

**Designing an Interactive Application to Support Caregiver's Feeding
Practices of Young Children in Poor Areas of China**



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Abstract

There are many problems with child feeding in poverty-stricken areas, such as western China. Problematic child feeding has led to social health and public nutrition issues (Zhang et al., 2018b), including growth retardation, wasting (Feng et al., 2022), and anemia in children (Li et al., 2020). Caregivers have been using nutrition apps to mitigate nutrition issues in child feeding. However, most existing nutrition apps on international platforms are not accessible to China mainland users or do not support Chinese. On the other hand, existing apps on Chinese platforms are not satisfactory in terms of low quality, such as not scientifically well-designed recipes, and massive advertisements, which make it difficult for child caregivers to choose reliable apps to improve their child feeding practices (Zhao et al., 2017). This project aims to mitigate the aforementioned problems by designing one app regarding to children nutrition guidance for child caregivers in poor areas of China. The main features of the designed app are free, easy to understand and use, with scientifically designed recipes suitable for Chinese eating habits. This dissertation first introduces some background knowledge about children health and nutrition. After discussing the aims and objectives, it reviews existing work on nutrition and feeding apps and discusses their disadvantages and ill-suitedness by analysing requirements in poor areas of China. It then presents the approaches and designs adopted and proposed to resolve the problems. It also demonstrates the structure of code implementation and analyses of the heuristic and user evaluation results, which draw conclusions and reveal several weak points left for future work.

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Special thanks to Cardiff University Trevithick Library, where I spent a wonderful summer. I loved the window seat on the west side, where the large, unknown trees grew in abundance and the summer breeze rustled through. In a few minutes a small train would go by, and the sound of the whirring train reached my ears through the summer wind and the summer leaves, which was very pleasant. In good weather, at noon there would be young students with their lunch sitting under the big trees, chatting and enjoying their lunch, and sometimes the sound of laughter would come and infect me. Occasionally, a young student would sit alone on the stone steps under the tree, looking like he or she was thinking about life. Thanks to the Trevithick Building cafeteria for the free strawberries, which were large and sweet. There is a lovely staff with a long beard in the library. I do not know his name, but his beard swings with his arms when he is doing his rounds, which is very cute. The building of the School of Computer Science provided a very pleasant place for my thesis writing, and I witnessed the growth of the big trees. Occasionally, when I encountered a bottleneck in my thesis, I would sit quietly under the big trees and think in the sun.

Thanks to the teaching assistants in the School of Computer Science. The thesis guidance classes three times every week were very useful.

Thanks to my family, friends and classmates who have stood behind me and supported me.

Thanks to the Welsh sheep, who are so lively and cute, I occasionally went to the farm to play with lambs on weekends during my thesis writing. They are white, black, black and white, and they have very soft coats. When it was hot, they would crouch in the shadows in the corner. Most of them are not afraid of people and will ask for food very intimately. Occasionally, a pregnant and naughty ewe will steal my apples. These cute lambs made my thesis period very happy and helped me to progress smoothly, so thanks again to these lambs.

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Chapter 1 – Introduction

China, officially the People's Republic of China (PRC), is a developing country in East Asia. China has an area of about 9.6 million square kilometres, which makes it the world's third largest country. Although the country is large, it is also the world's most populous country, with a population approximately 1.402 billion people in 2020. This makes China be lack of resources per capita. Moreover, the development inside China is also unbalanced. In particular, some areas in western China are much more underdeveloped compared with other regions. Moreover, combined with complex geography, fragile ecology, and frequent natural disasters especially in western parts (Yang et al., 2020), a number of Chinese people in poor areas have a backward standard of living. One of the very direct effects is the high prevalence of developmental delay among children aged 6 to 35 months (Zhang et al., 2018a).

Another reason for development issues in children is the food safety issue in China. For example, some unscrupulous manufacturers added melamine in milk powder for raising nitrogen levels during protein content tests. In 2008, Chinese government announced that melamine has been detected in infant milk powder from 22 dairy companies, resulting in nearly 300,000 illnesses and over 50,000 hospitalisations (Qiao et al., 2012). Currently, the Chinese government is treating food safety issues more seriously, and the growth retardation rate of children under 5 years old in China was 8.1% in 2013, decreasing 76% compared to 1990 (Yang et al., 2015). However, most improvements are from urban and more developed areas, while child caregivers in poor areas are still facing challenges to feed their children safely and healthily (Zhou, 2017).

To mitigate the problems of unsafe and unhealthy child feeding in China, this project considers

the idea of designing a scientifically nutritional software for child caregivers in poor areas of China, to guide them to choose healthy ingredients and make foods with adequate nutrients.

Currently, there exist software applications available on international platforms for scientific feeding of children, such as “Annabel Karmel”, “Food Buying Guide for CNP”, and “Easy Bites Child Nutrition”, to name a few. In general, these apps are of high quality and good design, but are not quite suitable for Chinese caregivers for reasons. In particular, some apps involve nutrition terminologies, which are too complicated to learn and understand for child caregivers in less developed areas, who usually have low education levels; some apps need users to register and pay for memberships, which is not affordable for people in poor areas; some apps recommend western style meals, such as sandwiches and cheese, which are not suitable for Chinese eating habits; most apps only support English, etc.

There also exist Chinese apps which claim to provide infant feeding and nutrition guidance. However, the quality of information and effect of guidance in existing apps have not been extensively evaluated or verified. In fact, a recent study over 26 Chinese nutrition apps showed that only 3 of the 26 apps provided information covering the three practices in the World Health Organisation’s infant feeding recommendations (Zhao et al., 2017), and most of those apps are full of advertising information, making it difficult for child caregivers in poor areas of China to choose a reliable nutrition app.

To mitigate the above-mentioned problems, this project proposes to design an app to support child feeding practice of child caregivers in poor areas of China. On the one hand, the designed app aims to focus on scientific and nutritional food recommendation without

advertising. The app should also have useful functions such as setting food budgets and portions for different types of foods, achieving the similar effects of nutrition guidance as existing apps on international platforms. On the other hand, the app should be tailored and designed to satisfy specific requirements of people in poor areas of China. It is free and necessary to support Chinese language. The designs and functions should be simple and direct, rather than complicated or confusing. Taking into account that child caregivers from poor areas usually do not have high literacy levels, it would also be helpful to integrate assistive techniques into the app, such as hand-drawn pictures, and sound instructions, to make it easy for child caregivers to learn and understand nutritional information.

The remaining of the dissertation is organised as follows. Chapter 2 discusses aims and objectives of the project. Chapter 3 introduces background knowledge about children health and nutrition, while Chapter 4 reviews related work on existing nutrition apps. Chapters 5 and 6 demonstrate the main approaches and implementations of the project, respectively. Chapter 7 presents the user evaluation results. Chapters 8 and 9 provide discussions and reflections during the study of this project. Chapter 10 briefly concludes the dissertation.

Chapter 2 - Aims and Objectives

Primary Aim:

To design an interactive nutrition application to support child caregiver's infant feeding practices in poor areas of China.

Secondary Aims:

- To understand daily nutrition requirements of children aged 2-5 years.
- To understand the requirements and difficulties in current child feeding practices of child caregivers in poor areas of China.
- To understand advantages and weaknesses of existing nutrition apps.

Objectives:

- To review literature on the population status of child caregivers in poor areas of China, such as western China.
- To understand the nutritional status of children in poor areas of China from literature research.
- To do survey research on existing relevant interactive applications which support feeding practices of child caregivers.
- To gather and collect user requirements from literature and analysis of existing nutrition apps.
- To design an initial prototype based on collected requirements.

- To evaluate the prototype based on user feedbacks gathered from voluntary participants or heuristic criteria.
- To modify and improve the prototype design based on feedbacks in several iterations.
- To develop and evaluate the designed-based nutrition software application.

Chapter 3 – Background

3.1 Children Health and Nutrition Issues

3.1.1 World's Children Health and Nutrition

With the development of society and the advancement of technology, the children health and nutrition has also become a significant problem all over the world (Staton and Harding, 2004). On the one hand, the proportion of obesity among children is gradually increasing in a number of countries (Caballero, 2007). In the meanwhile, many children in underdeveloped areas are still malnourished (Cleghorn et al., 1991).

According to a report released by United Nations Children's Fund (UNICEF) about the state of the world's children, food and nutrition (Keeley et al., 2019a), in 2018, from a worldwide perspective,

- 149 million children have stunted growth or are too short for their ages.
- 50 million children are wasted or too thin in stature.
- 340 million children (i.e., one in every two children) have deficiencies in essential vitamins and minerals, such as vitamin A and iron.
- 40 million children are overweight or obese.

The above information from the UNICEF report (Keeley et al., 2019a) demonstrates that in worldwide, children health and nutrition are significant problems.

It has been shown that nutritional status of children varies among countries with different

levels of development (Leslie, 1988). Among different countries, the problems of children health and nutrition are more serious in underdeveloped areas than developed areas for the following two main reasons. First, it is well known that the population of developing countries is larger than that of developed countries (Mills and Tan, 1980), which suggests more chances for problems to happen in developing areas. Second, it has been shown that children in less developed countries grow more slowly compared with developed countries, which implies that they are facing more serious issues with respect to health and nutrition (Brown, 1991).

3.1.2 World's Countries Development Levels

The development across different countries in the world is uneven, which could result from different reasons, such as differences in natural resources and geographical conditions, differences in the educational level of the population, and different policies or political situations (Arrighi, 2007).

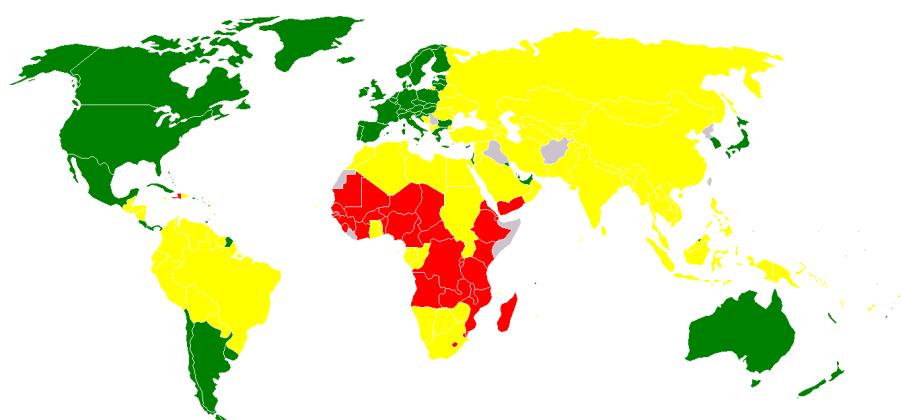


Figure 1. Three different levels of development of all countries

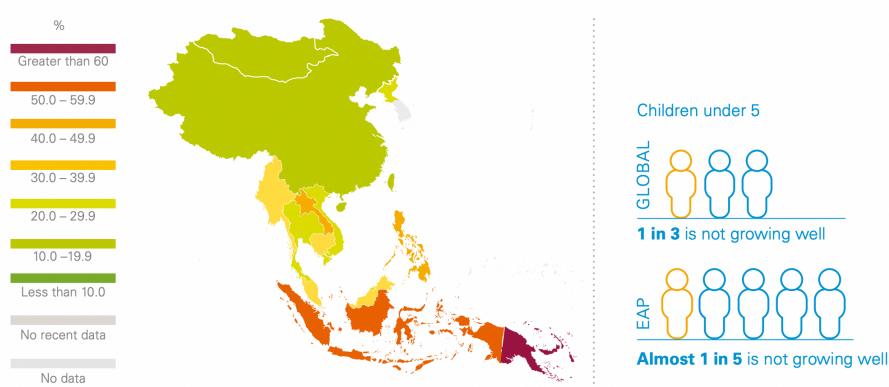
(<https://zh.m.wikipedia.org/zh-cn/%E7%AC%AC%E4%B8%89%E4%B8%96%E7%95%8C>, in Chinese).

Figure 1 demonstrates the development status of different countries. In particular, the figure shows three different levels of development according to the Human Development Index (HDI) colour scheme. Green refers to first world countries, which are most developed countries. Yellow indicates second world countries, which are developing countries. And red denotes third world countries, which are least developed countries, while grey is unknown due to data being unavailable. As shown in Figure 1, China is one of the developing countries, which is at roughly the median world level (You et al., 2020). As a consequence, China's current nutritional status of children is expected to be at the median world level, which is worth paying attention and taking further investigation (Leslie, 1988).

3.1.3 Children Health and Nutrition Issues in China

The following Figure 2 demonstrates that, in East Asia and Pacific (EAP) region, the prevalence of children under 5 years who are not growing well, in terms of percentage. According to Figure 2, about 18 percent of children under 5 in China are not growing well, which is worse than the average region level (17 percent), indicating that children health and nutrition situation in China is not optimistic and is noteworthy.

FIGURE 1 | Prevalence of children under 5 who are not growing well (stunted, wasted or overweight), East Asia and Pacific, (EAP) 2018



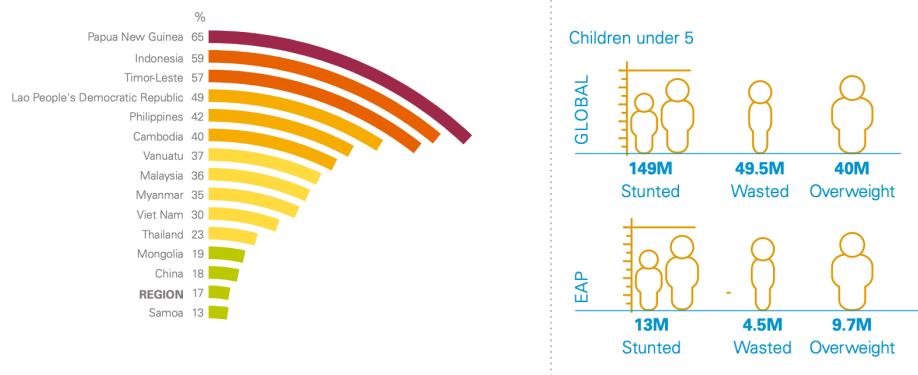


Figure 2. Prevalence of children under 5 who are not growing well (stunted, wasted or overweight), EAP, 2018 (Keeley et al., 2019b).

Since young children or infants mainly obtain nutrients and foods from feedings, it is natural to consider that not growing well mainly results from their feedings are not satisfactory. This reasoning is supported by existing research (Buchmiller et al., 1994) as well as the following concrete data shown in Figure 3.

What are young children eating? The importance of first foods

FIGURE 2 | Percentage of children aged 6–23 months fed food groups, by type, East Asia and Pacific, 2018



Figure 3. Percentage of children aged 6-23 months fed food groups, by type, EAP, 2018 (Keeley et al., 2019b).

As shown in Figure 3, the chart demonstrates that in the EAP region, among children aged 6 to 23 months, 90 percent of them have their first food in Grains category, which accounts for the largest proportion. 23 percent were legumes, which take the smallest proportion. Among these children, 25 percent of them were not fed adequate nutrition from animal source food. 23 percent of the children were not fed any vegetables and fruits (Keeley et al., 2019b).

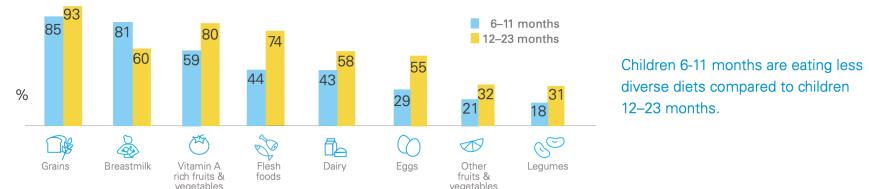
To check more detailed data of China and provide further evidences, the following chart in Figure 4 shows that only 35 percent of Chinese children between the ages of 6 and 23 months are fed at least five out of food groups (Minimum Dietary Diversity), which is below average level compared with other countries in EAP region.

FIGURE 3 | Percentage of children aged 6–23 months eating at least 5 of 8 food groups (Minimum Dietary Diversity), by country 2018



3 in 5 children do not eat foods from the minimum number of food groups in East Asia and Pacific.

FIGURE 4 | Percentage of children aged 6–23 months fed food groups, by type and age, East Asia and Pacific, 2018



Children 6–11 months are eating less diverse diets compared to children 12–23 months.

Figure 4. Percentage of children aged 6–23 months fed food groups, by country, type, and age, EAP, 2018 (Keeley et al., 2019b).

According to the evidences shown in the above figures and charts, the following two points are well supported. First, children health and nutrition are serious issues in China. Second, a

large number of Chinese children do not gain enough amount of nutrients from their feedings.

3.1.4 Issues in Poor Areas of China

It has been shown in previous sections by data and evidences that children health and nutrition are serious issues in China. However, over the past four decades, the world has witnessed the rapid development and economic growth of China (Gandhi and Zhou, 2014). Considering the positive correlation between children nutritional status and development level (Leslie, 1988), it would be interesting to understand how China's children nutritional status is still not satisfactory given its rapid development and economic growth.

Figure 5 demonstrates that the growth retardation rate of children under 5 years in different areas of China from 1990 to 2013. The green curve refers to the national data, and the red and the blue curves denote the city and village data, respectively. These three curves show that the growth retardation rate of young children kept decreasing in nationwide as well as in cities and villages, which is aligned with the rapid development of China in general.

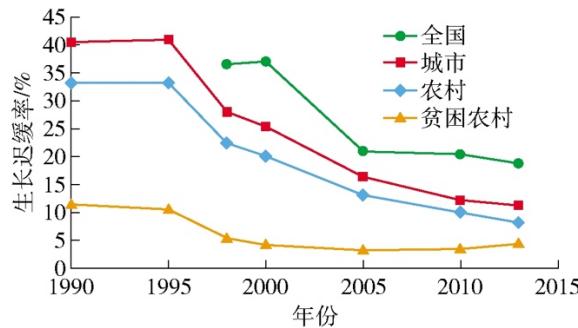


Figure 5. Growth retardation rate of children under 5 years in China during 1990 to 2013;

green: the whole nation; red: cities; blue: villages; yellow: poor rural areas

(<http://www.btbuspxb.com/html/spkxjsxb/2020/2/20200202.html>, in Chinese).

However, the yellow curve represents the data collected from poor rural areas, which does not decrease that much, not like the other three curves. In particular, from 2010 to 2013, the growth retardation rate of young children in poor rural areas actually continued to increase. This result essentially clarifies that the children health and nutrition issues in China are most serious in poor rural areas of China, and the situation has worsened in recent years. Given that 75% of Chinese children are raised in rural environments (Wang et al., 2021), this problem is definitely worth paying much more attention than before.

3.2 Food Safety Issues in China

It is obvious that food safety is directly related to children health issues. Actually, it has been studied that the recent rapid development of China also plays a controversial role in food security (Gandhi and Zhou, 2014). The food safety issue in China has always been a hot topic, and Chinese people consider food safety issue as the second most important risk in their lives (Paudyal et al., 2018), given several events regarding to food safety have been revealed to general public in recent years.

After the melamine incident as mentioned in Chapter 1 (Qiao et al., 2012), several other scandals of intentional food contamination have been revealed by media, which were widely and highly publicised in China (Hays et al., 2010), including the detection of Sudan Red G in chicken (Qiao et al., 2012), which is a kind of dye and has been shown to be genotoxic and carcinogenic to human beings (An et al., 2007); the detection of clenbuterol in pork, which has made many people sick after eating contaminated pork (Tang et al., 2016); recognition of water-injected meat, where injecting water into meat has been applied to large amounts of pork and almost all beef for more than 20 years (Qiao et al., 2012), and so on.

In addition to intentionally contaminating foods, some Chinese manufactures would also substitute good with bad. In Figure 6 below (in Chinese), the product name of the food is “Flavored Lamb Kebabs”, while the ingredient list shows that duck and lamb fat were used.



Figure 6. An inconsistency between the food product name and its ingredients

(https://wap.libaclub.com/t_13_11196522_1.htm, in Chinese).

In general, mitigating and even resolving food safety issues rely on the government and general public, which is beyond the capability of any individuals. Currently, Chinese government is treating food safety issues more seriously than before, but people are still not feeling absolutely assured and the situation is worth paying constant attention.

3.3 The Situation of Child Caregivers in Poor Areas of China

The first noticeable feature of child caregivers in poor areas of China is about their relatively low education levels. It has been shown by previous studies that the education in rural areas of China is significantly and positively related to family earnings (Wei et al., 1999).

Therefore, in poor areas of China, many caregivers of children are not well educated and some of them are illiterate (Tan et al., 2020). For those caregivers with low education levels, it would be difficult to learn and understand information on scientific feeding of children through books and other text information resources, including newspapers and reports.

Second, many child caregivers in poor areas of China are children's grandparents (Xu et al., 2012). In some poor areas of China, such as western China, there are many "left-behind children" (He et al., 2012), whose parents are working in urban areas to support their families, while leaving their children to remain in rural regions. Usually, those left-behind children are taken care of by their grandparents, who stay in rural areas as well. However, it has been verified that parents' feeding habits largely predict and impact children's eating behaviors (Snuggs et al., 2019), which means scientific feedings are important. While Chinese grandparents of children as caregivers are more inclined to feed their children according to their outdated experience than parents (Yue et al., 2018), which creates difficulties for scientific child feeding in these areas.

3.4 Chinese Eating Habits

It is reasonable to expect China has quite different eating habits compared with western countries due to their different cultures (Hashim and Zhiliang, 2003). Moreover, as mentioned in Chapter 1, as a big country, even inside China itself, eating habits vary widely in different regions (King, 2020), as shown in the following Figure 7.

Therefore, it is unlikely that there exist one or two universal recipes that would be suitable for child caregivers from all poor regions of China, which are distributed across almost the whole country (Liu et al., 2017).

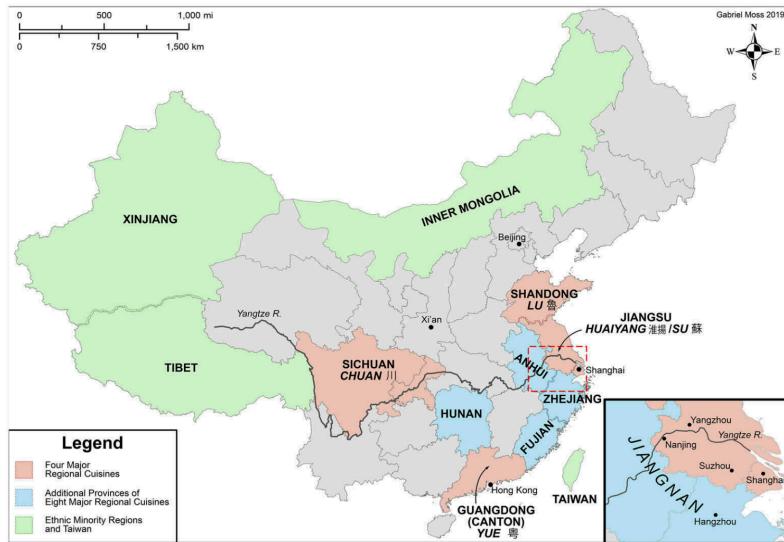


Figure 7. Map of China's Four and Eight Major Culinary Regions, Taiwan and Ethnic Minority Regions. (map by Gabriel Moss, MossMaps.wordpress.com)

3.5 Summary

To briefly summarise, Section 3.1 demonstrates that children health and nutrition in China, especially in poor areas of China, are serious issues; Sections 3.2 – 3.4 discuss background knowledge related to children feeding issues in China, i.e., food safety issues, situation of child caregivers in poor areas, and eating habits, respectively.

The main points of this section are as follows. First, due to low levels of development, poor areas in China are suffering difficulties like backward standards of living, which lead to children health and nutrition issues. Second, data and evidences show that Chinese children are not fed well and healthily. Third, there are many difficulties to deal with for improving child feeding practices in poor areas of China, including caregivers with low education levels, food safety, and very different eating habits, which create challenges for the research problem studied in this project.

