Designing and Developing a Web Application of Food Products Focusing on Plant-based Diets for Better Health

Way Kiat Bong, Abubakar Yousaf, Yuan Jing Li, and Weiqin Chen

Oslo Metropolitan University (OsloMet)
P.O.Box 4, St. Olavs plass, 0130 Oslo, Norway
{wayki, s339945, s343868, weiche}@oslomet.no

Abstract. Plant-based food products are getting more popular in the market as they are claimed to be healthier and more sustainable to the environment. However, there is a lack of platform where consumers can easily obtain nutritional information of these on-the-shelf plant-based food products. Therefore, our study aimed to design a web application where the consumers could easily access this information. To design and develop the web application, user-centered design (UCD) approach was adopted to involve health and nutrition researchers, and consumers. After three iterations of design, development, and usability evaluations of UCD process, four focus group interviews focusing more on summative data were conducted using the final version of the prototype. The findings indicate that the web application was easy to learn and use but its design could be less attractive to some users. Involvement of health and nutrition researchers throughout the UCD process ensured that the web application was perceived credible and trustworthy. Started as a research-oriented study, the web application was originally developed for the health and nutrition researchers. By extending its use to consumers, the study contributes to more understanding in involving researchers and consumers throughout a UCD process and providing considerations in designing health-related digital tools.

Keywords. User-centered design, Usability, Health, Plant-based diets

1 Introduction

Diet plays an essential role in shaping our health and well-being. Plant-based diets have been getting extensively popular among consumers. They are one of the fastest growing dietary trends globally and especially in European countries [1, 2]. By consuming plant-based diets, the consumers can make a positive impact to their own health. Plant-based food can contribute in reducing the risks of developing numerous chronic diseases, such as obesity, cancer, heart disease and so forth [3]. In addition, they are considered more effective in the treatment of fatal diseases such as chronic kidney disease [4] and hypertension [5]. They are also perceived as sustainable food that contributes to better environmental well-being [2, 3]. All these benefits are aligned with United Nation's

sustainable development goals such as good health and well-being (goal 3), responsible consumption and production (goal 12) and climate action (goal 13).

The review from Fehér, Gazdecki [3] identified several shortcomings in practicing plant-based diets; challenges in obtaining information about the diet was one of them. For the past 20 years, consumers found it challenging to prepare plant-based food, as there were little relevant and available information concerning what dishes were worth preparing, how to prepare them, and which ingredients could replace meat [6-8]. As plant-based diets are getting more popular, this information is getting more widespread. However, such information is yet to be extended further to market-available plant-based food products, i.e., all type of processed food products which are not raw ingredients.

Using information and communication technologies (ICT) as a platform for information sharing can reach more users in an accessible way. Many ICT tools in the form of websites and applications have been developed to promote healthier diets. Useful information and guidance are provided to the users with the aim to make wiser choice for their diets. Some of these ICT tools focused on on-the-shelf food products [9-12], and the results were promising. However, there is a lack of focus on plant-based diets among these tools. ICT tools for plant-based diets, as the other way around has paid less attention to on-the-shelf food products [8, 13]. The above-mentioned apps were either only used at national level or in countries speaking the same language. In Norway, there is no such ICT tool yet. Localization is important as the contents displaying nutritional information across food products of different brands and manufacturers, while categorizing food products based on plant-based and non-plant-based have to appear credible to the users. In this paper, food products refer to both plant-based and non-plant-based meat products and dairy products.

Besides that, too little attention has been paid in involving both researchers in health and nutrition, and consumers in the process of developing food product-related ICT tools. As experts, researchers could contribute to assisting consumers in getting the most important and relevant nutritional information of food products. Consumers as end users, have to be able to understand the information to be benefited. Thus, in this study we intended to involve both groups in designing a web application where the users could easily assess and understand information about food products sold in the market, concerning the amount of nutrients and type of food. The food products displayed in the web application were aimed to be categorized based on plant-based and non-plant-based to promote plant-based diets. Usability of this web application was crucial in ensuring the consumers find it easy to learn and use.

This study is part of a bigger project about health effects and consumer perceptions of meat substitutes. The study started with the idea from the health and nutrition researchers wanting to use the web application for their research work. At the same time, they also wished to extend the use of web application to the consumers. This was the reason why the study started with the design of a web application and not a mobile app. By the time of writing this paper, we were designing and developing a mobile app version of the web application, with the aim to offer another platform for the consumers. Through the web application, we hoped the consumers could make better choices when choosing market available food products, increase their awareness about the benefits of

consuming plant-based food products (after comparing the nutrients in both plant-based and non-plant-based food products), and thus improve their diets and health.

