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# **Development of a theory and evidence-based, user-centred family healthy eating app**

**By**

**Kristina Elizabeth Curtis**

A thesis submitted in partial fulfilment of the requirements for the  
degree of

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## **Declaration and Inclusion of Material from a Prior Thesis**

The author declares that all the work contained within this thesis is her own work and has not been used previously. The thesis has not been submitted for a degree at another university. All the research was undertaken independently by the author at the Institute of Digital Healthcare, WMG, University of Warwick, with no other data sources incorporated. Parts of this thesis have been published by the author as follows:

**Curtis, K.,** Lahiri, S., Brown, K., (2015) Targeting parents for childhood weight management: Development of a Theory- Driven and User-Centred Healthy Eating App. *JMIR mHealth and uHealth*, Vol 3, 1-18

**Curtis, K.,** Karasouli, E., (2014). An assessment of the potential of health promotion apps to support health behaviour change. *Health Psychology Update*, 23(2).

**Curtis, K.,** Balancing theory with engagement: the development of a paediatric weight management app targeting parents for local public health services. *Medicine 2.0*, Malaga, 9-10th October 2014

**Curtis, K.,** Identification of evidence based behaviour change techniques for use in a paediatric weight management mobile app targeting parents. *European Health Psychology Society Conference*, Austria, 26-30 August 2014

**Curtis, K.** The Behaviour Change Wheel: A user's experience. *Behaviour Change Wheel Launch*, UCL Centre for Behaviour Change, London, 14 May 2014  
<https://www.youtube.com/watch?v=EnkZ2R-G9Es>

**Curtis, K.,** Lewis, T., Wyatt, J How to improve the quality and safety of apps for medicine and health promotion. *Medicine 2.0 conference*, London, 24-26 September 2013

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**Curtis, K.,** Brown, K. Lessons learned from the development of a theoretically grounded Health Application. *Doctors 2.0 & You Conference*, Cité Internationale Universitaire de Paris, Paris, 6-7 June 2013

**Curtis, K.,** Brown, K., Parents' emotional barriers to making change to their children's diets. *The Midlands Health Psychology Network Conference*, Birmingham University, 14 February 2013

The current research has also been used as a case study within *The Behaviour Change Wheel A Guide to Designing Interventions* (Michie, Atkins & West, 2014: Box 1.13:83). Silverback Publishing.

## Abstract

The proliferation of health promotion apps along with smartphone's array of features supporting health behaviour change, offers a new and innovative approach to childhood weight management. However, research on the content of current industry led apps reveals they lack a basis in behaviour change theory and evidence. Equally important remains the issue of how to maximise users' engagement with mHealth. Therefore the thesis aimed to address these gaps and design and develop an evidence and theory based, user-centred healthy eating app targeting parents for childhood weight management.

The Behaviour Change Wheel framework (BCW), a theoretically-based approach for health behaviour change intervention development, along with a user-centred design philosophy and collaboration with industry, guided the development process. This involved a review of the evidence and conducting a series of nine focus groups (Study one and two), a usability workshop and a 'Think Aloud' study (study three) (N=70) comprised of Change4Life advisors, parents with overweight and healthy weight children aged 5-11 years, university students and staff and consultation with experts to inform the app development. Thematic analysis of focus groups helped to extract information related to relevant theoretical (using the Capability, Opportunity, Motivation, Behaviour Model (COM-B) and Theoretical Domains Framework (TDF)), user-centred and technological components to underpin the design and development of the app.

Inputs from parents, case workers and experts working in the area of childhood weight management helped to identify the main target behaviour: to support parents' provision of age appropriate food portion sizes. To achieve this target behaviour, the behavioural analysis revealed the need for eliciting change in parents' Capability, Motivation and Opportunity and twelve associated TDF domains. Therefore, the thesis provides a more comprehensive analysis of the problem compared to previous theoretical accounts, demonstrating that parents' internal processes such as their emotional responses, habits and beliefs, along with social influences such as partners and grandparents and the environmental influences relating to aspects such as schools, the media, and household objects, all interact and impact on their portion behaviours. Theoretical domains were subsequently mapped to five intervention functions and twenty-three behaviour change techniques (BCTs) to bring about change in this target behaviour. BCTs were then translated into engaging app features drawing on parental preferences for healthy eating app features including ease of use, minimal data input, visual aids of food and gamification. Overall parents viewed the prototype app positively. The 'Think Aloud' study highlighted key areas to improve usability in such as navigability.

Application of the BCW to the issue of childhood weight management yielded a novel conceptualisation of potential approaches to supporting parents' portion behaviours in the home environment. This thesis is also the first to fully explicate the systematic approach applied in developing a family-oriented mHealth app grounded in the BCW framework and evidence, and balanced with users' preferences to help maximise its potential engagement with the target population. Challenges and adaptations relating to the implementation of the BCW are discussed and suggestions for future research in mHealth development and childhood weight management are provided, along with the implications for public health practice.

## Abbreviations

Abbreviation	Full term presented within thesis
BCTs	Behaviour Change Techniques
BCTT(v1)	Behaviour Change Technique Taxonomy (v1)
COM-B	Capability, Opportunity, Motivation, Behaviour
EST	Ecological Systems Theory
HBM	Health Belief Model
IF	Intervention Function
mHealth	Mobile Health
NCMP	National Child Measurement Programme
SCT	Social Cognitive Theory
TDF	Theoretical Domains Framework
TPB	Theory of Planned Behaviour
UCD	User-Centred Design
WMP	Weight management programme

## **Glossary**

**Behaviour change technique:** An active ingredient of an intervention that directly changes behaviour.

**Behaviour Change Theory:** A model that aims to describe and predict phenomena.

**COM-B Behavioural Diagnosis:** Using sources of information (e.g. interviews, focus groups, evidence, expert advice) to identify which components in the COM-B system need to change in order for the target behaviour to occur.

**Childhood overweight and obesity:** Children's abnormal and excessive fat accumulation

**Health behaviour change intervention frameworks:** A co-ordinated set of activities that aim to change the behaviours of individuals or populations.

**Intervention function:** A broad function in an intervention that bring about change in a behaviour

**Intervention mapping table:** A table showing the systematic development of evidence and theory based interventions.

**mHealth:** An abbreviation for mobile health referring to the practice of public health and medicine through the use of mobile devices such as mobile phones, tablet computers and PDAs.

**Theoretical Domains Framework:** A synthesis of constructs from a range of behaviour change theories designed to make theories more accessible for implementing in behaviour change interventions.

**The eatwell plate:** An infographic developed by the DOH for highlighting the different food groups, and their proportions, that make up a well-balanced diet.



## **Chapter 1 Introduction**

Mobile health (mHealth) represents a nascent and rapidly growing field and there is a strong impetus for harnessing mobile devices to improve the public's health. As the field of mHealth continues to grow, so does the problem of childhood overweight and obesity, and there is now concord amongst researchers, parents, practitioners and the government, that these two fields should converge in an effort to explore this medium for addressing a major global health epidemic. Therefore, this chapter presents an overview of the research context as well as the applied mHealth project.

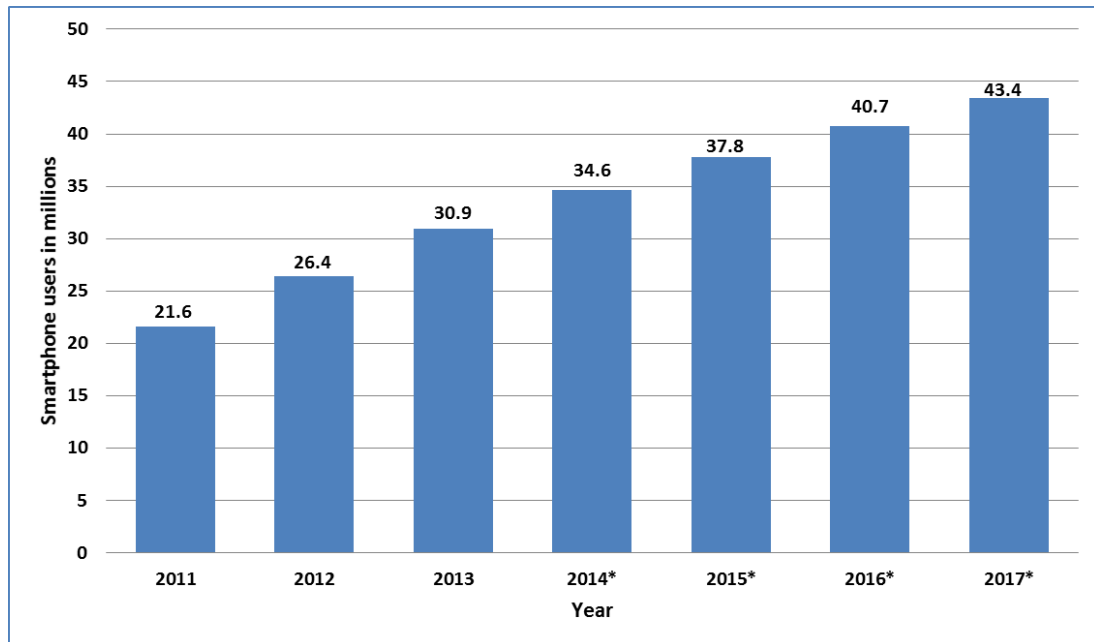
### **1.1 Smartphones: their potential for supporting health behaviour change**

According to Ahern, David and Phalen (2007), eHealth can be defined as 'the use of emerging interactive technologies' that enable people to improve their health and well-being and improve health care services (Ahern et al., 2007:5). This thesis focuses on a sub-discipline of eHealth known as mobile health (mHealth), defined by the Global Observatory of eHealth (GOe) as mobile devices such as mobile phones, personal digital assistants (PDA), and other wireless devices supporting a medical or public health practice (WHO, 2011). Within mHealth, it is the advent of the smartphone, accompanied by an explosion of commercial mobile health and medical apps (mHealth apps), that is transforming approaches to personal health management (Bert, Giacometti, Gualano & Siliquini, 2014:1).

Smartphones are a combination of a mobile phone and personal digital assistant, often combined with sensors such as accelerometers, cameras and GPS. They are typically classified by their manufacturer or operating system (OS) with the most popular systems supporting Android, iOS, Windows phone and Blackberry OS

platforms (IDC, 2014.). Figure 1 below shows the UK smartphone penetration rates.

It is forecasted that by 2017 approximately 43.4 million people will own a smartphone.



**Figure 1: Number of smartphone users in the UK from 2011-2017 (in millions)**

Source: Statista, 2014; (\* = predicted numbers).

The release of the Apple iPhone in 2007 is widely seen as having paved the way for developers to create a catalogue of applications for the new generation of smartphones (Franko, 2011). A mobile app is a small programme or application downloaded from a website (e.g. Apple's App Store) which runs on a smartphone or tablet computer. By 2016, it is estimated that more than 44 billion apps will have been downloaded which is equal to six apps downloaded for every person worldwide (West et al., 2013).

With regards to smartphones, the exponential growth of mHealth apps have converted them into tools for medical education and functions (e.g. medical reference apps, clinical decision support apps), self-management of chronic

conditions (e.g. diabetes apps) and especially, health promotion (e.g. weight loss apps). This thesis focuses specifically on health promotion apps (predominantly listed in the 'Health & Fitness' categories of app stores), which are the most commonly downloaded mHealth app (Butler, 2012.).

Health promotion apps can be defined as primary prevention apps aimed at helping users start or reinforce one or more health behaviours (e.g. nutrition apps) and/or reduce risk behaviours (e.g. smoking cessation apps) and improve well-being (Curtis & Karasouli, 2014). They vary in complexity from simply locating the nearest pharmacy to a whole suite of tools, providing tailored information, advice and feedback to help users achieve their health goals. This thesis focuses on the latter more complex apps, where it is now well documented that smartphones offer a number of attributes that maximise their potential for supporting health behaviour change including: accessibility (e.g. global proliferation, widespread adoption across socioeconomic and demographic populations, ubiquity); personal nature (e.g. always on the person, emotional attachment and connectivity) and; programming flexibility (e.g. information tailoring, context aware capabilities, automated sensors); (Bert, et al., 2014; Klasnja & Pratt, 2012; Klasnja & Pratt, 2014; Riley et al., 2011; Tate et al., 2013; Kumar et al., 2013). Additionally, smartphones offer benefits for researchers regarding implementation (e.g. low cost, rapid scalability, ease of use, zero-geography, low participant burden), real time monitoring, data collection and analysis (Tate et al., 2013; World Health Organisation, 2011).

To date, nutrition and diet apps represent the fastest growing area of health promotion apps (Bert et al., 2014). If these mHealth apps were all effective, they may hold significant potential for ameliorating major threats to public health such as the childhood overweight and obesity epidemic.

## **1.2 Childhood overweight and obesity**

Childhood overweight and obesity is increasing rapidly around the globe and represents one of the most serious public health issues in the 21<sup>st</sup> century (World Health Organisation, 2014). It has been estimated that in 2010, 42 million children under the age of five were overweight or obese, where the United States (US) ranked the highest and the United Kingdom (UK) and Australia following closely behind (Public Health England, 2014). The UK has one of the highest rates of childhood obesity among European countries where the latest figures indicate that 14% of children aged between 2 and 15 are obese and 28% are overweight (Public Health England, 2012).

## **1.3 Government initiatives to tackle the problem**

As a response to the global epidemic of childhood obesity (World Health Organization, 2000; Flynn et al., 2006), governments world-wide are employing a range of behaviour change strategies relating to diet and physical activity (Waters et al., 2011). According to Lowe (2003), ‘society-wide’ attempts to educate the public and modify the food environment are comparable to the huge efforts that were focused on tackling cigarette smoking in the 1950s and 1960s.

Within the UK, the government in its white paper: *Healthy Lives, Healthy People: A call to action on obesity in England*, announced its ambition for preventing and reversing the trend in excess weight in children by 2020 (Department of Health, 2011). Perhaps the most extensive UK government initiative to date has been the Change4life social marketing campaign, originating in 2009 as a strategy for childhood obesity prevention, and expanding to address adult obesity to support the ambitions of the aforementioned white paper. Among other weight management

related initiatives are also a range of additional campaigns employed by other organisations and charities, such as the British Heart Foundation's Food4Thought and the Academy of Medical Royal Colleges (AoMRC) campaigns, both calling for a ban on junk food advertising aimed at children.

An important part of the government's strategy to tackle childhood overweight and obesity, is the National Child Measurement programme (NCMP), launched in 2006, and jointly led by the Department of Health (DoH) and Department for Education (DfE). The nationwide monitoring programme, overseen by trained healthcare professionals in school settings, involves measurement of children's weight and height in reception year (4-5 years old) and Year 6 (10-11 years old) to assess overweight and obesity levels at primary schools (National Obesity Observatory [NOO], 2010). The NCMP measures over one million children a year and results are seen to provide a 'robust' indication of the prevalence of childhood obesity in each Primary Care Trust cluster (NCMP, 2011).

With regards to mHealth interventions, Change4life (initiated and supported by Public Health England) along with a website offering a range of tools to support families in healthy eating and increasing their activity levels, released a healthy eating app, in June 2014. The app known as Change4Life Smart Recipes® aims to provide adults with healthy recipes as well as a range of other features such as help with planning and cooking meals. Within the same year, Change4life released Smart Restart® which aims to support parents in helping their children to follow healthier routines where parents can choose to start with a healthy change in relation to screen time, exercise or food. However, due to technical difficulties at the time of writing, an informal review of public ratings in Apple's app store indicated that so far users have not been able to login in and begin using the app.

## **1.4 Childhood weight management interventions**

Up to now, the majority of childhood weight management interventions have been conducted in school-based settings (Brown, Kelly & Summerbell, 2007; Sharma, 2006; Summerbell et al., 2005; Hingle, O'Connor, Dave & Baranowski, 2010). One of the benefits of school-based interventions is that they offer continuous access to large numbers of children and potentially their parents (Summerbell et al., 2005; Brown & Summerbell 2009; Katz, O'Connell, Njike, Yeh & Nawaz, 2008; Hendrie et al., 2012) and avoid stigmatising children that are overweight or obese (Dobbins, Decorby, Robeson, Husson & Tirilis, 2009). However, so far, school based interventions have had limited success (Baranowski, Buday, Thompson & Baranowski, 2008; Birch & Ventura, 2009). For those interventions that have shown significant improvements, their effects are small in comparison to the increased rate of childhood overweight and obesity, making it difficult for them to have a meaningful impact on current obesity trends (Birch & Ventura, 2009).

