represented as list rather than grid.

Help Users Recognise, Diagnose and Recover from Errors

Use traditional error-message visuals, explain in non-technical terms, and provide solutions.

- Create Account and Log In need error messages to let user know this has failed.
- User should be notified if they set calories outside of typical range.
- If the user removes too many foods from a diet, the system cannot replace all of these.
- Notify user if they attempt to "Save" calorie calculation without valid inputs.

Help and Documentation

Searchable, contextual help should be available with steps.

- Presence of help button throughout ensures this is mostly fulfilled.
- The initial page does not have any help, e.g. so target users recognise the preview is not the app itself, and what scenarios "Create Account" should be used vs "Log In".
- Less clear elements should have their own supplementary help button, indicating a non-obvious implementation to users.
- The help system itself does not have info on how to use it.

3.6. Refinements

As part of the iterative development process, the final group of changes considering the following criteria were implemented. The refined prototype is accessible through this footnote[1]

- Score 3/5 or above for importance (see analysis subheading)

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[1] https://figma.fun/iQPN1g

- Under 3 hours' time-to-implement total since development time limited.
- Favouring those which aligned with "feeling confident using the system". "Reducing unnecessary complexity" found too time-consuming.

*Fixing bug where items in "my plan" say "add" rather than remove (**4/5**):*

This was illuminated during the cooperative evaluation, where the user questioned what would happen if they clicked "add" on the items in "my plan". Identified as a mistake, the button was rectified to read "remove" so that adding items is reversible, increasing user control and freedom.

*Implementing error messages which tell user that creating account or logging in has failed, and requisite changes. (**4/5**):*

Prior to this, the "Sign up" and "Log in" buttons could simply be pressed, and interaction with the email and password fields was not implemented. To make this change, the email, password, and repeat password fields were made into components. Then, variants of these were produced where they were filled in. For the "Password" component, a 2nd variant was added representing an incorrect password. Touch interactions were added to these components to change variant, and a *delay* interaction after switching to change local variables "EmailInput", "PasswordCorrect", and "RepeatPasswordCorrect" respectively. The "Log in" button was given a conditional interaction on *tap*, whereas the "sign up" button was given two, one for *touch down* and one for *touch up*. The "Log in" buttons interaction specified that if both PasswordCorrect and EmailInput == true, then the button allowed navigation to the home page. If not, then an "invalid email or password" overlay was displayed. The "Sign up" button's first interaction on *touch down* set a local variable *"FilledInEmail"* to true, else opening the "invalid email" overlay. It's second interaction on *touch up* navigates to the Personalisation page if FilledInEmail, PasswordCorrect and RepeatPasswordCorrect are all true. This means that the user gets a separate error if the email is incorrect, vs if the passwords don't match.

Unlabelled "+" buttons, or those with "New", were changed to "Create X". (3/5)

This combines findings from the heuristic evaluation, where this breached *internal consistency* and *recognition rather than recall*, with the cooperative evaluation where the user thought "New" suggested that it was notifying the user of a new available recipe. As such, it was important both to add labels and rename labels to "create".

Change Recipe list so that ingredients and method accessed by tapping recipe itself rather than specific button. (3/5)

This increased internal consistency, where the specific buttons for items in a list were typically "add" or "remove", and details were viewed by tapping on the item itself. This change meant the button was given a different functionality, decided as "remove", increasing users control and freedom over recipes.

*Add interactive ellipses to the breakdown. **(4/5)***

In the prototype, ellipses which contained calories, fibre etc. were not interactive, limiting internal consistency of ellipses representing buttons. A change was made so these buttons could be tapped to bring up an overlay detailing which foods in that given day contributed most to that nutrient, and general facts about the nutrient.

*Change the start screen's stock photo. **(2/5)***

This was included as courtesy to the interviewee, who strongly held this opinion, since implementation was very quick. The "pained" man was replaced by a more clearly happy man.

4. Results and Evaluation

Throughout the lifecycle of the project, many evaluable results were produced, as listed below:

- Conclusions from background review as research
- Paper prototypes and wireframes
- Initial prototype
- User research as process and results
- 2nd prototype
- Evaluation as process and results
- Final prototype[2]

Since much writing about evaluation by users and myself is included in previous sections, this shorter section will focus on evaluating the process of obtaining these results as well as the results themselves.

4.1. Background Review Evaluation

The results of the background review include the "foundational findings", and the abstraction of "current state of knowledge". The foundational findings aligned well with how the project developed, with much reliance on the lower foundations, but it could be said that this was not considered throughout, and instead simply reflected the project's structure, rather than informing it. The "current state of knowledge" was useful in consolidating knowledge, however, this may not be an accurate picture of the "current state of knowledge", given a lack of studies considered and no focus on recent studies over older ones.

To better utilise the background review, more BCTs from Villinger *et al* [10] and Pimenta [11], could have been implemented. For example, "story" to increase long-term engagement.

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[2] https://figma.fun/iQPN1g

One study in the background review that was not useful was Chau [12] since it was later noticed that the review exclusively considered studies of young adults. This was reflected in user research where older adults did not value social features.