2 Related Research

Most of the existing plant-based diet-related ICT tools in the market are either only focusing on ingredients or dishes. In a content analysis study assessing free and popular plant-based mobile health apps for Canadians, 16 apps that were included by Lee, Ahmed [14] comprised of five main types. They were recipe manager and meal planners (ten apps), food scanners (two apps), vegan community builders (two apps), restaurant identifier and sustainability-focused (one app each). None of them focused on on-the-shelf food products. In addition, Lee, Ahmed [14] pinpointed the low support of knowledge acquisition in these apps. Support of knowledge acquisition, which comes in the form of education is as one of the primary factors included in an evaluation instrument assessing quality of nutrition apps [15]. This education has to be reliable so that the users can gain correct nutrition knowledge and practice genuine health diets. Comparing other sources like crowdsourcing of food composition database and commercialized entities, academic apps are more reliable and therefore more often being used in nutritional and clinical studies [16]. Hence, to increase the credibility of diet-related ICT tools used among consumers, there is a need to include trustworthy sources, i.e., researchers.

In Thailand, Tangsripairoj, Wongkham [9] developed a mobile application named "WhatTheHealth" that aimed to guide consumers in purchasing healthier packaged food. It had functionalities such as user profile, logging food consumption, comparing between two food products, etc. These functionalities could assist consumers practicing a healthier diet to help preventing and controlling non-communicable diseases, i.e., chronic diseases that are not passed from individual to individual and mostly caused by individual lifestyles and behaviors such as diets. A French mobile app named Yuka [10], and Australian mobile app named FoodSwitch [12] offered similar functionalities. After scanning a food product's barcode, users could obtain its detailed information. This could assist them in choosing products that were healthier for their health. Foodle also offered the consumers guidance to buy healthier food [11]. The application first collected the users' grocery receipt data, and then proposed them what to buy based on the nutritional goal and historic nutrition data linked to their receipt database.

In Norway, despite being able to easily buy market-available food products on the shelves in supermarkets and shops, there is a lack of platform that can provide consumers an overview about the nutrients contained in these food products. Apps such as Yuka [10] and FoodSwitch [17] were mostly only being used in French-speaking countries, and English-speaking countries respectively. When FoodSwitch was extended to China and India, issues concerning differences in nutrition labelling occurred [17].

3 Methodology

In this study, we first adopted a UCD approach involving two user groups, i.e., researchers of health and nutrition, and consumers who were target users of the web application to design and develop the web application. Using the final version of prototype resulted from the UCD process, we then conducted four focus group interviews for a more summative evaluation.

3.1 User-centered design (UCD)

The two user groups we involved were very different. Studies have shown that UCD could result in producing an end product that fulfilled different needs among diverse end users [18, 19]. By adopting UCD approach, we aimed to develop the web application based on user requirements and feedback from these two user groups. Throughout the UCD process, we had a total of three iterations of design, development, and usability evaluation. At this stage, the evaluation aimed to provide formative data so that the improvements to the design could be gathered for next iteration [20].

Due to the restrictions under the COVID-19 pandemic, we conducted all usability evaluations remotely; Some were synchronous, and some were asynchronous. All participants of usability evaluation were asked to perform a series of testing tasks. The tasks were navigating to the home page, using the search function to find a food product under a particular product category (e.g., meat burgers, plant-based sausages, plant-based cheese, etc.), searching a food product under a particular product category with filters of nutrients (e.g., meatballs with less than 1000 kilojoules (kJ) of energy, plant-based nuggets with less than 15 grams (g) of fat, etc.) and sorting the search results.

For synchronous evaluations, we conducted them through digital video conferencing platforms such as Zoom, Teams and Google Meet. We observed how the participants performed the tasks, asked their opinions regarding the prototype they were using, and clarified with them when we had follow-up questions based on the observation. Asynchronous participants were required to write down their notes and comments in an excel file that was provided to them together with the testing tasks. After performing the evaluation by themselves, they sent back the filled-up excel file to us. We clarified with them when the answers appeared unclear to us. Both user groups, i.e., researchers and consumers have never met during the evaluations so that we were able to compare their feedback.