Chapter 4 - Related Work

4.1 Children Healthy Eating

4.1.1 International Recommended Principles for Healthy Eating

It is well known that common foods are usually grouped into several main dietary indicators: fruits, vegetables, legumes and pulses, nuts and seeds, whole grains, red and processed meats, fish and seafood, milk and total energy (Gobbo et al., 2015). In general, there are several principles which are well verified and widely accepted. For example, eating adequate vegetables and fruits is very beneficial for health (Joffe and Robertson, 2001). The followings are also commonly believed to be healthy: high consumption of legumes and grains; moderate consumption of milk and dairy products, such as cheese; low consumption of meat and meat products (Trichopoulou et al., 1997). Most people would benefit from reduced consumption of red and processed meats, refined grains, sugars, sodium, and saturated fats (McGuire et al., 2016).

4.1.2 Scientific Diets for Children Healthy Eating

Despite different geographical, socioeconomic and cultural contexts in different countries, most nutritional recommendations for children also share the following similar features (Kastorini et al., 2019). First, it is known that carbohydrates are important for the health of infants and children (Stephen et al., 2012). Second, it is also commonly believed that micronutrients are very important and can be naturally obtained from various foods (Samuel et al., 2022). Third, people in general consider children should eat more whole grains (Gidding et al., 2005). According to the above-mentioned common knowledge for children healthy eating, there also exist widely used diets. For example, existing experience of

providing healthy diets for young children in inland cities of England has been widely applied in many countries (Goldthorpe et al., 2018).

Figure 8 shows a summary table of recommendations for key nutrients by age group across several different countries, including Australia, Canada, the UK and USA, and so on (Hollis et al., 2020). As shown in Figure 8, different countries often recommend different but similar amounts of nutrients for infants, children, and adolescents. For example, both Canada and the USA recommend 400 micrograms vitamin A for children aged 0-6 months, and both the USA and the UK recommend ~7 milligrams iron for children of 1-3 years, etc.

Table 2
Summary table of recommendations for key nutrients by age group for Australia and New Zealand (National Health and Medical Research Council, 2006), Canada (Government of Canada, 2010), the UK (Scientific Advisory Committee on Nutrition (SACN), 2018, Scientific Advisory Committee on Nutrition, 2014) (Public Health England, 2016), USA (U.S. Department of Health and Human Services and U.S. Department of Agriculture, 2015), Institute of Medicine (US) Committee to Review Dietary Reference Intakes for Vitamin D and Calcium et al., 2011), Kenya (Republic of Kenya Ministry of Health, 2010), Oman (Ministry of Health Oman, 2009), and Cambodia (Foundation for Interventional Development/Relief et al., 2017).

Country	Age group	Sex	Vitamin A	Vitamin D	Iron	Zinc	Iodine	Potassium	Sodium	Calcium	Fluoride
Australia, New Zealand	0-6 months	All	250 µg of retinol (as retinyl esters) AI	5 µg (AI)	0.2 mg (AI)	2 mg (AI)	90 µg (AI)	400 mg (AI)	120 mg (AI)	210 mg (AI)	NA
Canada	0-6 months	All	400 µg (AI)	10 µg (AI)	0.27 mg (AI)	2 mg (AI)	110 µg (AI)	400 mg (AI)	120 mg (AI)	200 mg (AI)	0.01 mg (AI)
UK	0-3 months	All	350 µg (RNI)	8.5-10 µg (safe intake)	1.7 mg (RNI)	NA (RNI)	50 µg (RNI)	NA (RNI)	NA (RNI)	NA (RNI)	NA
UK	4-6 months	All	350 µg (RNI)	8.5-10 µg (safe intake)	4.3 mg (RNI)	NA (RNI)	60 µg (RNI)	NA (RNI)	NA (RNI)	NA (RNI)	NA
USA	0-6 months	All	400 µg (AI)	10 µg (AI)	0.27 mg (AI)	1 mg (AI)	110 µg (AI)	0.4 g (AI)	0.12 g (AI)	200 mg (AI)	0.01 mg (AI)
Australia, New Zealand	7-12 months	All	430 µg of retinol equivalents (RDI)	5 µg (AI)	11 mg (RDI)	3 mg (RDI)	110 µg (RDI)	700 mg (AI)	170 mg (AI)	270 mg (AI)	0.5 mg (AI)
Canada	7-12 months	All	500 µg (AI)	10 µg (AI)	11 mg (RDA)	3 mg (RDA)	130 µg (RDA)	700 mg (AI)	370 mg (AI)	260 mg (AI)	0.5 mg (AI)
UK	7-12 months	All	350 µg (RNI)	8.5-10 µg (safe intake)	7.8 mg (RNI)	NA (RNI)	60 µg (RNI)	NA (RNI)	NA (RNI)	NA (RNI)	NA
USA	7-12 months	All	500 µg (AI)	10 µg (AI)	11 mg (RDA)	3 mg (RDA)	130 µg (RDA)	0.7 g (AI)	0.37 g (AI)	260 mg (AI)	0.5 mg (AI)
Australia, New Zealand	1-3 years	All	300 µg (RDI)	5 µg (AI)	9 mg (RDI)	3 mg (RDI)	90 µg (RDI)	2000 mg (AI)	200-400 mg (AI)	500 mg (RDI)	0.6 mg (AI)
Canada	1-3 years	All	300 µg (RDA)	15 µg (AI)	7 mg (RDA)	3 mg (RDA)	90 µg (RDA)	3000 mg (AI)	1000 mg (AI)	700 mg (RDA)	0.7 mg (AI)
USA	1-3 years	All	300 mg RAE (RDA)	600 IU (RDA)	7 mg (RDA)	3 mg (RDA)	NA (RDA)	3000 mg (AI)	1500 mg (UL)	700 mg (RDA)	NA
UK	1-3 years	All	400 µg (RNI)	10 µg (RNI)	6.9 mg (RNI)	5 mg (RNI)	70 µg (RNI)	800 mg (RNI)	0.8 g (RNI)	350 mg (RNI)	NA
Kenya	1-3 years	All	400 µg RE (RNI)	5 µg (RNI)	10 mg (RNI)	10 mg (RNI)	75 µg (RNI)	NA (RNI)	NA (RNI)	500 mg (RNI)	NA
Oman	1-3 years	All	350-500 µg RE	2.5-5.0 µg	5.5 mg (RNI)	10 mg (RNI)	75 µg (RNI)	NA (RNI)	2.5 g (RNI)	250-400 mg (RNI)	0.5-1 mg (RNI)
Cambodia	4-6 years	Boys	450 µg (RDA)	5 µg (RDA)	6.5 mg (RDA)	5.5 mg (RDA)	90 µg (RDA)	1300 mg (RDA)	1600 mg (RDA)	550 mg (RDA)	NA
Cambodia	4-6 years	Girls	450 µg (RDA)	5 µg (RDA)	7.5 mg (RDA)	5.5 mg (RDA)	110 µg (RDA)	1400 mg (RDA)	1600 mg (RDA)	600 mg (RDA)	NA
Kenya	4-6 years	All	500 µg RE (RNI)	5 µg (RNI)	10 mg (RNI)	10 mg (RNI)	110 µg (RNI)	NA (RNI)	NA (RNI)	600 mg (RNI)	NA
Australia, New Zealand	4-8 years	All	400 µg (RDI)	5 µg (AI)	10 mg (RDI)	4 mg (RDI)	90 µg (RDI)	2300 mg (AI)	300-600 mg (AI)	700 mg (RDI)	1.1 mg (AI)
Canada	4-8 years	All	400 µg (RDA)	15 µg (AI)	10 mg (RDA)	5 mg (RDA)	90 µg (RDA)	3800 mg (AI)	1200 mg (AI)	1000 mg (RDA)	1 mg (AI)
USA	4-8 years	Girls	400 mg RAE (RDA)	600 IU (RDA)	10 mg (RDA)	5 mg (RDA)	NA (RDA)	3800 mg (AI)	1900 mg (AI)	1000 mg (RDA)	NA
USA	4-8 years	Boys	400 mg RAE (RDA)	600 IU (RDA)	10 mg (RDA)	5 mg (RDA)	NA (RDA)	3800 mg (AI)	1900 mg (AI)	1000 mg (RDA)	NA
UK	4-6 years	All	400 µg (RNI)	10 µg (RNI)	6.1 mg (RNI)	6.5 mg (RNI)	100 µg (RNI)	1100 mg (RNI)	1.2 g (RNI)	450 mg (RNI)	NA

Figure 8. Recommendations for key nutrients for infants, children, and adolescents, across different countries (Hollis et al., 2020).

Besides the amounts of recommended nutrients, the following Figure 9 provides a recommended average number of daily servings from each of the five food groups across different countries (Hollis et al., 2020). As shown in Figure 9, both Australia and Greece recommend 1 serving of fruits every day for 2-3 years old children. It can also be observed that different countries also share similarities regarding to recommended numbers of daily servings of foods.

Country	Age group	Sex	Vegetables and legumes/beans	Fruit	Grain (cereal) foods, mostly wholegrain	Lean meat and poultry, fish, eggs, nuts and seeds, and legumes/beans	Milk, yoghurt, cheeses and alternatives (mostly reduced fat)
Australia	1-2 years	All	2-3 servings	½ servings	4 servings	1 servings	1-½ servings
Greece	1-2 years	All	1 serving	1 serving	2 servings	3-4 servings/week (meat and poultry 40-60g), 2 servings/week (seafood 60g), 4-7 eggs/week, 1-2 servings/week (legumes 40-60g)	2 servings
Australia	2-3 years	All	2½ servings	1 serving	4 servings	1 servings	1½ servings
Greece	2-3 years	All	1 serving	1 serving	3 servings	2-3 servings/week (meat and poultry 60g), 2 servings/week (seafood 60-90g), 4-7 eggs/week, ≤3 servings/week (legumes 60-90g)	2 servings
New Zealand	2-5 years	All	2 servings	2 servings	4 servings	2-3 servings	1-2 servings
Oman	1-5 years	All	1.5 c	2 c	0.5 c (whole), 2 c (refined)	60 g (meat), 0.5 c (legume)	0.3 c
Australia	4-8 years	Boys	4½ servings	1½ servings	4 servings	1½ servings	2 servings
Australia	4-8 years	Girls	4½ servings	1½ servings	4 servings	1½ servings	1½ servings
Greece	4-8 years	All	1-2 servings	1-2 servings	4-5 servings	2-3 servings/week (meat and poultry 60-90g), 2-3 servings/week (seafood 90-120g), 4-7 eggs/week, 3 servings/week (legumes 90-120g)	2-3 servings
New Zealand	5-12 years	All	3 servings	2 servings	5 servings	2-3 servings	1-2 servings
Oman	6-14 years	All	2.5 c	3 c	1 c (whole), 3 c (refined)	100 g (meat), 1 c (legume)	0.5 c
Australia	9-11 years	Boys	5 servings	2 servings	5 servings	2½ servings	2½ servings
Australia	9-11 years	Girls	5 servings	2 servings	4 servings	2½ servings	3 servings
Greece	9-13 years	All	2-3 servings	2-3 servings	5-6 servings	2-3 servings/week (meat and poultry 90-120g), 2-3 servings/week (seafood 120-150g), 4-7 eggs/week, >3 servings/week (legumes 120-150g)	3-4 servings
Australia	12-13 years	Boys	5½ servings	2 servings	6 servings	2½ servings	3½ servings
Australia	12-13 years	Girls	5 servings	2 servings	5 servings	2½ servings	3½ servings
New Zealand	12-18 years	All	3 servings	2 servings	6 servings	3 servings	2 servings
Australia	14-18 years	Boys	5½ servings	2 servings	7 servings	2½ servings	3½ servings
Australia	14-18 years	Girls	5 servings	2 servings	7 servings	2½ servings	3½ servings
Oman	14-18 years	Boys	4.5 c	5 c	1.5 c (whole), 4.5 c (refined)	130 g (meat), 1 c (legume)	1 c
Oman	14-18 years	Girls	4 c	4 c	1 c (whole), 4 c (refined)	100 g (meat), 1 c (legume)	0.5 c

Figure 9. Recommended average number of daily servings from each of the five food groups by age across different countries (Hollis et al., 2020).

Finally, the following Figure 10 provides an example for dietary patterns of healthy child and adolescent diets by age group recommended by different countries (Hollis et al., 2020). It can be observed that different countries usually recommend different detailed items of foods, which is reasonable since people probably have different eating cultures and habits in

different places. It is also worth noting that different specific foods could contain the same nutrients, such as animal proteins widely exist in different meats including pork, beef and chicken (Stokstad and Jukes, 1950), which provides flexibilities for designing and recommending detailed diets for children healthy eating.

Table 4
Example dietary patterns of healthy child and adolescent diets by age group recommended by different countries including the UK ([e Children's Food Trust for Public Health England, 2017](#)), New Zealand ([Ministry of Health, 2015](#)), [National Health and Medical Research Council, 2013a](#), Kenya (Republic of Kenya Ministry of Health, 2010) and Cambodia ([Foundation for Interventional Development/Relief et al, 2017](#)).

Age group	1 years	1-4 years	3 years	6-9 years	6 years	11 years	13-17 years
Country Breakfast	Kenya Whole milk, cereal, fruit	UK ½ hard-boiled egg ½ cup tomatoes ½ wholemeal bread and spread, ½ banana ½ cup milk or water	New Zealand 2 Weetbix ½ banana 1 piece of toast with margarine and vegetables ½ cup trim milk ½ cup low fat milk	Australia 2 Weetbix ½ banana ½ banana with raisins ½ banana with margarine	New Zealand 2 wheat biscuits ½ cup low fat calcium enriched milk	New Zealand 2 wheat biscuits ½ cup low fat calcium enriched milk	Cambodia 240g cooked rice, ½ duck egg, 10g marinated fried pork, 30g cucumber, 1 ½ banana, 300 ml milk
Mid-morning snack	Whole milk, fruit	½ cup yoghurt with sliced grapes ½ cup milk or water	2 crackers 2 slices of cheese 2 slices of tomato ½ cup reduced fat milk (1.5%)	2 rice cakes with margarine and cheese ½ cup water	1 plum 1 potte yoghurt ½ cup water	1 banana 1 piece of toast 2 tbsp peanut butter 1 cup water 1 raw carrot 1 small box of raisins 4 tsp hummus 1 cup Water	-
Lunch	Whole milk, mashed staple, vegetables, minced meat/mashed legume	½ cup pork ragu (or soya and apple ragu) 1-2 new potatoes ½ cup broad beans and courgettes ½ cup pineapple upside down pudding with custard	1 small bread roll 1 tsp margarine 1 slice of cheese ½ cup pumpkin soup ½ apple ½ cup water	1 chicken and salad sandwich cordial	1 small bread roll 1 tsp margarine 50g canned tuna 2 slices of beetroot 2 tbsp grated carrot 1 lettuce leaf 1 tsp mayonnaise ½ cup water	2 slices wholemeal bread 2 tsp margarine 1 boiled egg 1 tsp low-fat mayonnaise ½ cup salad with cheese 1 potte fruit yoghurt 1 cup Water	240g cooked rice, 45g fish, 90g pumpkin/ivygoourd/waxgourd
Mid-afternoon snack	Whole milk, fruit	½ cup mashed avocado ½ pitta bread ½ cup milk or water	½ grated apple 2 plain biscuit ½ cup water	100g low fat fruit yoghurt 2 milk arrowroot biscuits	1 slice wholemeal bread 2 slices cheese ½ tsp yeast based spread ½ cup trim milk	1 pear 1/3 cup baked beans 1 tsp margarine 1 piece of toast 1 cup water	30g sweet potato
Tea/Dinner	Whole milk, cereal/ proteins, vegetables	½ cup pasta ½ cup beans and peas ½ cup rice pudding with peach purée	1 small chicken fillet 1 small Kumara ½ cup mixed vegetables ½ cup water	2 small chops ½ cup mashed potato ½ cup broccoli and carrots ½ cup water	1 medium chicken fillet ½ cup rice ½ cup broccoli ½ cup mixed vegetables ½ cup water	¾ cup stewed lean beef mince ½ cup bolognese sauce 1 cup boiled pasta ½ cup corn kernels ½ cup cooked Silverbeet 1 cup water 1 cup low fat calcium enriched milk	240g cooked rice, 20g pork belly, amarantha, 100g sapodilla
Evening snack	-	1 cup of milk 2-4 tbsp canned fruit	½ cup chopped fresh fruit salad 2 tbsp yoghurt	1 cup of low fat milk	½ cup apple crumble 1 small scoop ice cream	-	-

Figure 10. Example dietary patterns of healthy child and adolescent diets by age group recommended by different countries (Hollis et al., 2020).

Results from another study (Ramsay et al., 2012) are shown in the below Figures 11 and 12, which present several widely accepted approaches for recommending diets for children. As shown in Figure 11, for grains, both the methods of CACFP and MyPyramid recommend about $\frac{1}{2}$ slice bread and $\frac{1}{4}$ c cereal. Also, as shown in Figure 12, both the methods of T/y and MyPyramid recommend similar amounts of fat consumption for both female and male 2

years old children. According to these results, it can be concluded that different approaches for food recommendations also share similarities in terms of serving sizes and consumption of nutrients (Ramsay et al., 2012).

Table 1
Serving sizes for the T/y, CACFP, and MyPyramid approaches.

Food group	2 years of age	3 years of age	4 years of age	5 years of age
T/y ^a	Serving size – 2 TBSP	Serving size – 3 TBSP	Serving size – 4 TBSP	Serving size – 5 TBSP
Breads and grains	1/2 slice bread, 1/4 c pasta or cereal	1/2 slice bread, 1/4 c pasta or cereal	1 slice bread or 1/2 c pasta or cereal	1 slice bread or 1/2 c pasta or cereal
Vegetables	2 TBSP	3 TBSP	4 TBSP	5 TBSP
Fruit	2 TBSP	3 TBSP	4 TBSP	5 TBSP
Dairy	1/2 c	1/2 c	3/4 c	3/4 c
Meat and meat substitute	2 TBSP	3 TBSP	4 TBSP	5 TBSP
CACFP	Breakfast (Br): must include two of the five food groups, snack (Sn): select two (milk, fruit/vegetable, meat, or bread), lunch/dinner (Lu): must include all food groups			
Breads and grains	1/2 slice bread, 1/4 c cooked or dry cereal	1/2 slice bread, 1/4 c cooked cereal, 1/3 c dry cereal	1/2 slice bread, 1/4 c cooked cereal, 1/3 c dry cereal	1/2 slice bread, 1/4 c cooked cereal, 1/3 c dry cereal
Vegetables	Br: 1/4 c Sn: 1/2 c Lu: 1/4 c	Br and Sn: 1/2 c Lu: 1/2 c	Br and Sn: 1/2 c Lu: 1/2 c	Br and Sn: 1/2 c Lu: 1/2 c
Fruit	Br: 1/4 c Sn: 1/2 c Lu: 1/4 c	Br and Sn: 1/2 c Lu: 1/2 c	Br and Sn: 1/2 c Lu: 1/2 c	Br and Sn: 1/2 c Lu: 1/2 c
Dairy	Br, Sn, and Lu: 1/2 c	Sn: 1/2 c Br and Lu: 3/4 c	Sn: 1/2 c Br and Lu: 3/4 c	Sn: 1/2 c Br and Lu: 3/4 c
Meat and meat substitute	1/2 oz meat/cheese, 1 egg, 1/4 c beans, 2 TBSP peanut butter, 1/2 c yogurt	1/2 oz meat/cheese, 1 egg, 3/8 c beans, 3 tbsp peanut butter, 3/4 c yogurt	1/2 oz meat/cheese, 1 egg, 3/8 c beans, 3 TBSP peanut butter, 3/4 c yogurt	1/2 oz meat/cheese, 1 egg, 3/8 c beans, 3 TBSP peanut butter, 3/4 c yogurt
MyPyramid calories ^b	Serving sizes for 1000 calories	Serving sizes for 1200 calories	Serving sizes for 1400 calories	Serving sizes for 1400 calories
Grains	1/2 slice bread, 1/4 c pasta or cereal	1/2 slice bread, 1/4 c pasta or cereal	1 slice bread or 1/2 c pasta or cereal	1 slice bread or 1/2 c pasta or cereal
Vegetables	2-3 TBSP	2-3 TBSP	3-4 TBSP	3-4 TBSP
Fruit	1/2 small pc	1/2 small pc	1/2-1 small pc	1/2-1 small pc
Dairy	1/2 c	1/2 c	3/4 c	3/4 c
Meat and meat substitute	1 oz	1 oz	1 oz	1 oz

^a T/y recommendation adapted from Lowenberg (1993).

^b Children are assumed to be moderately active.

Figure 11. Serving sizes for the T/y, CACFP, and MyPyramid approaches (Ramsay et al., 2012).

Table 2
Energy and fat contents of menus for young children using tablespoon per year (T/y), MyPyramid, and Child and Adult Care Food Program (CACFP) serving size approaches.

Females			Males				
Age	Approach	Calories' kcal (MJ) mean ± SD	Percent EER [*] (%)	Fat ^{**} (g/d) mean ± SD	Calories' kcal mean ± SD	Percent EER (%)	Fat ^{**} (g/d) mean ± SD
2 year old	EER [*]	972 (4.07)	–	32-43	1093 (4.57)	–	36-49
	T/y	860 ± 200 (3.60)	89	25 ± 8	860 ± 200 (3.60)	79	25 ± 8
	MyPyramid	950 ± 120 (3.97)	98	26 ± 8	950 ± 120 (3.97)	87	26 ± 8
	CACFP	970 ± 260 (4.06)	99	26 ± 11	970 ± 260 (4.06)	88	26 ± 11
3 year old	EER [*]	1219 (5.10)	–	41-54	1313 (5.49)	–	44-58
	T/y	870 ± 170a (3.64)	72	24 ± 8	870 ± 170 ^a (3.64)	67	24 ± 8 ^a
	MyPyramid	1250 ± 190 ^b (5.23)	102	35 ± 11	1410 ± 210 ^b (5.90)	107	40 ± 11 ^b
	CACFP	1310 ± 280 ^b (5.48)	107	33 ± 13	1310 ± 280 ^b (5.48)	99	33 ± 14 ^{a,b}
4 year old	EER [*]	1278 (5.35)	–	28-50	1371 (5.74)	–	31-53
	T/y	1150 ± 250 ^b (4.81)	90	30 ± 9	1150 ± 250 ^b (4.81)	84	30 ± 9
	MyPyramid	1410 ± 210 ^b (5.90)	110	40 ± 11	1410 ± 210 ^b (5.90)	103	40 ± 11
	CACFP	1310 ± 280 ^b (5.48)	102	33 ± 14	1310 ± 280 ^b (5.48)	95	33 ± 14
5 year old	EER [*]	1356 (5.67)	–	30-52	1441 (6.03)	–	32-56
	T/y	1200 ± 250 (5.02)	89	31 ± 10	1200 ± 250 (5.02)	83	31 ± 10
	MyPyramid	1410 ± 210 (5.90)	104	40 ± 11	1410 ± 210 (5.90)	98	40 ± 11
	CACFP	1310 ± 280 (5.48)	96	33 ± 14	1310 ± 280 (5.48)	91	33 ± 14

Values with different superscripts are significantly different at the $p \leq .01$ level.

^{*} Institute of Medicine (IOM) Estimated Energy Requirements using sex-and-age adjusted 50th percentile for height and weight on the Center for Disease Control growth charts.

^{**} Fat intake Acceptable Macronutrient Distribution Range (AMDR) from IOM Dietary Guidelines.

Figure 12. Energy and fat contents of menus for young children using tablespoon per year (T/y), MyPyramid, and Child and Adult Care Food Program (CACFP) serving size approaches (Ramsay et al., 2012).

4.2 Existing Measures to Address Children Nutrition Issues

4.2.1 Worldwide Measures

In 1989, the United Nations Children's Fund (UNICEF) published the “Convention on the Rights of the Child”, which is an international human rights treaty, setting out “the civil, political, economic, social, health and cultural rights of children” (UNICEF, 1989).