This suggests validity should have been reviewed for all studies sooner to avoid such issues, since this was only noticed following completion of the background review.

4.2. Paper Prototypes and Wireframes Evaluation

One main flaw with the paper prototypes produced was not creating multiple variations. This would have meant it could be assessed which layout and functionalities were immediately engaging, and early user-feedback could have even been elicited using these. Furthermore, use of pencil would have been preferable to pen, to encourage adjusting the paper prototype and improving the design further at this stage.

When creating the wireframes, it would have been useful to consider a set of standards like the android UI design guide. This would have allowed for a more valid prototype and provided a better foundation for further work. Additionally, there was a lack of development from the paper prototype stage. Most development was done when fidelity was increased past wireframing, but it would have been more efficient to do this is a wireframe then improve fidelity subsequently.

4.3. Evaluation of Initial Prototype

Designing the initial prototype was a key process, where the direction for UI of the project overall was illuminated. However, the initial prototype itself is flawed. For one, there was a regression in abandoning the idea of a "Human body" mental model for "My health", being replaced with a more generic UI that is less engaging. Furthermore, there is too much reliance on others work that is not tailored to the project, like generic icons and stock images. Finally, considering UI from other solutions further would have fast-tracked refinement, as the mistakes that were later found may have been avoided, since these would have provided a strong foundation compared to an unstructured design process.

4.4.   Evaluation of User Research

The results of User Research are already evaluated in this paper, so the focus will be on the process.

Overall, the user research was very effective in eliciting adjustments that needed to be made to the initial prototype, however, the methodology was not perfect.

For one, despite Adams [23] stressing the importance of question sequencing, the implementation of this was poor. That is, long questions were frequently found at the end of sections and the form, which encourages the user to rush these as they become impatient throughout. Though, it should be noted that including these early in the form can discourage users from completion. As such, including qualitative, answer-box, questions in the middle of the form and sections would have been best.

A pertinent flaw with this project's methodology is the lack of robust sampling methods for acquiring user research participants. Though a target user was identified, it was difficult to acquire enough participants who aligned with this user to gather valuable data. To alleviate this, further thought could have gone into how to contact older users, for example by taking a random sample of a Facebook group with a high proportion of these users and contacting them. This would still provide younger users too, allowing for comparison.

Considering the interview, the findings from the questionnaire could have better been used to influence its structure. For example, a key finding in the questionnaire is that boosting mood is very popular among older users, but the interviewee was not asked about this.

The use of a Likert scale was inconsistent in the questionnaire. Some questions used numbered scales of 1-7 as is typical when forcing participants to decide in one direction, but others used labelled responses of "not important", "somewhat important" etc. By making this more consistent, results would have been more comparable.

In reflection, it is possible there was a bias in development towards inferences from user research which were easier or quicker to implement. Admittedly, the user research suggested restructuring social and planning features could be the best approach, but easier findings like fleshing out recipes were implemented preferentially.

Finally, the rationale of the project was actually contradicted by the user research. It was not found here that older users lacked nutrition literacy based on self-report scores and assessment from the interview. Instead, it appeared they had higher nutrition literacy than younger participants. That said, this sample was biased towards peers of an educated, professional older respondent.

4.5.   Evaluation of Second Prototype

The second prototype was much improved upon the first but did not incorporate all knowledge gathered hitherto.

For one, social features could have been disregarded entirely, considering the validity of one background review source supporting them, and their unpopularity in research.

Limitations in Figma proficiency impacted the quality of the prototype and the efficiency of its development. For example, the use of components could have been more prevalent throughout, and some had flawed implementation that was considered irremediable at the time, such as allowing for selection of more than one age range.

The UX and UI designs of the prototype did utilise background reviews and user research, but they did not have a solid methodology besides this. There was no use of accepted standards or guidelines like Nielsen's heuristics [34] during development, and little consideration of technical HCI design concepts like *dialog initiative* or *task conformance.* Instead, the design was mostly intuitive and reliant upon user feedback and a small selection of literature.

4.6.   Evaluation of Analysis

During the analysis, the most prominent problem was the lack of respondents. This was an issue because it meant there was only one individual willing to perform a cooperative evaluation, and the heuristic evaluation had to be self-administered.

Additionally, the user in the cooperative evaluation was the same as the interview. This is quite flawed since there is a lack of breadth of viewpoints in these conversational methods.

Though, on reflection, self-administering the heuristic evaluation seemed to be rather effective, since simply a set of objective guidelines for usability were used. Still, potential for bias is not eliminated due to this.

Furthermore, the system-usability-scale form was underutilised. Besides providing an overall assessment that the project had good usability, the weak areas identified of "Reducing Unnecessary Complexity" and "Feeling Confident Using the System" were not regarded enough when considering the final refinements. Although, it was identified that improvements linked to "Reducing Unnecessary Complexity" would be very time-consuming to implement, which was one reason for this.

Crucially, some flaws were missed in the analysis that were later identified when carrying out the refinements:

Sharing does not include groups:

In some screens there are "Share" buttons which are intended to allow the user to share with friends and groups. However, these simply trigger an overlay where the user can share via text or with friends, not groups. This was not identified in analysis, perhaps as respondents do not value this feature.