3.2 Focus group interview

After three iterations of design, development, and usability evaluation, we conducted a series of focus group interviews to perform final evaluation with consumers of diverse background. The focus group interviews were conducted either as local evaluations, i.e., the participant and the evaluator are at the same location, or as remote evaluations. Same as usability evaluations in the UCD process, the participants were given the same series of testing task to perform using the web application (the final version of prototype) and being observed how they performed the tasks. Some were requested to use a

laptop, while others were assigned to use a tablet to perform the evaluation. In addition to observation, the participants were also asked to discuss about the design of the web application when performing the testing tasks. Other questions concerning the potential of the web application were probed. For instance, “Overall, what do you think of the web application?”, “Any other functionalities you would like to add?”, “Any functionality shall be removed”, and “Who do you think will use, or benefit from this web application?”. As this evaluation was more summative than formative [21], we asked the participants to provide their System Usability Scale (SUS) scores [22] after using the web application.

3.3 Recruitment and participants

We recruited the participants using convenience sampling [23], i.e., they were recruited as they were easily accessible. Two researchers in health and nutrition who were part of the bigger project of health effects and consumer perceptions of meat substitutes, participated in the usability evaluations throughout all iterations of UCD process in this study. 17 participants presenting the user group of consumers participated only once, either in usability evaluation during UCD process or in focus group interview. We took into the consideration of having diversified participants based on their demographic background, such as age, ICT skills, education, and diet. All participants in this study, from UCD usability evaluation to focus group interview were first briefed about the study. They were then presented with the consent form, and their consent together with some demographic information were provided prior to participating in the study.

When asking about demographic information, in addition to age, gender, education and so forth, we asked the participants to rate themselves their ICT skills (on a scale from 1 to 10; 1 is very bad and 10 is very good) and their concern and/or interest regarding nutritional information (on a scale from 1 to 10; 1 is not concerned at all and 10 is very concerned). The demographic information of all participants, and their participation are summarized in Table 1, except for the researchers in health and nutrition. Their demographic backgrounds were considered less relevant in influencing the design of the prototype, as they were the ones providing contents of the web application.

Table 1. Summary of all participants' demographic information and participation.

	Gender	Age	Occupation	Highest education	ICT skills	Diet	Concern (nutrition)	Participation
R1	-							All UCD iteration
R2	-							
C1	M	33	PhD candidate	Master	8	Vegan	8	UCD iteration 1
C2	F	36	QC specialist	PhD	7	Regular	4	
C3	M	62	Seller	High school	5	Regular	3	UCD iteration 2
C4	F	46	Housewife. Earlier web designer	Bachelor	8.5	Regular	7	
C5	F	36	PhD candidate	Master	7	Vegetarian	8	UCD iteration 3
C6	M	40	Researcher	Master	7	Vegan	7	
C7	M	29	Programmer	Master	2	Regular	1	Focus group 1
C8	M	31	Retail worker	Bachelor	6	Regular	2	
C9	F	32	Retail worker	High school	4	Regular	7	
C10	F	28	Freelance illustrator	Master	3	Regular	3	
C11	F	45	Tax manager	Master	7	Regular	6	Focus group 2
C12	M	48	Senior IT advisor	Master	10	Regular	7	
C13	M	29	Reception	Bachelor	7	Vegan	1	Focus group 3
C14	F	26	Master student	Bachelor	5	Regular	4	
C15	M	27	Master student	Bachelor	4	Regular	8	
C16	M	57	Receiving disability benefit. Earlier cook	High school	2	Regular	4	Focus group 4
C17	F	65	Retired. Previously housekeeper.	High school	0	Regular	1	

4 Results

4.1 Iterations of Design, Development and Usability Evaluation

In the first iteration, using user requirements given by the researchers in health and nutrition, the first version of prototype was developed. The prototype was then evaluated by both researchers and consumers. In the second and third iterations, feedback

gathered in the usability evaluation in the previous iteration were used to improve the design of the prototype, and then researchers and consumers evaluated the prototype. In addition, the prototype was tested using WAVE (web accessibility evaluation tool) to ensure it met accessibility requirements from Web Content Accessibility Guideline. The final version of prototype is the web application, which is described in the section 4.2.