It has been argued that one of the key reasons for their limited effectiveness is that many school interventions do not comprise of a strong enough component that involves support from parents to allow for behaviour change to be maintained in the long term (Eisenmann et al., 2008; Van Cauwenberghe et al., 2010; Zenzen & Kridli, 2001). This is congruent with reviews of school-based interventions where studies involving parents show higher effects on childhood obesity indices (Sharma, 2007; Cook-cottone, Casey & Feeley, 2009). As previously mentioned, parents exert strong influences on children's eating behaviours (Tabacchi, Giammanco, La Guardia & Giammanco, 2007; Birch, 2006; Knowlden & Sharma, 2012; Hingle et al., 2010), underscoring the importance of their involvement in childhood weight management.

Hingle et al. (2010) conducted a systematic review assessing whether parent involvement enhanced children's dietary intake and found support for including parents in dietary interventions. Additionally, those studies employing direct methods to involve parents (e.g. parents are present in nutrition education classes and attended family behavioural counselling or training sessions), were more likely to report positive results compared to those who employed more indirect methods (e.g. provision of information not requiring a response from the parents such as leaflets or emails and invitations to take part in activities such as health fairs). Hence, while indirect methods remain the most commonly used strategies to engage parents, direct methods show more promise which necessitates further research into direct methods for involving parents in a well-designed childhood weight management intervention. It is anticipated that this will improve our understanding for example, of whether the success of direct strategies to target parents in an intervention are dependent upon their appeal to more motivated parents or whether their success is more dependent upon their 'intensity' (e.g. dosage of techniques used) that can overcome barriers to behaviour change (Hingle et al., 2010: 109), or indeed the combined effect of both. The authors of the review also highlight the need to develop interventions in meaningful settings where parents are directly involved in the intervention development process (Hingle et al., 2010), and which take account of both the psychosocial and environmental influences on dietary behaviours (Baranowski et al., 2003).

Other reviews of school-based childhood weight management interventions have recommended that, in addition to including the crucial aspect of parental involvement, interventions should be guided by theoretical frameworks (National Obesity Observatory, 2009; Zenzen & Kridli, 2001). Up to now, only a small

number of childhood weight management interventions report their use of theory, which reflects a wider issue for health behaviour change interventions where there is a lack of reference made to theory in their design (Michie, West, Campbell, Brown & Gainforth, 2014). Of those childhood weight management interventions that have reported use of theory, some authors suggest that the majority are based on central elements of Social Cognitive Theory (Zenzen & Kridli, 2001; Gorely, Nevill, Morris, Stensell & Nevill, 2009). However, more recently, a systematic review of childhood weight management interventions (Golley, Hendrie, Slater & Corsini, 2011) reported that the majority of interventions were underpinned by behavioural learning theory (10/17) and ecological models (5/17). Interestingly however, seven studies reviewed by the authors employed more than one theory which may suggest that few theories are comprehensive enough in isolation to guide the development of childhood weight management interventions. Arguably, more research is needed regarding which theoretical frameworks are most relevant for childhood weight management targeting parents where none has found to be more superior to another (Baranowski, Cullen, Nicklas, Thompson & Baranowski, 2003). Hence, prevailing behaviour change theories within the field of health psychology are described and evaluated with regards to their suitability for guiding the design of childhood weight management interventions in section 2.4.

Another potential reason for existing childhood weight management interventions' limited effectiveness is that they tend to focus on a large range of target behaviours (e.g. increasing fruit and vegetables, exercise; reducing fat) and little prioritisation is given to behaviours that contribute most to overweight (Lowe, 2003). Indeed, experts in the field of behaviour change argue that it is essential that we understand the nature and context of the behaviour targeted for change in order to increase an



intervention's potential for effectiveness (House of Lords Science and Technology Select Committee, 2011; Michie et al., 2014a). Furthermore, it is important that interventions sufficiently address the system of behaviours that surround the target behaviour(s) (Michie, Atkins, & West, 2014). It could be argued that this lack of understanding of the target behaviours, is reflected in current childhood weight management interventions, which have tended to focus on distal goals such as weight loss rather than the specific target behaviour (McLean, Griffin, Toney & Hardeman, 2003). Consequently, school-based childhood weight management interventions have been criticised for their use of several intervention components and weak study designs which limits their evaluations of independent effects, resulting in greater uncertainty around effective components (Birch & Ventura, 2009; Waters et al., 2011).

Lastly, reviews of school-based interventions recommend that such programmes are developed in consultation with the parent target population (Hingle et al., 2010, National Obesity Observatory 2009; Cook-cottone et al., 2009; Summerbell et al., 2005), providing them with the opportunities to specify the information they require (e.g. ideas for healthy snacks) (Sahota et al., 2001; Pocock et al., 2010). There is also a need to train parents in the use of behavioural techniques such as goal setting and self-monitoring, to ensure that changes are maintained in the long term (Katz et al., 2008; McLean et al., 2003; National Obesity Observatory, 2009).

While community based programmes make up a smaller focus with respect to managing children's weight, nonetheless, reviews of these programmes have also revealed shortcomings. For example, evidence suggests that important barriers to parents attending community based childhood weight management programmes relate to their: time commitments, physical access, scheduling conflicts,

interpersonal dynamics (e.g. not getting on with other parents), fear of stigmatising children, negative emotional state and denial of the problem (Hingle et al., 2010; Barlow & Ohlemeyer, 2006; Pocock et al., 2009; Brown, Dolisca & Cheng, 2014).

With respect to the aforementioned limitations of both school-based and community interventions, consensus is building amongst researchers in the field for the need to explore novel approaches such as online interventions (Hingle et al., 2010; Knowlden & Sharma, 2012; Staniford, Breckon & Copeland, 2011) and mobile health applications (Schoffman, Turner-McGrievy, Jones & Wilcox, 2013; Tate et al., 2013). Arguably, advances in mobile technology can vastly increase the reach and access of childhood weight management interventions, where parents are no longer bound by their location (Boulos, Wheeler, Tavaras & Jones, 2011).

Moreover, research shows that parents are advocates of the use of digital technology to support weight management within their families (Brown et al., 2014).

Fundamentally, mHealth interventions have the potential to enable more direct support and involvement of parents in childhood weight management interventions compared to traditional delivery settings such as schools and community based settings.

## **1.5 Collaboration with Public Health Warwickshire**

Given the aforementioned challenges with existing approaches to childhood weight management, widespread adoption of smartphones and popularity of mobile health apps (mHealth apps), Public Health Warwickshire and Warwickshire County Council (WCC), identified the need to explore the use of a mHealth app to complement their existing family weight management services. In 2011, the thesis author (KC) conducted voluntary work for the public health department of WCC

under the supervision of one of their health psychologists (KB). During this period the thesis author was approached by the Health Improvement Commissioning and Performance Lead, responsible for commissioning family weight management services within Warwickshire, to develop a mHealth app.

After several stakeholder meetings at WCC with the commissioning staff and the Obesity Projects' Co-ordinating team members, the decision was made to focus on developing a smartphone app that would specifically support parents (with overweight and very overweight children) in providing healthier food for their children. A contract between WCC and the University of Warwick was drawn up and agreed for a sum of £10,000 from WCC to the University of Warwick to fund the technical development and programming of a mHealth app to support childhood weight management.

In addition to conducting the research, the thesis author's role also required extensive project management of all elements involved in app development for public health including liaising with: the commercial app company for the design and technical development of the prototype app; the council's IT and legal staff on licensing and Intellectual Property (IP) issues; and attending quarterly meetings with Public Health Warwickshire staff.

The thesis author considered two local digital media companies who had experience with app development. However, after several meetings it became clear that they were going to exceed the budget and therefore start-up companies in the area of mhealth were sought. One local company was found but lacked the commercial experience required to ensure that the app was engaging and fun to use. Virtually Free Ltd (VF) was finally chosen by the thesis author because they were a start-up

company led by two psychiatrists who understood that theory, evidence and research with parents and Change4life advisors were important for informing app development and would therefore require more time. They were also currently engaged in academic research for their own mHealth app projects and therefore had a good comprehension of the research process. Furthermore, they were partnered with a commercial gaming company who would carry out the design and programming of the app, applying elements of gamification. Their role in the project was to advise on which functionality (e.g. forums, BMI calculator, notifications), came within the budget, and how certain behaviour change techniques (BCTs) could be operationalised into app features. Interactions with the app company involved several face to face meetings, emails and phone calls with the project team at VF to take the app from the concept stage through to the prototype app.

To provide further context to the project, Warwickshire's existing weight management services are described below. These services were also used to recruit research participants to inform app development.

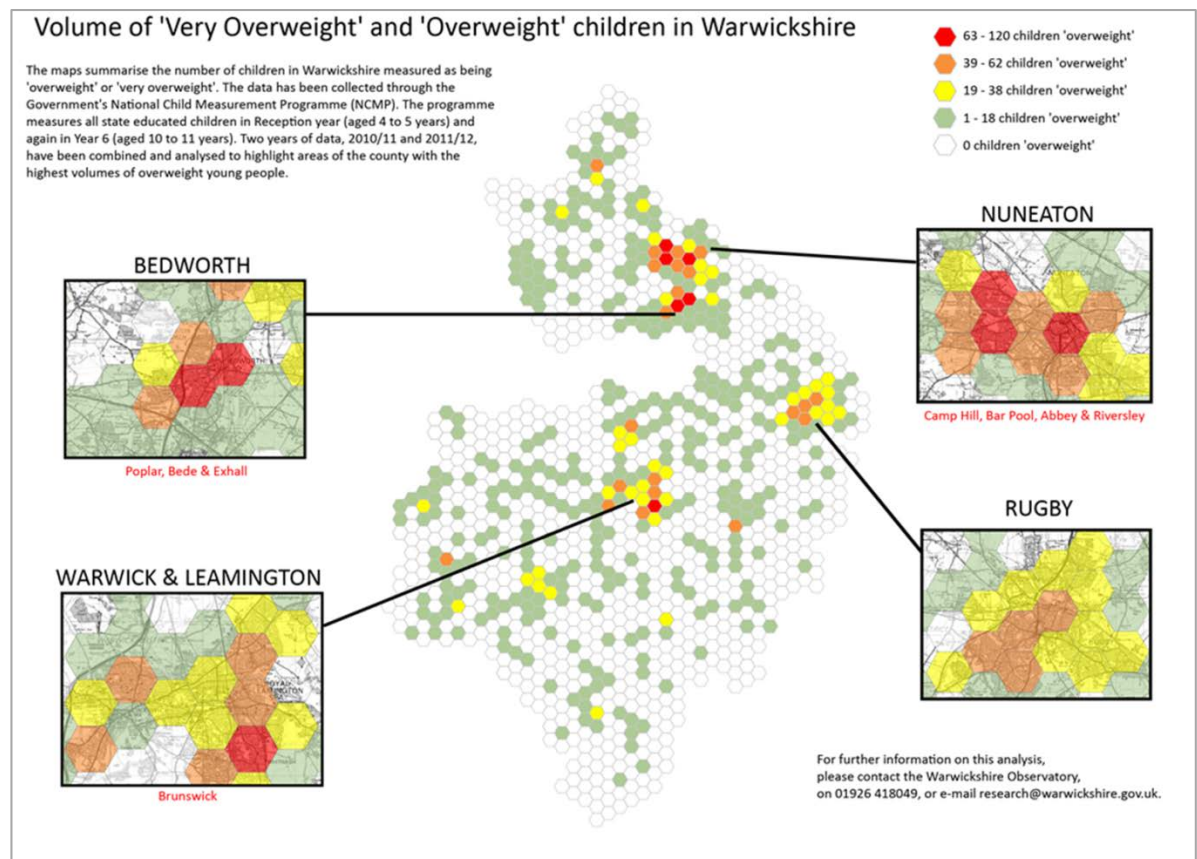
### **1.5.1 The Change4life Advisors Service**

Along with receiving feedback on children's BMI status from the NCMP, the DoH has also launched the Change4Life programme operating county wide across the UK to provide families with one-to-one support in family weight management. For example, in Warwickshire, after children are measured through the NCMP, letters are sent out to parents to indicate which percentile their child falls into and, in line with best practice guidance from the DoH, families of children falling into the 98<sup>th</sup> percentile are contacted by local Change4Life advisors to offer families support on weight management (Olander et al., 2011). It should be noted that in Warwickshire, the term "obese" is replaced with "very overweight" when contacting parents.

However, the Change4Life programme has been shown to have limited reach within Warwickshire. For example, in 2011, out of the 1620 children in Warwickshire who were identified as either very overweight (32.5%) or overweight (67.5%), only 168 families were contacted by Change4Life advisors from December 2010-July 2011 due to challenges in setting up the service. Furthermore, a large proportion of families who were contacted by Change4Life advisors declined the service. The main reasons given by parents for declining the service, related to their disagreement with the NCMP measurement, or their belief that they had their child's weight under control (Orlander, Akinson & French, 2011).

### **1.5.2 Local Family Weight Management Programmes**

In addition to the local Change4Life service, since January 2011, Warwickshire County Council (WCC) jointly with NHS Warwickshire (now Public Health Warwickshire) has commissioned Rugby Borough Council (RBC) and Nuneaton and Bedworth Leisure Trust (NBLT) to set up and manage family weight management programmes. The programmes last for approximately 8-10 weeks in duration and are situated in school and community based settings. The rationale for providing this additional level of weight management service was due to the BMI characteristics of children in those localities. Nuneaton and Bedworth have a higher prevalence of overweight and very overweight children than the national average for both reception and year 6 children as shown in NCMP data summarised in Figure 2. Rugby also has a high rate of overweight and very overweight children that falls in line with the national average. Hence, it was deemed important to offer additional weight management services to children and families in these districts.



**Figure 2: Map summarising volume of very overweight and overweight children in Warwickshire.**

Source: Warwickshire Observatory, 2012. \* Overweight and very overweight are added together.

## **1.6 Harnessing mHealth technologies for childhood weight management**

Smartphone features make mHealth apps particularly suitable when it comes to supporting parental involvement in childhood weight management. For, example, their zero-geography feature means that access to apps are not restricted to locations and can be delivered directly to families in the comfort and privacy of their own home (Tate et al., 2013). This is especially advantageous for a parent population who report lack of time, scheduling conflicts and location difficulties as major barriers to attending childhood weight management programmes (Barlow & Ohlemeyer, 2006).

Smartphones also support the use of ‘glanceable displays’ that can provide parents with a quick and coherent overview of their child’s health information, potentially increasing their engagement with children’s weight related behaviours (Klasnja & Pratt, 2012). More importantly, parents can continue to access an intervention long after completion, which is essential in weight management where there is often a high rate of relapse (Tate et al., 2013). In addition, a recent systematic review of mHealth technologies supporting childhood weight management, reported that, although many of the mHealth studies employing the latest state of art in technology are still in the research development stage, they show significant levels of usability, acceptability and feasibility for supporting childhood weight management (Turner, Spruijt-Metz, Wen & Hingle, 2015).

### **1.7 The problems of mHealth apps: Lack of evidence and theory**

With regards to mHealth app development, there is growing consensus, that mHealth interventions should be based on evidence, behaviour change theory and formative research with the target population (Buller et al., 2013; Whittaker, Merry, Dorey & Maddison, 2012; Stroulia et al., 2013; Fjeldsoe, Miller, O'Brien & Marshall, 2012). Moreover, underpinning interventions with theory is a key recommendation of the UK Medical Research Council’s framework for developing and evaluating complex interventions (Craig et al., 2008). This is further supported by systematic reviews suggesting that eHealth interventions and mHealth interventions (using text messaging) are more effective when underpinned with behaviour change theory compared to those that are not (Webb, Joseph, Yardley & Michie, 2010; Cole-Lewis & Kershaw 2010). Indeed, behaviour change is central to advancing ‘implementation of evidence based practice and public health’, where ‘Behaviour change interventions’ are defined as ‘coordinated sets of activities designed to change

specified behaviour patterns' (Michie, van Stralen & West, 2011:1). Furthermore, evidence synthesised from behaviour change interventions are used to guide health providers on the implementation of best practice guidelines (e.g. NICE guidelines, Cochrane reviews) (Michie et al., 2011a).