"Add to Plan"

Given that items are already in a plan, "Add to plan" may be a confusing term, which should be replace with "Add to my plan" to indicate that the item is being procured for a personalisation functionality.

% in breakdown

For micronutrients, the % indicated under the weight of that nutrient is not specified to be referring to Recommended daily Allowance/Intake. This could lead users to think that is the percentage of that food which is that nutrient, leading to misinformation, which is an ethical concern.

Finally, not all points from the analysis were able to be implemented for reasons such as time constraints. These are addressed under the "What Remains to be Done" subheading.

4.7.   Evaluation of Final Prototype

4.7.1. Aims and Objectives

The most notable evaluation of the final prototype regarding aims and objectives would be its development from a proposed application to a UX prototype. This was due to various factors, for example maintaining a HCI focus, being able to implement greater UX detail by focussing on this, and time-constraints. This is no doubt a failing towards the aim, but it means when considering the following aims and objectives, they will be assessed insofar as they are relevant to a UX prototype, not an application.

Aims:

The aim in this project was to "produce a mobile application that can generate a diet from scratch, fulfilling all nutrients, and consider factors like dietary needs." The prototype indeed can do this from a UX perspective, meeting this aim.

Objectives:

Diet Planner functionality, Educational functionality, Weight Loss functionality, and Usability for Older Adults were all implemented sufficiently. The following details fulfilment of the other objectives:

Use of CoFID Database:

Although the CoFID database was used to advise nutritional information provided in the prototype, there was no such function which utilised this database to procure foods that were above average in certain nutrients, given the limitations of a UX prototype.

Use of Agile, Participatory Design:

Agile design was used, but not collaboration with users was not enough to be called "participatory design". To note, an iterative design cycle was used throughout.

Overall, 4/6 objectives were met sufficiently, and 2 met partially; an acceptable solution.

4.7.2. Requirements

Of the functional requirements elicited following user research, only 3 of these were not wholly met.

The Application should require Minimal time and Effort.

This is not necessarily fulfilled because users may not understand that some features, like planning, or recipes, are supplementary rather than mandatory for the functioning of the app. If so, then more time and effort than is necessary will be invested in using these.

Increase Long-Term Engagement.

Although measures like maintaining novelty through breadth of educational info, and use of *social support* are implemented, it cannot be said that long-term engagement is certainly superior to other mobile nutrition interventions.

Implement "Goals and Planning"

Although *goals and planning* are certainly implemented to a degree through the inclusion of the "My Plan" functionality, it should be addressed that the suggestion of *goals and planning* as an effective BCT may be limited to completable goals, rather than a long-term structure.

All non-functional requirements were met.

5. Conclusions

5.1. What has Been Learnt during the Project?

During this project, an incidental investigation was conducted in the form of a background review, user research, and analysis of a prototype. This both improved my personal knowledge and revealed some of its own findings. Both are detailed below.

5.1.1. Personal Learning

During researching and writing for the introduction, I learnt and used the following key points:

- Dietary risk factors are the second leading cause of mortality [1].
    - This justified this as a valuable research area.
- Health literacy is lacking among older adults [4].
    - This helped identify a target user.

The background review illuminated the following key points to be used:

- Mobile interventions are effective in changing nutrition behaviours [10].
    - This justified the approach to the problem.
- Older adults need more support in applications [14].
    - Informed how to consider the target user in development.
- Those with poor diets prefer drawn foods to photographs in visual communications [16].
    - Icons were thus used as well as text.
- Current systems have poor UI.
    - This elucidated need for deep UI consideration.
- Users have a strong positive perception of personalisation and customisation in similar systems.
    - These features should be included.

5.1.2. This Paper's Findings

Findings from User Research:

- In nutrition apps, educational features are considered much more important/valuable than social features.
    - This is despite social features being much more common in current solutions.
- In these apps, ease-of-use is valued over customisability.
- A primary concern for users regarding nutrition planners is aggravation of eating disorders.
- Older users prioritise boosting mood and dietary choices (like vegetarianism) more than the rest of the population when it comes to nutrition. There is an insignificant difference in consideration of living longer. Further research would be required to explain this.
- Older users perceive social features even more negatively.
- Older users are not concerned with weight loss. Despite this, many older adults are obese, which suggests a lack of desire to change eating habits.
- All older users preferred easy-to-understand information over detailed information, despite educated respondent population.

Findings from the interview cannot be extrapolated to be general findings due to lack of interviewees, but some which are deemed as aligning with general feedback from older users are outlined below:

- Older users would rather use apps that are tailored to their demographic.
- Apps should take up little time and effort.
- Accessibility for visually impaired users is important.

Findings from analysis:

- Older users struggle to comprehend which features are mandatory vs which are supplementary. Reducing complexity key.
- Precise measures may be overwhelming compared to general measures.
- Tutorials proposed as likely popular, despite HCI focus on contextual help.

- Design motifs should be implemented consistently to avoid confusion.
- Help buttons need to be clearly visible.