According to the “Convention on the Rights of the Child”, to provide children with “adequate nutritious foods and clean drinking-water” is necessary and critical “to combat disease and malnutrition” (UNICEF, 1989).

To guarantee the provision of adequate nutritious foods, the actions in the current food systems are twofold (Keeley et al., 2019c). On the one hand, it aims to help families, children and adolescents to increase their demand for nutritious food from a demand perspective. On the other hand, food providers need to be encouraged to do the right things for children by providing healthy food that is more accessible, affordable, safe and convenient (Keeley et al., 2019c).

4.2.2 Measures in China

In 2017, General Office of the State Council of China has announced the issuance of China’s National Nutrition Plan for 2017 to 2030 (information resource, in Chinese, https://www.chinacdc.cn/jkzt/yyhspws/xzdc/201707/t20170720_148174.html). The plan emphasised the importance of integrating nutritional intervention into health and poverty alleviation work, and encouraged local governments to carry out nutritional and dietary guidance according to local conditions. Some general strategies for improving the implementation of the plan are as follows, to enhance nutrition and food safety monitoring

and assessment, to strengthen the sharing and utilisation of basic data on nutrition and health, and to popularise nutrition and health knowledge, etc. The plan also set up goals for addressing children nutrition issues specifically, such as before 2030, the rate of anemia in children under 5 years old should be controlled below 10%, and growth stunting rates in children under 5 should fall below 5%, and so on (information resource, in Chinese, https://www.chinacdc.cn/jkzt/yyhspws/xzdc/201707/t20170720_148174.html).

4.3 Children Nutrition Apps

On September 1, 2022, searching for the key words “children nutrition” on the UK iOS App Store platform, the results showed that 60 apps in total were identified as “children nutrition” and were available for download. Among those apps, 90% of them are free, while 6 apps required an upfront payment with average number of £4.27 (range £0.89 to £10.99). Three representative and popular apps are briefly introduced below.

Among the searched apps, the most downloaded one is “Annabel Karmel”, as shown in Figure 13, which provides a handy and simple mealtime guide. People need to pay £5.99 before using it. The app contains more than 300 number of recipes, the ingredients of which are available to users. The app integrated an interactive speaker and many other features. Child caregivers can make children’s foods following video and voice instructions. However, the biggest issue that makes this app unsuitable for child caregivers in poor areas of China is that the it is not affordable in backward areas of China due to the fees required.



Figure 13. The nutritional app, “Annabel Karmel”.

Another popular app is called “Food Buying Guide for CNP”, as shown in Figure 14. This is a food buying guide for the child nutrition program developed in the USA. The app is free and has many useful features. For example, users can create a list of favorite foods such that they can save foods and check their details. People can compare different foods, and create shopping lists, etc. The overall style of design and use is simple and straightforward, with a lot of food pictures. The very important thing about this app, making it not suitable for Chinese caregivers in poor areas, is that the app contains much text information and many English nutritional terminologies, which are difficult for child caregivers with low education levels to understand.

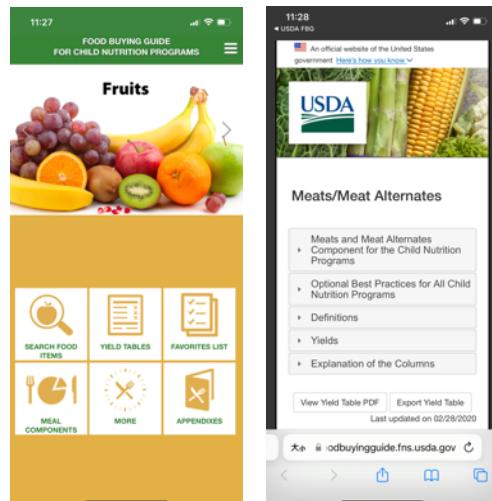


Figure 14. The nutritional app, “Food Buying Guide for CNP”.

The following Figure 15 shows another app, called “Easy Bites Child Nutrition”, which is a science-driven app created by a team of feeding and nutrition experts. It provides research-driven food menus and feeding tutorials, with daily tips and videos which illustrate how to safely introduce new things to children. What makes this app not suitable for Chinese caregivers is that the recipes are designed to be of western styles and thus are not suitable for the Chinese diets.

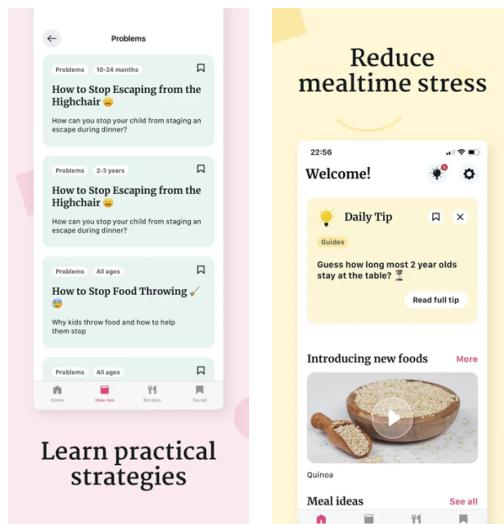


Figure 15. The nutritional app, “Easy Bites Child Nutrition”.

4.4 Chinese Children Nutrition Apps

A recent study on infant health and feeding apps in China (Zhao et al., 2017) showed that “a total of 4,925 apps were screened, and 26 apps that met the selection criteria were evaluated. All 26 apps were developed by commercial entities, and most of them were rated poorly. The highest overall score was 62.2 (out of 100) and the lowest was 16.7. None of the four quality areas assessed met all accountability criteria. 3 of the 26 apps provided information covering

the three practices in the World Health Organisation's infant feeding recommendations. 20 of the 26 apps promoted infant formula banner ads on their homepage. In addition, 12 apps included e-commerce stores and featured infant formula ads.”

According to the research, it has been shown that children feeding apps in China are of deep concern, especially in terms of being lack of scientific footings and nutrition guidance, as well as the large number of commercials displayed (Zhao et al., 2017). Therefore, it is arguably difficult for child caregivers in areas of China to choose a reliable children nutrition and feeding app.

4.5 Other Studies and Techniques

As mentioned in above sections, many children nutrition apps with high quality can be found on international app platforms. However, they are not suitable for Chinese caregivers for different reasons. On the other hand, existing Chinese children nutrition and feeding apps are of low quality, not satisfying scientific nutrition standard and being mixed with commercial advertisements. In general, it is difficult for child caregivers in poor areas of China to find a reliable nutrition guidance app.

This subsection keeps looking at other existing studies on children nutrition apps, to further understand what kind of properties should be considered or not by designers of children nutrition apps for child caregivers in poor areas of China.

An existing study (Burrows et al., 2015) reviewed 27 children's apps (for ages 12+) available for download in Australia in April 2015. The apps were searched by using the key word “nutrition”, summarising the features of the apps reviewed. Figure 16 shows the summarised

some common characteristics of existing children nutrition apps.

Table 2 The most common characteristics of downloadable nutrition apps that could be classified available for paediatric management (n = 27)

App features	n	%
1. Nutrition components		
Based on dietary/nutritional guidelines	3	11
Promote energy balance	12	44
Promote water as a drink	9	33
Focus on portion size	15	56
Self-monitoring (daily/weekly/monthly)	11	41
Information on the nutrient database used	7	26
2. Physical activity/sedentary behaviour components		
Promote regular exercise	3	11
Self-monitoring	6	22
Decrease sedentary behaviour	1	4
Based on physical activity guidelines	1	4
GPS capability to track distance/time	2	7
3. Lifestyle components (generic)		
Mood tracking/emotional eating	4	15
Mindful eating	17	63
Barriers to change	18	67
Family involvement	8	30
4. Tools/features		
Meal plan/recipes/shopping list	8	30
Bar code scanner	1	4
Nutrition information panel reader/interpreter	1	4
Goal setting (general)	15	56
5. Social networking (forums, activity feeds, blogs)	2	7

Figure 16. The most common characteristics of downloadable nutrition apps that could be classified available for paediatric management (Burrows et al., 2015).

Among these characteristics, for children aged 2 to 5 years, two of these functions are worth reflecting on. First, “focus on portion size”, i.e., it is suggested that apps should specify portion sizes of meals. It has been shown by research that children’s perception of portion sizes appears to be influenced by the height and volume of foods (Fisher et al., 2007). And to ensure that children receive adequate daily nutrition, apps should contain detailed food recommendations down to exact number of grams for at most six meals every day, seven days every week, for eight or nine major food groups. Second, apps should care about “goal setting”. In studies of health behavior change, setting appropriately difficult goals would lead to higher performance (Strecher et al., 1995). Finally, given some child caregivers in poor areas of China are with low education levels or even do not know how to read (Tan et al.,

2020), a third important point is to include pictures in the application, which could be very helpful for caregivers to understand nutrition guidance easily.

4.6 Summary

To briefly summarise, Section 4.1 reviews some common knowledge and widely used experiences in children healthy eating, while Section 4.2 reviews existing measures in the world and China for addressing current issues of children health and nutrition. Sections 4.3 and 4.4 introduce existing children nutrition and feeding apps available on international and Chinese platforms, analysing their advantages and ill-suitedness for child caregivers in poor areas of China. Sections 4.5 keeps looking at existing studies to further understand other important techniques and characteristics of children nutrition apps.

The main points of this section are as follows. First, existing children nutrition apps available on international app platforms are of high scientific quality but not suitable for child caregivers in poor areas of China for different reasons. Second, existing Chinese children nutrition and feeding apps are not reliable and not good enough to be used to guide child feeding practices. Third, existing studies suggest some other important characteristics which are worth paying attention in designing apps for child caregivers in poor areas of China.

Chapter 5 – Approach

5.1 User-centred Design

Throughout the whole procedure of designing app interfaces and functions, I followed the high-level ideas of user-centred design methods. As Don Norman said (Norman 2013), “People are so adaptable that they are capable of shouldering the entire burden of accommodation to an artifact, but skillful designers make large parts of this burden vanish by adapting the artifact to the users.” To gain a deeper insight into the specific needs of child caregivers in poor areas of China, as shown in Sections 3 and 4, I conducted multidisciplinary research from different information resources, including literature, existing apps, newspapers and reports, to analyse specific conditions in poor areas of China relevant to child feeding.

For designing the app, as shown in Section 4, I investigated a number of children nutrition apps on different platforms to check and compare their advantages and disadvantages. Some apps have nice interfaces but are not suitable for Chinese eating habits (such as “Easy Bites Child Nutrition” as shown in Figure 15), while some other apps have scientifically designed recipes but are difficult for child caregivers in poor areas to use since they are full of nutritional terminologies (such as “Food Buying Guide for CNP” as shown in Figure 14). The design was completed in four iterations, where in the first and second iterations the designed was optimised and improved according to results of heuristic evaluations, and in the third and fourth iterations user feedbacks were collected from participants.

For the main theme of the app, I used green color, which is considered to be calming, soothing, happy and a sign of health. Green is believed to relieve stress and aid in healing (O’Connor et al., 2011), which is also the second color preference for women (Mikellides et

al., 2012). It is stated by Tom Porter that the same green is the most preferred color for the 60-90 years old in Oxford (Porter and Mikellides, 2019).

During the first two iterations, heuristic evaluation has been conducted to improve the designs, using Nielsen's ten usability heuristics for user interface design (Nielsen, 1994).

During the last two iterations, real users are asked to use the app and provide their user experiences. Four people who had child feeding experiences and common knowledge about nutrition were asked for feedback regarding the design and functions of the app. Each design iteration was presented to them for further improvement of the designs based on feedbacks.

5.2 System Design

5.2.1 Gather Initial Requirement

As aforementioned, initial requirements of child caregivers' feeding practices in poor areas of China are collected from research on existing apps and literature studies. Existing nutrition apps provide a reasonable starting point for designing requirements of children feeding apps in general. In most existing apps on widely used platforms such as iOS App Store, everyday food recipes and recommendations, as well as food lists and budgets are main functions.

According to main functions of existing children nutrition apps, I concluded that the preliminary requirements would include:

- Everyday food recipes and recommendations
- Favorite food lists with food information
- Food budgets

According to scientific recommendations and the nutritional calculations such as those experiences shown in Figures 8 to 12, and considering ingredients available in most Chinese local markets, I also design some food recipes and recommendations.

As mentioned before, in poor areas some additional requirements are needed since child caregivers there often have low education levels and experience difficulties reading and understanding food recipes and recommendations. Therefore, I added the following additional requirements:

- Cartoon pictures of foods
- Visualisation of numbers, such as pie charts

Based on the use cases as shown later, I created a diagram as shown in Figure 17.

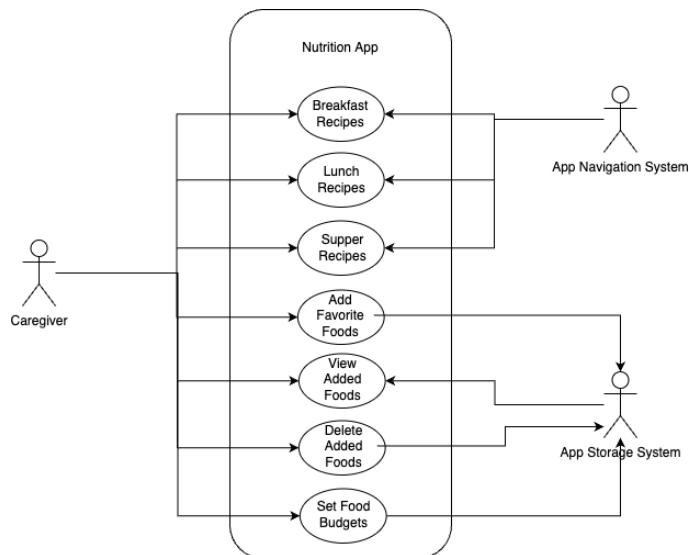


Figure 17. Use case diagram for the app.

Use Case 1: Breakfast recipes

Description:

Caregivers request to view recommendations for breakfast recipes.

Start Condition:

Caregivers opened the app and are on the main screen of the app.

Basic Flow:

1. Click on the Recipes button in the bottom tab bar
2. The app returns a screen with recipe options
3. Click on the Breakfast button in the top tab bar
4. The app navigates to the recipe page for breakfasts in all days of one week
5. Click on the day (Monday to Sunday) in the page
6. The app shows the recommended breakfast recipes

Use Case 2: Lunch recipes

Description:

Caregivers request to view recommendations for lunch recipes.

Start Condition:

Caregivers opened the app and are on the main screen of the app.

Basic Flow:

1. Click on the Recipes button in the bottom tab bar
2. The app returns a screen with recipe options
3. Click on the Lunch button in the top tab bar
4. The app navigates to the recipe page for lunches in all days of one week
5. Click on the day (Monday to Sunday) in the page
6. The app shows the recommended lunch recipes

Use Case 3: Supper recipes

Description:

Caregivers request to view recommendations for supper recipes.

Start Condition:

Caregivers opened the app and are on the main screen of the app.

Basic Flow:

1. Click on the Recipes button in the bottom tab bar

2. The app returns a screen with recipe options
3. Click on the Supper button in the top tab bar
4. The app navigates to the recipe page for suppers in all days of one week
5. Click on the day (Monday to Sunday) in the page
6. The app shows the recommended supper recipes

Use Case 4: Add favorite foods

Description:

Caregivers request to add foods into their favorite lists.

Start Condition:

Caregivers opened the app and are on the main screen of the app.

Basic Flow:

1. Click on the Add button in the bottom tab bar
2. The app returns a screen with food categories
3. Click on one food category tag
4. The app navigates to list of foods
5. Click on the specific food tag
6. The app shows the information of the selected food
7. Click on “Add this food” button

8. The app navigates to the favorite page and shows the added food

Use Case 5: View added foods

Description:

Caregivers request to viewed foods which were already added into their favorite lists.

Start Condition:

Caregivers opened the app and are on the main screen of the app. Caregivers already added some foods into their favorite lists.

Basic Flow:

1. Click on the Favorite button in the bottom tab bar
2. The app returns a screen with favorited foods
3. Click on one food in the favorite list
4. The app shows information of the selected added food

Use Case 6: Delete added foods

Description:

Caregivers request to delete foods which were added into their favorite lists.

Start Condition:

Caregivers opened the app and are on the main screen of the app. Caregivers already added some foods into their favorite lists.

Basic Flow:

1. Click on the Favorite button in the bottom tab bar
2. The app returns a screen with favorited foods
3. Click on one food in the favorite list
4. The app shows information of the selected added food
5. Click on the Delete button in the added food page
6. The app returns to the favorite list of foods, and the deleted food is no longer listed

Use Case 7: Set food budgets**Description:**

Caregivers request to set food budgets for the current month.

Start Condition:

Caregivers opened the app and are on the main screen of the app.

Basic Flow:

1. Click on the Budget button in the bottom tab bar
2. The app returns a screen displaying the current monthly budget
3. Click on the “Set monthly budget” button in the middle of the page
4. The app navigates to the monthly budget setting page
5. Use the sliders to change the budget to the wanted number and click “Save” button
6. The app returns back to the budget screen and displays the selected budget number

5.2.2 Activity Diagrams

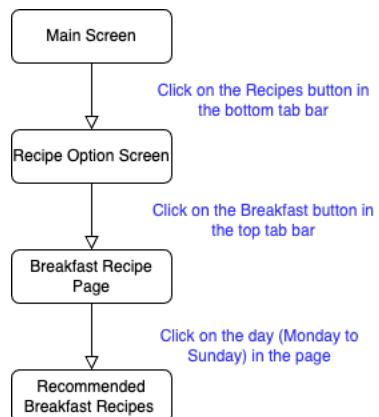


Figure 18. Activity Diagram – Breakfast Recipes.

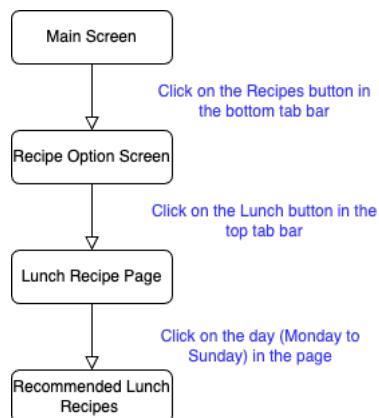


Figure 19. Activity Diagram – Lunch Recipes.

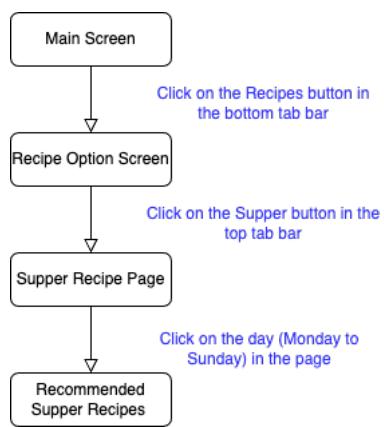


Figure 20. Activity Diagram – Supper Recipes.

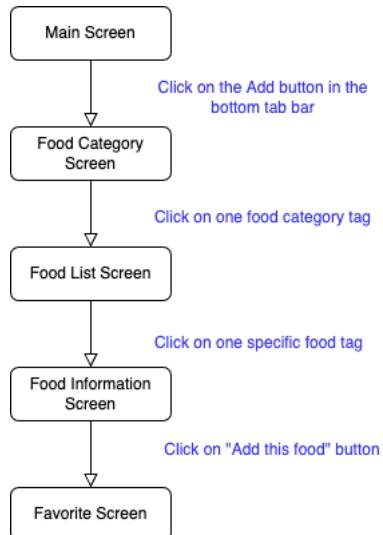


Figure 21. Activity Diagram – Add Favorite Foods.

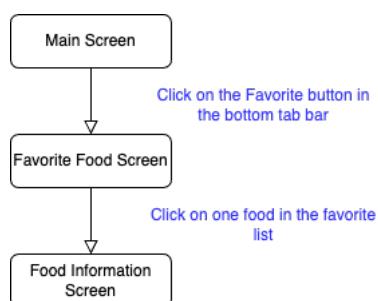


Figure 22. Activity Diagram – View Added Foods.

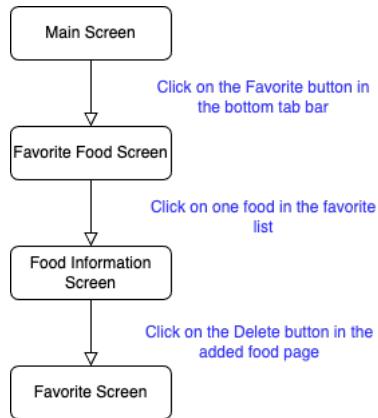


Figure 23. Activity Diagram – Delete Added Foods.

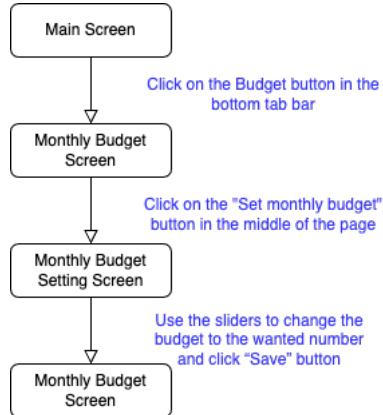


Figure 24. Activity Diagram – Set Food Budgets.

5.3 User Interface Design

According to the initial requirements, I designed the interfaces of the app using Figma software, as shown in the following Figure 25.

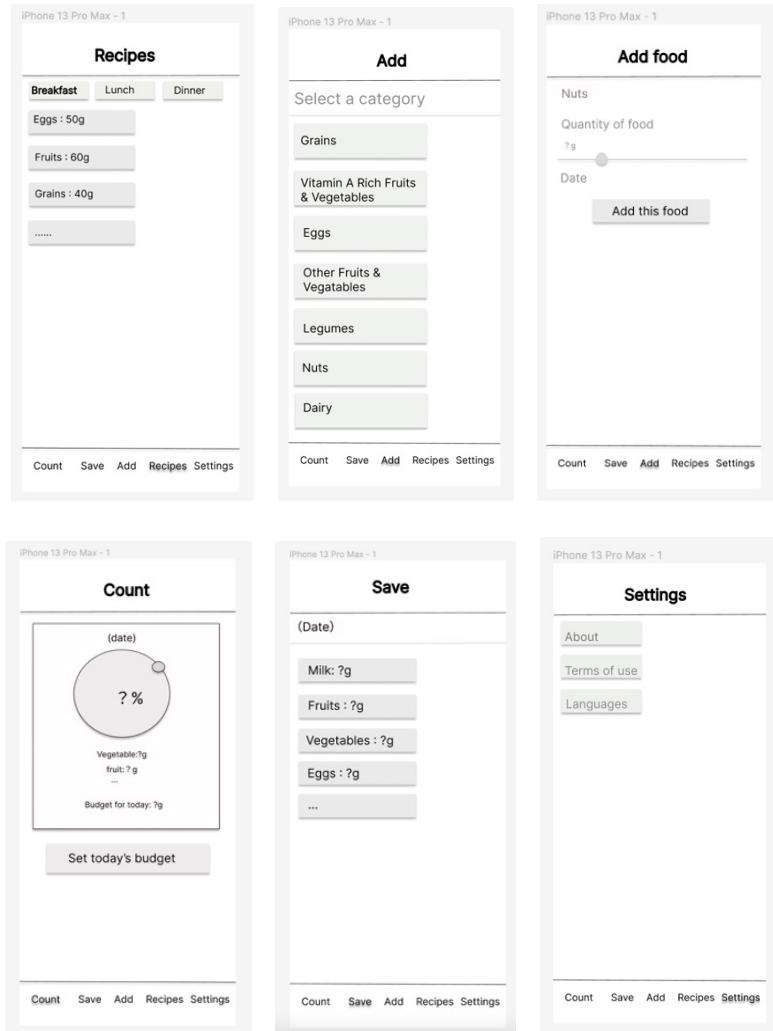


Figure 25. First design for user interfaces, including food recipes page, add food pages, food budget pages, and settings page.