Throughout the three usability evaluations, the common issues being raised by both researcher and consumers participants were mostly visual related, i.e., choice of colors and placement of the elements. They wanted different colors in the homepage and search results page to differentiate the two of them, despite the information displayed was already different. The placements of elements reflected on the usability aspects, which involved the functionalities of performing search, and sorting search results. They wanted the search function to be divided into two parts, basic and advanced. In terms of sorting results, they wanted the sorting to be able to perform as easy as possible, i.e., by clicking directly at the parameters offering sorting possibilities. Both user groups also provided suggestions about other functionalities that could be included in the next research. Due to time and resource constraints, we had started the implementation but yet to have them completed in the next iteration. These suggestions are presented as potential improvements, in section 4.4, which is after we present the findings of focus group interview.

Other issues, which the consumer participants brought up more than researcher participants, were related to the wordings and formulation of information. For example, they would like to have more information about the amount of nutrients in relationships to the amount of food products. We then added the sentence “All nutrients displayed in the table are per 100 grams of food product” to clarify better. They preferred the wordings “product type” and “product category” over “food group”, as these terms were more reasonable and understandable from the consumers’ perspectives. All these suggestions were first clarified with the health and nutrition researchers so that the changes to be made were correct from the perspectives of experts and not only the consumers. The roles of health and nutrition researchers as educators were observed. For instance, they provided inputs on the correct way to display nutrient value, to categorize food products, and what the consumers should pay attention to and how they should interpret the information displayed on the web application.

4.2 Web application

The web application was named as “Nutrition database for meat and dairy products & plant-based substitutes” (see Figure 1). It consisted of two main functionalities. First was the homepage to display all food products, with their respective amount of nutrients. These nutrients included energy in both kJ and kilocalorie (kcal), and fat, saturated fat, carbohydrates, sugar, fiber, protein, and salt in gram.

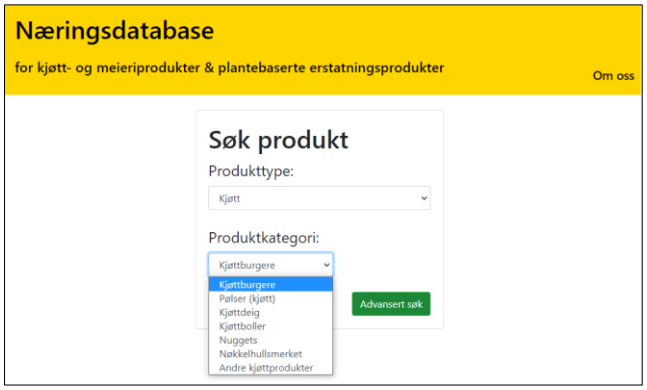

Fig. 1. Search function of the web application.

Figure 1 illustrates the second functionality, which was a search page to search food products based on two main parameters. First was product type, which included meat, meat substitutes, dairy products, and plant-based dairy products. Second was product category; as shown in Figure 1 (product categories for meat): burger, sausages, minced meat, meatballs, nuggets, keyhole-marked and others. Keyhole-marked (nøkkelhulls-merket) is a public label for healthier foods that indicates the product contains less fat, sugar and salt, and more fiber and whole grains. The same product categories applied for meat substitutes. For both dairy and plant-based dairy products, their product categories included cheese, ice cream, yogurt, cream, milk, and others. Users could also perform advanced search by providing a range for nutrients' amount.

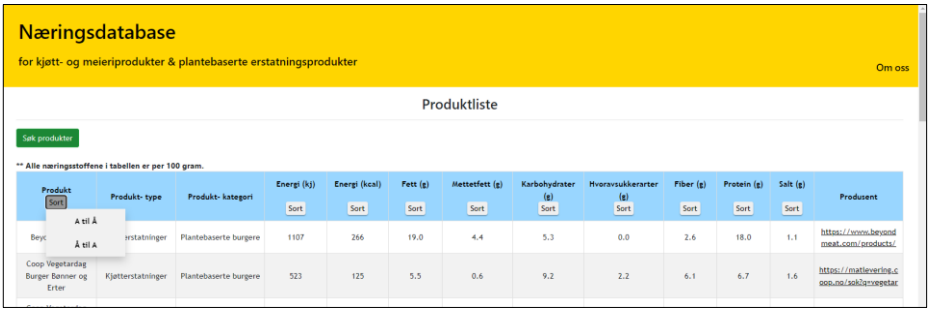

Fig. 2. Search results page and sort function of the web application.

As shown in Figure 2, after getting the search results, the users could choose to sort the results by the food products' name alphabetically, and by each nutrient in either ascending or descending order.