5.2.   What Could Have Been Done Better or Differently?

This is largely addressed under the evaluation heading. Most pertinently, larger-scale user research would have allowed for more findings, and more reliable findings, resulting in a better final prototype.

5.3.   What Remains to be Done?

The most apposite remaining work to be done would be implementing any refinements from the analysis which were not implemented under "refinements". Some of these are detailed below:

Error Prevention for manual input of calories:

Manual input of calories should be restricted to a range of numbers, to avoid invalid input, and address ethical concerns where a user may use the app to facilitate eating disorder behaviour.

Add Indicators of Default Diet Settings Outside of Settings Screen:

This would prevent users from assuming which settings are default without checking, and creating diets that do not match their expectation of how the system will function.

System Should Recognise Foods Added and Removed and Respond to This:

As well as simply adding and deleting new foods, the system would, in a final application, have to adjust the diet to accommodate for these changes. Any resulting changes from food addition or removal should be made clear to the user, so they can see how the system has changed and be presented with option to "undo" or choose a different accommodation for their change.

Change "My Plan" Implementation:

My Plan would perhaps provide better long-term engagement if it was implemented as list of goals that were completable, rather than general guides. Tracking could also be factored into this. For example, a daily streak of eating less salt, that is completed once done for a year, for example.

Adjust Help Overlay:

To improve the UX of the help overlay, it could be revised so the user can click on any blurred element to bring it into focus and bring up the help for that element. This would be an intuitive interaction mode for older users.

As well as these further refinements, more iterations of the software development lifecycle could be performed to perfect the prototype. This could be done until the number of criticisms vs praise was below a certain threshold, to indicate sufficient usability.

As an aspirational change, gamification could be implemented. This would certainly aid in long-term engagement due to the habit-forming effects of gaming. One way of implementing this would be for educational features, since many people do not enjoy learning without play. For example, there could be a quiz feature using personas, in which a persona is struggling with an aspect of their health, and the user recommends them foods or nutrients to deal with this.

Finally, a concrete plan going forward would be to implement all the above changes into a new UX prototype, perform several iterative design cycles on this, then use ReactNative to develop this into a functional mobile application.

5.4. *PlanMyPlate*

To conclude, the final prototype of "PlanMyPlate", an educational nutrition planner targeting adults with low nutrition literacy, despite evolving from an application to a UX prototype, met: Its overall aim, four out of 6 objectives wholly, all but three of its functional requirements, and all non-functional requirements. Furthermore, the requisite research for this project revealed many findings that could be influential to other works, and there is a clear plan going forward to finalise it for deployment as a nutrition intervention, if so desired.

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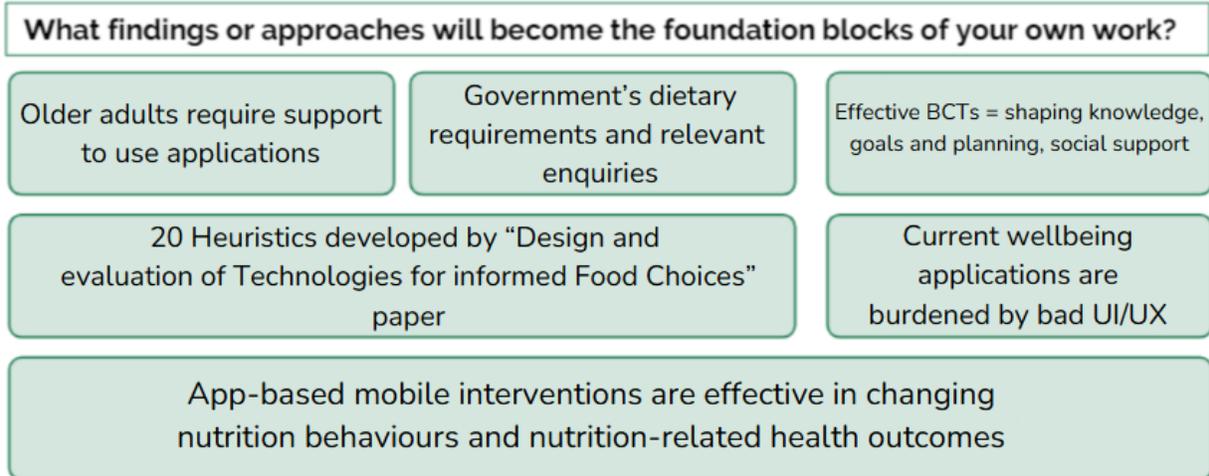
Appendices

Appendix A

Ethics Checklist

My project:
1. Will *not* involve working with **animals** or users/staff/premises of the **NHS**
2. Will be carried out **within the UK or European Economic Area**
3. Will *not* have any impact on the **environment**
4. Will *not* work with populations who do *not* have **capacity to consent**
5. Will *not* involve work with **human tissues**
6. Will *not* involve work with **vulnerable groups** (Children/Learning disabled/Mental health issues, etc.).
7. Will *not* involve any *potentially* **sensitive topics** (Examples include but are not exclusive to body image; relationships; protected characteristics; sexual behaviours; substance use; political views; distressing images, etc.)
8. Will *not* involve the collection of any identifiable personal data