Figure 25 shows the low-fidelity initial sketches for pages which correspond to main functions. It contains five main functions, i.e., food recipes and recommendations, adding foods into lists, food budgets, checking saved foods, and setting page. This design aims to make the user interfaces simple and easy to use. It is used as the starting point and will be further refined during iterations, such as adding comfortable color configurations, and displaying with higher fidelity.

5.4 Heuristic Evaluation and Analysis

To investigate whether the above initial designs and functions are reasonably good, I conducted heuristic evaluation using Nielsen's ten usability heuristics for user interface design (Nielsen, 1994), where the rating scale consists of five choices, i.e., Very good, Good, Moderate, Fair, and Poor. The heuristic evaluation results are as follows. For detailed descriptions of ratings, “+” means advantages of the current design, while “--” follows by some weaknesses or missing points, which could be taken to improve the design in subsequent iterations.

Heuristic Principle	Rating	Description
Visibility of system status	Good	<p>+ The bottom tab appears in every page with five main functions displayed, and this makes users to be always aware of the current status of the system.</p> <p>+ Every page has a title at the top center, which keeps users informed which main function is being used.</p> <p>-- The bottom tab bar design could choose to use simple icons. First, the page titles and bottom bar texts are mostly same. Second, pictures and icons could be more friendly and easier for users to recognize.</p> <p>-- There could be some highlight on selected tabs to make it more clear to users</p>

		about the current status of the system.
Match between system and the real world	Good	<ul style="list-style-type: none"> + The system mostly meets users' habits in reality. For example, there are no many confusing nutrition terminologies. + The page design is simple and direct, which makes it clear and easy to view. The pie charts for budgets are clear and easy to understand. -- Some texts could still be complicated and confusing possibly for some child caregivers with low education levels. It would be better to add pictures for different food categories.
User control and freedom	Moderate	<ul style="list-style-type: none"> + The buttons in the bottom tab are convenient for users to navigate and switch between different pages in an efficient way. -- There could be some more designs for users' convenience. For example, a "get back to last page" button could be added. -- For some functions, such as add favorite food, users need to click three times to select food category, sub-category, and food amount. There could be some mistakes, and without an option of

		undoing would make the control not easy.
Consistency and standards	Very good	+ Phrases used have consistent names and meanings on all the pages, such as Save, Add, Recipes, Breakfast, Lunch, Dinner, and food categories.
Error prevention	Good	+ The design mostly requires users to only press buttons, which eliminate most error-prone conditions due to being static. -- Users can add foods, and it is reasonable they should also be able to delete foods. Errors could happen in this scenario and should be handled.
Recognition rather than recall	Moderate	+ Users can add foods into the saved food list, which makes users do not need to remember foods. -- There is also a count or budget page, and it would be useful if the calculation is automatically completed once foods are added to make users not need to remember budgets. -- Foods are displayed in different categories, which makes sense. However, that means users need to remember which category a specific food belongs to.
Flexibility and efficiency of use	Good	+ The system is user-friendly for both new

		<p>and experienced users.</p> <p>-- There could be some shortcuts for efficiency of use if necessary.</p>
Aesthetic and minimalist design	Very good	<ul style="list-style-type: none"> + The pages contain only necessary information and are clean and straightforward. + Different pages have similar layouts. + Same color theme is used with different tones to keep minimalistic look. + Button shapes are simple and widgets are clearly displayed and separated. + Most functions only require users to click less than three times to complete.
Help users recognize, diagnose, and recover from errors	Very good	<ul style="list-style-type: none"> + When foods are added, the app is then directed to the favorite food page, which clearly indicates users if they make right choices.
Help and documentation	Good	<ul style="list-style-type: none"> + There are pages for about, and terms of use information. -- There could also be instructions and quick guides for using the app.

According to the heuristic evaluation, the main design and functions are reasonable, which achieved good or sometimes very good ratings. However, there are also spaces for improvement. The second version of design incorporates the results of the heuristic

evaluations, keeping good designs while adding or changing suggested features. The new design of interfaces is shown in the following Figure 26.

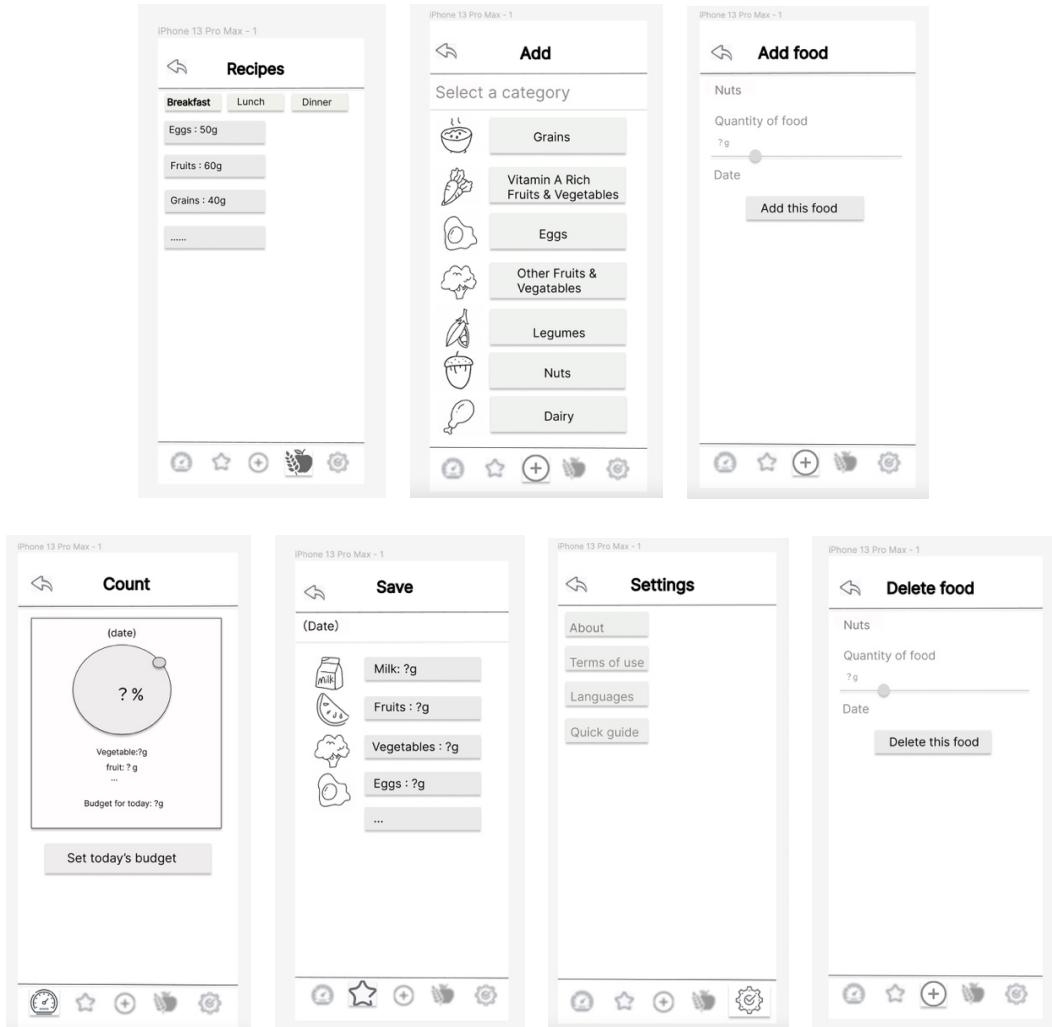


Figure 26. The second version of design after heuristic evaluation.

As shown in Figure 26, there are several major changes. First, features like the bottom tab and page title remain unchanged as in the first version since they help users understand the current status of the system, while the bottom bar now uses icons rather than texts to avoid redundancy with the page title texts. Details about the pictures are presented in Appendix 1. Moreover, the selected page's icon is highlighted to make the current status clear to users. Second, useful visualization tools like pie charts are kept, and pictures are added for food

categories, which make it easier for users to understand their meanings, especially for caregivers with low education levels. Third, to make users control and recover from mistaken clicks, an undo choice for getting back to last page with an arrow icon is added at top left on each page. Fourth, a page for deleting added foods is provided, and users can remove foods which they do not want to keep. Finally, a quick guide item is added in the settings page to provide relevant information for using the app.

Chapter 6 – Implementation

Given the initial design which has been refined after the results of heuristic evaluations, I implemented the app that can be run on the widely used iOS platform. Since I had experience of using JavaScript during my master study, I chose to use the React Native framework to build my app, where a similar language TypeScript is used for the implementation of the app.

Each screen displayed in the application is a component function, which consists of core React Native components, TSX and style functions with files. These screens were imported into the main App.tsx file to be compiled into a multi-page application.

Most information in the app has English version, which is for assessment. Some information also has Chinese version, which is for further use by target child caregivers from poor areas of China. Since child caregivers in poor areas may have low levels of education and some do not have capability of word recognition. Therefore, many pictures of foods are included in the app interfaces.

6.1 Code Structure

The code structure of the project is shown in the following Figure 27. The app package contains the main components, which will be illustrated into details later. The assets package contains necessary resources, such as font configurations and image files.

```

    < app
      > components
      > constant
      > ducks
      > interfaces
      > navigation
      > redux
      > screens
      > style
      > types
      > utils
      > assets

```

Figure 27. Code structure of the project.

The app/components directory contains all used components in the app, including but not limited to buttons, lists, html images, icons, and customized components, such as clickable panel with images contained. The app/constant directory contains links for image resources and global layout parameters such as spacing and screen width and height. The app/navigation directory contains navigation between different pages using react-navigation. The app/screens directory contains files implementing each screen in the app. The app/style directory contains configurations such as fonts and colors. The app/utils directory contains strings for frequently used words in the app.

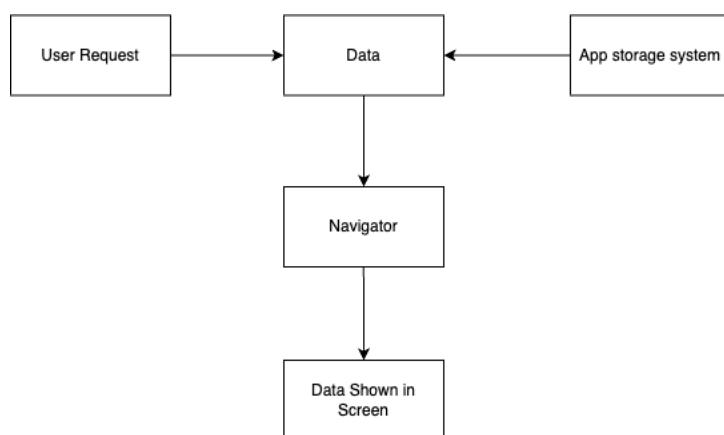


Figure 28. Software Architecture Diagram of the Nutrition App.

6.2 Main Functions

As shown in Figure 25, there are five main pages in the initial design, and a bottom tab appeared in every page to make it easy for users to understand the current system status and to switch between different pages efficiently.

6.2.1 Bottom Tab

The bottom tab is shown in Figure 29. It contains the tabs for the five main functions of the app, i.e., budget, favorite, add, recipes, and settings.

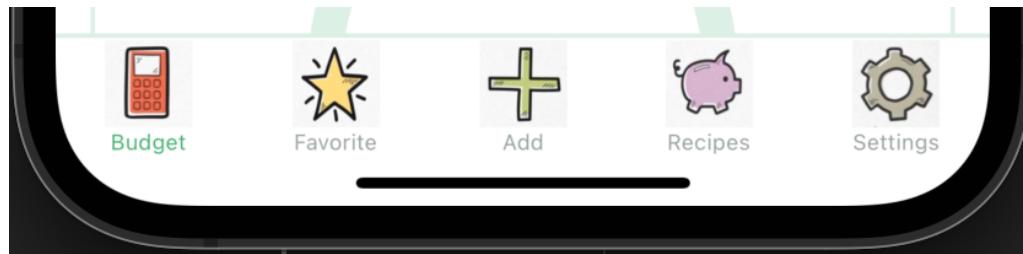


Figure 29. Bottom Tab of the app.

As shown in Figure 30, in the app/navigation package, the file BottomTabNavigator.tsx, and the files under Navigator/BottomTab directory are used for generating the bottom tabs.

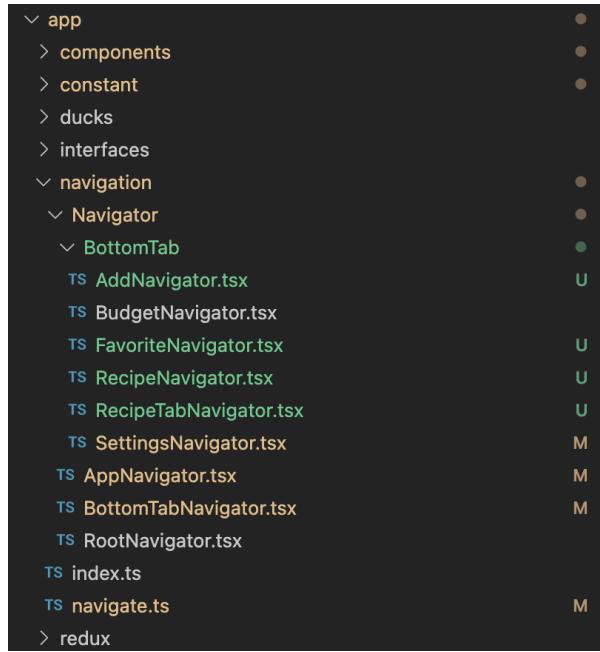


Figure 30. Navigator files for generating the bottom tabs.

In particular, as shown in Figure 31, the following code in BottomTabNavigator called all the five navigators and generated the five tabs.

```

const BottomTabNavigator = (): React.ReactElement => {
  const { bottom } = useSafeAreaInsets();
  return (
    <BottomTab.Navigator
      initialRouteName="FavoriteNavigator"
      tabBarOptions={{
        activeTintColor: Colors.green50,
        inactiveTintColor: Colors.grey40,
        style: {
          backgroundColor: Colors.white,
          borderTopWidth: 2,
          borderTopColor: Colors.green10,
          paddingBottom: bottom / 2 + 6,
        },
      }}
    >
      <BottomTab.Screen
        name="BudgetNavigator"
        options={BudgetOptions}
        component={BudgetNavigator}
      />
      <BottomTab.Screen
        name="FavoriteNavigator"
        options={FavoriteOptions}
        component={FavoriteNavigator}
      />
      <BottomTab.Screen
        name="AddNavigator"
        options={AddOptions}
        component={AddNavigator}
      />
      <BottomTab.Screen name="Recipe" options={RecipeOptions} component={RecipeNavigator} />
      <BottomTab.Screen
        name="SettingsNavigator"
        options={SettingsOptions}
        component={SettingsNavigator}
      />
    </BottomTab.Navigator>
  );
};

```

Figure 31. BottomTabNavigator code.

6.2.2 Budget Module

As shown in the Bottom Tab in Figure 29, which appears in every screen of the app, the system design contains five main functionalities, where the first main function is the budget module. As shown in Figure 32, BudgetNavigator is called in BottomTabNavigator to navigate the page to the budget screen. The code for BudgetNavigator is shown in Figure 31, which generates the budget screen.

```
const BudgetNavigator = (): React.ReactElement => (
  <Stack.Navigator>
    <Stack.Screen
      name="Budget"
      options={BudgetScreen.navigationOptions}
      component={BudgetScreen}
    />
    <Stack.Screen
      name="MonthlyBudget"
      options={MontlyBudgetScreen.navigationOptions}
      component={MontlyBudgetScreen}
    />
    <Stack.Screen
      name="AddFavorite"
      options={AddFavoriteScreen.navigationOptions}
      component={AddFavoriteScreen}
    />
  </Stack.Navigator>
);
```

Figure 32. BudgetNavigator code.

Clicking on the Budget tab in Figure 29, the app will navigate to the budget screen, as shown in Figure 33. The budget page consists of three major parts, which are monthly budget, “Set monthly budget” button, and yearly budget, as shown in the budget screen. Users can check the total monthly and yearly budgets of foods, and how many percent of budgets has already been taken, which is visualized in the pie chart in Figure 33.

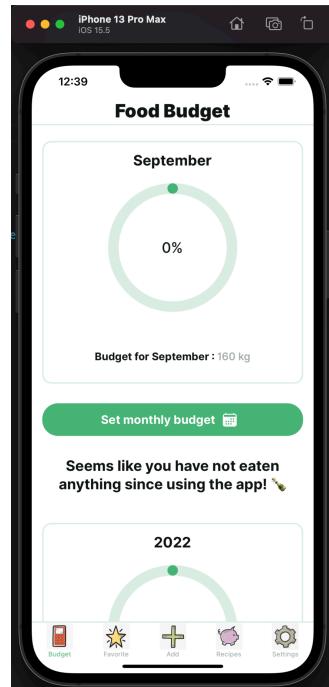


Figure 33. The budget screen page.

As shown in Figure 32, BudgetScreen is called in BudgetNavigator first to generate the budget screen. Figure 34 shows the returned three parts in BudgetScreen code. As shown in Figure 34, the monthly budget and yearly budget are implemented using a ProgressChart component, while the “Set monthly budget” button is implemented using a Button component.

```

return (
  <ScrollView style={styles.container}>
    <ProgressChart
      isMonth
      totalCalories={totalCurrentMonthCalories}
      otherfruitCalories={otherfruitCurrentMonthCalories}
      grainCalories={grainCurrentMonthCalories}
      vitaminaCalories={vitaminaCurrentMonthCalories}
      freshfoodsCalories={freshfoodsCurrentMonthCalories}
      dairyCalories={dairyCurrentMonthCalories}
      eggsCalories={eggsCurrentMonthCalories}
      legumesCalories={legumesCurrentMonthCalories}
      dessertCalories={dessertCurrentMonthCalories}
      nutsCalories={nutsCurrentMonthCalories}
      monthlyCaloriesBudget={monthlyCaloriesBudget}
    />
    <Button.Primary
      icon="calendar"
      style={styles.monthlyBudgetButton}
      fullWidth
      text={t("BUDGET_SCREEN_SET_MONTHLY_BUDGET")}
      onPress={() => navigator.openMonthlyBudget()}
    />
    <NumberOfDaysVegetarian />
    <ProgressChart
      totalCalories={totalCurrentYearCalories}
      otherfruitCalories={otherfruitCurrentYearCalories}
      grainCalories={grainCurrentYearCalories}
      vitaminaCalories={vitaminaCurrentYearCalories}
      freshfoodsCalories={freshfoodsCurrentYearCalories}
      dairyCalories={dairyCurrentYearCalories}
      eggsCalories={eggsCurrentYearCalories}
      legumesCalories={legumesCurrentYearCalories}
      dessertCalories={dessertCurrentYearCalories}
      nutsCalories={nutsCurrentYearCalories}
      monthlyCaloriesBudget={monthlyCaloriesBudget}
    />
  </ScrollView>
);

```

Figure 34. BudgetScreen code.

The code for the ProgressChart component is shown in Figure 35, which uses Progress.Circle in react-native-progress to display the pie chart in Figure 33, and Legend and PeriodBudget components to display the texts for used budget.

```

return (
  <View style={styles.container}>
    <View style={styles.periodContainer}>
      <Text.H3 style={styles.header}>{period}</Text.H3>
      <Progress.Circle
        animated={false}
        showsText
        strokeCap="round"
        textStyle={styles.textPourcentage}
        thickness={16}
        color={totalCaloriesRatio > 1 ? Colors.apricot : Colors.green50}
        unfilledColor={Colors.green10}
        borderColor="transparent"
        borderWidth={2}
        progress={totalCaloriesRatio}
        size={circleSize}
      />
    </View>
    <Legend
      totalCalories={totalCalories}
      otherfruitCalories={otherfruitCalories}
      grainCalories={grainCalories}
      vitaminaCalories={vitaminaCalories}
      freshfoodsCalories={freshfoodsCalories}
      dairyCalories={dairyCalories}
      eggsCalories={eggsCalories}
      legumesCalories={legumesCalories}
      dessertCalories={dessertCalories}
      nutsCalories={nutsCalories}
    />
    <PeriodBudget period={period} periodCaloriesBudget={periodCaloriesBudget} />
  </View>
);

```

Figure 35. ProgressChart component code.

Clicking the button “Set monthly budget” will navigate to the following page, as shown in Figure 36. Users can check the recommended budgets as shown in the text, and they can also use the sliders to change the budget to the wanted number.

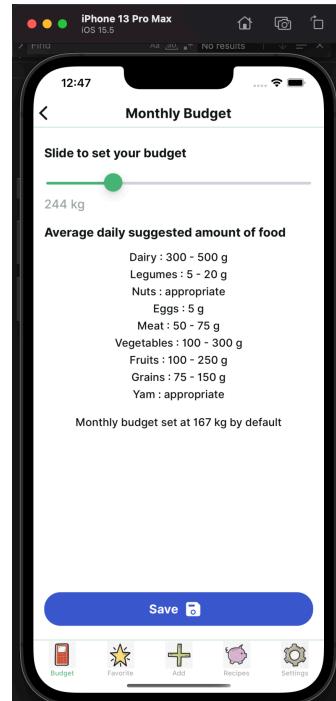


Figure 36. Set monthly budget page.

As shown in Figure 34, the navigation after clicking “Set monthly budget” button is implemented using the onPress() function openMonthlyBudget. As shown in Figure 37, the openMonthlyBudget function will push the MonthlyBudget screen, which was called in BudgetNavigator, as shown in Figure 32.

```
const openMontlyBudget = (navigation) => (props = {}) => {  
  |   navigation.push("MonthlyBudget", props);  
};
```

Figure 37. openMonthlyBudget function code.

In Figure 36, select a budget number using the slider and click “Save” will return back to the budget screen, and the selected budget number will display, as shown in Figure 38. Compared with Figure 33, the total budget number displayed is changed.

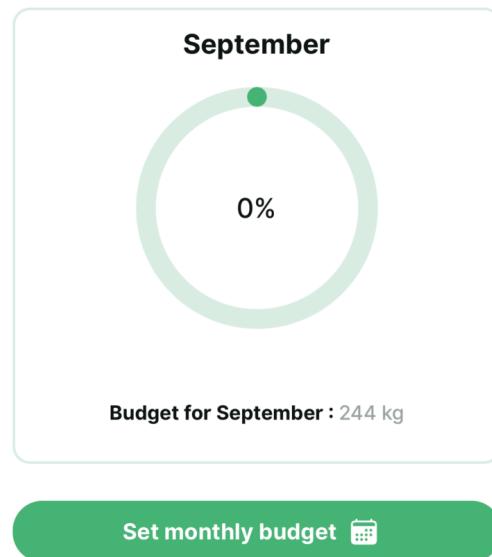


Figure 38. Saved budget number.

6.2.3 Favorite Module

In Figure 29, the effect of selecting the favorite tab is as shown in Figure 39. Users can check their favorite list of foods. When the favorite food list is empty (users have not added any favorite food yet), the page displayed a button to remind users to add food into the favorite list.

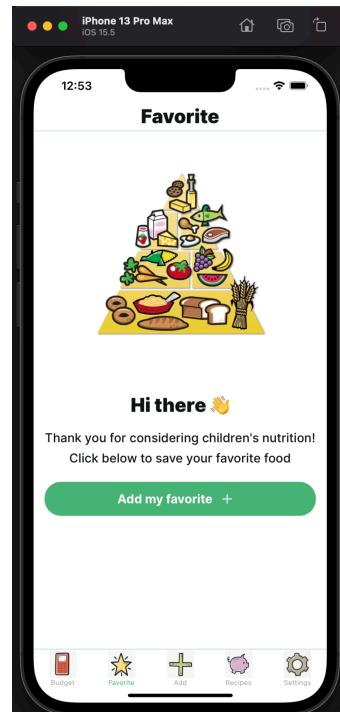


Figure 39. The favorite screen.