4.3 Focus group interview

Overall, all participants managed to perform the testing tasks. Issues such as wordings and formulation of information that were encountered during the UCD process, did not occur in focus group interview. All participants agreed that the web application was simple to learn and use. They understood that the focus was about nutrients of various food products and perceived the information as clear and easy to understand. However, due to the simplicity in design, participants such as C7, C8 and C10 thought the web application could appear easy to use for older adults but less appealing and attractive for younger people. They also expressed that this kind of design could be acceptable for consumers who were more interested in nutrients of food they ate and practiced healthy diets, but not for them. As shown in Table 1, participants in this study were either very concern about food nutrition (self-rated as high as 7 and 8 out of 10) or very little (as low as 1 to 3). C7, C8 and C10 happened to be in the group who concerned less about food nutrition, and they were also in the younger user group as well (age 29, 31 and 28 respectively).

Most recommendations were associated with visual aspects, which were also subjective to individuals. However, we did observe commonalities among some participants. For instance, younger participants tended to emphasize more on visual design when providing feedback. Focus group 1 and 3 wanted the web application to be more "fashionable", which could attract their attentions more and motivate them in using it eventually. As shown in Figure 2, buttons "Sort" in the page of search results were currently having text ("Sort", "Highest", "Lowest", "A to Å", and "Å to A"). Younger participants expressed that the icons with arrow would be sufficient.

One usability issue pointed out by all focus groups is the design of displaying food products. Its current design displayed all food products in one page. This was perceived as boring and too much information to take in. The participants in focus group 3 pointed out specifically that they would prefer a page that displays a maximum of 20 food products, and the users could press next page to view more. Another issue was concerning the advanced search. Some participants thought it was a complicated function for consumers in general, as most people might not completely understood the nutrients-related terms. They might not be aware of what the recommended range of nutrients was. Lastly, the participants perceived the web application lacking clear navigation. Currently the web application had neither navigation pane nor button that could provide clearer navigation.

Table 2. Summary of SUS results.

SUS statements (**to rate from 1 to 5; 1 = *strongly disagree*, 2 = *disagree*, 3 = *neutral*, 4 = *agree*, 5 = *strongly agree***)		**Average scores**
1.	I think that I would like to use this system frequently.	1.63
2.	I found the system unnecessarily complex.	3.28
3.	I thought the system was easy to use.	3.00
4.	I think that I would need the support of a technical person to be able to use this system.	1.36
5.	I found the various functions in this system were well integrated.	2.36

6.	I thought there was too much inconsistency in this system.	2.36
7.	I would imagine that most people would learn to use this system very quickly.	4.00
8.	I found the system very cumbersome to use.	2.82
9.	I felt very confident using the system.	3.72
10.	I needed to learn a lot of things before I could get going with this system.	2.00

Table 2 presents the average scores of SUS questionnaires. As the average scores show, the web application scored very high in statements 7 and 9, and very low in statements 4 and 10. This aligned with the findings of observation and discussion concerning the design of the web application being simple and easy to learn and use. The score of statement 1 indicated low interest among the participants in using the web application. The reasons provided by the participants were either because they were not very interested in information about food nutrition, or they thought the web application did not appear attractive to them.

Despite being perceived as easy to learn and use, some participants thought the web application was unnecessarily complex (statement 2). Interestingly, this group of participants were all from focus group 1 and 2, and these two groups were the only two groups which compared the design of the web application with a common web application in Norway named Finn.no [24]. Finn.no is a classified advertisement digital platform where users can both advertise and search advertisements of buying and selling all kind of brand new and used items, properties, transportations, travels, and services. Finn.no offers both website and mobile app version to the users. The first thing that being compared was the search functionality. These participants wanted the search possibilities to be displayed as single items in grid view, instead of a dropdown list (refer Figure 1). Secondly, the search result page should have displayed the search parameters that the users had selected. Lastly, we had several sort buttons on the search results page (refer Figure 2) and the participants expressed it could be less complex by having all sorts grouped at one dropdown list like in Finn.no.

In summary, all participants in focus group interview saw the potential in this web application and appreciated its purpose as a platform to provide consumers nutritional information of market-available food products. Other findings gathered during the focus group interview were similar as those gathered during the UCD process. They were potential improvements that the project team had started working with since the UCD process started. However, they were yet to be completely implemented before the focus group interview were conducted due to concerns such as copyright, collaborations with other organizations, etc. We present these feedbacks in section 4.4.