Despite these recommendations, several reviews of commercial health promotion apps have revealed a significant lack of use of evidence based guidelines (Abroms, Padmanabhan, Thaweetha & Phillips, 2011; Breton, Fuemmeler & Abroms, 2011; Cowan et al., 2013) and health behaviour change theory constructs (West et al., 2012; West et al., 2013) in their development processes. Furthermore, results from a review of 57 paediatric weight management apps conducted by Schoffman et al., (2013), indicated that an overwhelming majority of the apps (61%), did not use any recommended behaviour change strategies or behavioural targets. Moreover, few apps targeted parents/families (Schoffman et al., 2013), a vital element when managing children's weight (Birch, 2006; Hingle et al., 2010; Knowlden & Sharma, 2012; Tabacchi et al., 2007) and a key recommendation by the National Institute for Health and Clinical Excellence (NICE) (2006) Obesity (CG43) guidelines for the prevention, assessment and management of obesity in adults and children.

## **1.8 Maximising user's engagement in mHealth interventions**

While there is a need to incorporate evidence and theory into more complex health promotion apps, other important aspects to consider, relate to their social validity and acceptability amongst stakeholders (Danaher & Seeley, 2009). This is especially pertinent in the case of apps where approximately 26% of all apps downloaded are discarded after first use (Localytics, 2011). Consequently, there is a growing trend towards adopting a user-centred design approach (UCD) (Dennison, Morrison,



Conway & Yardley, 2013; Hebden, Cook, van der Ploeg & Allman-Farinelli, 2012), a participatory design approach focusing on the user and on ‘incorporating the user’s perspective in all stages of the design process’ (Devi, Sen & Hemachandran, 2012:1). According to Bate and Robert (2006), involving the target population in service development has played a central role in the reformulation of healthcare processes over the last decade. The authors observe that healthcare has traditionally been associated with the first two aspects of design: performance (e.g. evidence based practice) and engineering (e.g. safety standards). However, far less attention has been given to the third aspect of design: experience (e.g. user experience of a service). Therefore, it is important that interventions draw from the design disciplines such that they can be guided on processes to involve end-users in the design of products and services. This is essential within the context of childhood weight management given that it is a sensitive issue for the families involved, where current weight management interventions are characterised by widespread non-attendance (Barlow & Ohlemeyer, 2006; Staniford et al., 2011).

The importance of including engaging design principles also requires consideration, where current evidence implies that mHealth apps with more evidence-based strategies are amongst the least popular with consumers (Pagoto, Schneider, Jojic, Debiase & Mann, 2013). This may suggest that commercial mHealth apps, compared to research led apps are designed in a way that promotes greater engagement for consumers, despite their lack of theoretical content. For example, commercial app companies may use more engaging design features with regards to aesthetics and interactive components. Arguably then, mHealth development would benefit from greater collaboration between experts in behaviour change and the

commercial app industry to help address these gaps (West et al. 2013; Curtis & Karasouli, 2014).

The mHealth app industry moves forward at an exceptional rate, compared to the pace of research (Pagoto & Bennett 2013; Curtis & Karasouli, 2014). Consequently, there is a significant lack of knowledge regarding which components of apps are effective for behaviour change and whether apps, as a medium, are even effective for behaviour change; as well as which target populations certain components might work best for. However, answering these questions will require a systematic development approach drawing on relevant: evidence, theory and user-centred components, to allow for their replication, evidence synthesis and rigorous evaluation. It may be argued that only then, can we truly begin to advance the field of mHealth (Curtis & Karasouli, 2014).

## **1.9 Focus of research**

Despite the major push to harness smartphone features in the support of health behaviour change, precisely how to develop theory informed mHealth interventions that engage users remains a challenge. Arguably, there needs to be a balance between the use of engaging features and the theoretical and evidence based content of apps to ensure their: (i) successful uptake; (ii) sustained use; (iii) ability to support behaviour change; and (iv) impact on surrogate and real health outcomes (Curtis and Karasouli, 2014). Given the growing consensus that the application of behavioural science (Carter et al., 2013; Pagoto & Bennett, 2013; West et al., 2013) user-centred design (UCD) (Cafazzo, Casselman, Hamming, Katzman & Palmert, 2012; Fjeldsoe et al., 2012) and industry input (Pagoto & Bennett, 2013) can potentially increase the effectiveness and engagement of mHealth interventions, this

thesis explicates a preliminary attempt at exploring ways to incorporate these elements into the development of a mHealth app and the learning and outcomes achieved from this process within a case study context of childhood weight management.

## **1.10 Thesis Overview**

The thesis comprises nine further chapters. Chapter 2 provides an overview of three interlinking areas of extant research relating to: childhood weight management; mobile health apps and the science of behaviour change. The chapter also introduces the Behaviour Change Wheel framework (BCW) (Michie, et al., 2014b) and builds a rationale for why it has been applied to achieve the overall aim of the thesis. Guided by current evidence, a ten-step process was followed for the development of the proposed evidence and theory-driven user-centred health promotion app. The chapter also highlights the thesis aims and associated objectives.

In Chapter 3, an overview is provided of the research methodologies used to conduct the study. It also makes explicit which of the steps in the BCW framework were drawn upon in the current mHealth intervention and the sequence followed for the current intervention development process.

Chapter 4 provides an overview the health problem in behavioural terms, the setting that the intervention will target and the target population. It also details the process for selecting the target nutrition behaviour. Focus group data and consultations with experts also provide further support for decisions on the target behaviour.

Chapter 5 provides information on two interlinked foci; understanding the psychological levers of change to target in the intervention; and exploring parents' preference for app features. Results are presented in two parts. The first part of

chapter 5 presents details involving qualitative research (i), with Change4Life advisors and parents to understand feelings, thoughts, beliefs, and experiences in relation to parents providing a healthier diet for children. Findings from the analysis of the data were linked to relevant theoretical domains and then used in conjunction with reviews of evidence to help determine key psychological levers for change that could be addressed in the intervention. The second part of the chapter presents the qualitative research (ii), in relation to parents' preferences for healthy eating app features. During the analysis, the findings were also linked to the previous theoretical findings identifying the contribution to better understanding factors influencing childhood overweight and obesity. This chapter represents the first stage in the UCD approach. Hence, this chapter forms the first pillar of the overall thesis aim to develop an evidence, theory driven and user-centred mHealth intervention supporting parents for childhood weight management.

Chapter 6 presents information regarding the translation of research findings into app features. A decision criteria was developed as part of this stage and applied to the data collected on user preferences to help inform decisions on whether to take user preferences forward or not. At the same time, theoretical constructs were mapped to specific intervention functions, behaviour change techniques and app features. Lastly, information on how specific behaviour change techniques can be operationalised in mHealth apps is presented which facilitated consultations with industry experts. An interactive mock-up was generated working with industry experts to allow the next phase of development: pre-testing the app concept and features with the target population.

In Chapter 7, information on the second empirical study is presented. This study involved the use of interactive mock-ups to pilot proposed features and content for

the app. A model of usability and user experience goals introduced in Chapter 6, is applied to parents' feedback to help give an overview of their view on app features. An overview of the app known as 'Health Heroes' is presented, along with the final intervention mapping table and content.

Chapter 8 provides details of the usability evaluation of the app (study three), involving two individual studies. One study involved a workshop with 19 parents recruited from the local family weight management programme where they were asked to give feedback on screenshots of the prototype app and especially the messaging. The second study involved a Think Aloud study comprised of university students and staff where the functional usability of the app was tested. Both studies led to refinements of the app.

In Chapter 9, a summary of the findings from each stage in mHealth app intervention development are presented along with a discussion of the theoretical contributions to knowledge framed in the COM-B model. Methodological issues and limitations of the research are also discussed.

Chapter 10 provides directions for future research and development that are recommended for Health Heroes and conclusions to the research.

In summary, this thesis aimed to develop a detailed concept and prototype healthy eating app targeting parents for childhood weight management, through simultaneously incorporating theoretical, technological and UCD elements into a systematic development process. Additionally, this thesis aims to assess the challenges of uniting these elements in mHealth development (where theory meets practice) and provide recommendations on how this process can be improved for future mHealth intervention.

## **Chapter 2 Literature review**

In line with the theoretical approach taken in intervention development, the literature review begins by providing an extensive account of the case study problem, before moving onto possible ways to solve it. Therefore, three interlinking foci of childhood weight management, health behaviour change theory and mobile technology guide the review and culminate in the aims and objectives of the research.

### **2.1 Determinants of childhood overweight and obesity**

Childhood obesity is a serious global health issue ‘having a multifactor etiology’ where genetic and environmental factors interact to establish a highly prevalent disease (Tabacchi, et al., 2007:587). Overweight and obesity refer to excess adiposity seen as harmful to health, where children’s body mass index (BMI) is used as a common measure to identify their weight status (e.g. obese, overweight, healthy weight, underweight) (Waters et al., 2011). Within the UK, childhood obesity is commonly defined as  $\geq 95^{\text{th}}$  centile while overweight is seen as  $> 85^{\text{th}}$  percentile (Warwickshire Observatory, 2014).

Widely seen as a ‘multisystem’ disease, obesity has serious consequences for children’s health including the development of cardiovascular disease risk factors (e.g. insulin resistance syndrome), Type 2 diabetes and asthma as well as other serious complications in neurological, musculoskeletal, renal and hepatic regions (Ebbeling, Pawlak & Ludwig, 2002). Non biological consequences include serious psychosocial issues affecting mental health, relationships with families and peers and health quality of life (Daniels, 2006). Overweight and obese children are also more at risk of becoming obese in adulthood and developing metabolic syndrome (Lee et al., 2011), where co-morbidities including cancers, diabetes mellitus, heart disease,

stroke and osteoarthritis, are estimated to cost the NHS £5.1 billion a year (Scarborough et al., 2011).

In the case of childhood weight management, the National Institute for Health and Clinical Excellence (NICE) (2006) Obesity (CG43) guidelines for the prevention, assessment and management of obesity in adults and children, recommend that childhood weight management interventions should target lifestyles within the microenvironment (family) and in the social setting. Interventions should either reduce energy intake and/ or increase physical activity through incorporating a range of behaviour change techniques tailored with a clear aim of supporting weight management. In addition, for children under 12 years old, 'parents (or carers) should be encouraged to take the main responsibility for lifestyle changes for overweight and obese children' (NICE, 2006:85).

According to Wells and Siervo (2011), the science underlying overweight and obesity has been dominated by the notion of the energy balance which suggests that energy cannot be destroyed, only stored, lost or gained by any organism. Therefore, excessive food consumption and/or lack of exercise acts as the main determinants of energy imbalance resulting in weight gain. The energy balance equation and its subsequent determinants are supported by both the World Health Organisation (2009) and NICE (2006) guidelines, resulting in the majority of interventions targeting diet and physical activity, viewed as the major prerequisites for losing weight (Lorentzen, Dyeremose & Larsen, 2012).

However, there is growing evidence that the energy intake side of the energy balance equation, focusing on modifying dietary behaviours, may hold more promise for childhood weight management (Lowe 2003; Swinburn, Jolley, Kremer, Salbe &

Ravussin, 2006; Katz et al. 2008; Cook-cottone, Casey & Feeley, 2009; Katz, 2011). For example, findings from a meta-analysis reviewing interventions aimed at increasing physical activity of children found no improvement in children's BMI (Harris, Kuramoto, Schulzer & Retallack, 2009). Moreover, a meta-analytic review of childhood obesity prevention programmes in schools reported that interventions without any physical activity components resulted in greater effects than those programmes that included physical activity (Cook-cottone et al., 2009). Therefore, informed by current evidence as well as key recommendations from leading experts in the field of behaviour change with regards to starting with small behavioural changes and building upon these incrementally (Michie et al., 2014b), this thesis focusses on children's dietary intake.

## **2.2 Children's eating behaviours**

According to Kral and Rauh (2010), the evidence that overweight or obese parents are more likely to have overweight or obese children indicates that either genes, the environment or a combination of both, are responsible for this increased risk. The authors concluded from their review of the evidence on children's eating habits, that while food preferences could be transmitted biologically from parents, they can also be modified by environmental factors including parents' own eating habits (through modelling) and the way parents feed, select and make food accessible in the home.

There has been support for parental transmission of environmental effects (through parents' behaviours) on children's BMI levels with regards to parenting styles (e.g. authoritative, permissive) which in turn influence parenting practices (Gonzalez et al., 2012; Skouteris et al., 2012, Birch & Fisher, 2000) as well as from parents' overweight status, which could be both transmitted both genetically and



environmentally (Bartz & Freemark, 2012; Fassihi, Rudolf, McElhone & Feltbower, 2012). However, there has been growing support for the role of the environment over genetic factors in causing increased levels of adiposity. For example, Tam and Ravussin (2012) in their model examining gene-environment interactions on the development of obesity propose that although the variability of BMI depends on a genetic predisposition, it is much more strongly affected by the obesogenic environment. Moreover, although young children have innate mechanisms to control appetite, these processes may be overridden in older children by environmental and social factors (Collins, Watson & Burrows, 2010). Lastly and perhaps most fundamentally, Biro and Wien (2010), maintain that the process of genes storing excess calories as fat has remained the same over thousands of years until they became ‘maladaptive’ in response to the changed environment, favouring minimal energy expenditure and maximum energy intake. This has led to a huge effort to identify exact environmental determinants, their level of impact, and how they can be modified to reduce their burden upon the obesity epidemic as a whole.

### **2.2.1 The macro environment**

The Foresight Report (2007), states that it is the complex interplay of environmental factors that create what has been termed as the ‘obesogenic environment’ defined as the total sum of all the environmental influences leading to obesity at the individual and population levels (Butland et al., 2007). The obesogenic environment favours increased energy intake (Golan & Crow, 2004) most likely resulting from the increased availability of high energy density food and drinks (Tam & Ravussin, 2012). In a systematic review of childhood weight management interventions, Brown, Kelly and Summerbell (2007) reported that regular large portions of high

density calorie foods and sugary drinks increased the risk of childhood overweight and obesity.

Indeed, the food industry provides enormous variety and accessibility of cheap high energy foods (including fast foods) and increased food portion sizes, which has created a demand where consumers want larger quantities of foods for lower prices (Golan & Crow, 2004; Ledikwe, Ello-martin & Rolls, 2005). Subsequently, it has been argued that this change in our food environment has contributed significantly to the obesogenic environment (Marchiori, Papies & Klein, 2014; Pourshahidi, Kerr, McCaffrey & Livingstone, 2014). This is demonstrated in a number of settings where the availability of high energy density food portions have increased including: super-markets (Young & Nestle, 2003), home cooking (Wansink, 2004), and fast food outlets and restaurants (Young & Nestle, 2002). There is now strong consensus that this increase in the availability of large portions of high energy density foods and beverages, parallels the rise in both childhood and adult obesity (Colapinto, Fitzgerald, Taper & Veugelers, 2007, Ledikwe et al. 2005, Schwartz & Byrd-Bredbenner, 2006).

To add to the problem, the large volume of marketing of high energy density foods, is considered by many researchers in the field, as one of the most harmful environmental influences on food intake by youth (Andreyeva, Kelly & Harris, 2011). This may result from children's mental representations of food goals being activated without their conscious awareness (known as goal priming); TV advertising may become a prime for children eating more snacks while watching TV (Sheeran, Gollwitzer & Bargh, 2013). In this regard, a number of reviews on food advertising targeting children conclude that greater exposure to food advertising leads to greater preference and purchase of these foods (Harris, Bargh & Brownell,

2009). Andreyeva and colleagues (2011), further report that soft drink and fast food television advertising is associated with their increased consumption amongst elementary school children demonstrating that television food advertising can have a significant impact on children's dietary patterns. In addition, a recent systematic review identified food advertising, large portion sizes and sugar-sweetened soft drinks as moderately strong influences on childhood weight gain compared to other influences in the food environment. However, although these findings relate to the macro environment, they can also be tackled by individual level and family based behaviour change interventions (Osei-Assibey et al., 2012).