Appendix B

Foundational vs Supplementary findings

> **What findings or approaches will become the foundation blocks of your own work?**

Older adults require support to use applications	Government's dietary requirements and relevant enquiries	Effective BCTs = shaping knowledge, goals and planning, social support

20 Heuristics developed by "Design and evaluation of Technologies for informed Food Choices" paper	Current wellbeing applications are burdened by bad UI/UX

App-based mobile interventions are effective in changing nutrition behaviours and nutrition-related health outcomes

Appendix C

<u>Consent form</u>

Please sign below if you consent to being interviewed as part of user research for a nutrition planner application prototype, for the BSc Computer Science Dissertation of Jacob Peel titled "An Educational Nutrition Planner Targeting Adults with Low Nutrition Literacy". This will consist of relevant questions on nutrition and applications, and should take just over an hour.

S Gates

Date

27/04/2024

Please sign below if you consent to the transcript of this interview being analysed for research. The recording itself will be deleted once the transcript has been analysed. All identifiable info will be anonymized.
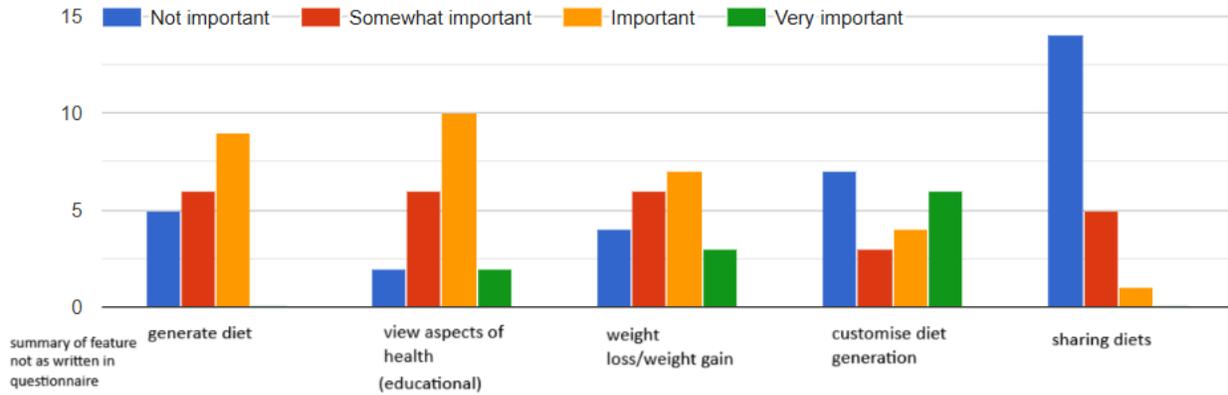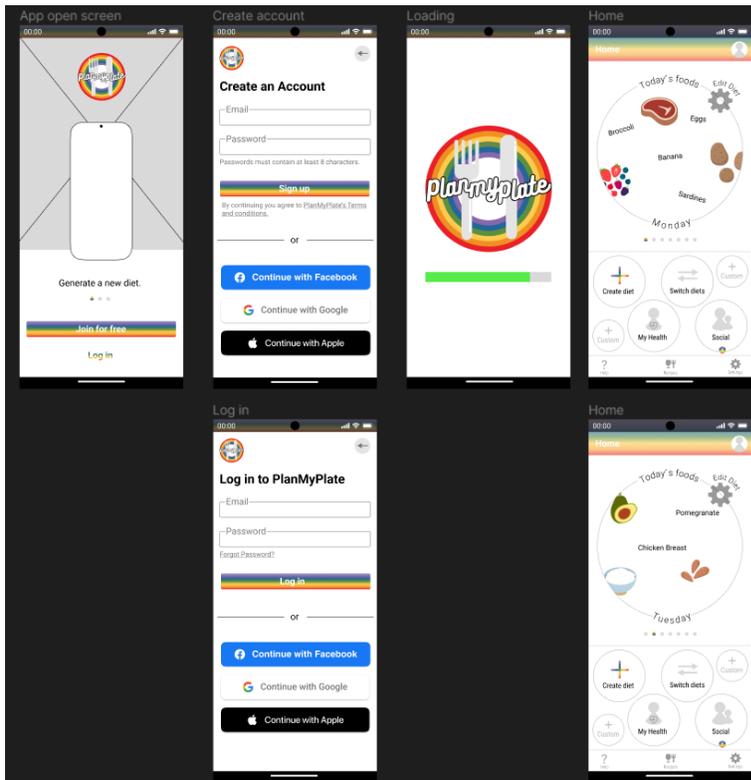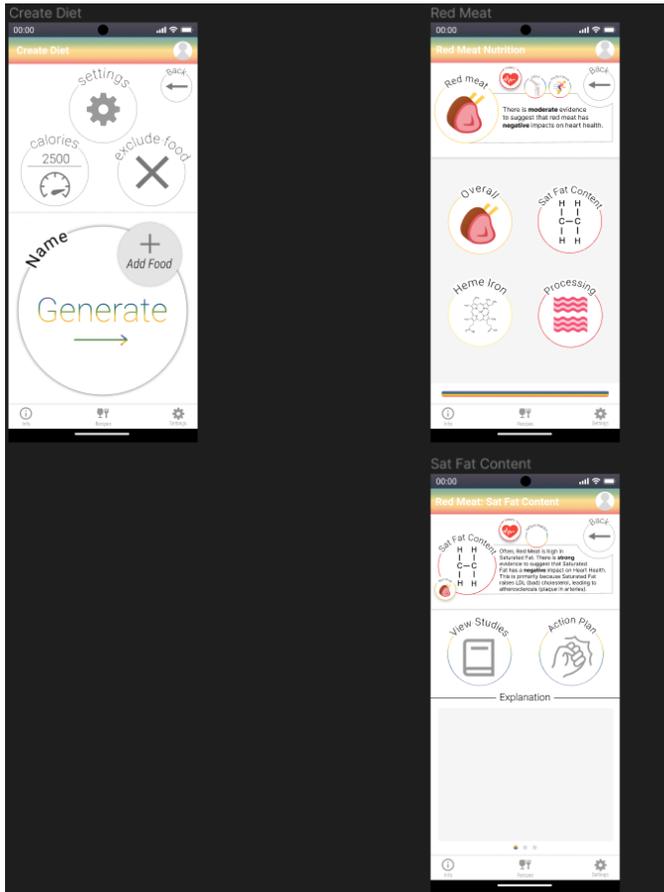
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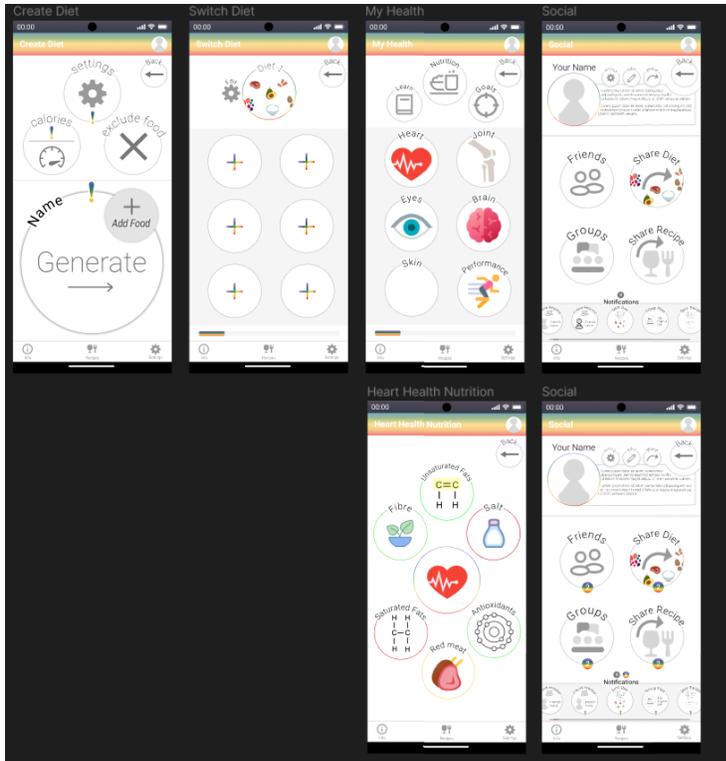27/04/2024