As shown in Figure 31, FavoriteNavigator is called in BottomTabNavigator to show navigate the page to the favorite screen. The code for FavoriteNavigator is shown in Figure 40, which generates the favorite screen.

```
const FavoriteNavigator = (): React.ReactElement => (
  <Stack.Navigator>
    <Stack.Screen
      name="FavoritesScreen"
      options={FavoritesScreen.navigationOptions}
      component={FavoritesScreen}
    />
    <Stack.Screen
      name="FavoriteItem"
      options={FavoriteItemScreen.navigationOptions}
      component={FavoriteItemScreen}
    />
    <Stack.Screen
      name="MonthlyFoods"
      options={MonthlyFoodsScreen.navigationOptions}
      component={MonthlyFoodsScreen}
    />
    <Stack.Screen
      name="RecurringFoods"
      options={RecurringFoodsScreen.navigationOptions}
      component={RecurringFoodsScreen}
    />
  </Stack.Navigator>
);
```

Figure 40. FavoriteNavigator code.

6.2.4 Add Module

In Figure 29, clicking the button “Add my favorite” will navigate to the following add page, as shown in Figure 41. Users can check the food category list, which contains different types of foods.

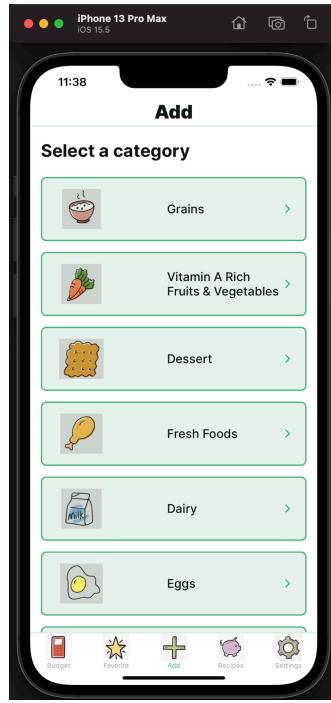


Figure 41. The add screen.

As shown in Figure 31, AddNavigator is called in BottomTabNavigator to show navigate the page to the favorite screen. The code for AddNavigator is shown in Figure 42, which generates the add screen.

```
const AddNavigator = (): React.ReactElement => (
  <Stack.Navigator>
    <Stack.Screen
      name="CategorySelection"
      options={CategorySelectionScreen.navigationOptions}
      component={CategorySelectionScreen}
    />
    <Stack.Screen
      name="SubCategorySelection"
      options={SubCategorySelectionScreen.navigationOptions}
      component={SubCategorySelectionScreen}
    />
    <Stack.Screen
      name="AddFavorite"
      options={AddFavoriteScreen.navigationOptions}
      component={AddFavoriteScreen}
    />
```

Figure 42. AddNavigator code.

Figure 43 shows the code of CategorySelectionScreen, which is called first in AddNavigator in Figure 42. As can be seen in Figure 43, the effect of food category list in Figure 41 is implemented using ScrollView component in react-native, and each food category tab is implemented using Tag component for each type of predefined food, where each Tag component consists of one image and one text component. Each Tag also contains an onPress function which is defined by openSubCategorySelection.

```

const onPress = ({ foodType }) => {
  navigator.openSubCategorySelection({ foodType });
};

return (
  <ScrollView style={styles.container}>
    <Text.H2 style={styles.info}>{t("CATEGORY_SELECTION_SCREEN_SELECT_CATEGORY")}</Text.H2>
    {categories.map((category, index) =>
      <Tag
        key={index}
        imageicon={category.imageicon}
        text={ui.getTranslationFoodsType(category.foodType)}
        onPress={() => onPress(category)}
      />
    )));
    <View style={styles.separator}>
    </View>
  </ScrollView>
);

```

Figure 43. CategorySelectionScreen code.

As shown in Figure 44, the openSubCategorySelection function will push the SubCategorySelection screen, which was called in AddNavigator, as shown in Figure 42.

```

const openSubCategorySelection = (navigation) => (props = {}) => {
  navigation.push("SubCategorySelection", props);
};

```

Figure 44. openSubCategorySelection function code.

The detailed implementation of Tag component is shown in Figure 45. It uses TouchableOpacity in react-native, as well as ImageIcon component for food pictures, Text component for food category names, and Ionicons component for the arrow at rightmost, as

we have seen in its effect shown in Figure 41.

```
const Tag: React.FC<Props> = ({ text, onPress, icon, imageicon }) => {
  let iconItem = null;
  let imageiconItem = null;

  if (icon) {
    iconItem = <Ionicons name={icon} size={32} style={styles.mainIcon} color={Colors.green50} />;
  }

  if (imageicon) {
    imageiconItem = <ImageIcon sticker={imageicon} />;
  }

  return (
    <TouchableOpacity onPress={onPress} style={styles.container}>
      {iconItem}
      {imageiconItem}
      <View style={styles.textContainer}>
        <Text.Primary style={styles.text}>{text}</Text.Primary>
      </View>
      <Ionicons name="chevron-forward" size={20} color={Colors.green50} />
    </TouchableOpacity>
  );
};
```

Figure 45. Tag component code.

6.2.5 Recipe Module

In Figure 29, the effect of selecting the recipes tab is as shown in Figure 46. Users can check every day's recommended recipes for breakfast, morning tea, lunch, afternoon tea, supper, and evening snack.

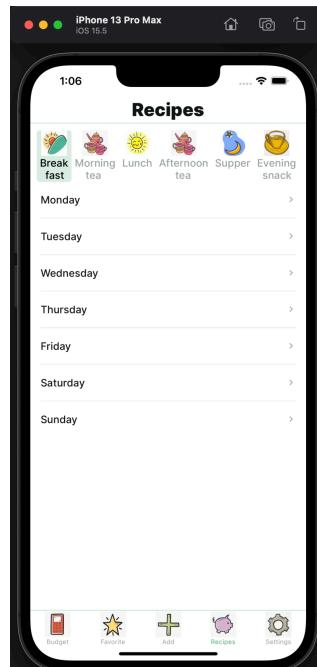


Figure 46. The recipes screen.

As shown in Figure 31, RecipeNavigator is called in BottomTabNavigator to show navigate the page to the favorite screen. The code for RecipeNavigator is shown in Figure 47, which generates the recipes screen.

```
const RecipeNavigator = (): React.ReactElement => (
  <Stack.Navigator>
    <Stack.Screen
      name="RecipeTabNavigator"
      options={RecipeTabNavigator.navigationOptions}
      component={RecipeTabNavigator}
    />
    <Stack.Screen
      name="RecipeDetail"
      component={RecipeDetailScreen}
      options={RecipeDetailScreen.navigationOptions}
    />
  </Stack.Navigator>
);
```

Figure 47. RecipeNavigator code.

In particular, as shown in Figure 48, the code for RecipeTabNavigator is first called in RecipeNavigator in Figure 47 to generate the top tab in Figure 46. RecipeTabNavigator returns Tab components, which are created using createMaterialTopTabNavigator function in react-navigation/material-top-tabs. Each Tab component uses a key in the variable tabs.

```
const RecipeTabNavigator: NavStatelessComponent = () => (
  <Tab.Navigator tabBar={(props) => <TopTabBar {...props} />}>
    {tabs.map((tab) => (
      <Tab.Screen key={tab} name={tab} component={RecipeScreen} options={{ tabBarLabel: tab }} />
    ))}
  </Tab.Navigator>
);
```

Figure 48. RecipeTabNavigator code.

As shown in Figure 49, tabs variable is created by reading keys from GuideCategory, which

is imported from the directory of app/types/guide.

```
const tabs = Object.keys(GuideCategory);  
  
import { GuideCategory } from "../../types/guide";
```

Figure 49. tabs variable and GuideCategory import code.

As shown in Figure 50, the GuideCategory enum contains six strings, i.e., “Breakfast”, “Morning tea”, “Lunch”, “Afternoon tea”, “Supper”, and “Evening snack”, which are what have been shown in Figure 46.

```
export enum GuideCategory {  
  breakfast = "Break\n fast",  
  morningtea = "Morning\n tea",  
  lunch = "Lunch",  
  afternoontea = "Afternoon\n tea",  
  supper = "Supper",  
  eveningsnack = "Evening\n snack",  
}  
  
export interface Guide {  
  title: string;  
  category: GuideCategory;  
  body: string;  
  key: string;  
}
```

Figure 50. app/types/guide.ts.

Another screen called in RecipeNavigator in Figure 47 is RecipeDetailScreen, and its code is shown in Figure 51. RecipeDetailScreen uses a HTML component to display recipes. The recipe content is displayed by enumerating pre-stored key-value pairs, and for each of them using a Tab component, where the key is the type of meals, and the value is day in one week, and the page content is also pre-defined in strings with HTML grammars, such that the

HTML can display them.

```
return (
  <ScrollView style={styles.container}>
    <HTML
      source={{ html: body }}
      contentWidth={contentWidth}
      onLinkPress={ui.onHTMLBodyLinkPress}
      baseFontStyle={baseFontStyle}
      renderers={{
        img: (attribs) => {
          const [img] = [attribs.src]
          return <HTMLImage uri={img} key={img} />;
        },
      }}
    />
  </ScrollView>
);
```

Figure 51. RecipeDetailScreen code.

6.2.6 Settings Page

In Figure 29, the effect of selecting the settings tab is as shown in Figure 52. The page is created by simply returning two sub-pages and one image component.



Figure 52. The settings screen.

As shown in Figure 31, SettingsNavigator in BottomTabNavigator to show navigate the page to the favorite screen. The code for SettingsNavigator is shown in Figure 53, which generates the settings screen.

```
const SettingsNavigator = (): React.ReactElement => (
  <Stack.Navigator>
    <Stack.Screen
      name="Settings"
      options={SettingsScreen.navigationOptions}
      component={SettingsScreen}
    />
    <Stack.Screen
      name="About"
      options={AboutScreen.navigationOptions}
      component={AboutScreen}
    />
    <Stack.Screen
      name="Languages"
      options={LanguagesScreen.navigationOptions}
      component={LanguagesScreen}
    />
  </Stack.Navigator>
);
```

Figure 53. SettingsNavigator code.

As shown in Figure 54, SettingsScreen is first called in SettingsNavigator in Figure 53.

SettingsScreen uses a ListItem component for several tabs such as about and language, as well as an Image component to display the app logo, as can be seen from Figure 52.

```
const rowItems = [
  {
    title: t("SETTINGS_SCREEN_ABOUT"),
    onPress: navigator.openAbout,
  },
  {
    title: t("SETTINGS_SCREEN_HEALTHY_DIET"),
    onPress: () => WebBrowser.openBrowserAsync("https://en.wikipedia.org/wiki/Healthy_diet"),
  },
];

if (__DEV__) {
  rowItems.push({
    title: t("SETTINGS_SCREEN_LANGUAGES"),
    onPress: navigator.openLanguages,
  });
}

const [steps, setSteps] = useState(0);

return (
  <ScrollView style={styles.container}>
    {rowItems.map((item, index) => (
      <ListItem
        key={index}
        showBottomLine={index !== rowItems.length - 1}
        onPress={item.onPress}
        title={item.title}
      />
    ))}
    <TouchableWithoutFeedback onPress={() => setSteps(steps + 1)}>
      <View style={styles.logoContainer}>
        <Image style={styles.logo} resizeMode="contain" source={ImagesAssets.logos.logo} />
      </View>
    </TouchableWithoutFeedback>
  </ScrollView>
);
```

Figure 54. SettingsScreen code.

6.3 Demonstration of the App

The above section demonstrates the implemented main functions, i.e., checking recipes and food recommendations, adding favorite foods, checking favorite food lists, checking food budgets, and setting pages, which is a high-fidelity version of the design in Figure 26. A brief demonstration of the implementation is as follows.

6.3.1 Add Favorite Foods

In Figure 41, selecting the first “Grains” tag will navigate to the following sub-category page as shown in Figure 55. As shown in Figure 44, this navigation is implemented by openSubCategorySelection function. The page is created similarly to the previous page of Figure 41 by calling Tag components in Figure 45 for all the pre-defined sub-categories of foods.

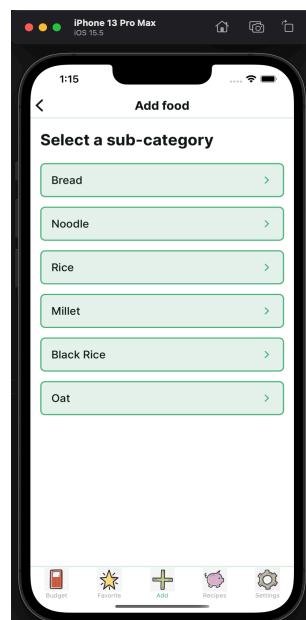


Figure 55. The “Grains” sub-category page.

Select the “Bread” tag, the result is shown in Figure 56. Users can check the food’s category and sub-category and its name. There displays a slider, which enables users to select the amount of food to be added.

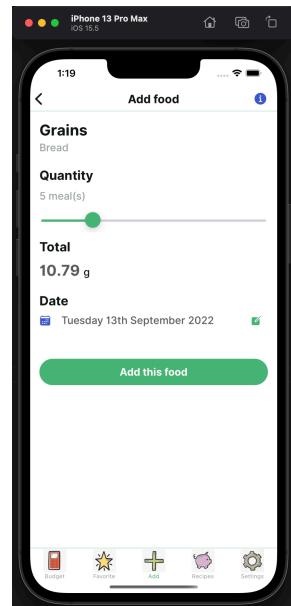


Figure 56. The add food page for “Bread”.

Use the slider to select the amount of food, and click “Add this food”, then the page will automatically navigate to the favorite page, as shown in Figure 57. Users can then check the added food’s name and amount.

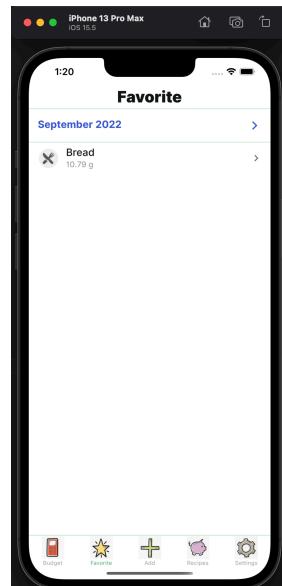


Figure 57. The favorite page after adding foods.

6.3.2 Checking Food Budget

Clicking the “Budget” bottom tab now will show the following results in Figure 58. Users now can check the updated used budget.

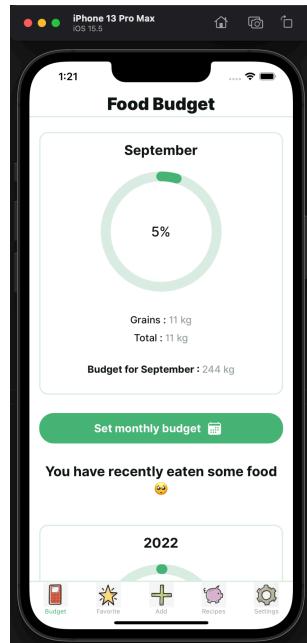


Figure 58. The budget page after adding foods.

6.3.3 Checking and Deleting Favorite Foods

Select the added favorite food in Figure 57, the results are shown in Figure 59. Users can also delete the added food as well as check the food’s basic information as before.

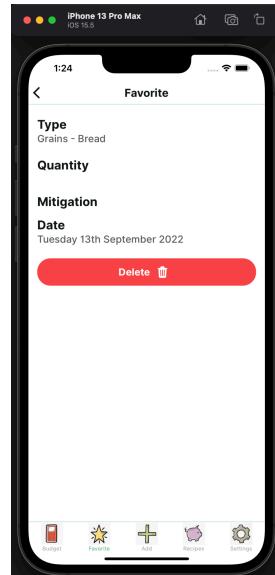


Figure 59. The selected added favorite food.

Click “Delete” button, the added food will be removed, and the result now is the same as shown in Figure 38.

6.3.4 Checking Recipes

Click “Tuesday” in Figure 46, the result is shown in Figure 60. Users can check the text information which provides recommendations for the specific chosen day and meal. As mentioned around Figure 51, this is implemented by RecipeDetailScreen using HTML components to display strings written in HTML grammars.

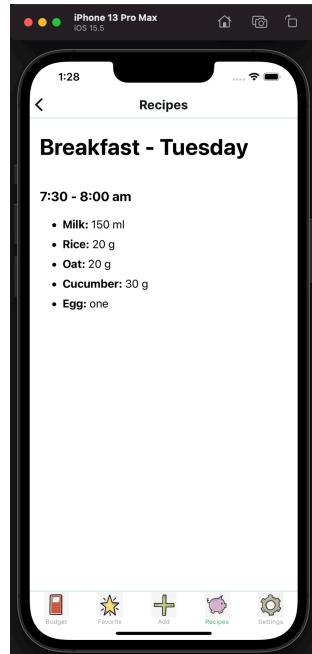


Figure 60. Recipes for Tuesday breakfasts.

6.4 Deployment of the App

The app is deployed using expo. Users need to use iPhone and download the “Expo Go” app.

After I start running the program in my computer, a scan code will be generated. I then provide users the scan code, and users can use iPhone camera app to scan the code. The “Expo Go” app will then load and run the nutrition app.

Chapter 7 – Evaluation

7.1 Testing

Chapter 6 demonstrates the implementation of the app based on the initial design and refined design in Chapter 5. Before conducting real user evaluation, the app was checked to ensure that it is functional and has no or minimal bugs. Demonstration of the app in Chapter 6 show that the main functions of the app are implemented as designed.

7.2 Real User Evaluation

7.2.1 Online Survey

As part of the user-centred design procedure, online surveys were conducted to collect data from real users after using the implemented app. The survey was approved by the Cardiff School of Computer Science and Informatics Ethics Committee before it was released. The documents for approval are shown in Appendix 2 for completeness.

User Study		INSTRUCTION for interviewers																					
<p>Before I show you the app, I would like to know:</p> <ul style="list-style-type: none"> • Do you already know or use nutrition apps? If yes - which ones? • According to the information you had so far: How would you like the app to work, or what features would you like the app to have? <p>Now we come to the actual app test: We will check six important goals and functions of the app step by step!</p> <table border="1"> <thead> <tr> <th>Aims of the App</th> <th>Instruction for interviewers</th> </tr> </thead> <tbody> <tr> <td>1. View main pages and functions in the app - Question: What is your first impression of the app?</td> <td>take time, encourage to explore and view everything</td> </tr> <tr> <td>2. Find recipes for breakfast, lunch and supper in the app</td> <td>Encourage them to look at the buttons, fields and contents</td> </tr> <tr> <td>3. Add favorite foods</td> <td></td> </tr> <tr> <td>4. View and delete favorite foods</td> <td></td> </tr> <tr> <td>5. Check food budgets</td> <td></td> </tr> </tbody> </table> <table border="1"> <thead> <tr> <th>Completion & Questions</th> <th>Answer</th> </tr> </thead> <tbody> <tr> <td> <ul style="list-style-type: none"> • After looking at the main functions of the app, do you consider the app has potential to benefit caregivers' child feeding, in terms of ease of use, and providing nutritional suggestions for meals? </td> <td></td> </tr> <tr> <td> <ul style="list-style-type: none"> • Are your expectations fulfilled? • Do you think the app lacks any important features? • If yes - which ones? </td> <td></td> </tr> <tr> <td> <ul style="list-style-type: none"> • Do you find any of the functions superfluous? • If yes - which ones? </td> <td></td> </tr> </tbody> </table>				Aims of the App	Instruction for interviewers	1. View main pages and functions in the app - Question: What is your first impression of the app?	take time, encourage to explore and view everything	2. Find recipes for breakfast, lunch and supper in the app	Encourage them to look at the buttons, fields and contents	3. Add favorite foods		4. View and delete favorite foods		5. Check food budgets		Completion & Questions	Answer	<ul style="list-style-type: none"> • After looking at the main functions of the app, do you consider the app has potential to benefit caregivers' child feeding, in terms of ease of use, and providing nutritional suggestions for meals? 		<ul style="list-style-type: none"> • Are your expectations fulfilled? • Do you think the app lacks any important features? • If yes - which ones? 		<ul style="list-style-type: none"> • Do you find any of the functions superfluous? • If yes - which ones? 	
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<p>Intermittent questions (as often as possible)</p> <table border="1"> <tr> <td><i>What are you looking at?</i></td> </tr> <tr> <td><i>What do you notice?</i></td> </tr> <tr> <td><i>What arouses your interest?</i></td> </tr> <tr> <td><i>What would you like to do next?</i></td> </tr> <tr> <td><i>How would you rate the font size, color contrast and visibility of the operating elements, as well as the operating structure?</i></td> </tr> <tr> <td><i>What did you like?</i></td> </tr> <tr> <td><i>What problems have occurred?</i></td> </tr> <tr> <td><i>What could be improved?</i></td> </tr> <tr> <td><i>What is your overall impression?</i></td> </tr> <tr> <td><i>How do you rate the quality of picture, and how easy it is to understand?</i></td> </tr> <tr> <td><i>How does the design of the app work? What stands out, what bothers you?</i></td> </tr> </table>				<i>What are you looking at?</i>	<i>What do you notice?</i>	<i>What arouses your interest?</i>	<i>What would you like to do next?</i>	<i>How would you rate the font size, color contrast and visibility of the operating elements, as well as the operating structure?</i>	<i>What did you like?</i>	<i>What problems have occurred?</i>	<i>What could be improved?</i>	<i>What is your overall impression?</i>	<i>How do you rate the quality of picture, and how easy it is to understand?</i>	<i>How does the design of the app work? What stands out, what bothers you?</i>									
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<i>How does the design of the app work? What stands out, what bothers you?</i>																							

Figure 61. Data collection form of user surveys.

Figure 61 shows the tasks and questions in the survey for users after using the app. The tasks are mainly using the main functions and pages, while the questions are with respect to the page designs, functions, and usability of the app.

7.2.2 Recruiting Participants

As approved by the Cardiff School of Computer Science and Informatics Ethics Committee, school email lists and social media are used to recruit participants for user evaluation, as shown in Figure 62.

Dear friends,
For my dissertation I am working on a project entitled “Designing an Interactive Application to Support Caregivers’ Feeding Practices of Young Children in Poor Areas of China”. I am looking for any volunteers who are interested in helping me evaluate my application.
During the evaluation, I will share a link to access my application, and you would need to check most interfaces of this application. After using it, I will ask you some questions about your experience with the application’s user interface e.g., picture quality, features, aesthetics, etc. The whole process may take up to 20 minutes.
I will show you personal information sheet and consent form. If you are interested, please contact me. This is my email address: TianY37@Cardiff.ac.uk. I would be very grateful if you would like to be a participant for my user evaluation!
Best wishes,

Figure 62. Twitter post for recruiting participants.

5 participants were recruited to use the app, including 3 males and 2 females, and among them 4 people are students at Cardiff university.

7.2.3 User Data

As shown in Figure 61, we ask participants to use the main functions of the app, and for their opinions of the app. The major goals for the experiments are to understand,

1. If the designed app interfaces are aligned with their habits of using apps
2. If the designed functions are enough to satisfy expectations for nutrition apps
3. If the recommended foods in the app contain enough nutrition and are easy to obtain
4. If the app contains superfluous functions

In particular, the first part is for feedbacks with respect to the designed user interfaces. For example, it would be good to know whether the designed icons are simple and clear, and

whether the color configurations used in the pages are user friendly and comfortable looking.

The second part is for evaluating the functions in the app. For example, we need to understand if there are any superfluous functions which they actually do not really need, and if there are some functions which they really want to have but are not in the app. The third part is for analyses of recommended foods in the app. For example, we would like to understand if the foods are easy to obtain and the nutrition in everyday recipes is enough for children.

The results of user evaluation are as follows.