### **2.2.2 The micro environment: the role of parents**

It has been widely contended that the most prevalent category of determinants and risk factors for childhood obesity (e.g. dietary behaviour, physical activity and sedentary behaviour), begin within the family environment (Knowlden & Sharma, 2012; Birch et al., 2001; Tabacchi et al., 2007) where children consume around two-thirds of their daily food intake (Knowlden & Sharma, 2012). For this reason, arguably, we cannot prevent and manage childhood overweight and obesity in isolation of the micro food environment (Davison & Birch, 2001). Hence, family based approaches are now well recognised in the childhood weight management literature (West, Sanders, Cleghorn & Davies, 2010), where they are considered the 'gold standard' to improving children's weight status and overall health (Skelton, Buehler, Irby & Grzywacz, 2012).

In a systematic review of parental involvement in childhood weight management interventions, Hingle et al. (2010) concluded that interventions should continue to target parents for nutrition interventions because they are essentially the 'nutrition gatekeepers' that enhance their children's food choices (2010:109). Children are

dependent on their parents and carers to provide food that is conducive to both a healthy weight and development (Birch, 2006). According to Tabacchi et al. (2007), parents can exert influences on children's weight status through an array of mediators including: availability of food, meal structure, their own weight status, socialisation of food practices, food preferences, socioeconomic status, attitudes towards their children, family structure, physical activity and cultural practices.

Evidence has shown the importance of involving parents in changing a number of children's dietary behaviours such as increasing children's fruit and vegetable intake and reducing children's consumption of fat and high sugar foods (Epstein et al., 2001; Paineau et al., 2008, Harvey-Berino & Rourke, 2003). In addition, interventions have targeted a number of parental determinants such as parents' eating habits and child feeding practices (Epstein et al., 2001; Eisenmann et al., 2008); self-efficacy and knowledge (Reynolds et al., 2000); along with encouraging parents to implement a number of behaviour change techniques with their children such as self-monitoring and environmental restructuring (Golley et al., 2011).

Recent research indicates that children have increased motivation to manage their weight for social and family reasons compared to personal reasons (Braden, Crow & Boutelle, 2014), and changes in parental BMI predict changes in children's BMI levels (Wrotniak, Epstein, Paluch & Roemmich, 2004). Moreover, interventions targeting only children may have detrimental effects including stigmatization and a vulnerability towards developing eating disorders or body-image disturbances (West et al. 2010). It is therefore important that interventions promote parental lifestyle changes to help improve children's treatment outcomes (Fassihi et al. 2012), a recommendation also supported by NICE obesity guidelines (NICE, 2010).

Research has also identified a number of psychosocial determinants identified in relation to parental feeding practices, such as lack of family meal times (Fiese, Hammons & Grigsby-Toussaint, 2012), familial stress and lack of sleep (Gundersen, Mahatmya, Garasky & Lohman, 2011), parental divorce, mental and/ or physical abuse (Nieman & Leblanc, 2012), and parents' failure to recognise their children's overweight status and its associated health risks (Puder & Munsch 2010, Faith et al., 2012).

Despite the strong consensus and focus of research with respect to parental influences on children's weight related behaviours, they continue to be 'acutely underemphasized' in childhood weight management interventions (Andrews, Silk & Eneli, 2010:96). Consequently, our understanding of parental influences on children's behaviour in the context of the obesogenic environment is still considerably limited (Skouteris et al., 2012). Therefore, there is need to report in more detail which parenting practices were used in childhood weight management interventions (Faith et al., 2012). Furthermore, the research is often cross-sectional so it is difficult to ascertain whether parent-child interactions predicted eating and weight status, or whether child weight determined parent-child interactions (Skouteris et al., 2012). Therefore, although parents are seen as primary agents of change for the prevention and management of childhood obesity, it remains unclear as to precisely how we go about supporting parents to change their dietary behaviours with their children (Golley et al., 2011).

## **2.3 Smartphones and health**

According to Boulos et al. (2011) in the last decade smartphones have penetrated the lives of both the young and the old with enormous success, where latest figures

indicate that 61% of UK adults own a smartphone (Ofcom, 2014). Within the context of healthcare, smartphones reflect ‘an intersection of two fast-evolving ecosystems: health and technology’. Thereupon, this convergence has provided a platform of communication between app developers and consumers whilst at the same time enhancing ‘their engagement with health information technology’ (Sarasohn-Kahn, 2010:2). Furthermore, it could be argued that the burgeoning industry of mHealth apps, reflects not only developers perceived potential of these applications as tools for health promotion, but also the public’s demand for a shift from an accepted paternalistic healthcare system to a more person-centred health system, allowing consumers to take more control over their health.

### **2.3.1 The content of existing health promotion apps on the market**

Several reviews relating to the content of existing commercial health promotion apps have exposed their lack of evidence based guidelines (see Abroms et al., 2011, Breton et al., 2011) and behavioural science input (see West et al., 2013, Cowan et al., 2013). Within the case of weight loss apps, Breton et al. (2011) reviewed the descriptions of 204 weight loss apps in the US iTunes store and rated their adherence to 13 evidence based weight management practices. The findings revealed that only 15% of apps had five or more of the 13 practices and some contained unconventional strategies. For example, one app advised the user to place the Smartphone on their stomach and use the vibrating function to disperse fat cells. According to the authors, the disparate pace between research and technology necessitates further research on second generation apps to determine whether they are increasingly developed using evidence based guidelines. It is worth noting that Brenton et al. (2011) reported only a small number of apps enabling social support (3%). It is likely that second generation apps have now capitalised on the rapid popularisation of social networks

and online communities and therefore are more likely to link users to supportive online communities. Furthermore, the study relied on the descriptions of apps in the iTunes store and therefore they cannot be certain that suggested evidence based practices were actually present in the app considering that Apple does not review any of its apps for content validity (Breton et al., 2011). However, more recently, West et al. (2013) downloaded apps from the US 'Health and fitness category' in the iTunes store. The authors coded a total of 58 diet apps after applying the following inclusion criteria: iPhone apps only (e.g. apps designed for iPads were excluded) and apps costing up to \$5.00 due to budget constraints. Apps recommending other behaviours outside dieting (e.g. physical activity), and downloaded apps that were found not to be fully functioning were excluded. The authors adapted an established and valid measure developed by Doshi et al. (2003) to code the use of theoretical constructs from four prominent behaviour change theories: the Theory of Planned Behaviour, Transtheoretical Model, Health Belief Model and Social Cognitive Theory (West et al., 2013). The measure includes 20 theory based constructs (e.g. self-efficacy, social support, relapse prevention) and assessment of these includes five levels of user interactions: general information, assessment, feedback, assistance and tailoring. This results in a total of 100 theory based items. As hypothesized, most apps were largely deficient in health behaviour theory constructs where the average theory score was 6.19 ( $SD = 6.52$ ) out of a possible 100. The findings indicated that knowledge and cognitive based strategies were most common. In relation to behaviour change models, the Health Belief Model (HBM) constructs were the most common across apps.

### **2.3.2 Childhood weight management apps**

The ‘science of mobile and wireless health’ known as mHealth (Nilsen et al., 2012:6), has so far shown promise for improving preventative health behaviours (Fjeldsoe et al., 2009, Cole-Lewis & Kershaw 2010, Free et al., 2011, Vodopivec-Jamsek et al., 2012, Abroms et al., 2012), including parents’ behaviours for childhood weight management (Sharifi et al., 2013, Shapiro et al., 2008). However, the majority of evidence to date has largely involved targeting children and adolescents in games and a short messaging service (SMS) as opposed to targeting parents and the latest smartphone technology (Buller et al., 2013; Turner et al., 2015). This in part reflects the rapid pace of technology and the slower pace of research (Pagoto & Bennett, 2013; Curtis & Karasouli, 2014), where industry figures indicate that there are 20,696 apps in the healthcare and fitness category of the iTunes store (148Apps.biz, 2013). Therefore, the mHealth technologies used in childhood weight management trials are ‘often no longer the state of the art’ where the studies that are employing all of the latest technologies are only in the development phase (Turner et al., 2015:5).

To date, although there are lots of commercially available apps aimed at childhood weight management, the majority of these apps lack appropriate content and fail to target parents. For example, Schoffman et al., (2013) reviewed childhood weight management apps using the guidelines of the Expert Committee for Paediatric Obesity Prevention (ECPOP) to inform their evaluation. The authors also collected data on the app’s price, user ratings and the use of game principles to gain an idea of their acceptability for consumers and engagement for children. Apps were classified as games if they included the four key components defined by an expert in game design (and adopted by the ‘Games for Health’ journal’) which included a focus on:



(1) goals; (2) rules; (3) feedback; and (4) accepted feedback by the user. The results indicated that 61% of the apps ( $n = 35$ ) did not use any of the recommended strategies or behavioural targets and 56% of apps were classified as games. Apps that focused on both healthy eating and physical (12%) activity, adhered to more recommendations. Apps most frequently used strategies of goal setting ( $n = 16$ ), and the nutrition targets for reducing sugary drinks ( $n = 9$ ) and increasing fruit and vegetables ( $n = 8$ ). In addition, few apps ( $n = 15$ ) gave an indication of the age group the app was aimed at. Furthermore, the authors also noted that there were only six apps found in their search that specifically targeted parents/families despite their importance for childhood weight management (section 2.2.2). Thus, health promotion apps need to target parents in the intervention itself and also employ clearer labelling so they can be found easily by parents.

### **2.3.3 The potential of smartphone features to support parental dietary behaviours**

Mobile health applications (mHealth apps) ‘offer state-of-the-art approaches to intervention design, delivery and diffusion of treatment and prevention efforts’ (Tate et al., 2013:406). There are a number of aforementioned features that make mobile health apps apt for childhood weight management interventions targeting parents (section 1.6). In addition, certain behaviour change techniques important for weight management can also be optimised through this medium. For example, self-monitoring techniques, shown to be most effective for adult and child weight management (Dombrowski et al., 2012; Mockus et al., 2011; Michie, Abraham, Whittington, McAteer, & Gupta, 2009; Turner et al., 2015) are optimised through this medium (Curtis & Karasouli, 2014), and continue to increase in their sophistication (Riley et al., 2011). A key aspect of why mHealth apps may be

effective for improving health behaviours is their ability to deliver behaviour change techniques. Indeed, parents often report difficulty in monitoring children's dietary behaviours (Borra, Kelly, Shirreffs, Neville, & Geiger, 2003); hence, features such as cameras can be employed for children's dietary monitoring (Boushey, Kerr, & Wright, 2009); an element also shown to be effective for helping users monitor and reflect on their own eating behaviours (Brown et al., 2006). Furthermore, a recent systematic review of mHealth technologies supporting childhood weight management reported that apps have been shown in studies to improve dietary monitoring while at the same time providing novel methods to track diet (Turner et al., 2015). Additional behaviour change techniques such as role modelling behaviours, can be also be implemented through the use of games that families can play together allowing parental behaviours to influence their children's eating behaviours (Tate et al., 2013).

mHealth apps may also offer more detailed and accurate measures of dietary behaviours, the results of which can be used to increase the robustness of childhood obesity interventions where current studies are limited by self-reports (Riley et al., 2011). Furthermore, they allow for a population based intervention to be individually tailored (Michie et al., 2014b), where mHealth interventions using tailored text messages have been shown to be more effective for behaviour change compared to those that are not (Cole-Lewis & Kershaw, 2010; Fjeldsoe et al., 2009).

Arguably, underpinning mHealth interventions with relevant theories of behaviour change can help to maximise their potential in changing behaviour, as recommended for any intervention aimed at changing behaviour (Michie et al., 2014a), and advocated in the Medical Research Council's recommendations for development of complex interventions (Craig et al., 2008).

## **2.4 Theories of behaviour change**

According to West and Brown (2013) theories are fundamental to science and are defined as distinct and clear descriptions of phenomena resulting from a process of extrapolation and interpretation. Theories provide explanation of observed phenomena, generate predictions and specify the causal relationship between entities (West & Brown, 2013).

Behaviour can be defined as ‘anything a person does in response to internal or external events. Actions may be overt (motor or verbal) and directly measurable or, covert (activities not viewable but involving voluntary muscles) and indirectly measurable; behaviours are physical events that occur in the body and are controlled by the brain’ (Michie et al., 2014a:36). When applied to behaviour change, theories aims to explain the when, why and how of behaviour, and the significant sources of influence that should be targeted in an intervention to modify the behaviour.

Additionally, they should indicate ‘the relevant mechanisms of action and researchers of change’ (Michie, et al., 2014a: 22). This then advances our understanding of what works and why, leading to their refinement, and facilitates the design of new interventions that draw on theory in the future (Michie, 2008). There are a vast number of behaviour change theories that can be used to underpin health behaviour change interventions. Whilst a review of all these is beyond the scope of this thesis a majority are included in a recent publication by Michie et al., (2014a). Additionally, within the nascent field of mHealth it is yet to be established whether certain theories may be more appropriate than others for underpinning app development. Potential theories considered as the basis for informing the development of the mHealth intervention in this thesis were therefore selected based on the following principles: (i) they represent one of the prevailing theories in the

psychology of behaviour change that has been applied to weight management and dietary behaviour; (ii) they have previously been examined within the context of mHealth apps (e.g., Cowan, et al., 2013; West et al., 2013); (iii) they have been used as the basis for developing eHealth interventions (Riley et al., 2011) and; (iv) they are specifically relevant to childhood weight management where existing research has shown the utility of some aspects of these theories. Theories identified as meeting these criteria are explained below within the current research context of supporting parents in childhood weight management.

#### **2.4.1 Theory of Planned behaviour**

The Theory of Planned Behaviour (TPB: Ajzen 1991), is arguably one of the most researched models of behaviour (Armitage & Conner, 2001) and studies that incorporate the TPB are seen by some researchers as the most ‘innovative research on correlates of diet and physical activity’ (Baranowski et al., 2010:30). A central premise of the theory is that behaviour can be predicted by intentions to carry out that behaviour. Intentions in turn, are influenced by attitudes concerning the behaviour, subjective norms (SN) and perceived behavioural control (PBC) (McMillan & Conner, 2003). For example, within the context of childhood weight management, parental intentions to make changes to their children’s diet may be influenced by: their attitudes towards healthy eating as well as childhood overweight; their friends and other family members; and their perceived confidence in their ability to carry out changes successfully with their children.

Perceived behavioural control has been derived from Bandura’s concept of self-efficacy (McMillan & Conner 2003), and is based on an ‘interactive function’ of control beliefs, i.e. beliefs about factors that will either impede or facilitate behaviour and the perceived strength of these factors (Baranowski et al., 2010). So

for example, this may translate into parents' perceived control over their children's eating habits where parents have cited grandparents and schools as significant barriers to them providing healthier food for their children (Lorentzen et al., 2012).

With regards to SN, this refers to 'an individual's perception of general pressure to perform (or not perform) a behaviour' where they are more or less likely to perform a behaviour if a significant other supports it or not (Armitage & Conner, 2001:474).

Within the case of parents, research shows that parents view family members and health professionals as important normative referents that would approve of them providing healthier food (Villarrubia, 2006). Furthermore, family and peer support for healthy eating has been found to be a significant predictor of children's weight loss (Epstein et al., 1990).

Systematic reviews (Pocock et al., 2010) and empirical studies (Gerards, Dagnelie, Jansen, De Vries, & Kremers, 2012; Etelson, Brand, Patrick & Shirali, 2003; Slater et al., 2010; Lorentzen et al., 2012) researching parental attitudes towards their children's diet and weight status provide a number of different insights. For example, one study collected questionnaire data measuring parental attitudes to excess weight in childhood compared to other circumstances that they may perceive as a health risk. The results revealed that parents' level of concern for excess weight gain was akin to their level of concerns for history of sunburns and lengthy television viewing ( i.e. 78% parents would be 'quite' or 'extremely' concerned with excess weight compared to 76% sunburn and 67% television viewing) but less concerned than children smoking cigarettes (83%) (Etelson et al., 2003).