4.4 Potential improvements

Both researcher and consumer participants in the UCD process and focus group interview would like to have images of food products instead of just pure text. When developing the web application, the project team was surveying the possibilities in having these images on the web application in relations to the concern of copyright. Other suggestions such as including information about shops which sell food products and

prices were also brought up, both during the UCD and focus group interview. These suggestions could be implemented with the collaborations with food producers, shops, and supermarkets. The participants expressed that it would be beneficial if the web application could suggest them healthy food products that were on promotions.

Another functionality that most participants wanted was having a user profile. This functionality could offer users to have their own account, log in, and save the items into their own favorite list. We have evaluated this function during the UCD process concerning user interface design and its usability; the results were promising. However, due to the concern of General Data Protection Regulation (GDPR) and privacy issue when implementing it, this function was not included in the evaluations in focus group interview.

5 Discussion

The study started as a research-oriented project where the web application was originally designed and developed for the use of researchers in health and nutrition. Using user requirements provided by them, the very first prototype was made. As the nutritional information could be relevant for the consumers in assisting them in making better choice for healthier diets, and encouraging them to practice plant-based diets, these researchers wished to extend the use of the web application to the consumers. The findings show the potential of the web application, in addition to the innovation of the study; ICT tools nowadays providing guidance and information of market-available food products do not focus on plant-based food products [9-12], while ICT tools focusing on plant-based diets only focused on ingredients or recipes, and not on-the-shelves food products [6, 8].

When assessing free and popular mobile apps for supporting plant-based diets for Canadians, Lee, Ahmed [14] identified issue of lacking credible and trustworthy sources among the evaluated apps. Contributions from researchers in health and nutrition in this study was important in addressing this issue. Besides advising us about the design of the web application, their input and feedback have been used as a form of education to the consumer user group, which include what the consumers should be aware of, and the information displayed in the web application being credible and trustworthy. Such practice is important in designing and developing all kind of health-related ICT tools.

In order to impact on consumers' attitude change, information targeted to them has to appear both attractive and credible [25]. UCD approach involving both researchers in health and nutrition, and consumers was therefore adopted. Comparing feedback from researchers in health and nutrition, and consumer participants from UCD usability evaluation and focus group interview, different perspectives were observed. Researchers in health and nutrition, and consumer participants in UCD had more interest in nutritional information, while consumer participants in focus group interview had less. This resulted in more focus in elements concerning attractiveness in focus group interview than in UCD. Concerning credibility of the information, we wish to highlight the

importance of health and nutrition researchers' involvement and contribution in ensuring that the web application was perceived credible and trustworthy.

Alongside to credibility of an app, Van Loo, Hoefkens [25] emphasized other factors such as attractiveness and personal motivation in making an attitude change in consumers choosing healthier and more sustainable plant-based diets. In this study, the participants in focus group interview expressed that the visual appearance of the web application was less attractive. This was reflected on their SUS scores, indicating them being less interested in using the web application. Comparing to participants in focus group interview, consumer participants in UCD process rated themselves having higher concern in nutritional information in food. Out of six of them, two of them were vegan and one was vegetarian. Other than these participants, two health and nutrition researchers participated throughout the entire UCD process. It is likely that the participants' personal motivation outweighed attractiveness of the web application during the UCD process. This then resulted in the concern of web application being less attractive was not mentioned during the UCD process but only in the focus group interview.

In the focus group interview, participants suggested other design features that could make the web application appeared more attractive to them. One of them was suggesting healthy food products that were on promotions to the users. In a review identifying factors that could contribute to promoting plant-based food consumptions, Taufik, Verain [13] concluded that price incentive was one of the effective factors. Ball, McNaughton [26] compared three interventions to investigate effects on the consumptions of healthy food and beverages. These were intervention with a 20% price reduction, intervention with a skill-building, and a intervention of a combination of both. Information alone, i.e., newsletters about health eating combined with other skill-building resources such as opportunity to participate in an online forum, budgeting worksheets, goal-setting, and self-monitoring exercises were found ineffective in promoting the consumers to buy healthy food and beverages. On the other hand, price reduction alone and the combination of price reduction and skill-building resulted in higher consumption of healthy food and beverages. As suggested by some participants in this study, the nutritional information alone did not appear attractive enough for them. Combining this information with information about promotions could give stronger impact. In addition to food products on promotions, others suggested design included having images to illustrate the food products, indicating the consumers where they could get the food products and having a user profile where they could save the food products into their favorite list.