Appendix D

How important are the following features for you personally?   Copy

Appendix E

The UI design prior to conducting the interview:

Appendix F

Table reflecting questionnaire data.

Question	Hypothesis	Finding	Insight	Application
Age Range for questionnaire	High number of younger respondents due to dissemination method	As hypothesis, only 5 (25%) of respondents age 40+	Data may be less relevant to target user	Consider data from 5 key users identified more in development decisions
Most important aspects of nutrition (checkbox)	Respondents will be concerned with *living longer*, and *boosting mood*	Significantly largest proportion concerned with *food tasting good* (80% of participants), only 25% concerned with living longer. Boosting mood among most popular but only 45%. Also 45% think fat loss important for them.	Nearly all users think food tasting good is among most important concerns, and few living longer, which could be due to youth of participant population. 45% concern with fat loss higher than 28% overweight in age group 16-24 nationwide, which may suggest unrealistic body image in this group.	Though this data should be considered with the knowledge that the population is more youthful than target users, it should be considered that, even among key respondents, food tasting good was widely considered important, and so "recipes" may be a key feature rather than just suggesting foods. Concerns of unrealistic body image should be addressed by notifying users that fat loss is not recommended if they are already a healthy BMI.
Most important aspects of nutrition ranked	As above	*Food tasting good* is typically most important concern for those who picked it. *Convenience* and *Boosting Mood* are typically ranked as less important for those who picked them than other factors	Reinforces that *food tasting good* very important. Lack of import given to *boosting mood* may reflect users' moods already being sufficient (perhaps more common in participant population) or that they doubt	As above. And make sure to include detailed information and studies on how food can boost mood within educational aspects of application.