Andrews, Silk & Eneli (2010) conducted the first study using the TPB to model parental attitudes and behaviours towards healthy eating. Parents completed surveys

based on the TPB constructs with the addition of ‘response efficacy’ (Bandura, 1977), which refers to a parental beliefs of the effectiveness of a given behaviour at bringing about change in weight status. Results indicated that parental attitudes towards providing healthy food and limiting unhealthy foods, social norms and perceived behavioural control predicted their intentions to monitor food intake, and intentions in turn, predicted their tracking of their children’s food intake. Interestingly, response efficacy was also a significant predictor of parental tracking behaviour suggesting that parents may not track their children’s behaviour if they do not view this as an effective strategy for childhood weight management (Andrews et al., 2010).

#### **2.4.2 Health Belief Model**

The Health Belief Model (HBM: Rosenstock, 1974) was the first conceptual model of behaviour developed for understanding health behaviours on a larger scale, and specifically for public health issues (Baranowski et al. 2010). Indeed, the HBM has been shown to be effective for a number of health behaviours including healthy eating (Webb, Sniehotta & Michie, 2010). The six constructs comprising the framework are *perceived susceptibility* (e.g. parents’ perceived risk of their child becoming overweight), *perceived severity*: (e.g. how serious a parent perceives childhood overweightness to be to their children’s health), *perceived benefits* (e.g. parents’ perception of the benefits of helping their children reduce unhealthy snacks to prevent weight gain), *perceived barriers*: (e.g. parents’ perception that children will behave badly without unhealthy snacks used as rewards for good behaviour), *cues to action* (e.g. hearing news reports about the rise in childhood type 2 diabetes linked to childhood overweight ) and *self-efficacy* (e.g. parents’ confidence that they can change their children’s eating behaviours) (Orji & Mandryk, 2014).

A number of studies have shown a relationship between parents' low levels of perceived severity and perceived susceptibility of their own behaviours and that of their child's weight outcomes. For example, research has shown that parental concern for their child's weight (in causing serious illness and interfering with children's activities) predicted their child's weight loss (Becker, Maiman & Kirscht, 1977, Andrews et al., 2010). Furthermore, a content analysis of 15 studies found 'fatalism' to be associated with parental perception of weight gain in children which may lead to parents not changing their behaviours in the belief that child weight gain is inevitable (Mareno, 2013).

### **2.4.3 Social Cognitive Theory**

The Social Cognitive Theory (SCT: Bandura, 2004) has been used widely in the design of educational and nutrition interventions (Baranowski et al. 2003). However, in contrast to other social cognitive models, SCT explicates the connection between beliefs and behaviour as a reciprocal process wherein people learn from their experiences (Webb et al., 2010b). The key constructs within SCT are summarised by Baranowski et al., (2003) as skills: the ability to enact a behaviour (e.g. parents' skills in measuring portion sizes); self-efficacy: the confidence that one can perform a behaviour (e.g. parents' confidence in their ability to measure portion sizes); and outcome expectancies: the outcome expected from enacting the behaviour (e.g. parents' belief that serving appropriate portion sizes will help to manage children's weight). At the macro level, central environmental variables comprise of modelling: learning from someone to perform a behaviour and receiving reinforcement for it, and availability: whether resources in your environment are present for you to use (e.g. tools to help measure portions such as scales).

According to Bandura (2004), a person's belief about whether they can perform a specific behaviour is central to the person's motivation and action. If people do not believe they can produce the desired effects by enacting the behaviour, then they have 'little incentive to act or to persevere in the face of difficulties' (Bandura, 2004:144).

In the context of children's eating behaviour, Campbell, Hesketh, Silverii and Abbott (2010), found that higher mother self-efficacy was linked to children having fewer weight gain related behaviours. While the findings of the study are limited due to its small sampling and cross sectional study design, the direction of the association indicates that targeting mother's self-efficacy may be an important strategy for developing childhood obesity interventions, a finding also borne out elsewhere (Golan & Crow, 2004).

With regards to role modelling, substantial research has shown that parental eating habits influence children's eating habits (Kral & Rauh, 2010; Skouteris et al., 2012; Golan & Crow, 2004). While the concepts of the SCT might not be fully sufficient for understanding diet and physical activity within the context of children's behaviour, they provide a basis for understanding parents as the main agents of change. According to Baranowski and colleagues (2003), self-efficacy has been strongly linked to adults' intention to enact healthier eating behaviours and interventions with parental involvement based on the SCT have shown positive effects on children's dietary behaviours (Anand et al., 2007, Epstein et al., 2001).

#### **2.4.4 Control Theory**

Control theory has been widely applied to adult weight management (Michie et al., 2009, Dombrowski et al., 2012) and also provides useful insights into childhood



weight management. According to Carver & Scheier (1982) control theory refers to self-regulating systems where similar to SCT's 'outcome expectancies', there is a perception of a state we wish to achieve (and our value for it) and our attempt to achieve it. Therefore, behaviours such as self-monitoring and feedback on behaviour are key for people to obtain information and compare it to a 'reference value'. This then determines if there is a discrepancy and results in people taking action to change this back to the 'standard of comparison' (Carver & Scheier, 1982: 112). Arguably, larger portion sizes served in fast food outlets and the degree of overweight children in parents' environments may function as norms that parents use as a *standard of comparison*. The goal of interventions could be to address norms that parents have (e.g. by making them aware of the recommended portion sizes for children and showing them visual cues for what a healthy weight for a child should be) as well as supporting parents to self-regulate their own healthy eating behaviours and for them to help their children to self-regulate and gain control over their eating behaviours (Faith et al., 2012; Evans, Fuller-Rowell & Doan, 2012).

Indeed, one of the key behaviour change techniques derived from this theory is self-monitoring. Recent studies on behavioural interventions targeting physical activity and healthy eating in adults, revealed that self-monitoring along with other central techniques congruent with control theory (e.g. goal setting, monitoring behaviours, receiving feedback on behaviour and reviewing goals based on this feedback) had significantly greater effect on interventions (Michie et al., 2009; Dombrowski et al., 2012)

With regards to a paediatric population, a recent study involving behavioural intervention with a sample of overweight children ( $N = 153$ ) aged 7- 12 years found that children who engaged in a higher degree of self-monitoring had significantly

lower percentage overweight, even after controlling for gender, ethnicity, SES and parental weight (Mockus et al., 2011).

#### **2.4.5 Limitations of psychological models of behaviour change**

All four psychological approaches outlined above offer a unique perspective on the mechanisms by which parents can influence their children's eating behaviours.

However, they rely heavily on individual reflective cognitive processes and largely ignore automatic processes comprising of emotional variables, impulses, habits, associative learning and self-control (West, 2007). For example, the TPB fails to address important influences on behaviour such as self-control and transient emotional reactions. However, there has been evidence to show that higher cognitive processes such as complex decision making, operate within the unconscious and implicit system too (Sheeran, Gollwitzer & Bargh, 2013). In addition, research suggests that peoples' eating behaviours are influenced by the environment resulting in automatic eating decisions, and that people are often unaware that the environment has any effect on their eating behaviour (Ogden, Coop, Cousins, & Crump, 2013).

There is consensus amongst researchers that the strength of prevailing behaviour change theories lie in their predictive utility of health behaviours (where no model has been found to be superior to another in predicting eating behaviours), as opposed to their ability in changing behaviour through providing techniques to modify theoretical determinants (Baranowski et al., 2003; Orji & Mandryk 2014; Michie et al., 2009; Sheeran et al., 2013; Webb et al., 2010b).

Principal theories of behaviour change also fail to address the full canvas of relevant theoretical constructs for behaviour change where there is significant overlap

between constructs (Lenert, Norman, Mailhot, & Patrick, 2005; West & Brown, 2013). In this regard, according to Kaptein (2011), we need to be more critical of these theories when designing interventions and design interventions that more closely reflect real-world behaviour in real-world contexts.

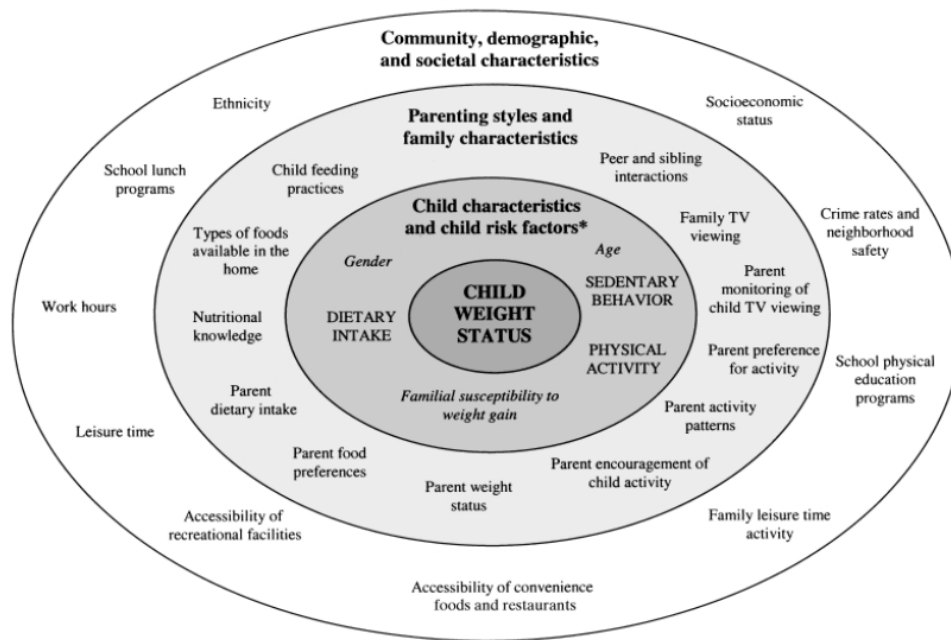
In addition, theories of behaviour change are somewhat limited by their unsuccessful attempts to account for more ‘dynamic behaviours’ (e.g. parental experiences of childhood weight management may impact on their beliefs that they can successfully manage their children’s weight) and their failure to account for system level factors (HBM) (Eliasson, Barber, & Weinman, 2011). Furthermore, they primarily focus on intra-individual factors as opposed to wider social and environmental factors (Glanz & Bishop, 2010), therefore, they only weakly address the parent-child dyad and the environmental system processes where interactions among family members impact on parents’ behaviours (Skouteris et al., 2012; Lowe, 2003). Consequently, there is growing momentum for using social ecological models to address the wider environmental determinants of childhood weight gain (Baranowski et al. 2003; Davison & Birch 2001; Cislak, Safron, Pratt, Gasper, Luszczynska, 2012).

#### **2.4.6 The Ecological systems Theory**

The Ecological Systems Theory (EST; Bronfenbrenner, 1986) aims to explain the interactive environmental determinants of family functioning as a basis for human development. The EST proposes that individuals and groups exist in contexts that must be taken into account when seeking to understand behaviour (Skelton et al., 2012). Thus, changes in individual characteristics cannot be fully explained without taking into account individuals’ ‘ecological niche’ which includes both the immediate as well as wider contexts within which they function. In the case of a child, the ecological niche captures child characteristics (e.g. gender and age) and

risk factors (e.g. familial susceptibility), familial and school contexts and the wider community and societal contexts (e.g. the food industry and socioeconomic status). According to the EST, development of childhood obesity occurs as an effect of the interactions ‘with and among these contexts’ (Davison & Birch 2001:160).

Adapting Bronfenbrenner’s EST model, Davison and Birch (2001) have applied EST to research assessing predictors of childhood obesity, illustrated in Figure 3.



**Figure 3: Birch and Davidson’s (2001) Ecological model of the predictors of childhood overweight.**

\* = Child risk factors (shown in upper case) refer to children’s weight related behaviours. Child characteristics (shown in italics) interact with child risk factors and contextual factors in the development of overweight.

According to this model, child behavioural patterns of dietary intake, physical activity and sedentary behaviour can place a child at high risk of overweight and that these risk factors can be moderated by the child’s characteristics of age, gender and genetic predisposition to overweight. The authors argue that child risk factors are developed and influenced by parenting styles and family characteristics (e.g. parent’s dietary behaviour , nutritional knowledge, weight status, food preferences) and this

context is further shaped by schools, communities and demographics and wider environmental factors such as parents' working demands, the accessibility of food and exercise facilities and food advertising (Davison & Birch, 2001).

Nevertheless, ecological models have been criticised for their failure to incorporate parents' cognitions which may result in important motivational variables being ignored (Baranowski et al., (2003). In returning to the definition of behaviour (section 2.4), internal influences are largely ignored in an ecological model. In addition, similar to the prevailing theories of behaviour change, their strength lies in their predictive utility as opposed to providing practical strategies to change behaviour. While social cognitive approaches may be limited in changing behaviour without a consideration for the environmental factors, ecological models may be equally limited by their lack of consideration for motivational factors. Arguably, a combined approach (Baranowski et al., 2003), and one that links with behaviour change techniques, may have more potential in changing behaviour. Hence, these theoretical and practical limitations provide a rationale for using an alternative behaviour change model that builds upon these theories and offers a more comprehensive account of behaviour.

#### **2.4.7 Scope for a new model of behaviour change: The COM-B model**

The COM-B model was developed as a response to the inability of the majority of prevailing theories to provide strategies to change behaviour, and as part of a 'method for characterising interventions and linking them to an analysis of the targeted behaviour' (Michie et al. 2011a:1). It is essentially a behavioural system that posits the interaction of three components: Capability, Opportunity and Motivation (COM) which result in the performance of Behaviour (B) (Eliasson et al., 2011). COM-B canvases a range of mechanisms involved in behaviour change and is

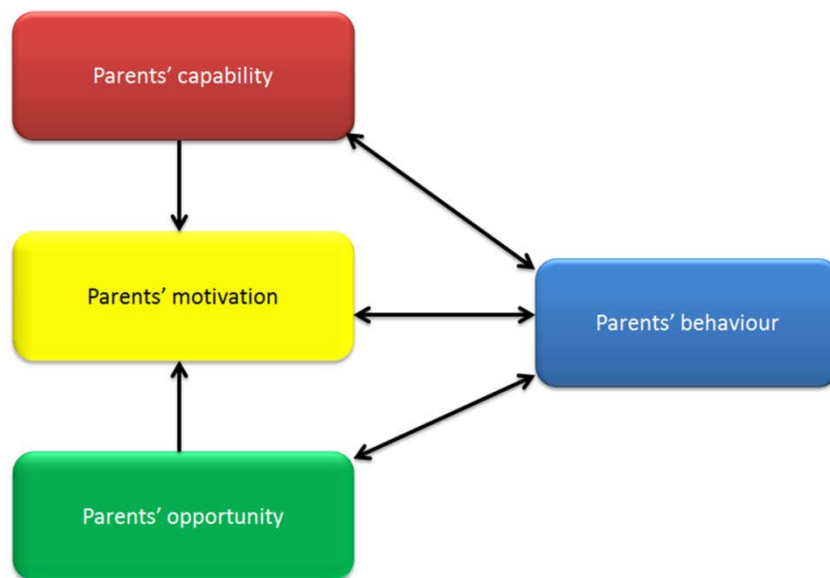
‘intended to be comprehensive, parsimonious and applicable to all behaviours’ (Eliasson et al., 2011:8). It is important to recognise that the prominent behaviour change theories described in this chapter, have functioned as a precursor to the COM-B model, which informs both an individualistic approach along with a wider and more system level perspective to behaviour change.

According to the authors, development of the COM-B model began with ‘Motivation’ defined as ‘brain processes that energize and direct behaviour’, which takes account of basic drives and ‘automatic’, unconscious processes, as well as conscious decision making processes (Michie et al., 2011a). Hence, the COM-B model bridges the gap left by many of the social cognitive and ecological models that fail to account for these automatic processes such as impulse and emotion along with neglecting ‘factors as a system level’ (e.g. HBM) (Eliasson et al., 2011:7).

Each component can be sub-divided into two heuristics: *Capability* can be either ‘psychological’ (involving knowledge and psychological skills) or ‘physical’ (involving physical skills); *Opportunity* can be either to ‘social’ (involving social influences and cultural norms) or ‘physical’ (involving environmental resources, triggers, time, locations, and physical barriers); *Motivation* can be either ‘reflective’ (involving conscious planning or evaluation) or ‘automatic’ (involving emotional responses, impulses and reflexive responses) (Michie et al., 2014b).