Some findings concerning usability perspective of the web application could be related to universal design (UD) principles. The focus group interview participants perceived the web application lacking clear navigation as it had neither navigation pane nor button that could provide clearer navigation. Besides, colors were one of the design elements wanted by both researcher and consumer participants in differentiating between the home page and the search results page. These could assist them feeling directed and knowing where they were when using the web application; supporting UD principle 4, perceptible information [27].

The participants in UCD process wanted the sort function to be simple, and we had the sort buttons at the parameters which could offer sort possibilities (refer Figure 2).

However, this design was perceived as confusing during focus group interview. The participants in the first and second focus group interviews pointed out that they preferred a design which was based on finn.no, a popular Norwegian classified advertisement digital platform. They were used to having only one dropdown list, displaying all types of sort possibilities. In addition to that, when performing search, all search possibilities could be displayed as single items in grid view, instead of a dropdown list (refer Figure 1). These findings are in line with UD principle 3, simple and intuitive use where the design has to "*be consistent with user expectations and intuition*" [27]. Since finn.no is very popular among people living in Norway, it was understandable that they compared the design of our web application to their experiences using finn.no. Hence, using a familiar web application can be a good approach as a starting point to design a brand-new prototype. This approach is in line with the guide for better usability proposed by Nielsen [28].

6 Conclusion and Future Work

This study demonstrates a UCD process involving both health and nutrition researchers, and consumers in producing a web application that enabled the consumers to easily obtain nutritional information about plant-based and non-plant-based food products sold in the market. The UCD process involved two health and nutrition researchers and six consumers in three iterations of design, development, and evaluations. Using the final version of the prototype, evaluations focusing on summative results were conducted with eleven consumers participating in four focus group interviews. The results show that the web application was easy to learn and use, due to the simplicity in its design. However, most of the participants thought this design appeared less appealing and attractive to them. Hence, they had less interest in using it in the future. On the other hand, such design was commented could be more suitable for older adults.

In this study, a UCD approach involving experts and consumers has proven beneficial in designing a diet-related web application. By consulting the researchers in health and nutrition, we managed to convey information that is scientifically precise to the consumers via the web application. By consulting the consumers, we could ensure the information on the web application is understandable to them, and inputs on how to make the web application more attractive have been gathered. One of the implications of this study is informing the researchers, designers and developers, policymakers, and industry players about the essential considerations in providing consumers health-related ICT tools, i.e., usability, credibility, and attractiveness.

This study was undertaken to design a web application that provides nutritional information of market-available food products to consumers. By enhancing the access to this information, we hope to promote more plant-based diets among the consumers, and hence they can have a healthier diet and better health. The web application can hopefully inspire other work in promoting plant-based diets as well, as plant-based food is more sustainable [2, 3]. As the study was at its preliminary stage, we have only focused on the aspects of usability and functionality. Therefore, the future works include to further improve the web application based on the participants' feedback and incorporate

proposed functionalities such as having prices, information about products on promotions, shops and supermarkets selling the products, and so forth.

Using the web application, we intend to evaluate its usage regarding user experience and impact on consumers' choice in choosing food products in a longer period of time. One limitation of this study is that we did not specifically include user groups that face risks of malnutrition, such as people with disabilities and older adults [29]. Some usability issues found in this study were related to UD principles [27]. Hence, we would highlight the importance of having the web application universally designed so that users with diverse background and needs could benefit from using it.