			food's ability to boost mood.	
Importance of educational features and social features for you personally? (2 Likert scales)	Social features will be more important than educational features. Social features considered above average importance whereas educational features considered below.	Social features average response = 2.25/6. Educational features average response = 3.25.\n\nEducational features considered much more important, contrary to hypothesis.	This shows that social features are of below-par importance, whereas educational features are of above-par importance. This is surprising and may indicate that current solutions are failing in this area, since many implement social features, but few implement educational features.	If lack of resources means that a choice must be made between social and educational features, educational features should be prioritised e.g. inclusion and depth of implementation.
Importance of 5 key features (Appendix D)	Thought sharing would be popular feature, and generation of diet would be considered "very important" by many	Generating diet, viewing aspects of health, weight loss/gain all mostly considered "important". Customisation and sharing mostly considered "not important""	Once again shows that social features (sharing) not considered important, and customisation less important than expected.	Social features do not need to be front-and-centre in design, and customisation should be optional.
Customisability vs ease-of-use and notifications vs none And Nutrition info detailed vs easy to understand. (multiple choice)	Customisability will be equally preferred as ease-of-use, notifications desired, easy-to-understand info preferred	Customisability preferred only by 20% of participants. Notifications 55%, easy-to-understand 25%. 1 participant specified easy-to-understand, but with a click option to get more detail.	Customisability is clearly less valued than ease-of-use. Notifications are less popular than expected. Easy-to-understand info preferred as expected	Make sure application design prioritises ease-of use e.g. labelling. Notifications should be used sparingly. Info should be easy to understand, draw from 20 heuristics study.
Likes/dislikes of health/wellbeing apps (qualitative, thematic analysis)	As in background review, participants will appreciate customisability and timesaving; dislike confusing UI	Only repeated opinion = like of tracking. Others note unclear breakdowns, giving tutorials	Lack of consensus and little continuity with background review. But some points mentioned	Include some form of tracking, and make sure educational features are detailed and considered.

			useful for example unclear breakdowns and enjoying tutorials can be summed up as educational features needing to be well-developed, and tracking is enjoyed.	
How would you envision perfect nutrition app? (qualitative, thematic analysis)	Users would like integration with exercise and automation which saves them time.	Two most common themes are that the app should not be overbearing and should be responsive to customisation.	Users stating that a perfect app should be responsive to customisation but not mentioning this for likes in the question above suggests that current solutions are failing to provide this. The app not being overbearing can be interpreted in many ways, 1 quote for this was "educate rather than dictate".	Make sure to include customisation despite above evidence against, and educational features should be suggestive rather than claiming there is one concrete diet to follow for example.
Challenges with using nutrition app	Effort and time-consuming to track foods. Become too concerned with what one is eating.	As in hypothesis, time and effort are constant themes. As well as forgetting to use the app.	Users don't like spending time and effort, perhaps this is a common response because many users have apps in mind that require lots of tracking like MyFitnessPal. Forgetting to use the app more of a concern with tracking-based apps also.	These concerns can be alleviated by not including mandatory tracking. Furthermore, reminding users to use app can be done through notifications.
Concerns about concept of nutrition app	Eating disorders may be exacerbated	Like in hypothesis, participants were concerned about	This is a concern which may be prevalent among respondent population since	Make sure to implement feature like "treat allowance" to avoid too much

		unhealthy eating habits.	young people have higher rates of eating disorders and mental health is considered more important.	regimentation. Furthermore, notify user if manual calories particularly low.

Appendix G

Table reflecting comparisons between target respondents and others in questionnaire.

Question	Hypothesis	Finding	Insight	Consequence
Important aspects of nutrition	Key respondents will care more about living longer than rest	4/5 key respondents (80%) listed dietary choices and boosting mood as important to them vs only 20% (3/15) for rest of respondents. 2/5 key respondents put living longer vs 3/15 for rest.	Key respondents significantly consider dietary choices (e.g. vegetarianism) and boosting mood important more often than rest of population. Further research would be required to assess why this is. Surprisingly, there is not a very significant difference in consideration of living longer. Perhaps this explains why dietary factors in fatal disease among older adults are so common, if they do not consider diet in this regard.	Make sure to include dietary choices in customisability and put mood front-and-centre in the education screen.
Use of applications	Target respondents will have used apps less, and prefer mobile apps in line with study	60% of target respondents have never used wellbeing app. 100% of them prefer mobile apps	Because many target respondents have never used wellbeing apps, cannot rely on their familiarity	Include guidance throughout app to make sure it is usable for older users. Of course, mobile application

		where some of the other respondents preferred web apps.	with UX or functions. Older users certainly prefer mobile apps.	remains the obvious choice.
Importance of social and educational features	Social features will be less popular among target respondents, whereas educational features will be more popular or the same.	If scoring response where not important = 1, somewhat important = 2, important = 3 and very important = 4; then target respondents have average response to social features of 1.4/4, whereas rest of respondents is 2.53/4. In the same methodology, target respondents perceive educational features with average 3.25/4, with rest of population being 2.8.	So, older users consider social features much less important, and consider educational features slightly more important than the rest of respondents. Overall, they do not consider social features important, but certainly consider educational features important.	As other evidence suggests, educational features should certainly be prioritised in development.
Weight Loss/Gain Functionality	Target respondents will be less concerned about losing weight	Using above methodology, the average score for target respondents on this matter was 1.8, vs 2.7 for the rest of the population.	As in hypothesis, older users are much less concerned about weight loss.	This should be considered; however, it should be noted that the respondents' opinion on the importance of weight loss does not necessarily reflect the importance of weight loss for their health. And the application should be suitable for other demographics who strongly favour this functionality.