Within the context of childhood weight management, the COM-B model accounts for a range of factors identified in the literature that may impede parents’ ability to provide healthier food for their children. For example, parents’ difficulty with communicating weight related issues with their children (Sealy & Zarcadoolas 2012; Borra et al., 2003) and parental modelling of unhealthy eating habits (Birch &

Ventura, 2009), relates to *psychological capability*. While parents' levels of self-efficacy in making changes to their children's diets (Campbell et al., 2010) relates to *reflective motivation* and parents' guilt in restricting unhealthy food (Steinsbekk, Ødegård, & Wichstrøm, 2011) relates to *automatic motivation*. Lastly, economic pressures, time constraints and the availability of large portions of energy-dense foods (Sealy & Zarcadoolas 2012; Thomas, Nelson, Harwood & Neumark-Sztainer, 2012; Colapinto et al., 2007; Fisher & Kral 2008; Banks et al., 2012) relate to parents' physical opportunity.



**Figure 4: Application of the COM-B model to parents' behaviour**

Figure 4 illustrates the relationship between the various COM-B components (Michie et al. 2011a). For example, eliciting positive changes in a person's capability or opportunity can potentially increase a person's motivation to perform a behaviour, whereas motivation can only increase opportunity or capability through performing the behaviour itself (Michie et al., 2014b).

Lastly, existing theories and models of behaviour change, with exception of the Social Cognitive Theory and Control Theory (Francis et al., 2009), do not specify how exactly they should be used to bring about change in a behaviour (Baranowski et al., 2003, Eliasson et al., 2011). Therefore, the COM-B model has been used to underpin a comprehensive framework known as the Behaviour Change Wheel (BCW) framework (section 2.6) that allows its theoretical conditions to be operationalized for changing behaviour and provides direct strategies for changing behaviour. This is particularly important for specifying in behaviour change protocols, where the link between theory and practice is not always explicit making it difficult to identify which theory, if any, has guided the intervention approach (Lenert, Norman, Mailhot & Patrick, 2005). The difficulty in recognising theory is exacerbated in childhood weight management interventions as a result of heterogeneity that has limited researchers' ability to link interventions to weight outcomes (Kamath et al., 2008). In addition, Hingle et al. (2010) argue that evidence synthesis is limited by the lack of 'comprehensive and transparent reporting' of published studies and found in their research that only four out of the 24 studies adhered to at least 70% of the CONSORT guidelines for non-pharmacologic Randomised Controlled Trials (RCTs) (Hingle, 2010:109).

Consequently, there has been a shift towards characterising an intervention's content by their use of behaviour change techniques (BCTs) (Baranowski et al., 2003; Golley et al., 2011; Martin, Chater & Lorencatto, 2013; Hendrie et al., 2012; van der Kruk, Kortekass, Lucas & Jager-Wittenaar, 2013). However, the lack of an overarching model of behaviour to guide intervention development limits our understanding of the relationship between BCTs and why some BCTs are more effective than others. This approach also makes it challenging to replicate interventions and test theories.



Arguably, there is a need for a systematic method for linking theoretical levers of change to mechanisms of action that can be implemented in behaviour change interventions. Hence, as well as the importance of underpinning behaviour change interventions with relevant theory (French et al. 2012; Michie et al., 2005; Michie et al., 2011b) which also applies to the fields of eHealth and mHealth (Webb et al., 2010a; Ritterband & Tate, 2009; Fjeldsoe et al., 2012), there are a number of published frameworks (e.g. Intervention mapping, MRC framework, see Chapter 3) that intervention designers can draw upon for the design of theory driven mHealth apps.

## **2.5 Health behaviour change intervention frameworks**

According to Glasgow, Lichtenstein and Marcus (2003), despite the growing evidence that health promotion interventions have been successful in controlled settings, few such interventions have been systematically implemented in real settings. Indeed, the science governing intervention development is still in its formative years (Ory, Jordan, & Bazzarre, 2002). As a result there have been a number of different frameworks that have attempted to close this gap between research and practice. According to Wallace, Brown & Hilton (2014), generic behaviour change frameworks such as intervention mapping (IM; Bartholomew et al. 2011), the Precede-Proceed model (Green & Kreuter, 2005), The Medical Research Council (Craig et al., 2008) and the RE-AIM (Reach, Efficacy or effectiveness, Adoption, Implementation, Maintenance) framework (Glasgow, Vogt, & Boles, 1999) allow one to draw from relevant psychological theory and evidence, input from the target population, as well as contextual factors, in the systematic development and evaluation of interventions.

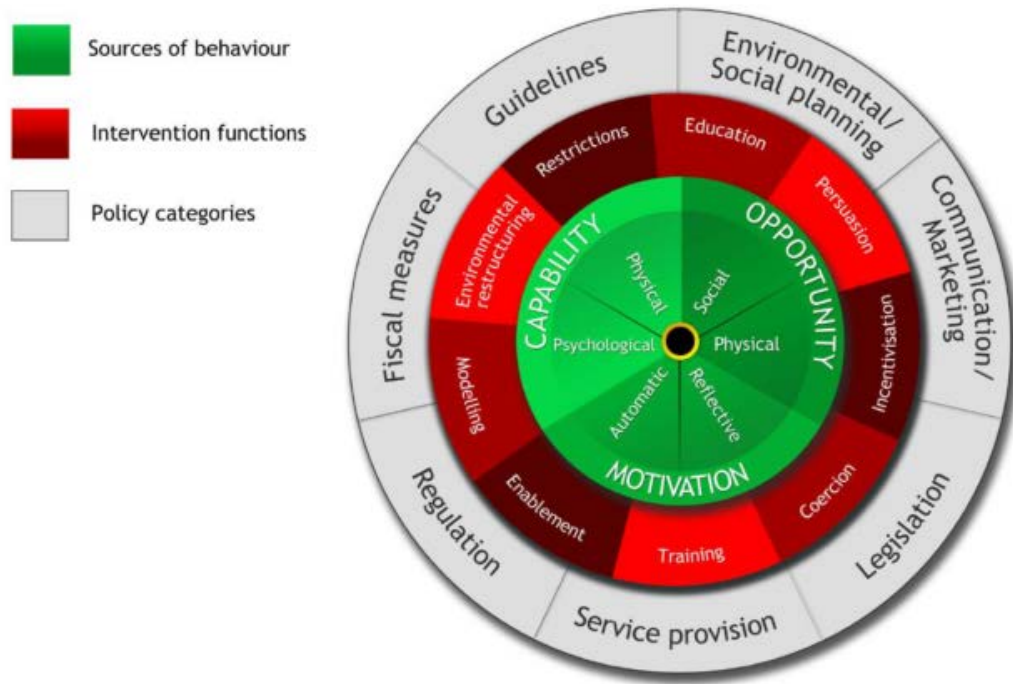
Michie et al. (2011a) conducted a systematic review of behaviour change frameworks, reporting that the Precede-Proceed and RE-AIM frameworks have limited ability in providing intervention techniques aimed at changing behaviour. According to the authors, the majority of intervention designers have refrained from using existing frameworks which may reflect their unmet needs. The analysis of existing frameworks included in the review, revealed that frameworks were limited by their failure to offer a full range of intervention functions such as training, education, incentivisation (section 2.6) and lacked coherence and grounding in a model of behaviour change. The authors further argue that most interventions fail to adopt a systematic approach including a 'formal analysis of either the target behaviour or the theoretically predicted mechanisms of action' (Michie et al., 2011a:2). Furthermore, even when interventions specify the use of a particular behaviour change theory or model guiding the intervention, they do not account for all of the possible influences on behaviour. In addition, intervention frameworks do not adopt a systematic process for selecting appropriate theories to guide the intervention. For example, while the Medical Research Council recommends basing intervention designs on theory, they do not offer guidance on 'how to select and apply theory' (Michie et al., 2011a:2). Indeed, this critical analysis of existing frameworks has led to the development of a new framework and practical guide. 'The Behaviour Change Wheel: A guide to designing Interventions' (BCW: Michie, Atkins & West, 2014) h brings together four recently developed behavioural science technologies that interlink with one another and guide the design of an intervention. The BCW is coherent, grounded in a model of behaviour and inclusive of all possible intervention functions. In addition, while frameworks such as 'intervention mapping' (IM) (Bartholomew et al., 2011) attempt to link behaviour to its

‘theoretical determinants’, the BCW accepts that behaviour can essentially derive from a combination of theoretical components within a behavioural system.

## **2.6 The Behaviour change Wheel: An overview**

Michie et al. (2011a) conducted a systematic review of behaviour change frameworks leading to a synthesis of 19 frameworks consisting of 9 intervention functions and seven policy categories. Within the BCW framework, these intervention functions and policy categories are then linked to the Capability, Opportunity, Motivation and Behaviour model (COM-B) at the centre of the wheel, forming a unified framework: the Behaviour Change Wheel (BCW).

Figure 5 below illustrates that the BCW comprises of three layers: at the core of the wheel is the COM-B model that helps to identify important levers for change for the new behaviour to occur; the next layer is the nine intervention functions that characterise the type of intervention that is needed; the third outer level signals seven types of policy categories that can be used for delivering these intervention functions. The authors of the framework emphasise that the COM-B model and BCW apply not only to one level (e.g. individual or systems) but also to any level (Michie et al., 2014b).



**Figure 5: The Behaviour Change Wheel framework (Michie et al., 2011)**

Intervention functions are defined as expansive classifications through which an intervention can modify behaviour (Michie et al., 2014b). Furthermore, one behaviour change technique (section 2.6.2) can have more than one intervention function (Michie, et al., 2011a). The nine intervention functions identified are: *Education* (increasing knowledge or comprehension), *Persuasion* (evoking emotions to stimulate action), *Incentivisation* (an expectation of rewards for behaviour), *Coercion*, (expectation of punitive consequences and costs), *Training* (transmitting skills), *Restriction* (using rules and regulation to reduce behaviour), *Environmental restructuring* (modifying the physical or social environment), *Modelling* (providing an exemplar of behaviour for people to emulate), and *Enablement* (increasing the means to carry out the behaviour) (Michie et al., 2014b). An expert consensus meeting identified links between each COM-B component and each intervention function likely to bring about change in these. An example of linking intervention

strategies, functions and COM-B components to reduce portion sizes would be to increase the availability of smaller portioned food products (Policy category) which is linked to the intervention function of *Environmental restructuring* and the COM-B component of physical opportunity (see example in Michie et al., 2014b:119).

The BCW recognises that behaviour is part of a system and a single intervention only addressing one part of this system may have consequences for other components within the system and therefore this approach is ‘based on a comprehensive causal analysis of behaviour’ (Michie et al., 2011a:9). Furthermore, frameworks such as IM draw on a range of theoretical approaches that independently focus on different aspects of the target behaviour. In contrast, the BCW is underpinned ‘by a single unifying theory of motivation that predicts what aspects of the motivational system will need to be influenced in what ways to achieve the behavioural target’ (Michie et al., 2011a:9).

Indeed, one of the major components differentiating the BCW guide from other frameworks for developing behaviour change interventions is that it is underpinned by a model of behaviour change which can be further delineated by the Theoretical Domains Framework.

### **2.6.1 The Theoretical Domains Framework**

Behavioural science and especially health psychology, is proliferated with evidence based theories and models aimed at predicting and changing behaviour. However, although it is logical to underpin interventions with these models, there are an overwhelming number of theories to choose from. Consequently, intervention designers cannot be fully confident that they have included all the key mediators when they use only one or a few theories (Francis, O’connor & Curran, 2012). One

solution to this may be the use of a broad framework that provides a range of key mediators drawn from a wide number of theories to guide intervention development.

In a response to the need for an overarching theoretical framework, experts in areas of health psychology, theory and health services have identified 128 initial theoretical constructs drawn from 33 psychological theories (Michie et al., 2005). Key constructs were then grouped into 12 (recently refined to 14) theoretical domains such as 'Knowledge', 'Skills' and 'Emotion' that resulted in the 'Theoretical domains framework' (TDF) and function as mediators of behaviour change (Francis et al., 2012; Cane et al., 2012). The TDF is designed to be 'an inclusive, rather than selective, approach to exploratory research in the field of implementation' (Francis et al., 2012:6).

In an effort to report the impact and development of the TDF, Francis et al. (2012) reviewed 21 studies citing the TDF as the basis for empirical research. They reported from these that the TDF had succeeded in making psychological theory accessible to multidisciplinary researchers; was not limited to reflective cognitive processes; is a comprehensive and exploratory approach rather than a selective one; and consists of theoretical constructs advanced over the course of a century. However, one of the limitations with the TDF is that it is descriptive in nature rather than a theoretical model and therefore fails to postulate the link between domains (Francis et al., 2009). However, further work has now grouped the theoretical constructs of the TDF into the COM-B model, specifying the relationship between domains in regards to a person's capability, motivation and opportunity to enact a behaviour (Michie et al., 2014b). Hence, both the COM-B and TDF theoretical tools are central to the BCW and once a behavioural analysis has been conducted, the BCW helps intervention designers to link to the theoretical levers for change to the intervention functions that

are most likely to bring about change in the target behaviour (see section 2.11).

Furthermore, these intervention functions can be broken down further into specific behaviour change techniques drawn from a taxonomy of evidence based behaviour change techniques.

### **2.6.2 The taxonomy of behaviour change techniques**

According to Baranowski et al. (2003), mediating variables are ‘in a cause-effect sequence between an intervention and an outcome’ and are the influences on behaviour that originate from theoretical or conceptual models of behaviour. Thus, the authors propose that interventions are more effective when the mediating variables are more strongly associated with the target behaviours and if interventions involve appropriate strategies to enable these mediating variables.

Michie et al. (2013) define behaviour change techniques (BCTs) as the observable, replicable and active ingredients in an intervention that directly bring about behaviour change. With regards to mHealth apps, previous research (see section 2.3.3) have shown that they are particularly suited to delivering certain behaviour change techniques such as self-monitoring and feedback on behaviour. This has been taken forward in a paper presented at the BPS Division of Health Psychology’s Annual Conference that assessed the potential for smartphone apps to deliver each of these 93 BCTs. West (2013) reported results from a study where the features of smartphones were characterised by their availability, information tailoring and programming flexibility. Following this, two behaviour change experts independently coded smartphone apps’ ability to deliver or help deliver each of the 93 BCTs. There was agreement between coders that smartphone apps had moderate potential to deliver 48 out of the 93 BCTs and limited capacity to deliver 18 of them. Apps were judged as particularly helpful in delivering BCTs relating to goals and

planning (e.g. goal setting, problem solving), feedback and monitoring (e.g. self-monitoring of behaviour), shaping knowledge (e.g. instruction on how to perform the behaviour), information about consequences, comparison of behaviour (e.g. information about others' approval) and antecedents (e.g. distraction). Apps were judged as moderately good at delivering BCTs related to: social support, repetition and substitution, comparison of outcomes, identity, self-belief and covert learning. And finally, apps were judged as less helpful at delivering BCTs aimed at creating associations, providing punishment or threat and emotional and drive regulation. West (2013) concludes from his research that smartphone apps are well equipped to delivering the majority of the 93-item taxonomy and therefore hold significant potential for supporting behaviour change.

With regards to childhood weight management, according to Golley et al. (2011), there has been a paucity of research evaluating specific behaviour techniques used in childhood weight management interventions. The authors argue for the need for greater consideration of how behaviour change theories are operationalised in interventions whereby linking theory to practice is likely to increase intervention effectiveness (Golley et al., 2011). In addition, Martin, Chater & Lorencatto (2013) state that our current understanding of which BCTs are effective for child obesity related behaviours is limited by the lack of standard terminology used amongst researchers, which makes it difficult to interpret and replicate interventions. Indeed, 'the complex and multicomponent nature' of childhood obesity interventions necessitates the importance of deconstructing these intervention components (2013:1).

The need for standardisation of terms used in health behaviour change interventions along with the need for reliably designing and specifying behaviour change



techniques used in health interventions, has led to development of the ‘BCT taxonomy V1’, an extensive list of 93 BCTs (Michie et al., 2013).

Earlier versions of the taxonomy (see Abraham & Michie 2008; Michie et al., 2011c) have been used to specify which behaviour change techniques are associated with more effective childhood weight management interventions (Golley et al., 2011; Hendrie et al., 2012; Martin et al., 2013; Van der Kruk et al., 2013). These reviews yielded the following BCTs as effective for childhood weight management interventions: (i) Prompt specific goal setting; (ii) Self-monitoring; (iii) Instruction on how to perform the behaviour; (iv) Plan for social support; (v) Provide general information about the behaviour-health link; (vi) Prompt intention, (vii) Environmental restructuring; (viii) Prompt practice; (ix) Prompt identification as a role model; (x) General communications skills training and; (xi) Stress management.