Participant 1

Completion & Questions	Answer
<ul style="list-style-type: none">• After looking at the main functions of the app, do you consider the app has potential to benefit caregivers' child feeding, in terms of ease of use, and providing nutritional suggestions for meals?	<ul style="list-style-type: none">• Calories vs gram, which one is a better option?• Pictures look nice and easy to understand• Some suggested recipes maybe?• Maybe add water as an option (just confirmed, water is considered as food)• The app looks clean and neat
<ul style="list-style-type: none">• Are your expectations fulfilled?	<ul style="list-style-type: none">• Yes, as in terms of planning the meals and seeing whether there are enough nutrients that would be consumed
<ul style="list-style-type: none">• Do you think the app lacks any important features?• If yes - which ones?	<ul style="list-style-type: none">• Maybe some notification at the start of the app, or different colour when the intake is not fulfilled• Maybe ask for the weight and height of the child
<ul style="list-style-type: none">• Do you find any of the functions superfluous?• If yes - which ones?	<ul style="list-style-type: none">• Not really

Participant 2

Completion & Questions	Answer
<ul style="list-style-type: none"> After looking at the main functions of the app, do you consider the app has potential to benefit caregivers' child feeding, in terms of ease of use, and providing nutritional suggestions for meals? 	<ul style="list-style-type: none"> The main bottom bar is useful The design is simple and easy to use Recipes are useful
<ul style="list-style-type: none"> Are your expectations fulfilled? 	<ul style="list-style-type: none"> Yes, but to some extent, see the comments below
<ul style="list-style-type: none"> Do you think the app lacks any important features? If yes - which ones? 	<ul style="list-style-type: none"> Add more scientific knowledge contents in recipes page would be helpful, such as six meals every day, and nutrition about vegetables, fruits, and meats Add food substitute. For example, some people are allergic to carrots, then there should be some other foods recommended. Some functions like adjusting fonts and saving data could be useful
<ul style="list-style-type: none"> Do you find any of the functions superfluous? If yes - which ones? 	<ul style="list-style-type: none"> Adding foods and favorite food list seem not useful to me

Participant 3

Completion & Questions	Answer
<ul style="list-style-type: none"> After looking at the main functions of the app, do you consider the app has potential to benefit caregivers' child feeding, in terms of ease of use, and providing nutritional suggestions for meals? 	<ul style="list-style-type: none"> Yes, the page design is good, and the pictures look interesting and helpful
<ul style="list-style-type: none"> Are your expectations fulfilled? 	<ul style="list-style-type: none"> Yes

<ul style="list-style-type: none"> • Do you think the app lacks any important features? • If yes - which ones? 	<ul style="list-style-type: none"> • Add calories for foods • Add notifications • Sometimes if do not want to eat some foods, there should be some other foods recommended with about the same nutrition • Budgets could be changed to money spent on buying foods • Add some advertisements for app promotion
<ul style="list-style-type: none"> • Do you find any of the functions superfluous? • If yes - which ones? 	<ul style="list-style-type: none"> • No

Participant 4

Completion & Questions	Answer
<ul style="list-style-type: none"> • After looking at the main functions of the app, do you consider the app has potential to benefit caregivers' child feeding, in terms of ease of use, and providing nutritional suggestions for meals? 	<ul style="list-style-type: none"> • Yes, the recipes are detailed
<ul style="list-style-type: none"> • Are your expectations fulfilled? 	<ul style="list-style-type: none"> • Yes
<ul style="list-style-type: none"> • Do you think the app lacks any important features? • If yes - which ones? 	<ul style="list-style-type: none"> • Foods in recipes should also have pictures • Some caregivers cannot read, so sound instructions could be used • Design different recipes for different age ranges, such as 1-2 years and 2-4 years old children could have different food recommendations • Add alarm for notifying meal time
<ul style="list-style-type: none"> • Do you find any of the functions superfluous? • If yes - which ones? 	<ul style="list-style-type: none"> • Favorite could be changed to note or food list, since it looks like a meal plan

Participant 5

Completion & Questions	Answer
<ul style="list-style-type: none"> After looking at the main functions of the app, do you consider the app has potential to benefit caregivers' child feeding, in terms of ease of use, and providing nutritional suggestions for meals? 	<ul style="list-style-type: none"> No
<ul style="list-style-type: none"> Are your expectations fulfilled? 	<ul style="list-style-type: none"> To some extent
<ul style="list-style-type: none"> Do you think the app lacks any important features? If yes - which ones? 	<ul style="list-style-type: none"> The first page should display the food recommendation, since this is the main function of a nutrition app There should be log in since parents could also check their children's eating Food nutrition knowledge could be integrated in the app
<ul style="list-style-type: none"> Do you find any of the functions superfluous? If yes - which ones? 	<ul style="list-style-type: none"> No

7.3 Analysis

As shown in the user evaluation results, several participants noted that the design is simple and easy to use, and the bottom tab is always making it easy to navigate during using the app. The main functions are considered to be clear and direct, and the pictures in the app are helpful, especially for caregivers with low education levels.

However, there are also negative comments. Several participants mentioned that the recipe page should be displayed first since this is the main function of the app, and pictures should also appear in the recipe page. Problems mentioned also relate to using calories than grams, which is arguably more useful in a nutrition app, and more scientific knowledge about foods should be integrated in the app.

The results support the idea of creating a multi-page app with simple designs, which is also verified by their positive comments. Negative comments also indicate that the app design should focus on functionality, language and ease-to-use, rather than complicated designs and details. An ideal app design should bridge the gap between the caregivers' practice and nutritional professionals' knowledge without creating complication and difficulty of using the app and understanding the contents (Nielsen and Molich, 1990).

Given the feedbacks and suggestions, several changes were made to the implementation as follows, since they are important for the better use of the nutrition apps. The corresponding new changes are shown in Figure 63.

- The recipe page is displayed first, since this is the main function of the nutrition app.
- Pictures are added for foods in recipes and food recommendations.
- Scientific knowledge is added. In particular, in the recipe page, clicking a food's name will direct the page to a Wikipedia webpage, which introduce the basic knowledge about the corresponding food. And clicking the picture of the food will navigate a YouTube page, which introduce the nutrition about the food.
- Calories are calculated and used for added food and the food budget.

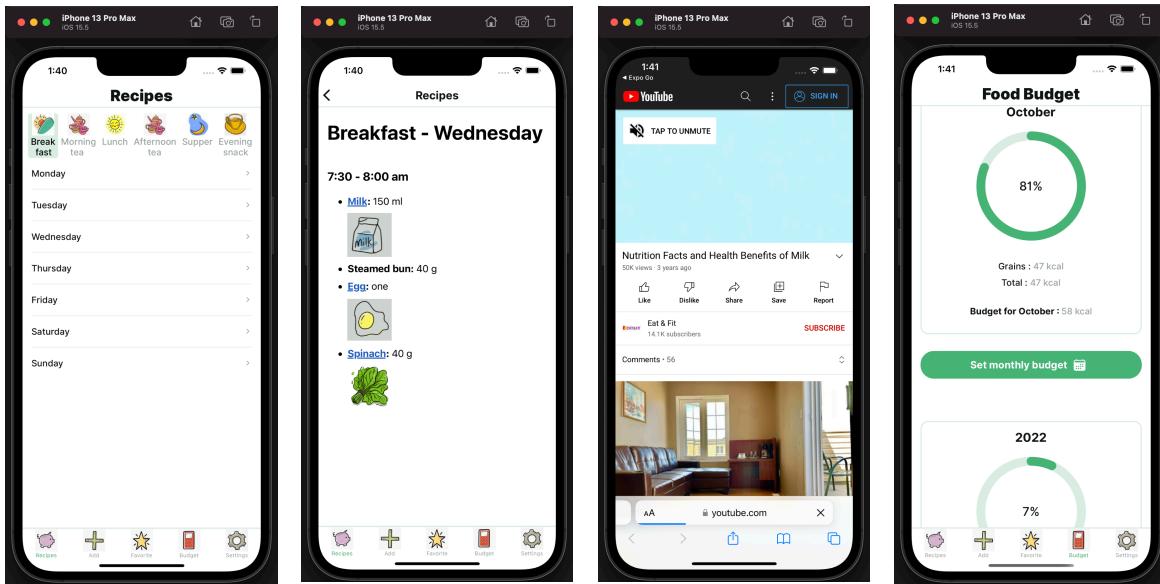


Figure 63. New changes after user evaluation.

More screenshots of running the app after making changes are shown in Appendix 3. Several other auxiliary functions are also great to be added and left as the future work.

- Log in and saving data functions, which could be helpful for parents to check their children's eating. This is particularly meaningful since it is aligned with the motivation of designing this app, which is to help caregivers and parents in poor areas to improve child feeding practice, and in many poor areas of China, parents often left their children in village while working in cities to support their families.
- Recommendation for food substitution could be added. Initially it was not considered that some people could be allergic or they do not want to have some foods. In this case, recommending some other foods with about the same amount of nutrition is important.

However, several suggestions from user evaluation are considered to be not favorable, and therefore we choose to not add them.

- One participant mentioned that budget could be changed to calculation of money used in buying food. However, as a nutrition app, the main focus is arguably about healthy eating and food recommendation. Calculating food expense should be of independent interest and could be distracting the main direction.
- One participant suggested to have different recipes for children at different age ranges (1-2 years and 2-4 years old children). Such a design is likely making the app more complicated and more confusing possibly for some child caregivers with low education levels. It has also been shown in existing research that it is actually difficult to tell the difference between appropriate recipes for children in these two age ranges (Hollis et al., 2020).
- One participant suggested to add alarm for notifying eating time. However, it is not clear if this is a real requirement for most caregivers. On the other hand, the alarm function already exists in cellphones, and adding such a function could be both redundant and distracting.
- One participant mentioned that some advertisements could be added to the app for the purpose of promotion. However, the app is still at early stage of implementation and we intended to design it to be simple. Therefore, the suggestion is not very relevant to our main motivation.

Chapter 8 – Discussion

8.1 Principal Findings

This project aims to design an app to support child feeding practice of child caregivers in poor areas of China. During the project, I made two main findings as follows.

The first finding is that existing children nutrition apps might be well designed from some aspects, but they are still not fulfilling user requirements in specific areas. This finding was from studying similar children nutrition apps available on platforms. As mentioned in Chapter 4, there exist full-featured children nutrition apps with well-designed interfaces, such as “Annabel Karmel” (as shown in Figure 13), which requires payment before using it. Child caregivers in poor areas of China would not use those apps which are unaffordable to them. Some other apps with scientific children nutrition contents might contain much text describing information (such as “Food Buying Guide for CNP” as shown in Figure 14), which is not suitable for child caregivers in poor areas of China since they usually have low education levels and have difficulties understanding complicated information. This finding implies that some designs and features might be good in some scenarios while at the same time might be not suitable in other cases, and designers should take specific contexts and user requirements into account to choose and design features.

Second, I obtained new understandings on children health and nutrition. As shown in Figure 5, the growth retardation rate changed differently over the past several decades in different regions. It is easy to get misleading conclusions that children health issues have been largely

resolved by only looking at total national data. And the data collected from poor rural areas reveals a different situation of children nutrition issues. This finding implies that it would be more reliable and insightful if we could collect more data and check different information resources before drawing conclusions.

8.2 Limitations of the Study

The study of this project is facing to main limitations as follows.

First, the app design is limited since it does not consider different user requirements. As mentioned in Chapter 1, China has a large population, many ethnic groups, varying levels of education and different living habits. Therefore, even the group of child caregivers would have various user requirements. The major design was considered for the core requirements and some opportunities have been missing. For example, users with higher education levels may feel that the food information in the app is not deep enough, while users with no education will likely consider that the app is still too complicated.

Second, the design for children nutrition and food recommendation is also limited. The current design is not able to guarantee that every recommended recipe is suitable for children with different ages, genders, heights, and weights. The app might contain some suitable recipes for children but it might require caregivers themselves to tell and choose according to their needs, which makes the app not friendly or easy to use.

Third, from research the time for checking the application before making it public on iOS App store is about three months. Due to the time limit, the app is not publicly available.

8.3 Future Work

This project has the following shortcomings which need to be improved in the future.

First, as mentioned in Section 8.2, one limitation is that the app is not able to adapt to different user requirements. It would be important to study how to make the app adaptive to users. One idea is to give users options to input their brief information such that the app can adjust itself to different modes.

Second, recommending food substitute could be implemented. As noted by several participants, if users are allergic or do not want eat some foods, then it would be good if the app can recommend some other food with similar nutrition.

Third, there could be more variety of food in the app. Not all ingredients in the app are suitable for people in poor areas of China. For example, some nutritious ingredients are hard to get or not affordable in poor areas of China. In the future, more research is needed to improve the ingredients, and the recipes could be updated based on the ingredients and traditional Chinese cooking methods.

Fourth, the number of assistive tools, such as adjusting fonts, dark mode, and sound instructions, which could make it more convenient for users. As mentioned in Chapter 3, many child caregivers in poor areas of China have low education levels. Therefore, it would be easier for those caregivers to have those helpful auxiliary functions so that they can easily use the app.

Fifth, the current bilingual functions are still incomplete. Since the target users are Chinese

people, it would be important to make all information in the app have Chinese version.

Last, the log-in function could be added and it is friendly and helpful for parents to check their children's eating, which is aligned with the initial motivation of designing this app, i.e., to help caregivers and parents in poor areas to improve child feeding practice.

Chapter 9 – Reflection

The process of this project consists of the following steps: literature review, user requirements analysis, prototype design, coding, and report writing. The whole process was difficult and joyful, from which I learned a lot.

First, during literature review, I read a number of papers and learned much knowledge of children health and nutrition, human-centered user interface, and so on. For writing literature research summary, with a lot of advice and feedbacks from my supervisor, I was able to get on the right track. During this process, I learned that literature review should be conducted with critical thinking to compare and analyse different work in the literature. I need to find not only literature which is closely related to the topic of study, but also gaps and problems hiding in existing work.

Second, during user needs analysis, I firstly brainstormed and listed all the user requirements I could think of. Then I checked many existing apps available on platforms and read their users' positive and negative feedbacks. I noted positive feedbacks and tried to avoid problems mentioned in negative feedbacks during my design process. After that I added some new user requirements and removed some unnecessary ones. I realized that collecting right user needs is crucial to an app. It is important to accurately grasp the real needs of users, so that a designed app can cater to the market.

Third, for the design of the prototype and flowchart, I chose the software Figma. Before working on this project, I had no experience using it. I found it to be a very complete, easy to operate and use software, which allows automatic saving in real time. Throughout the design phase, I followed the user-centered principle and adapted my app to users needs. With my

undergraduate animation background knowledge, I added many pictures and cartoon elements to make the user interface easier to understand for child caregivers. I realized that prototype diagrams are very important for the whole project, which show the typographic layout of pages and interactions, giving a visual representation for initial ideas of the design and a clear framework before the product takes shape.

Fourth, the most challenging part of the project to me was programming. My program was implemented using React Native. I compared the similarities and differences between React Native and Flutter, and made my choice since I studied JavaScript during my master's program. I encountered many difficulties in writing the code. I took publicly available code from Github projects as references, running and reading their logics, which are helpful for my own understanding.

The fifth part is evaluation. My undergraduate background is in animation, and there is usually no one right answer in the animation field. After this project, I learned that designing a software system is similar. Designers need to keep getting feedback from users and make improvements according to user feedback. My time management has also been improved through the constant evolution processes.

The last part is to write a report. During my writing, I encountered difficulties since my first language is not English. I read some books on report writing from the library and learned some basic knowledge. I found that report writing is not as easy as I thought. I learned that contents need to be simple, clear and contain enough details at the same time.

Overall, the whole project process was full of difficulties, where I kept encountering and

solving problems, from which I gained a lot of knowledge and techniques. In the meanwhile, I also feel my knowledge is limited, and I still need to learn a lot more. Fortunately, difficulties did not wear out my enthusiasm.

Chapter 10 – Conclusion

First, according to literature review, user requirements analysis, heuristic evaluations of the designed app, it can be concluded that the implementation of such an children nutrition and feeding app has the potential to benefit child caregivers in poor areas of China.

Second, our study suggested that there might be some barriers to the use of the app, such as child caregivers with low education levels would have difficulties understanding how to use the app and read food recipes and recommendations. However, the results also indicate that the idea of designing an app like ours would be well appreciated if further efforts are spent and several directions are better explored, such as increasing the number of pictures and videos about nutrition knowledge in the app. The research demonstrated that child caregivers in poor areas of China actually seriously take child nutrition into consideration. However, they do suffer from a lack of guidance and external assists (Yang et al., 2020).

For the future work, additional features, such as food substitute recommendation and log in functions, would require further study to check if the design is well aligned with caregivers' real needs and thus to explore alternative designs and improve the app for better user experience.

References

An, Y., Jiang, L., Cao, J., Geng, C. and Zhong, L., 2007. Sudan I induces genotoxic effects and oxidative DNA damage in HepG2 cells. *Mutation Research/Genetic Toxicology and Environmental Mutagenesis*, 627(2), pp.164-170.

Arrighi, G., 2007. Globalization and uneven development. In *Frontiers of Globalization Research* (pp. 185-201). Springer, Boston, MA.

Brown, K.H., 1991. The importance of dietary quality versus quantity for weanlings in less developed countries: a framework for discussion. *Food and Nutrition Bulletin*, 13(2), pp.1-9.

Buchmiller, T.L., Kim, C.S., Chopourian, H.L. and Fonkalsrud, E.W., 1994. Transamniotic fetal feeding: enhancement of growth in a rabbit model of intrauterine growth retardation. *Surgery*, 116(1), pp.36-41.

Burrows, T.L., Khambalia, A.Z., Perry, R., Carty, D., Hendrie, G.A., Allman-Farinelli, M.A., Garnett, S.P., McNaughton, S.A., Rangan, A.M., Truby, H. and Collins, C.E., 2015. Great ‘app-eal’but not there yet: a review of iPhone nutrition applications relevant to child weight management. *Nutrition & dietetics*, 72(4), pp.363-367.

Caballero, B., 2007. The global epidemic of obesity: an overview. *Epidemiologic reviews*, 29(1), pp.1-5.

Cleghorn, G.J., Greer, R., Holt, T.L., Shepherd, R.W., Erlich, J., Forrest, Y. and Bowling, F.G., 1991. Exocrine pancreatic dysfunction in malnourished Australian aboriginal children. Medical journal of Australia, 154(1), pp.45-48.

Del Gobbo, L.C., Khatibzadeh, S., Imamura, F., Micha, R., Shi, P., Smith, M., Myers, S.S. and Mozaffarian, D., 2015. Assessing global dietary habits: a comparison of national estimates from the FAO and the Global Dietary Database. The American journal of clinical nutrition, 101(5), pp.1038-1046.

Feng, J., Gong, Z., Wang, Y., Huo, J. and Zhuo, Q., 2022. Complementary Feeding and Malnutrition among Infants and Young Children Aged 6–23 Months in Rural Areas of China. Nutrients, 14(9), p.1807.

Fisher, J.O., Liu, Y., Birch, L.L. and Rolls, B.J., 2007. Effects of portion size and energy density on young children's intake at a meal. The American journal of clinical nutrition, 86(1), pp.174-179.

Gandhi, V.P. and Zhou, Z., 2014. Food demand and the food security challenge with rapid economic growth in the emerging economies of India and China. Food Research International, 63, pp.108-124.

Gidding, S.S., Dennison, B.A., Birch, L.L., Daniels, S.R., Gilman, M.W., Lichtenstein, A.H., Rattay, K.T., Steinberger, J., Stettler, N. and Van Horn, L., 2005. Dietary recommendations for children and adolescents: a guide for practitioners: consensus statement from the American Heart Association. Circulation, 112(13), pp.2061-2075.

Gokhale, M., Stürmer, T. and Buse, J.B., 2020. Real-world evidence: the devil is in the detail. *Diabetologia*, 63(9), pp.1694-1705.

Goldthorpe, J., Ali, N. and Calam, R., 2018. Providing healthy diets for young children: the experience of parents in a UK inner city. *International journal of qualitative studies on health and well-being*, 13(1), p.1490623.

Hashim, I.H. and Zhiliang, Y., 2003. Cultural and gender differences in perceiving stressors: a cross-cultural investigation of African and Western students in Chinese colleges. *Stress and Health*, 19(4), pp.217-225.

He, B., Fan, J., Liu, N., Li, H., Wang, Y., Williams, J. and Wong, K., 2012. Depression risk of 'left-behind children' in rural China. *Psychiatry research*, 200(2-3), pp.306-312.

Hollis, J.L., Collins, C.E., DeClerck, F., Chai, L.K., McColl, K. and Demaio, A.R., 2020. Defining healthy and sustainable diets for infants, children and adolescents. *Global Food Security*, 27, p.100401.

Joffe, M. and Robertson, A., 2001. The potential contribution of increased vegetable and fruit consumption to health gain in the European Union. *Public Health Nutrition*, 4(4), pp.893-901.

Kastorini, C.M., Critselis, E., Zota, D., Coritsidis, A.L., Nagarajan, M.K., Papadimitriou, E., Belogianni, K., Benetou, V., Linos, A. and Greek National Dietary Guidelines Scientific

Team, 2019. National Dietary Guidelines of Greece for children and adolescents: a tool for promoting healthy eating habits. *Public Health Nutrition*, 22(14), pp.2688-2699.

Keeley, B., Little, C. and Zuehlke, E., 2019a. The State of the World's Children 2019: Children, Food and Nutrition—Growing Well in a Changing World. UNICEF.

Keeley, B., Little, C. and Zuehlke, E., 2019b. The State of the World's Children 2019: Children, Food and Nutrition—Growing Well in a Changing World, East Asia and Pacific, UNICEF, <https://www.aidsdatahub.org/sites/default/files/resource/unicef-sowc-2019-eap.pdf>.

Keeley, B., Little, C. and Zuehlke, E., 2019c. The State of the World's Children 2019: Children, Food and Nutrition—Growing Well in a Changing World, Executive Summary, UNICEF, <https://www.aidsdatahub.org/sites/default/files/resource/unicef-sowc-2019-summary.pdf>.

King, M.T., 2020. What is “Chinese” food? Historicizing the concept of culinary regionalism. *Global Food History*, 6(2), pp.89-109.

Leslie, J., 1988. Women's work and child nutrition in the Third World. *World development*, 16(11), pp.1341-1362.

Li, H., Xiao, J., Liao, M., Huang, G., Zheng, J., Wang, H., Huang, Q. and Wang, A., 2020. Anemia prevalence, severity and associated factors among children aged 6–71 months in rural Hunan Province, China: a community-based cross-sectional study. *BMC public health*, 20(1), pp.1-13.

Liu, Y., Liu, J. and Zhou, Y., 2017. Spatio-temporal patterns of rural poverty in China and targeted poverty alleviation strategies. *Journal of Rural Studies*, 52, pp.66-75.

McGuire, S., 2016. Scientific report of the 2015 dietary guidelines advisory committee. Washington, dc: Us departments of agriculture and health and human services, 2015. *Advances in nutrition*, 7(1), pp.202-204.

Mikellides, B., 2012. Colour psychology: The emotional effects of colour perception. In *Colour Design* (pp. 105-128). Woodhead Publishing.

Mills, E.S. and Tan, J.P., 1980. A comparison of urban population density functions in developed and developing countries. *Urban studies*, 17(3), pp.313-321.

Nielsen, J., 1994, April. Usability inspection methods. In *Conference companion on Human factors in computing systems* (pp. 413-414).

Nielsen, J. and Molich, R., 1990, March. Heuristic evaluation of user interfaces. In *Proceedings of the SIGCHI conference on Human factors in computing systems* (pp. 249-256).

Norman, D., 2013. *The design of everyday things: Revised and expanded edition*. Basic books.

O'connor, Z., 2011. Colour psychology and colour therapy: Caveat emptor. *Color Research*

& Application, 36(3), pp.229-234.

Paudyal, N., Pan, H., Liao, X., Zhang, X., Li, X., Fang, W. and Yue, M., 2018. A meta-analysis of major foodborne pathogens in Chinese food commodities between 2006 and 2016. Foodborne Pathogens and Disease, 15(4), pp.187-197.

Porter, T. and Mikellides, B. eds., 2019. Colour for architecture today. Taylor & Francis.

Qiao, G., Guo, T. and Klein, K.K., 2012. Melamine and other food safety and health scares in China: Comparing households with and without young children. Food Control, 26(2), pp.378-386.