Easy to understand vs detail	Target respondents will prefer more detail because they are used to more detailed formats like books and newspapers rather than social media formats that are more condensed.	All older users preferred the app to be easy to understand, compared with 10/15 in the rest of the population.	This contradicts the hypothesis. Perhaps, this can be explained by older users having had experiences where they've struggled to understand the presentation of info within applications, due to lack of experience in these systems rather than the info itself.	Make sure information is presented in a way that's easy to understand, using colours, icons and bullet pointed explanation rather than paragraphs.

Appendix H

Table for information from interview.

Question or subject	Response Summary	Insight	Application
Dietary choices that make people live longer?	Balanced diet throughout life Fruit, veg, fish. Mediterranean diet	This is a good understanding of dietary choices which encourage living longer, and aligns well with research like "Eatwell guide" and [3]	This user represents an older user with good health-literacy, so findings may not be able to be extrapolated to target users.
Factors that affect your control over dietary choices?	Limited selection at local supermarket	Users of the application may struggle to find certain foods that are suggested.	Make sure that there is a toggle for "difficult-to-find" foods to avoid this issue.
How much do you consider health impacts of foods you choose?	Most of basket should be healthy but necessary to have some treats.	Necessity of treats reinforces idea of diet not being too rigid.	Implement "treat allowance" as mentioned in above table.
Reason you don't use wellbeing apps?	App not tailored to their demographic, would consider one that gave specific advice for menopausal women.	Confirms idea that current solutions are not suitable for target older users.	Continue to direct app towards older users to precipitate engagement, including specific dietary information to benefit older user's most common issues.
Thoughts on Fitbit app (which they used to use)	Interesting at first but lost novelty.	Aligns with literature that long-term	Ensure novelty is maintained by

	Disliked choosing foods from list rather than being able to search.	engagement for such applications poor.	incorporating lots of depth into educational features. Search functionality needed for food lists.
How would you envision perfect diet planning app?	General nutrition info but can go more in depth with further action. Easy when you're busy. Customisable to age and lifestyle. Weight loss targets. Considers food preferences. Different requirements for athletes to sedentary.	This aligns strongly with the previous analysis of the questionnaire. That is, the interviewee agrees with sentiments like easy-to-understand information, lack of time-consumption, customisability, and weight loss as important. Different requirements for athletes, besides TDEE, is a novel idea.	Continue with plan of implementing general info components that can be tapped to view more detail. Make sure time consumption not necessary e.g. customisability not mandatory. However, do include customisability, particularly personalisation to age and lifestyle. Weight loss functionality essential. Can implement personalisation where user specifies their athletic background and different foods will be recommended e.g. for long-distance runner vs weightlifter.
Value of social/educational features?	Social features = no value. "Preferred by younger crowd". Educational features quite important. Value for everyone. Downloading app signifies interest in nutrition. Educational features should be tailored to personalisation.	Social features continually found to be less important than expected. Downloading app signifying interest in nutrition may contradict aim of solution since it targets low nutrition-literacy users. Personalisation of educational features useful concept.	Educational features > Social features. Ensure app appeals to use without interest in nutrition through aesthetic choices and presentation. Can easily personalise educational features simply by making certain information easier to find based

	e.g. menopausal women should receive advice tailored to this.		on user info inputted e.g. menopausal diet easier to find for women above certain age.
Scenario = creating diet plan to refer to when shopping (asked about themselves, and John who is 70, overweight, and never used mobile phone)	Provide ideas of meals Set budget. Feed multiple people. John – Big font, simple to use	The incorporation of recipes into the shopping list could be novel. Feeding multiple people difficult to achieve in this system.	Each recipe could have its own shopping list that can be added on to the weekly shopping. Feeding multiple people could be achieved through family accounts with multiple users. Font size could increase with interaction, or in settings.
Scenario = educating oneself about nutrition	Benefits of different food groups Info about different vitamins No expectation to learn daily. John – foods to avoid section for weight loss. Don't make app look like similar apps and assume knowledge of how-to-use. Straightforward instructions	Expectation to learn daily could be derived from applications that incorporate "streaks" of learning like Duolingo [35] App looking like similar systems not an issue in and of itself, just without guidance.	Don't incorporate "streaks" functionality. Components that are typically recognised by application users should be labelled in most cases.
Scenario = User wants to share diet plans with close friend or relative.	Share through other apps like WhatsApp. John – Be able to share with family to showcase weight loss.	Social sharing functionality important as many would want to share with those who don't have accounts. Tracking features would be required to share weight loss.	Social sharing functionality should be implemented, with an option to "share as text" if messaging application not supported. Despite this insight, inclusion of tracking features weighted against by other evidence so requires consideration.