References

1. Alae-Carew, C., et al.: The role of plant-based alternative foods in sustainable and healthy food systems: Consumption trends in the UK. Science of The Total Environment, 807, 151041 (2022).
2. Aschemann-Witzel, J., et al.: Plant-based food and protein trend from a business perspective: markets, consumers, and the challenges and opportunities in the future. Critical Reviews in Food Science and Nutrition 61(18), 3119-3128 (2021).
3. Fehér, A., et al.: A Comprehensive Review of the Benefits of and the Barriers to the Switch to a Plant-Based Diet. Sustainability 12(10), 4136 (2020).
4. Banerjee, T., Liu, Y., Crews, D.C.: Dietary patterns and CKD progression. Blood purification 41(1-3), 117-122 (2016).
5. Joshi, S., Ettinger, L., Liebman, S.E.: Plant-based diets and hypertension. American Journal of Lifestyle Medicine 14(4), 397-405 (2020).
6. Lea, E., Worsley, A.: Benefits and barriers to the consumption of a vegetarian diet in Australia. Public Health Nutr 6(5), 505-11 (2003).
7. Lea, E., Worsley, A.: Influences on meat consumption in Australia. Appetite 36(2), 127-136 (2001).
8. Lea, E.J., Crawford, D., Worsley, A.: Public views of the benefits and barriers to the consumption of a plant-based diet. European Journal of Clinical Nutrition 60(7), 828-837 (2006).
9. Tangsripairoj, S., et al.: WhatTheHealth: An Android Application for Consumers of Healthy Food. in 2019 16th International Joint Conference on Computer Science and Software Engineering (JCSSE), 61-66. IEEE, Thailand (2019).
10. Southey, F.: Evaluating the Yuka 'Phenomenon': How Effective Is the Scanning App in Practice? 2019, https://www.foodnavigator.com/Article/2019/08/20/Evaluating-the-Yuka-phenomenon-How-effective-is-the-scanning-app-in-practice#, last accessed 2022/05/16
11. Wayman, E., Madhvanath, S.: Nudging Grocery Shoppers to Make Healthier Choices. in Proceedings of the 9th ACM Conference on Recommender Systems, 289-292, ACM, Austria (2015).
12. Dunford, E., et al.: FoodSwitch: a mobile phone app to enable consumers to make healthier food choices and crowdsourcing of national food composition data. JMIR mHealth and uHealth 2(3), e3230 (2014).
13. Taufik, D., et al.: Determinants of real-life behavioural interventions to stimulate more plant-based and less animal-based diets: A systematic review. Trends in Food Science & Technology 93, 281-303 (2019).

14. Lee, J., et al.: A Content Analysis of Free, Popular Plant-Based Mobile Health Apps. Current Developments in Nutrition 5(Supplement_2),1003-1003 (2021).
15. DiFilippo, K.N., Huang, W., Chapman-Novakofski, K.M.: A New Tool for Nutrition App Quality Evaluation (AQEL): Development, Validation, and Reliability Testing. JMIR Mhealth Uhealth 5(10), e163 (2017).
16. Khazen, W., et al.: Rethinking the use of mobile apps for dietary assessment in medical research. Journal of medical Internet research 22(6), e15619 (2020).
17. Dunford, E., Neal, B.: FoodSwitch and use of crowdsourcing to inform nutrient databases. Journal of Food Composition and Analysis 64, 13-17 (2017).
18. Winter, J., Rönkkö, K., Rissanen, M.: Identifying organizational barriers—a case study of usability work when developing software in the automation industry. Journal of Systems and Software 88, 54-73 (2014).
19. Kübler, A., Nijboer, F., Kleih, S.: Hearing the needs of clinical users, in Handbook of clinical neurology 168, 353-368 (2020).
20. Joyce, A.: Formative vs. Summative Evaluations, https://www.nngroup.com/articles/formative-vs-summative-evaluations/, last accessed 2022/05/17.
21. Nielsen, J.: 10 Usability Heuristics for User Interface Design, https://www.nngroup.com/articles/ten-usability-heuristics/, last accessed 2022/05/17.
22. Brooke, J.: SUS-A quick and dirty usability scale. Usability evaluation in industry 189(194), 4-7 (1996).
23. Sedgwick, P.: Convenience sampling. Bmj 347, f6304 (2013).
24. Finn.no: FINN.no - mulighetenes marked, http://www.finn.no, last accessed 2022/05/17.
25. Van Loo, E.J., Hoefkens, C., Verbeke, W.: Healthy, sustainable and plant-based eating: Perceived (mis) match and involvement-based consumer segments as targets for future policy. Food Policy 69, 46-57 (2017).
26. Ball, K., et al.: Influence of price discounts and skill-building strategies on purchase and consumption of healthy food and beverages: outcomes of the Supermarket Healthy Eating for Life randomized controlled trial. The American journal of clinical nutrition 101(5), 1055-1064 (2015).
27. Story, M.F.: Principles of universal design, Universal design handbook. 2nd edn. McGraw-Hill Professional New York, New York (2001).
28. Nielsen, J.: Usability 101: Introduction to usability, https://www.nngroup.com/articles/usability-101-introduction-to-usability/, last accessed 2022/05/19.
29. Groce, N., et al.: Malnutrition and disability: unexplored opportunities for collaboration. Paediatrics and international child health 34(4), 308-314 (2014).