In addition to careful specification of intervention content based on theory and evidence, there are other elements important for the design of mHealth apps such as aesthetics, novelty of content and features, and usability. Hence, it is important to consider how certain design features can maximise users’ engagement with a mHealth intervention (Pagoto & Bennett, 2013).

## **2.7 User engagement**

In today’s ‘mobile app ecosystems’, app developers build apps that adapt to users requirements fitting into ‘ever changing niches’ (Lim & Bentley, 2012:1), where users expect apps not only to be functional but also engaging. Indeed, apps are expected to go beyond usability to provide users with an experience (O’Brien & Toms, 2010).

The way in which people engage with digital technology has attracted attention from a wide number of disciplines including marketing, web applications, digital games, virtual reality and game-based learning (Bouvier, Lavoue, & Sehaba, 2014).

However, despite the growing emphasis on designing engaging technologies, there is a lack of consensus regarding its definition (O'Brien & Toms, 2008). However, there have been some helpful conceptualisations from the fields of education and game design. For example, engagement has been defined as the 'behavioral intensity and emotional quality of a person's active involvement during a task' (Reeve, Jang, Carrell, Jeon, & Barch, 2004) and 'the willingness to have emotions, affect, and thoughts directed toward and aroused by mediated activity in order to achieve a specific objective' (Bouvier, Lavoue & Sehaba, 2014:6). Hence, engagement can be seen as a multi-dimensional construct that includes behavioural, cognitive and emotional dimensions (Fredricks, Blumenfeld, & Paris, 2004) and will depend on the users 'willingness to invest time, effort and attention' in an interactive system (IJsselsteijn & Kort, 2007).

To date, the most extensive research carried out in the field of engagement has been conducted by O'Brien & Toms (2008, 2012). From their critical review of the multidisciplinary literature and their own research of users' engagement in technology, they have developed a process model of engagement. The model suggests that engaging experiences exist on a continuum and involve four stages in engagement: a point of engagement, a period of sustained engagement, disengagement and re-engagement. Users cycle through the stages of engagement multiple times in one session, therefore re-engagement is integral in the model. Each stage is characterised by its own engagement attributes which are 'products of users' interactions with the technology, since they depend on what the user finds innately

compelling’ (O’Brien & Toms, 2008:6). Therefore, the authors define engagement as ‘a quality of user experiences with technology characterized by challenge, aesthetic and sensory appeal, feedback, novelty, interactivity, perceived control and time, awareness, motivation, interest, and affect’ (2008:23). Further evidence for important engagement principles can be gleaned from eHealth research. For example, results from one study reported, that in contrast to ‘experts’, online consumers have greater susceptibility to the information architecture and aesthetics in relation to assessing the credibility of health websites (Danaher & Seeley, 2009:32). In addition, it has been suggested that interactivity and tailoring can also help to increase engagement in mobile interventions (Fjeldsoe et al., 2009).

Interestingly, there is evidence to suggest that apps with the most evidence-based strategies are not the most popular amongst consumers (Abroms et al., 2011; Pagoto et al., 2013), suggesting that commercial apps may be more engaging for consumers despite their lack of theoretical content. Arguably, it would be advantageous to draw on the expertise of commercial app developers who are more experienced in developing ‘engaging and user-friendly’ apps (Pagoto & Bennett, 2013:273).

Regardless of the vast increase in the percentage of health promotion apps available on the market, uptake rates have remained low (Fox & Duggan, 2012). This may indicate that the majority of health promotion apps may not adequately engage users and/or support long term health behaviour change, providing a rationale for bringing these two sectors together in the development of mHealth apps (West et al., 2013; Pagoto & Bennett, 2013). The design of eHealth interventions that promote engagement will require underpinning the content with evidence based health behaviour change intervention design frameworks and optimising the effectiveness of this content using engaging design principles. However, different theoretical

constructs and design principles will appeal to different target audiences. It is therefore important to use participatory approaches such as user-centred-design to combine relevant theoretical principles and engagement principles so that they are optimised for engaging the specific target audience.

### **2.7.1 Involving the target population in intervention development**

While mHealth is still a nascent field, research has predominantly focused on evaluating existing commercial applications available in the app stores (see Section 2.5.2) and not on theory driven mHealth design (Stroulia et al., 2013). Nevertheless, there is growing consensus that mHealth development should be guided by not only evidence-based behavioural strategies and behaviour change theory, but also a user-centred approach (Fjeldsoe et al., 2012; Pagoto & Bennett, 2013), where the users' needs and desires are central to the development process. UCD is a participatory design approach focusing on the user and on 'incorporating the user's perspective in all stages of the design process' (Devi et al., 2012:1).

According to Gulliksen, Göransson, Boivie et al. (2003), UCD exists more as a concept for a common practice, as opposed to an agreed definition, where it has been described by Norman (2002) as 'a philosophy based on the needs and interests of the user, with an emphasis on making products usable and understandable' (Gulliksen et al., 188). Although this definition does not necessarily mean users have to be involved in the UCD process, actively involving users in the process is a common method used to ensure that users' needs and desires are really being met (Devi et al., 2012). In addition, a study using the Technology Acceptance Model (TAM) found that participants were more likely to adopt new technology if they perceived it to be useful for them and easy to operate (Porter & Donthu, 2006).

Formative research using a UCD approach also ensures that a mHealth intervention has social validity with regards to its acceptability amongst its stakeholders (Danaher & Seeley, 2009) which, within the context of childhood weight management, may include parents, service providers and dietitians. Furthermore, involving parents in the development process may also safeguard their trust in using the app to support their family's eating behaviours (Buller et al., 2013). However, despite the influx of commercial mHealth apps on the market, few apps report whether they have been developed with a focus on the end user (Demidowich, Lu, Tamler, & Bloomgarden, 2012). Arguably, the majority of commercial apps have focused on a predominantly 'technology-centred' design (technology capabilities and limitations) as opposed to a 'user-centred' design (human capabilities and limitations) (Flach, Vicente, Tenebe, Monta & Rassmussen, 1988). Therefore, within this thesis it is posited that components relating to behavioural science (for underpinning with evidence and theory), user-centred design (for making sure the design inputs are relevant, liked and accepted by the target population) and input from the commercial app industry (for engaging design features) should all form an integrated approach to mHealth app development. Arguably, a UCD approach is required to 'forge the link between the technology and the intended audience while effectively addressing determinants of behaviour change' in order to fully harness mHealth technologies (Turner et al., 2015:4).

## **2.8 Summary of literature review**

There is broad consensus that childhood overweight and obesity results from an imbalance in the total energy consumed (through food) and the energy expended (through physical activity), where the intake side of the equation is evidenced as more important for children's weight gain. Therefore, this thesis focuses on

developing a smartphone app to support parents' dietary behaviours with their children.

Current childhood weight management programmes have so far had limited success due to factors such as their failure to directly target parents and involve them in the intervention development process, their lack of theoretical underpinning and their shortcomings involving programme delivery. Hence, there is growing interest in exploring the use of digital technologies to address childhood weight management.

Reviews of existing health promotion apps, including those aimed at weight management, indicate that they lack behaviour change constructs and evidence based guidelines. Indeed, there is strong support for underpinning interventions with relevant theory and evidence, however, there is a lack of research that has identified which underlying theories and mechanisms are most relevant for parents within the context of supporting parents' dietary behaviour with their children.

A critical review of prevalent social cognition theories revealed shortcomings regarding their failure to include relevant variables to support behaviour change. As childhood overweight and obesity is a complex 'multi-system' disease, theories and models of behaviour change must be more dynamic and include 'system' level factors that account for family system and obesogenic environmental interactions. For this reason, ecological theories are becoming a popular model for childhood weight management. However, they are limited by their lack of motivational variables and therefore it is argued that a combination of motivational and environmental variables offer greater promise in reversing the trend of childhood overweight and obesity. In addition, the theories provide limited knowledge and understanding of the parent-child dyad and the psychological barriers that prevent

parents from making changes to their children's dietary behaviours and also for providing direct strategies to change behaviour. This provided the rationale for exploratory research with parents using a psychological framework that is inclusive enough to account for all the potential psychological variables that may be involved in parents' dietary behaviours with their children. Thus, a new model of behaviour change that integrates with a framework for intervention development, the Behaviour Change Wheel (BCW), is drawn upon in this thesis.

Lastly, it was argued that underpinning mHealth apps with evidence and theory may have little value if considerations are not made to design features which initially appeal to consumers for their uptake, and enhances their experience and engagement for their sustained use of the app. Hence, this may represent a missed opportunity for behavioural scientists to partner with app developers who are likely to possess more expertise in designing engaging apps. However, different design principles will appeal to different target populations and therefore the importance of involving formative research with the target population was highlighted wherein a participatory approach such as a UCD approach, can facilitate this process.

## **2.9 Aims and objectives**

The principle aim of this thesis is:

*To systematically design and develop an evidence and theory driven, user-centred healthy eating app to support parents in childhood weight management.*

In particular, it involves: (i) the application of a new model of behaviour change, the Capability, Opportunity, Motivation-Behaviour model (COM-B) and associated intervention development framework, the Behaviour Change Wheel (BCW), along with (ii) a User-Centred Design (UCD) approach and input from a commercial app company.

### **2.9.1 Research objectives**

Achieving the overall aim of the thesis, involved three main research objectives. The first objective related to the implementation of the BCW framework and sought to identify the behavioural targets and theoretical levers for change to target in a mHealth intervention supporting parents in childhood weight management. The second research objective related to the first stage of the UCD approach which sought to identify parental preferences for mobile app features to help promote engagement. The third objective sought to translate the findings from the first two research objectives into tangible app features while drawing on the second and third stages of the UCD approach and collaboration with a commercial app company. Table 1 provides a summary of the research objectives and the methods used to achieve them.



**Table 1: Research Objectives**

<b>Research Objective</b>	<b>Methods</b>
<b>(i)</b> To identify nutritional behavioural target(s) and theory-informed components necessary for supporting parents' dietary behaviours with their children	(1) The BCW framework, (2) a review of the literature, (3) qualitative research using focus groups, (4) consultations with experts
<b>(ii)</b> To identify parental preferences for healthy eating app features to help promote engagement	(1) UCD approach, (2) a review of the literature, (3) qualitative research using focus groups
<b>(iii)</b> To translate the theoretical and user-centred research findings (objectives i & ii) into tangible app features and evaluate their usability and acceptability	(1) UCD approach, (2) consultation with a commercial app company, (3) qualitative research using focus groups (4) Usability evaluation involving a think aloud study and workshop

## **Chapter 3 Methodology**

This thesis focuses on the development of an evidence and theory driven, user-centred approach for the development of a family healthy eating app. It entailed integrating the Behaviour Change Wheel (BCW), a new behaviour change intervention development approach, with user-centred design (UCD) elements and smartphone technology. Overall, development of the app involved collaboration with stakeholders and triangulation of data drawn from three empirical studies, reviews of the evidence, and consultations with experts. This chapter provides an overview of the methodology, underpinned by the BCW framework and a UCD approach, including a justification of the methods chosen. The three specific studies and findings are presented in subsequent chapters.

### **3.1 Stakeholder groups**

#### **3.1.1 Public Health department**

Several meetings were conducted with staff from Public Health Warwickshire regarding the development and use of a mHealth app to complement their existing family weight management services (Section 1.5). Hence, the methodology drew on an intervention mapping approach (Bartholomew et al., 2011) with regards to the importance of stakeholder involvement. Public Health Warwickshire were important stakeholders in this research and ensuring they were fully on board from the start and throughout the intervention development process, will help to increase the likelihood of an intervention being used once developed (Wallace et al., 2014).

Stakeholder discussions led to decisions to focus on parents of overweight children as the main target population, wherein the majority of the study participants were recruited from two local family weight management programmes (69%). In

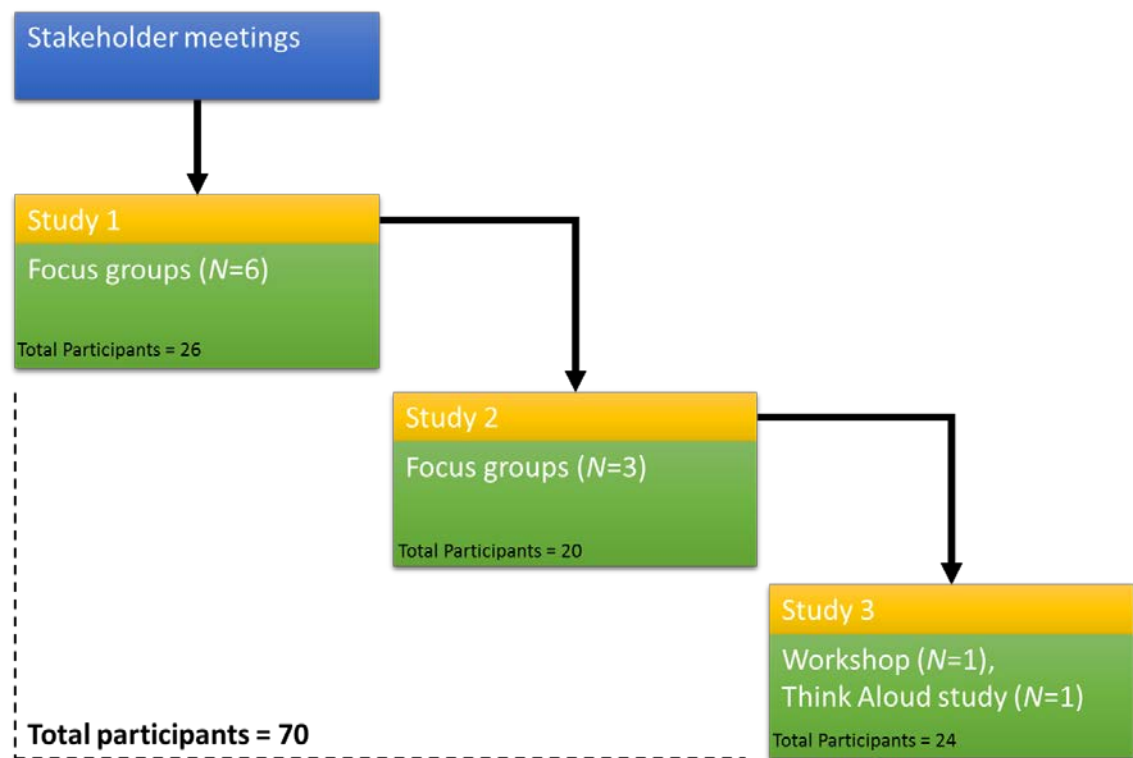
addition, the decision was made to target parents with children above the age of 5 years old where current local public health resources were lacking.

### **3.1.2 Participant groups**

Prior to recruiting parents, a focus group (FG1) was conducted with Change4life advisors as a way of scoping the problem and allowing: (i) familiarisation with the context of childhood obesity; and (ii) a ‘preliminary theoretical explanation’ to help guide decisions regarding questions to focus on with parents (see section 3.4.3).

Focus groups conducted with parents comprised of those with overweight children recruited from the weight management programmes (FG2, FG3, FG4, FG5, FG7, FG8 and the usability workshop) and those with healthy weight children (although some of them were classed as overweight) recruited from the university (FG6, FG9), to help extend the applicability of the app to other parent populations. This was mainly guided by the rationale that the app can be used in childhood weight management including both the prevention and the treatment of childhood overweight and obesity. Participants of the Think Aloud study were recruited from the university and comprised students and staff.

As shown in Figure 6 below, the thesis drew on the data collected in three empirical studies comprised of nine focus groups (studies one and two), one workshop and one Think Aloud study (study three).



**Figure 6: Overview of study plan**

### **3.1.3 Consultations with experts**

Expert opinion was sought and obtained for each of the research objectives (section 2.9.1) and throughout the app development process from a wide range of disciplines.