Ramsay, S.A., Branen, L.J. and Johnson, S.L., 2012. How much is enough? Tablespoon per year of age approach meets nutrient needs for children. Appetite, 58(1), pp.163-167.

Samuel, L., Ethan, D., Basch, C., Dunne, S. and Quinn, C., 2022. An analysis of nutrient facts labels of pediatric multi-vitamin and mineral supplements: Is there a risk of overexposure?. Nutrition and Health, p.02601060221100926.

Snuggs, S., Houston-Price, C. and Harvey, K., 2019. Development of a parental feeding goal measure: The family mealtime goals questionnaire. Frontiers in psychology, 10, p.455.

Staton, D.M. and Harding, M.H., 2004. Protecting child health worldwide. Pediatric annals, 33(10), pp.647-655.

Stephen, A., Alles, M., De Graaf, C., Fleith, M., Hadjilucas, E., Isaacs, E., Maffeis, C., Zeinstra, G., Matthys, C. and Gil, A., 2012. The role and requirements of digestible dietary carbohydrates in infants and toddlers. European journal of clinical nutrition, 66(7), pp.765-779.

Stokstad, E. and Jukes, T.H., 1950. Further observations on the “animal protein factor”. Proceedings of the Society for Experimental Biology and medicine, 73(3), pp.523-528.

Strecher, V.J., Seijts, G.H., Kok, G.J., Latham, G.P., Glasgow, R., DeVellis, B., Meertens, R.M. and Bulger, D.W., 1995. Goal setting as a strategy for health behavior change. Health education quarterly, 22(2), pp.190-200.

Tan, C., Zhao, C., Dou, Y., Duan, X., Shi, H., Wang, X., Huang, X. and Zhang, J., 2020. Caregivers' depressive symptoms and social-emotional development of left-behind children under 3 years old in poor rural China: the mediating role of home environment. Children and Youth Services Review, 116, p.105109.

Tang, Y., Lan, J., Gao, X., Liu, X., Zhang, D., Wei, L., Gao, Z. and Li, J., 2016. Determination of clenbuterol in pork and potable water samples by molecularly imprinted polymer through the use of covalent imprinting method. Food chemistry, 190, pp.952-959.

Trichopoulou, A. and Lagiou, P., 1997. Healthy traditional Mediterranean diet: an expression of culture, history, and lifestyle. Nutrition reviews, 55(11), pp.383-389.

Unicef, 1989. Convention on the Rights of the Child.

Wang, H., Cousineau, C., Hu, Y.A., Hu, G., Qi, S., Sun, A., Wu, H., Rozelle, S. and Singh, M., 2021. Examining the Relation between Caregiver Mental Health and Student Outcomes in Rural China. *International Journal of Environmental Research and Public Health*, 18(23), p.12613.

Wei, X., Tsang, M.C., Xu, W. and Chen, L.K., 1999. Education and earnings in rural China. *Education Economics*, 7(2), pp.167-187.

Xu, L., Wu, B., Chi, I. and Hsiao, H.Y., 2012. Intensity of grandparent caregiving and life satisfaction among rural Chinese older adults: a longitudinal study using latent difference score analysis. *Family and Community Health*, pp.287-299.

Yang, C., Kang, B., Mao, Y., Xu, Q., Yu, D. and Zhang, L., 2020. Anxiety among caregivers of children with epilepsy from western China: a cross-sectional survey. *Medicine*, 99(8).

Yang, Z., Duan, Y., Ma, G., Yang, X. and Yin, S., 2015. Comparison of the China growth charts with the WHO growth standards in assessing malnutrition of children. *BMJ open*, 5(2), p.e006107.

You, Z., Shi, H., Feng, Z. and Yang, Y., 2020. Creation and validation of a socioeconomic development index: A case study on the countries in the Belt and Road Initiative. *Journal of Cleaner Production*, 258, p.120634.

Yue, A., Zhang, N., Liu, X., Tang, L., Luo, R., Yang, M., Rozelle, S. and Medina, A., 2018. Do infant feeding practices differ between grandmothers and mothers in rural China? Evidence from rural Shaanxi Province. *Family & Community Health*, 41(4), pp.233-243.

Zhang, J., Guo, S., Li, Y., Wei, Q., Zhang, C., Wang, X., Luo, S., Zhao, C. and Scherbier, R.W., 2018a. Factors influencing developmental delay among young children in poor rural China: a latent variable approach. *BMJ open*, 8(8), p.e021628.

Zhang, Y., Huang, X., Yang, Y., Liu, X., Yang, C., Wang, A., Wang, Y. and Zhou, H., 2018b. Double burden of malnutrition among children under 5 in poor areas of China. *PloS One*, 13(9), p.e0204142.

Zhao, J., Freeman, B. and Li, M., 2017. How do infant feeding apps in China measure up? A content quality assessment. *JMIR mHealth and uHealth*, 5(12), p.e8764.

Zhou, G., 2017. The regulatory regime of food safety in China: governance and segmentation. Springer.

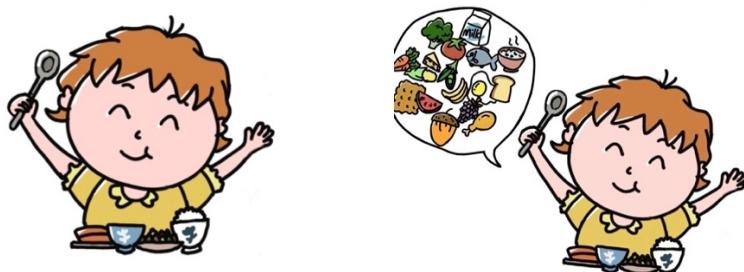
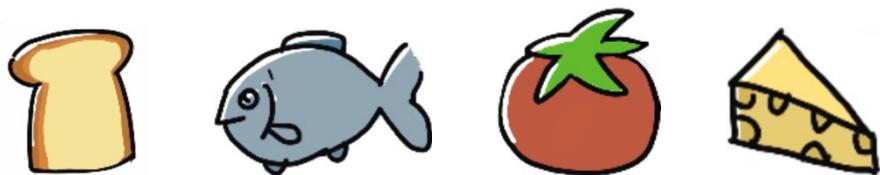
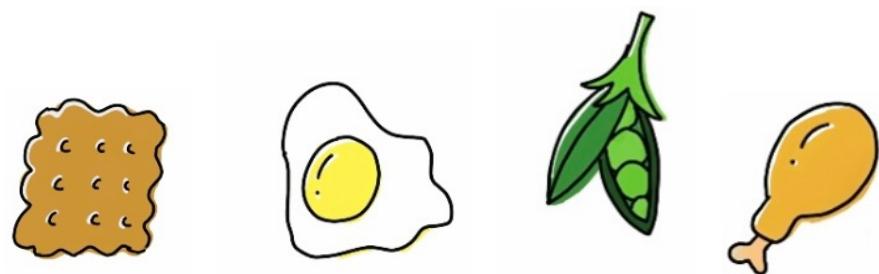
Appendices

Appendix 1 Hand-painted Pictures in the App

This section shows hand-painted pictures for food categories and icons shown in Figure 26 and also used in the app. The painting tools used are iPad and Procreate. First, I viewed many pictures from online resources (<https://zh.jf-staeulalia.pt/collection-food-pictures> and <https://www.vfx123.com/hand-drawn-icons-pack.html>). Second, I created black and white line art drafts. Finally, I colored the raw material.



Black and white line arts.



Colored pictures.

Appendix 2 Ethics Documents for User Evaluation

Dissertation project proposal and plan

In this project, I propose to design an interactive mobile to support caregivers' feeding practices of young children in poor areas of China.

Problem description:

Adequate nutrition is important for children's physical development. Brain development mostly occurs in the first three years of a child's growth and development (Dill et al., 2019). However, in poor rural areas of China, a range of problems resulting from nutrition in children aged 2 to 5 years have long plagued numerous families and the society (Zhang et al., 2018b). The prevalence of suspected stunting is high in children aged 6 to 35 months (Zhang et al., 2018a). Stunting and wasting are major public health problems (Feng et al., 2022), and childhood anemia has become a social public issue (Li et al., 2020). There are several specific causes of malnutrition among poor rural children in China as follows.

First, there are caregivers' education level and family income factors (Li et al., 2022). Some caregivers of children are not well educated and some of them cannot read. Therefore, it is difficult for those caregivers to use information on scientific feeding of children from books. On the other hand, parents' feeding habits can predict the eating behavior of children (Snuggs et al., 2019), which means scientific feeding is important. Grandparents of children as caregivers are more inclined to feed their children according to experience than parents (Yue et al., 2018).

Second, it is because of the scarcity of food resources. The geographical environment in poor areas, such as western China, is not advantageous, and the complex geography, fragile ecology and natural disaster impacts (Zhou et al., 2020) have led to difficulties in plant growth and road construction in some areas. As a result, people are unable to go out frequently to purchase food and the types of food they can purchase are highly limited.

Proposed Solution:

First, we need to gain insight into healthy eating. We classify common foods into several key dietary indicators: fruits, vegetables, beans and legumes, nuts and seeds, whole grains, red and processed meats, fish and seafood, milk, and total energy (Del Gobbo et al., 2015). Eating enough vegetables and fruits is beneficial for health (Joffe and Robertson, 2001). High consumption of vegetables, fruits, legumes and grains; moderate consumption of milk and dairy products, mainly cheese; low consumption of meat and meat products are also considered healthy (Trichopoulou and Lagiou, 1997). Most people would benefit from reduced consumption of red and processed meats,

refined grains, added sugars, sodium, and saturated fats (McGuire, 2016).

Second, we need to gain insight into the nutritional needs of children aged 2 to 5 years and to calculate and develop daily food groups and grams (Hollis et al., 2020). Most of the key nutritional recommendations are similar despite the different geographical, socioeconomic, and cultural contexts of countries (Kastorini et al., 2019). It is known that carbohydrates are important for the health of infants and children (Stephen et al., 2012). The reference to the experience of providing a healthy diet for young children in the inner city of England is taken into consideration (Goldthorpe et al., 2018). Moreover, micronutrients are very important and naturally found in various foods (Samuel et al., 2022). Children need to eat more whole grains (Gidding et al., 2005).

Third, we need to understand the factors of children's food preferences. To improve the nutritional quality of children's diets, it is essential to understand the factors that influence children's food preferences (Birch, 1998).

Fourth, it is important and necessary to review the available apps in the market, and to check some relevant app literature (Curtis et al., 2015).

Fifth, the goal is to design a mobile software with simple interaction. I use the user-centered principle to humanize the user interface design (Wu and Li, 2020). After studying the relationship between interactivity and narrative flow (Sargent, 2013), I chose to design using React Native. It is useful to design cartoon patterns and intersperse cartoon patterns into the interactive software. Cartoon patterns allow child caregivers to read the meaning expressed by the software even though they do not know the words and, at the same time, engage the children's interest. Healthy and happy family eating can be effective in improving family eating behaviors (Snuggs, 2020).

References

- Birch, L.L., 1998. Psychological influences on the childhood diet. *The Journal of nutrition*, 128(2), pp.407S-410S.
- Curtis, K.E., Lahiri, S. and Brown, K.E., 2015. Targeting parents for childhood weight management: development of a theory-driven and user-centered healthy eating app. *JMIR mHealth and uHealth*, 3(2), p.e3857.
- Del Gobbo, L.C., Khatibzadeh, S., Imamura, F., Micha, R., Shi, P., Smith, M., Myers, S.S. and Mozaffarian, D., 2015. Assessing global dietary habits: a comparison of national estimates from the FAO and the Global Dietary Database. *The American journal of clinical nutrition*, 101(5), pp.1038-1046.
- Dill, S.E., Ma, Y., Sun, A. and Rozelle, S., 2019. The landscape of early childhood development in rural China. *Asia-Pac. J*, 17, pp.1-16.

- Feng, J., Gong, Z., Wang, Y., Huo, J. and Zhuo, Q., 2022. Complementary Feeding and Malnutrition among Infants and Young Children Aged 6–23 Months in Rural Areas of China. *Nutrients*, 14(9), p.1807.
- Gidding, S.S., Dennison, B.A., Birch, L.L., Daniels, S.R., Gilman, M.W., Lichtenstein, A.H., Rattay, K.T., Steinberger, J., Stettler, N. and Van Horn, L., 2005. Dietary recommendations for children and adolescents: a guide for practitioners: consensus statement from the American Heart Association. *Circulation*, 112(13), pp.2061-2075.
- Goldthorpe, J., Ali, N. and Calam, R., 2018. Providing healthy diets for young children: the experience of parents in a UK inner city. *International journal of qualitative studies on health and well-being*, 13(1), p.1490623.
- Hollis, J.L., Collins, C.E., DeClerck, F., Chai, L.K., McColl, K. and Demasio, A.R., 2020. Defining healthy and sustainable diets for infants, children and adolescents. *Global Food Security*, 27, p.100401.
- Joffe, M. and Robertson, A., 2001. The potential contribution of increased vegetable and fruit consumption to health gain in the European Union. *Public Health Nutrition*, 4(4), pp.893-901.
- Kastorini, C.M., Criscello, E., Zota, D., Corridis, A.L., Nagarajan, M.K., Papadimitriou, E., Belogianni, K., Benetou, V., Linos, A. and Greek National Dietary Guidelines Scientific Team, 2019. National Dietary Guidelines of Greece for children and adolescents: a tool for promoting healthy eating habits. *Public Health Nutrition*, 22(14), pp.2688-2699.
- Li, H., Xiao, J., Liao, M., Huang, G., Zheng, J., Wang, H., Huang, Q. and Wang, A., 2020. Anemia prevalence, severity and associated factors among children aged 6–71 months in rural Hunan Province, China: a community-based cross-sectional study. *BMC public health*, 20(1), pp.1-13.
- Li, H., Yuan, S., Fang, H., Huang, G., Huang, Q., Wang, H. and Wang, A., 2022. Prevalence and associated factors for stunting, underweight and wasting among children under 6 years of age in rural Hunan Province, China: a community-based cross-sectional study. *BMC Public Health*, 22(1), pp.1-12.
- McGuire, S., 2016. Scientific report of the 2015 dietary guidelines advisory committee. Washington, dc: Us departments of agriculture and health and human services, 2015. *Advances in nutrition*, 7(1), pp.202-204.
- Samuel, L., Ethan, D., Basch, C., Dunne, S. and Quinn, C., 2022. An analysis of nutrient facts labels of pediatric multi-vitamin and mineral supplements: Is there a risk of overexposure? *Nutrition and Health*, p.02601060221100926.
- Sargeant, B., 2013. Interactive storytelling: How picture book conventions inform multimedia book app narratives. *Australian Journal of Intelligent Information Processing Systems*, 13(3), pp.29-35.
- Snuggs, S., 2020. Healthy Happy Family Eating: An investigation into the effectiveness of interventions aimed at improving family eating behaviours (Doctoral dissertation, University of Reading).
- Snuggs, S., Houston-Price, C. and Harvey, K., 2019. Development of a parental feeding goal measure: The family mealtime goals questionnaire. *Frontiers in psychology*, 10, p.455.
- Stephen, A., Alles, M., De Graaf, C., Fleith, M., Hadjilucas, E., Isaacs, E., Maffei, C., Zeinstra, G., Matthys, C. and Gil, A., 2012. The role and requirements of digestible dietary carbohydrates in infants and toddlers. *European journal of clinical nutrition*, 66(7), pp.765-779.
- Trichopoulou, A. and Lagiou, P., 1997. Healthy traditional Mediterranean diet: an expression of culture, history, and lifestyle. *Nutrition reviews*, 55(11), pp.383-389.
- Wu, H. and Li, G., 2020. Innovation and improvement of visual communication design of mobile app based on social network interaction interface design. *Multimedia Tools and Applications*, 79(1), pp.1-16.
- Yue, A., Zhang, N., Liu, X., Tang, L., Luo, R., Yang, M., Rozelle, S. and Medina, A., 2018. Do infant feeding practices differ between grandmothers and mothers in rural China? Evidence from rural Shaanxi Province. *Family & Community Health*, 41(4), pp.233-243.
- Zhang, J., Guo, S., Li, Y., Wei, Q., Zhang, C., Wang, X., Luo, S., Zhao, C. and Scherpbier, R.W., 2018a. Factors influencing developmental delay among young children in poor rural China: a latent variable approach. *BMJ open*, 8(8), p.e021628.
- Zhang, Y., Huang, X., Yang, Y., Liu, X., Yang, C., Wang, A., Wang, Y. and Zhou, H., 2018b. Double burden of malnutrition among children under 5 in poor areas of China. *PLoS One*, 13(9), p.e0204142.
- Zhou, Y., Li, Y. and Liu, Y., 2020. The nexus between regional eco-environmental degradation and rural impoverishment in China. *Habitat International*, 96, p.102086.

Research proposal.

Dear COMSC MSc Students,

For my dissertation I am working on a project entitled “Designing an Interactive Application to Support Caregivers’ Feeding Practices of Young Children in Poor Areas of China”. I am looking for any volunteers who are interested in helping me evaluate my application.

During the evaluation, I will share a link to access my application, and you would need to check most interfaces of this application. After using it, I will ask you some questions about your experience with the application’s user interface e.g., picture quality, features, aesthetics, etc. The whole process may take up to 20 minutes.

Please see the attached personal information sheet and consent form. If you are interested, please contact me. This is my email address: TianY37@Cardiff.ac.uk. I would be very grateful if you would like to be a participant for my user evaluation!

Best wishes,
Yueying Tian

Recruitment letter.

Designing an Interactive Application to Support Caregiver's Feeding Practices of Young Children in Poor Areas of China

You are being invited to take part in a research project. Before you decide whether or not to take part, it is important for you to understand why the research is being undertaken and what it will involve. Please take time to read the following information carefully and discuss it with others, if you wish.

Thank you for reading this.

1. What is the purpose of this research project?

In this project, I propose to design an interactive mobile and web application to support caregiver's feeding practices of young children in poor areas of China.

2. Why have I been invited to take part?

As a student at school of Computer Science and Informatics, you have been invited because of your skills on software engineering are valuable for evaluating the user experience of the app, and your feedbacks are helpful for improving the app development.

3. Do I have to take part?

You are free to withdraw your consent to participate in the research project at any time, without giving a reason, even after signing the consent form.

4. What will taking part involve?

You will be given a link to access my application, and you will be asked to click buttons on the app screen to test several designed use cases, including checking recipes, adding favorite foods, and editing food budgets. After using it, I will ask you some questions about your experience with the user interface e.g., picture quality, features, etc. I will write down your facial expressions when you use the app and answer questions, and of course write down your responses. The whole process may take up to 20 minutes. You will not be recorded by any audio video or photograph, and only the screen interactions in the app (clicking on buttons in the app) will be recorded.

5. Will I be paid for taking part?

No, you should understand that any data you give will be a gift and you will not benefit financially in the future.

6. What are the possible benefits of taking part?

There will be no direct advantages or benefits to you from taking part, but your contribution will help me improve the interface of the project.

7. What are the possible risks of taking part?

[Version 1.0]

[Date 08/09/22]

If you are harmed by taking part in this research project, there are no special compensation arrangements. If you are harmed due to someone's negligence, you may have grounds for legal action, but you may have to pay for it.

13. Who is organising and funding this research project?

The research is organised by Yueying Tian from Cardiff University and supervised by Neruo Verdezoto Dias.

14. Who has reviewed this research project?

This research project has been reviewed and given a favourable opinion by the School Research Ethics Committee.

15. Further information and contact details

Should you have any questions relating to this research project, you may contact us during normal working hours:

Yueying Tian, TianY37@cardiff.ac.uk

Thank you for considering taking part in this research project. If you decide to participate, you will be given a copy of the Participant Information Sheet and a signed consent form to keep for your records.

The only risk is maybe you will feel uncomfortable to answer my questions.

8. Will my taking part in this research project be kept confidential?

All information collected from (or about) you during the research project will be kept confidential and any personal information you provide will be managed in accordance with data protection legislation. Please see 'What will happen to my Personal Data?' (below) for further information.

9. What will happen to my Personal Data?

Cardiff University is the Data Controller and is committed to respecting and protecting your personal data in accordance with your expectations and Data Protection legislation. Further information about Data Protection, including:

- your rights
- the legal basis under which Cardiff University processes your personal data for research
- Cardiff University's Data Protection Policy
- how to contact the Cardiff University Data Protection Officer
- how to contact the Information Commissioner's Office

may be found at <https://www.cardiff.ac.uk/public-information/policies-and-procedures/data-protection>

After 23/09/2022, the research team will anonymise all the personal data it has collected from, or about, you in connection with this research project, with the exception of your consent form and email. Your consent form and email will be retained for 1 year or the university OneDrive of Yueying Tian is deactivated and may be accessed by members of the research team and, where necessary, by members of the University's governance and audit teams or by regulatory authorities. Anonymised information will be kept for a minimum of 1 year or the university OneDrive of Yueying Tian is deactivated but may be published in support of the research project and/or retained indefinitely, where it is likely to have continuing value for research purposes.

10. What happens to the data at the end of the research project?

The data will not be made publicly available or shared within or outside of the University. Future research will not use the data. The data will not be shared via any forms to others due to the sensitivity of the research project.

11. What will happen to the results of the research project?

It is our intention to publish the results of this research project in academic journals and present findings at conferences. Participants will not be identified in any report, publication or presentation. We will not use verbatim quotes from participants.

12. What if there is a problem?

If you wish to complain or have grounds for concerns about any aspect of the manner in which you have been approached or treated during this research, please contact Yueying Tian. If your complaint is not managed to your satisfaction, please contact School Research Ethics Committee (email: comsc-ethics@cardiff.ac.uk)

Participant information sheet.



Appendix 4

Participant ID no:
*Do not include box for
anonymised samples*

CONSENT FORM

Title of research project: Designing an Interactive Application to Support Caregiver's Feeding Practices of Young Children in Poor Areas of China

SREC reference and committee: School of Computer Science and Informatics School Research Ethics Committee

Name of Chief/Principal Investigator: ~~Jueying~~ Tian



Please
initial box

I confirm that I have read the information sheet dated 08/09/22 version 1.0 for the above research project.	
I confirm that I have understood the information sheet dated 08/09/22 version 1.0 for the above research project and that I have had the opportunity to ask questions and that these have been answered satisfactorily.	
I understand that my participation is voluntary and I am free to withdraw at any time without giving a reason and without any adverse consequences (e.g. to medical care or legal rights, if relevant). I understand that if I withdraw, information about me that has already been obtained may be kept by Cardiff University.	
I understand that data collected during the research project may be looked at by individuals from Cardiff University or from regulatory authorities, where it is relevant to my taking part in the research project. I give permission for these individuals to have access to my data.	
I consent to the processing of my personal information (gender) Cardiff university email for the purposes explained to me. I understand that such information will be held in accordance with all applicable data protection legislation and in strict confidence, unless disclosure is required by law or professional obligation.	
I understand who will have access to personal information provided, how the data will be stored and what will happen to the data at the end of the research project.	
I understand that anonymised excerpts and/or verbatim quotes from my interview and user studies (including my answers to questions, and recorded my interactions with apps, and my described reactions during interview) may be used as part of the research publication.	

Version 1.0

08/09/22

[Type here]

Appendix 4

Participant ID no:
*Do not include box for
anonymised samples*

I understand how the findings and results of the research project will be written up and published.	
I agree to take part in this research project.	

Name of participant (print)

Date

Signature

Name of person taking consent
(print)

Date

Signature

Role of person taking consent
(print)

THANK YOU FOR PARTICIPATING IN OUR RESEARCH
YOU WILL BE GIVEN A COPY OF THIS CONSENT FORM TO KEEP

Consent form.

SCHOOL OF COMPUTER SCIENCE AND INFORMATICS

APPLICATION FOR ETHICAL REVIEW

+

For Office Use Only	SREC Reference:	Meeting/Review Date:
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□

SECTION 1. GENERAL INFORMATION		
Application Type:	<input type="checkbox"/> Staff <input type="checkbox"/> PGR student <input checked="" type="checkbox"/> PGT/Masters Student <input type="checkbox"/> Undergraduate	
Research Project Title:	Designing an Interactive Application to Support Caregivers' Feeding Practices of Young Children in Poor Areas of China	
Short Title (where applicable):		
For Staff Projects		
Name of Chief/Principal Investigator:	Tian	
Contact details:	TianY37@cardiff.ac.uk	
Other members of research team:	Nervo Verdezoto Dias	
For Student Projects		
Name of Student:	Yueying Tian	
Contact details:	TianY37@cardiff.ac.uk	
Name of Supervisor(s):	Nervo Verdezoto Dias	
Contact details:	VerdezotoDiasN@cardiff.ac.uk	
Other members of research team:		
SECTION 2. SCREENING QUESTIONS		
	Yes	No
2.1 Is the research project categorised as 'Research' (as defined in the Cardiff University Policy on the Ethical Conduct of Research involving Human Participants, Human Material or Human Data (Ethics Policy))?	Yes	
<i>If no (i.e. the research project is a Service Evaluation or Audit), the Committee is not required to conduct a review of the proposal but may choose to do so. Please contact Committee (comsc-ethics@cardiff.ac.uk) to seek advice before proceeding with this application.</i>		
2.2 Does the research project involve human participants, human material or human data (as defined in the Ethics Policy)?	Yes	
<i>If no, you are not required to submit the research proposal to this Committee. Please do not continue with this application.</i>		
2.3 Does the research project require review by an external ethics committee (refer to Appendix 1 of the Ethics Policy)? Please note that this includes		No

[Version 21/22-1]

all research projects involving participants who lack the capacity to consent. <i>If yes, the research project should be submitted to the relevant external ethics committee for review and does not fall within the remit of this Committee. Please contact the Research Governance Team for further advice. Please do not continue with this application.</i>		
2.4 Has the research project been ethically reviewed by another university or research institution (for example, where the Chief/Principal Investigator for the research project is based at another institution)? <i>If yes, please provide evidence of the review conducted (such as an outcome letter or communication) and the ethical review policy of the relevant institution or committee. Please do not continue with this application.</i>		No
2.5 Is the research project exempt from ethical review under the University's framework for the Ethical Review of Research using Secondary Data and/or Publicly Available information only ? This framework allows certain research projects using only secondary data and/or publicly available information to proceed without ethical review by a SREC provided certain conditions are met. The framework is outlined in the Appendices of the Ethics Policy . For the avoidance of doubt, projects that involve the collection/use of data from social media platforms (or similar platforms) MUST be subject to ethical review. <i>If yes, you are not required to submit the research proposal to this Committee. Please do not continue with this application. If in doubt, please seek advice from the committee (comsc-ethics@cardiff.ac.uk).</i>		No
2.6 Does the research project fall within the scope of the UK Policy Framework for Health and Social Care Research ? This Framework broadly applies to research taking place within, or involving, the health and social care systems. <i>If yes, you will need to apply to the Research Governance Team for Sponsorship using the Advanced Project Information Proforma (APIP) (available on the Cardiff University intranet). The Research Governance Team will advise you on the approvals that are required for the research project after it has conducted a review of the APIP and supporting documentation. Please do not continue with this application until you have sought advice from the Research Governance Team.</i>		No
2.7 Does the research project involve the collection or use of Human Tissue (including, but not limited to, blood, saliva and bodily waste fluids)? <i>If yes, the research project should be submitted to the Human Tissue Act Compliance Team (HTACT) prior to submission to an ethics committee. Please note that submission of a research protocol/proposal to HTACT is essential for all projects involving the collection or use of Human Tissue. Please do not continue with this application until you have sought advice from HTACT.</i>		No
2.8 Does the research project fall within the scope of the University's Security-sensitive Research Policy ? This Policy broadly applies to		No

	research involving terrorism, extremism or radicalisation (or access to materials of such a nature).		
	<i>If yes, you must register the research in accordance with the Policy and comply with the IT and security arrangements contained in the Policy.</i>		
2.9	Has the research project received appropriate peer/scientific review? (For student research projects, review by the research project supervisor is an acceptable form of scientific review)	Yes	
	<i>If no, please obtain appropriate peer/scientific review before submitting the application to this Committee.</i>		
2.10	Have you <u>and</u> all other Cardiff University co-applicants/Supervisors/Members of the research team (as listed in Section 1) completed the University's Research Integrity Online Training Programme . <i>If no, you must complete the training before submitting the application to this Committee.</i>	Yes	
2.11	For student projects only - to be completed by the lead supervisor. As the lead supervisor for this proposal, provide a comment in support of the answers to 2.1 through 2.9 and that the School Research Ethics Committee is the appropriate committee to review the application.		
	For 2.1, yes this is a research project where the student will evaluate her application with a number of users to explore the potential usability of the application in the context of infant feeding. For 2.9, I have reviewed the different study protocols and provided feedback, comments and suggestions and the students have taken on board all the suggestions.		
2.12	Will this project involve the explicit recruitment of participants by the research team?	Yes	
2.13	Will this project involve the explicit recruitment of participants via a Gatekeeper? <i>A Gatekeeper is someone external to the research team that will facilitate initial (and where relevant continual) access to potential research participants. Further guidance on Gatekeepers can be found in Ethics Policy.</i>		No
2.14	If the answer to 2.12 OR 2.13 is 'Yes': Have you used the provided University templates for the Information Sheet and Consent form? <i>All applications are expected to use these templates. Links to these templates are provided at: https://www.cs.cf.ac.uk/ethics/</i> Have you addressed and resolved each of the instructions/placeholders in [square brackets] in the Consent Form template?	Yes	

	<i>Note that for new applications, the date should be the date of document creation and the version should be 1.0. This should be incremented along with a new date for each change and resubmission of documents.</i>		
	Have you removed anything not in accordance with the instructions/placeholders in [square brackets] from the content of the Consent Form? If Yes, explain what and why below. <i>Note that in almost all circumstances, any removals will not be considered as acceptable, EXCEPT for the "Participant ID no." box if participation will be anonymous AND the initials and signatures if presented in an online, anonymous format. However, the participant will still need to confirm they consent to each point in the consent form before being able to participate. Refer to the Ethics Policy for guidance on Informed Consent and describe how this will be achieved below.</i>		No
	Have you read, followed, and removed the "INSTRUCTIONS FOR RESEARCHER" section from the Participant Information Sheet template?	Yes	
	Have you addressed and resolved each of the instructions/placeholders in [square brackets] in the Participant Information Sheet template? <i>Note that for new applications, the date should be the date of document creation and the version should be 1.0. This should be incremented along with a new date for each change and resubmission of documents.</i>	Yes	
	Have you removed anything not in accordance with the instructions/placeholders in [square brackets] from the content of the Participant Information Sheet template? If Yes, explain what below. <i>Note that in almost all circumstances any removals will not be considered as acceptable.</i>		No
2.15	For student projects only - to be completed by the lead supervisor. As the lead supervisor for this proposal, provide a comment in support of the answers to 2.12, 2.13, and 2.14 and confirm that <u>appropriate decisions have been made and instructions followed</u> in the need for, and creation of a consent form and participant information sheet.		
	For 2.12, yes, her project involves looking for participants through the school mailing list or post in Twitter. For 2.13, no, there is no need for a gatekeeper as the student is recruiting through social media. For 2.14, yes, she has provided and changed all the templates.		
	If the research project involves the use of animals, please contact the Cardiff University Biological Standards Office bso@cardiff.ac.uk to seek further advice.		
	SECTION 3. PROJECT SUMMARY		

3.1	Summarise the research project (including the purpose and its methodology) using language that would be understood by a lay person.
The research project proposes to design an interactive mobile and web application to support caregiver's feeding practices of young children in poor areas of China.	
3.2	State the research question(s).
The overall research question is to understand how to help child caregivers in poor areas in China with their child feeding practices by designing children nutrition and feeding apps for them. The research question consists of the following sub-questions.	
1. What are the main requirements child caregivers have for children nutrition apps according to their child feeding practice? 2. What are the main difficulties they have from using existing nutrition apps? 3. What does a young child's diet look like?	
3.3	Estimated start date.
25/09/2022	
3.4	Estimated end date (usually the end of data collection).
15/10/2022	
3.5	Is the research project funded? If yes, please name the funding body.
No	
3.6	Are there any potential conflicts of interest? If yes, please confirm the action you propose to take to address such conflicts. <i>Information and guidance on conflicts of interest is contained in the Research Integrity Online Training Programme and the Research Integrity and Governance Code of Practice.</i>
No	
3.7	For student projects only - to be completed by the lead supervisor. As the lead supervisor for this proposal, provide a comment in support of <u>appropriateness</u> and <u>completeness</u> of the answers to this section.
Yes, I support the ethics application for her research project.	
SECTION 4. FULL REVIEW CRITERIA	
Your answers to the questions in this Section 4 will help the Committee determine whether your project requires full or proportionate review.	
If all 'No' boxes apply, your project may be considered for proportionate review.	
If a 'Yes' box applies, your project will proceed to full review unless the School has approved an Ethics Protocol for that particular criterion. The list of the School's Ethics Protocols are provided at: https://www.cs.cf.ac.uk/ethics/ . Where an Ethics Protocol applies, this is confirmed below. If you have complied with the Ethics Protocol, your project may be considered for proportionate review.	
Please refer to the School's Ethics Procedure for details and approximate lead times for the proportionate and full review systems: https://www.cs.cf.ac.uk/ethics/ .	

	Yes	No
4.1 Will the research project be performed without the participants' prior consent? <i>Note, research projects involving the collection/access of data from social media is likely to fall into this category.</i> If you have answered 'Yes' to 4.1, have you complied with the School's Ethics Protocol for Research using online data without participants' prior consent?		No
4.2 Does the research design include an element of deception, including covert research?	No	
4.3 Will the research project involve children under the age of 18 or 'at risk' (vulnerable) adults or groups? <i>The Cardiff University Safeguarding Children and Adults at Risk: Policy and Guidance sets out examples of 'at risk' or 'vulnerable' adults</i>	No	
4.4 Does the research project include topics which may be considered highly sensitive for participants? <i>This includes sexual behaviour, illegal activities, political, religious or spiritual beliefs, race or ethnicity, experience of violence, abuse or exploitation, and mental health.</i>	No	
4.5 Does the research project require access to records of a sensitive or confidential nature, including Special Category Data? <i>Special Category Data is defined in data protection legislation and currently includes information about an individual's: racial or ethnic origin; political opinions; religious beliefs; trade union membership; physical or mental health; sexual life or orientation; commission of offences or alleged offences; genetic data; and biometric data.</i>	No	
4.6 Is permission of a gatekeeper required for initial or continued access to participants? <i>This includes participants in custody and care settings, or research in communities where access to research participants is not possible without the permission of another adult, such as another family member or a community leader.</i> If you have answered 'Yes' to 4.6, have you complied with the School's Ethics Protocol for Research needing a Gatekeeper?	No	
4.7 Does the research project involve intrusive or invasive procedures? <i>This includes the administration of substances, vigorous physical exercise, procedures involving pain or more than mild discomfort to participants (including the risk of psychological distress, discomfort or anxiety to participants).</i>	No	
4.8 Does the research project involve visual or audio recordings where participants may be identified? If you have answered 'Yes' to 4.8, have you complied with the School's Ethics Protocol for Research involving visual or audio recordings?	No	

4.9	Does the research project involve the collection or use of human tissue?	No
4.10	Does the research project involve more than a minimal risk of harm to the safety and wellbeing of participants and/or the Researchers?	No
<p><i>Please answer this question based on your assessment of the risks involved in this project. Further information about possible harm or potential risks to participants/researchers must be provided in Section 7 of this form.</i></p>		
4.11	For student projects only - to be completed by the lead supervisor. As the lead supervisor for this proposal, provide a comment below in support of the answers of the answers to this section. For each question answered as 'Yes', provide a comment of support of why the project necessitates the answer needing to be 'Yes' and would not otherwise be feasible.	
All the answers to this section for this particular project are NO.		
SECTION 5. PARTICIPATION AND RECRUITMENT		
5.1	How will you identify and recruit participants to the research project? <i>Please note that wherever possible, potential participants should not be approached individually. Instead, 'broadcast style' communication such as mailing lists, social media posts, etc. should be used.</i>	
Using departmental system to email students in our department or post in Twitter.		
5.2	How many participants are you aiming to recruit? If applicable, please include a breakdown of participants by type and number. Four students (two males and two females).	
5.3	What are the inclusion and exclusion criteria for participants? The criteria for student participants are over 18 years old.	
5.4	Will the research project involve participants that are Cardiff University staff or students or clients of the University (or the place in which you may otherwise work)? If applicable, please provide details. Yes, we will email students in the Cardiff University, School of Computer Science and Informatics.	
5.5	For student projects only - to be completed by the lead supervisor. As the lead supervisor for this proposal, provide a comment in support of appropriateness and completeness of the answers to this section.	
I have checked and support the answers to this section.		
SECTION 6. CONSENT PROCEDURES		
6.1	Will informed consent be obtained from participants? If so, how? Please include who will be taking consent, how consent will be recorded, when participants will be provided with information about the research project, and how long potential participants will be given to decide whether to take part. Yes, participants will be taking consent. Before they participate, I will show them the participant information sheet about my project and the information consent. I will save the consent documents, and I will provide the information about my research project when our conversation starts. Potential candidates will be given five days to decide whether to take part.	
6.2	Will participants be offered any incentives to take part in the research project? No	
6.3	If a questionnaire is to be used, will you give participants the option of omitting questions they do not wish to answer? Yes	
6.4	Will participants be informed that their participation is voluntary and that they may withdraw at any time and for any reason? Yes	
6.5	Have you provided a detailed, lay summary of ALL task participants are expected to do AND how long each of these will take in Section 4 of the Participant Information Sheet template? Yes	
6.6	For student projects only - to be completed by the lead supervisor. As the lead supervisor for this proposal, provide a comment in support of appropriateness and completeness of the answers to this section.	
All supporting documents are attached.		
SECTION 7. POSSIBLE HARM TO PARTICIPANTS/RESEARCHERS		
7.1	Is there a risk of the participants experiencing physical, emotional or psychological harm or distress? <i>If yes, please provide details of how ethical issues will be handled and how any risks will be minimised. Please consider whether the research project includes topics which could be considered as highly sensitive for participants.</i>	
No		
7.2	Is there a risk of the Researcher(s) experiencing physical, emotional or psychological harm or distress? <i>If yes, please provide details of how ethical issues will be handled and how any risks will be minimised.</i>	
No		
7.3	For student projects only - to be completed by the lead supervisor. As the lead supervisor for this proposal, provide a comment in support of appropriateness and completeness of the answers to this section.	
I support the answers to this section. There are no risks associated to this project.		
SECTION 8. DATA MANAGEMENT, CONFIDENTIALITY AND DATA PROTECTION		
8.1	How, and by whom, will data be collected?	

<p>Questionnaires will be used to collect basic data, including gender and age information. In person interviews will be used to collect research related data. After using the app, participants will be asked questions about the user experience, and their answers will be kept, and their reactions during using the app, such as facial expressions, would possibly be also described in our notes.</p>								
<p>The data will be collected by the principal student investigator of this project.</p>								
8.2	<p>Will you be accessing or collecting Personal Data (identifiable personal information) as part of the research project?</p> <p>If yes, please confirm what data will be accessed and/or collected (including details of the information participants are asked to provide on a written consent form) and by who. For EACH piece of data, provide an explicit justification for why this is strictly necessary, linking back to the research questions in 3.2, and why the research will not be feasible without it.</p> <p><i>Note: If your project involves Personal Data, you are advised to review the University's GDPR Guidance for Researchers and to check whether your project requires, or would benefit from, the completion of a Data Protection Impact Assessment (DPIA). It is not the role of the SREC to review or advise on DPIA's, but if you have completed one, please confirm this below. For further advice, please refer to the 'DPIA' intranet page or contact complianceandrisk@cardiff.ac.uk.</i></p>							
<p>Yes</p> <table border="1"> <thead> <tr> <th>Data</th> <th>Collected/Accessed by</th> <th>Justification for needing the data</th> </tr> </thead> <tbody> <tr> <td>Email address</td> <td>Asking participants to provide.</td> <td>Email is needed in case of asking clarification questions or follow ups. Email addresses will be removed before analysis.</td> </tr> </tbody> </table>			Data	Collected/Accessed by	Justification for needing the data	Email address	Asking participants to provide.	Email is needed in case of asking clarification questions or follow ups. Email addresses will be removed before analysis.
Data	Collected/Accessed by	Justification for needing the data						
Email address	Asking participants to provide.	Email is needed in case of asking clarification questions or follow ups. Email addresses will be removed before analysis.						
8.3	<p>How long will you retain the Personal Data collected in connection with the research project? Please also explain any data deletion arrangements.</p> <p><i>Note: Research records and data must be retained for the period specified in Section 2.9 ('Research Project Conduct') of the University's Research Records Retention Schedule. If identifiable information is being collected, researchers must ensure that this is limited to the information necessary to achieve the relevant purpose (data minimisation). The University expects raw data containing identifiable information (questionnaires and audio tapes for example) to be retained for the full retention period unless: (1) the identifiable information is not required to support the research or to demonstrate good research conduct; and (2) stringent measures have been taken to verify and ensure the integrity of any anonymised or pseudonymised records/data produced from the raw data. Where (1) and (2) apply, the researcher must take the necessary steps to remove the personal data. Consent Forms must be retained for the full retention period.</i></p> <p><i>Please note that where UG and PGT projects do not contribute to a publication or wider research project, research records and data may be held for a shorter period. Please refer to the guidance notes in Section 2.9 of the University's Research Records Retention Schedule for further detail.</i></p>							
<p>For the full retention period until the project is finished.</p>								
8.4	<p>What efforts will be made to anonymise the data collected (where possible)?</p> <p>I will not ask real names of participants, and private identifiers will be replaced with fake identifiers or pseudonyms, and some of the data will be deliberately removed to make it less identifiable.</p>							
8.5	<p>Are you proposing to utilise 'public task' as the lawful basis for processing Personal Data for the purposes of the research project (as recommended in the University's GDPR Guidance for Researchers)?</p>							

<p>If no, please explain why and what alternative lawful basis you propose to use.</p>											
<p>Yes</p>											
8.6	<p>Have you utilised/incorporated into your Participant Information Sheet the following sections from the University's template Participant Information Sheet: 'What will happen to my Personal Data' and 'What happens to the data at the end of the research project'?</p> <p><i>If no, please explain why this has not been used and how you have otherwise ensured that the relevant data protection/privacy information has been provided to participants.</i></p>										
<p>Yes</p>											
8.7	<p>For how long will the collected anonymised data be retained? Please also explain any data deletion arrangements.</p> <p><i>Note: Anonymised research data must be retained for the period specified in Section 2.9 ('Research Project Conduct') of the University's Research Records Retention Schedule. Please note that where UG and PGT projects do not contribute to a publication or wider research project, research records and data may be held for a shorter period. Please refer to the guidance notes in Section 2.9 of the University's Research Records Retention Schedule for further detail.</i></p> <p>I will retain the data until I finish my project. After I finish my project, I will delete them.</p>										
8.8	<p>Who will have access to the data?</p>										
<p>My supervisor and me.</p>											
8.9	<p>Will the data be shared in any way, for example through deposit in a data repository, with third parties, or a transcription service?</p>										
<p>No</p>											
8.10	<p>What anonymised demographic, sensitive, or confidential data will be collected from or about participants, (e.g., Age, Sex, Gender, Employment status, etc.) including data concerning sensitive or confidential topics outlined in criteria 4.4 and 4.5?</p> <p>For EACH piece of data, provide an explicit justification for why this is strictly necessary, linking back to the research questions in 3.2, and why the research will not be feasible without it.</p>										
<table border="1"> <thead> <tr> <th>Data</th> <th>Collected/Accessed By</th> <th>Justification for needing the data</th> </tr> </thead> <tbody> <tr> <td>Gender</td> <td>Asking participants to provide.</td> <td>Age is used to study the effect of ages in feeding practice.</td> </tr> <tr> <td>Age</td> <td>Asking participants to provide.</td> <td>Gender is used to study the effect of genders in feeding practice and using the app.</td> </tr> </tbody> </table>			Data	Collected/Accessed By	Justification for needing the data	Gender	Asking participants to provide.	Age is used to study the effect of ages in feeding practice.	Age	Asking participants to provide.	Gender is used to study the effect of genders in feeding practice and using the app.
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8.11	<p>If the data collection involves the use of audio or video recording of participants, provide an explicit justification for why this is strictly necessary over alternative methods of data capture and why the research will not be feasible without it.</p>										
8.12	<p>For student projects only - to be completed by the lead supervisor.</p> <p>As the lead supervisor for this proposal, provide a comment below in support of the appropriateness and completeness of the answers to this section.</p>										
<p>Yes, I support the answers to this section. The usability study will require the use of non-identifiable recording to capture participants reactions to support the analysis and the re-design of the prototype.</p>											
<p>SECTION 9. OTHER ETHICAL CONSIDERATIONS</p>											

<p>Please outline any other ethical considerations raised by the research project and how you intend to address these. You are obliged to bring to the attention of the SREC any ethical issues not covered in this Ethics Review Application Proforma.</p> <p>No</p>																																										
SECTION 10. SUPPORTING DOCUMENTS																																										
I have attached the following documents in support of this application – marked with an X.																																										
All documents should be provided as files. Web links will NOT be accepted.																																										
All documents should be attached if this is a resubmission or an amendment, NOT just the adjusted documents, with the changes highlighted.																																										
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If you have selected 'No' for any of the documents listed above, please confirm why these have not been provided. If a listed document is not relevant to your project, please confirm this below.																																										

SECTION 11. SIGNATURES AND DECLARATIONS

Applicant declaration		
I confirm that:		
<p>a. The information in this form is accurate to the best of my knowledge and belief and I take full responsibility for it.</p> <p>b. I have the necessary skills, training and/or expertise to conduct the research project as proposed.</p> <p>c. I am familiar with the University's health and safety requirements and policies and that all relevant health and safety measures have been taken into account for the research project.</p> <p>d. I am familiar with, and will comply with, the University's Policy on the Ethical Conduct of Research involving Human Participants, Human Material or Human Data and the University's Research Integrity and Governance Code of Practice.</p> <p>e. The relevant equality and diversity considerations have been taken into account when designing the research project.</p> <p>f. If the research project is approved, I undertake to adhere to the research project protocol, the terms of the full application as approved and any conditions set out by the Committee and any other body required to review and/or approve the research project.</p> <p>g. I will notify the Committee and all other review bodies of substantial amendments to the protocol or the terms of the approved application, and to seek a favourable opinion from the Committee before implementing the amendment.</p>		
<p><i>Yueying Tian</i> Signed: Print name: <u>Yueying Tian</u></p>		
Date: 13/09/2022		
SUPERVISOR DECLARATION (FOR STUDENT PROJECTS)		
I confirm that:		
<p>a. I am familiar with the University's Policy on the Ethical Conduct of Research involving Human Participants, Human Material or Human Data and the University's Research Integrity and Governance Code of Practice.</p> <p>b. I have reviewed this application, and all supporting documents, and I am satisfied that the project as proposed meets the University's ethical standards.</p> <p>c. I have the necessary skills, training and/or expertise to offer appropriate supervision and support to the student researcher/applicant.</p> <p>d. I will encourage the student to discuss with me, and reflect on, any ethical issues that arise during or after the project and, where relevant, I will ensure such issues are notified to the SREC.</p> <p>e. I have written the application form sections starting with 'For student projects only - to be completed by the lead supervisor.'</p>		
<p><i>Neruo Verdezoto</i> Signed: Print name: <u>Neruo Verdezoto</u></p>		
Date: 23/09/2022		

Please submit the completed application and supporting documents to comscethics@cardiff.ac.uk

[Version 21/22-1]

Your electronic submission should contain wet-ink or electronic signatures of all relevant parties. Please note that if any information is missing, the application may be returned to you.

COMSC SREC application form.

Appendix 3 Screenshots of the App

This section shows more screenshots of the app pages.