#### **3.1.3.1 Experts in childhood weight management**

For the first part of objective (i) experts were consulted to help identify which nutrition behaviour(s) to target in the intervention. Consultations took place alongside the first three focus groups so that parents' acceptability for this target behaviour could also be gauged from focus group discussions. Four face to face meetings took place involving: (1) a paediatrician from the Division of Metabolic and Vascular Health, along with a community dietician both from the University Hospital Coventry and Warwickshire NHS Trust; (2) a public health specialist in childhood obesity from The University of Warwick; (3) a children, learning and

achievement consultant from the Healthy School, Learning and Young People's Directorate, Coventry City Council; and (4) a family lifestyle officer from Rugby Borough Council. Experts were asked for their views on what particular nutrition behaviours were contributing most to children's weight gain.

#### **3.1.3.2 Experts in health behaviour change**

For the second part of objective (i), which concerned the identification of theoretical components to target in the intervention, expert advice was obtained to: (i) advise on how to select data (e.g. codes) to focus on in the intervention; (ii) ensure findings from the focus groups had been coded under the relevant TDF and COM-B domains and; (iii) ensure appropriate mapping of TDF components to relevant intervention functions and behaviour change techniques (Sections 6.3.1 and 6.5.1). Several face to face meetings, email communications and telephone calls took place with a chartered psychologist, specialised in behaviour change, at UCL Centre for Behaviour Change, University College London and a health psychologist specialised in behaviour change and eHealth, from the Centre for Technology Enabled Health Research (CTEHR) Faculty of Health & Life Sciences Coventry University.

#### **3.1.3.3 Expert in user-centred design (UCD)**

For objective (ii), the project sought advice from an expert in UCD from Loughborough Design School, Loughborough University with regards to the process of conducting UCD approach to mHealth development. In particular, advice was given before conducting focus groups regarding key literature and design models to draw on during the research process.

#### **3.1.3.4 Experts in app design and development**

For objective (iii), expert advice was obtained from the app company (Virtually Free ltd) in regards to the concept design and technical development of the app.

Therefore, the app company was consulted at key stages in the research process including: (1) after data analysis to help make decisions on what is amendable to change in an app (Section 6.2); (2) to help with translating behaviour change techniques into potentially engaging app features (Section 6.6.1 & 6.6.2); and to develop a conceptual specification to help foster communications on what amendments need to be made before the prototype app is developed (Section 6.5.5). Consultations took place via face to face meetings, Skype video calls, telephone calls and email communications.

#### **3.1.3.5 Experts in nutrition**

A dietary steering board was convened to receive advice for the dietary content of the app. A working relationship was established with two dietitians, working for South Warwickshire NHS Foundation Trust, and a family lifestyle officer, with a background in nutrition, working for Rugby Borough Council. This involved email communication and several face to face meetings. Advice was sought and obtained at key stages in the research including: (1) to provide recommendations of age appropriate portion sizes (Section 7.1.4.1; Table 17); (2) to review portion guide artwork (Section 7.5); (3) to review the nutritional information in quiz (Appendix 4D); and (4) to review and make suggestions for tips on portion control (Appendix 4E).

#### **3.1.3.6 Consultation with an expert in usability evaluation**

A meeting took place with a Knowledge Transfer Specialist, to advice on the process of evaluating the usability of the prototype app. It was recommended that a

‘cognitive walkthrough’ (referred to in this thesis as ‘task scenarios’, Section 8.4.4.1.1) document was developed to indicate a chronological list of tasks required to use the app to measure and log portion sizes.

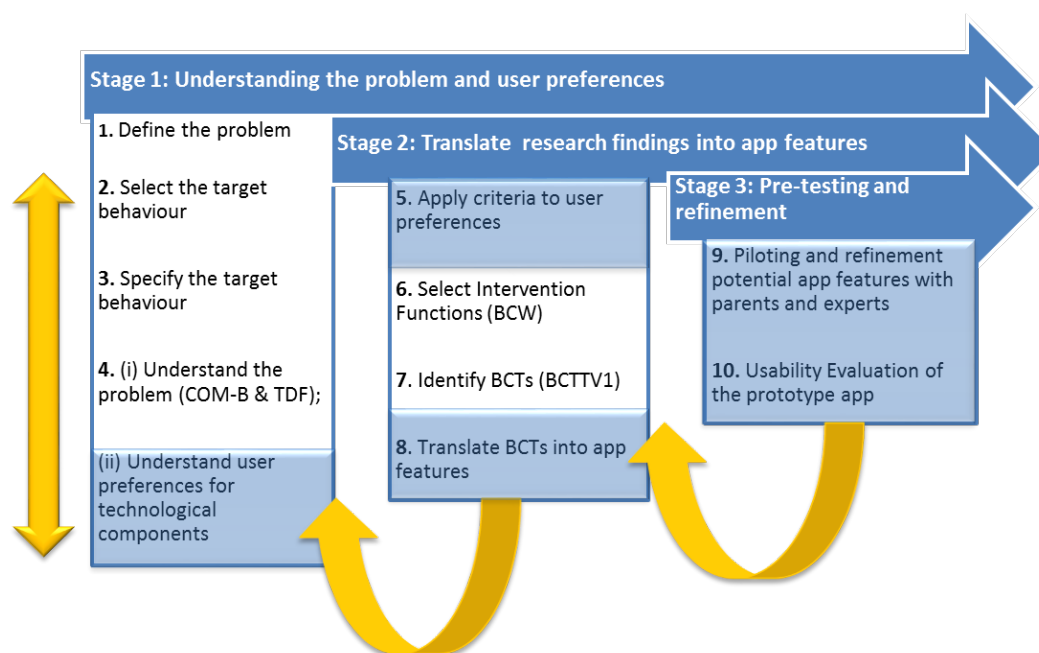
### **3.2 Methodological approach**

Current health promotion apps on the market have been developed without sufficient attention to a combination of factors that could help to maximise their potential for effectiveness. Formative research was conducted simultaneously on the theoretical, user-centred and technological aspects which were then revisited, adapted and refined through an iterative and cyclic design process. An important part of the intervention development process was the role parents played: as well as being directly targeted in the intervention as the main agents of change, parents formed an integral part of the intervention development process.

To ensure that the app was guided by relevant theory and evidence, the current study drew from a draft version of a recently published practical guide on how to apply the BCW framework to the design of health behaviour change interventions (Michie et al., 2014b).

The BCW framework comprises of eight steps for intervention development of which six were drawn upon for the current study. The remaining two steps in the BCW referred to the delivery of the intervention with regards to modes of delivery and policy categories. However, for the current thesis, these steps were decided before the intervention development process began in line with the local public health department objectives: the need for a mHealth app (mode of delivery) to support existing family weight management services (Service provision and Communication/Marketing).

The BCW framework does not include steps that are needed when developing behaviour change interventions in the digital environment. To address this current gap, the proposed mHealth app intervention development process also involved developing five additional steps. Hence, a total of ten sequential steps arranged into three stages, as shown in Figure 7 below, were followed in the current study.



**Figure 7: mHealth app intervention development process**

Figure 7 illustrates the sequence of steps followed in the intervention development process where the blue shaded boxes indicate the new steps that were added to the BCW framework within the context of developing a mHealth app.

The arrows underneath stages two and three signify that it was necessary to cycle back through stages based upon the information gathered at each stage. The arrow to the left side of stage one of development illustrates that steps two-four were conducted simultaneously, in contrast to the BCW framework which recommends



selecting the target behaviour before conducting qualitative research with the target population. Since it was unclear from a review of the literature as to: (1) which target behaviour was having the most impact on children's weight gain; and (2) which target behaviour was acceptable for parents to change, it was deemed necessary to first explore this topic with parents, along with consultations with experts in the field, before decisions could be made on which target behaviour to select.

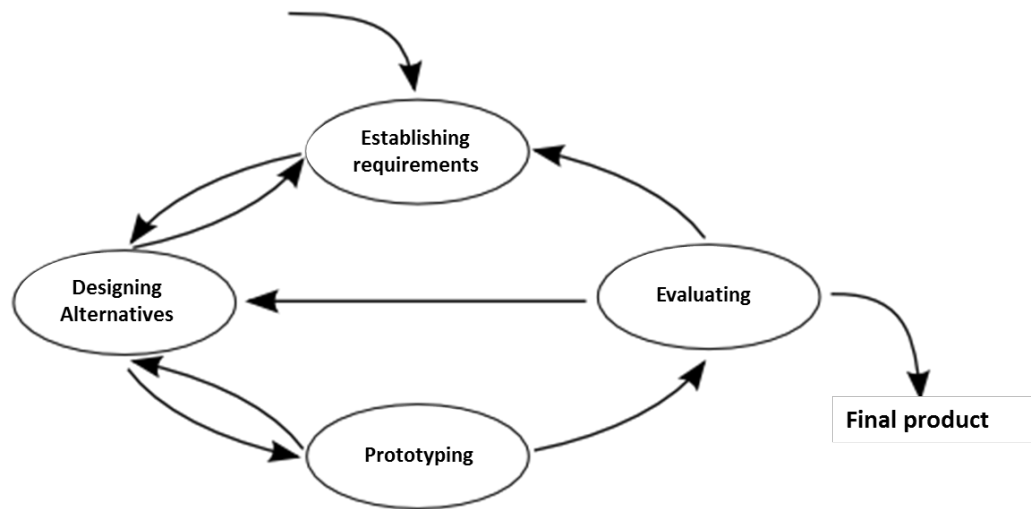
### **3.3 User-Centred Design**

One approach to increasing parental engagement with the app is to ensure that the app incorporates their preferences and requirements for app features using a user-centred design approach (UCD). According to Rogers, Sharp and Preece (2011), in a UCD approach 'while technology will inform design options and choices, it should not be the driving force' (2011:327).

Devi et al. (2012) describe the key elements within a UCD approach as firstly, involving the end users directly in the entire design process; and secondly, conducting the process in an iterative form, repeating this cycle until the project's objectives are satisfied. This then makes it 'critical that the participants in these methods accurately reflect the profile of the actual users (Devi et al., 2012:1). The third aspect highlighted by Rogers et al. (2011) relates to observing and measuring the intended users' reactions and performances to prototypes.

Rogers et al. (2011) have developed a simple interaction design model shown in Figure 8, combining the three key aspects of UCD described above, with basic principles in interaction design. Interaction design refers to 'developing interactive products that are easy, effective and pleasurable to use – from the users' perspective'. (2011:2). Therefore, for the current study, three key activities

recommended by the authors were followed involving firstly, the identification of users' needs and requirements (information was gathered from participants on their preferences for healthy eating app features during study one); secondly, the development of alternative designs (involved generation of a conceptual specification and alternate icons, images and menu designs) and lastly, prototyping (involved developing interactive mock-ups and receiving feedback from parents on these during study two). Their final recommendation includes an evaluation (involved gaining feedback from participants relating to the usability, experience, acceptability of the prototype app during study three) of the prototype app (Chapter 8). Usability evaluation helps to determine a system's perceived usability amongst users and is key to ensuring that design requirements are in line with users' needs (De Vreede, Fruhling, & Chakrapani, 2005; Yen & Bakken, 2009). It is also a method to highlight specific problems in relation to the usability of a system or product where researchers inspect the interface. The advantage of considering usability issues early on in the engineering lifecycle of the app includes enhanced predictability, greater efficiency with less errors, better alignment with user needs and savings in resources (i.e. development period and budget) (Yen & Bakken, 2009).



**Figure 8: A simple interaction design model (Rogers, Sharp & Preece, 2011)**

It has been argued that consumers expect software applications to be more than just functional, they expect them to be engaging. Consequently, there is ‘an impetus for technology developers to exceed usability and provide an experience’ (Brien & Toms 2010:2). Hence, in line with recommendations from Preece, Rogers and Sharp (2002), their usability and user experience goals model was applied in the analysis of the data collected from both studies and also used to structure questions in study two (Section 7.2.5).

To ensure that the target population is directly involved in the UCD process, a number of empirical methods can be used including surveys, interviews, focus groups and field studies. For the current thesis, focus groups (Section 3.4.2) and a usability workshop (Section 8.1.1.2) were used to collect data on parental requirements for app features (Devi et al., 2012). This involved firstly: qualitative enquiry with Change4Life advisors and parents to gather insights into users’ preferences and requirements for the design of the family healthy eating app and;

secondly: pre-testing the app features and content with participants (Cafazzo et al., 2012, Fjeldsoe et al., 2012).

### **3.4 Qualitative research**

A qualitative method of enquiry was used so that both the BCW framework and the UCD methodologies could be used simultaneously to achieve all three research objectives (Table 1, Section 2.9.1). In addition, qualitative research allows an examination of the social context and may 'be a way to reinvigorate current health psychology theories' (Lyons, 2011:5), including with respect to this study which involves harnessing digital technologies for health promotion. Hence, for the current study, qualitative enquiry was valuable for assessing which components of the TDF and COM-B model are most important to target in the intervention as well as providing insights into parental preferences for app features.

Qualitative research may be defined as 'the exploration of meanings of social phenomena as experienced by the individual themselves, in their natural context' (Malterud, 2001:483), which employ non-quantitative methods to increase knowledge and build new perspectives in an area (Tong et al. 2007). Qualitative research not only encompasses techniques of data collection and analysis but also a paradigm (beliefs, practices and assumptions held by the research community), providing an overarching framework for research (Braun & Clarke, 2013).

#### **3.4.1 Qualitative research as a paradigm**

According to Braun and Clarke (2013), extensive collections of features and assumptions form a non-positivist qualitative research paradigm where it is not assumed that there is only one correct version of reality. Essentially, it originates from the idea that there are multiple realities (even within one person) which depend

on the context they ensue in. Therefore, most qualitative researchers maintain that knowledge should not be considered outside of the research context, including both data generation (e.g. focus group setting) and the wider environmental context (e.g. sociocultural and political contexts) of the research. The authors also make the point that qualitative research is not simply a complementary approach to the quantitative research paradigm.

The role of the researcher involves subjectivity and reflexivity where findings are continually questioned at each step in the research process instead of taking them at face value. According to Creswell and Miller (2010), the ‘lens’ used by the researcher establishes the validity of the study, where validity is referred to in terms of the inferences drawn from the data, as opposed to the data itself. For example, one lens to determine the credibility of a study may range from decisions as to whether data saturation has been reached, to the process of re-analysing data to check if constructs and interpretations make sense. Altheide and Johnson (1994) refer to this as ‘validity-as-reflexive-accounting’ (1994:489) where there is an interaction between the researcher, research topic and the analytic process (Creswell & Miller, 2010).

### **3.4.2 Focus groups**

Data for study one and two was collected using a focus group study design, which allowed an exploratory approach to help to identify relevant theoretical constructs and user preferences to target in the intervention. Focus groups also helped to facilitate interactions among participants that stimulated rich data for analysis (McLafferty, 2004), where the researcher played an active role in guiding the discussions for data collection (Morgan, 1996). These ‘group processes’ helped participants to exchange and clarify their ideas and experiences that are not always

amenable in a one to one interview (Kitzinger, 1995). Open-ended, semi-structured questions allowed for more in-depth responses around issues that were important to participants and using their own terminology and language (Kitzinger, 1995).

For study one, the Theoretical Domains Framework (TDF) was used to structure questions. According to Francis et al. (2012), opponents may criticise the use of the TDF as a topic guide with regards to only eliciting responses in those particular areas, which could be seen by some as too restrictive. However, one study conducted randomised designs to make direct comparisons of studies conducting focus groups, interviews and questionnaires using the TDF compared to those studies employing atheoretical methods (Dyson et al., 2011). The findings revealed that TDF based studies were able to elicit beliefs that could not be stimulated in those studies using atheoretical methods. Furthermore, the TDF based studies were able to generate more data on the emotional determinants of behaviour, rather than limiting its reach to only reflective cognitive processes (Dyson et al., 2011).

Focus groups also helped the researcher to gain access to a variety of forms of communication such as humour and anecdotes which is beneficial because ‘people’s knowledge and attitudes are not entirely encapsulated by responses to direct questions’ (Kitzinger, 1995:299). Humour helped participants to feel more at ease and lightened the mood in a sensitive topic area. In addition, the focus group discussions were sensitive to participants’ levels of education; cultural issues (allowing identification of social norms); and allowed discussion of the difficult subject of childhood overweight which may be perceived as a particularly sensitive issue for some parents (Kitzinger, 1995).

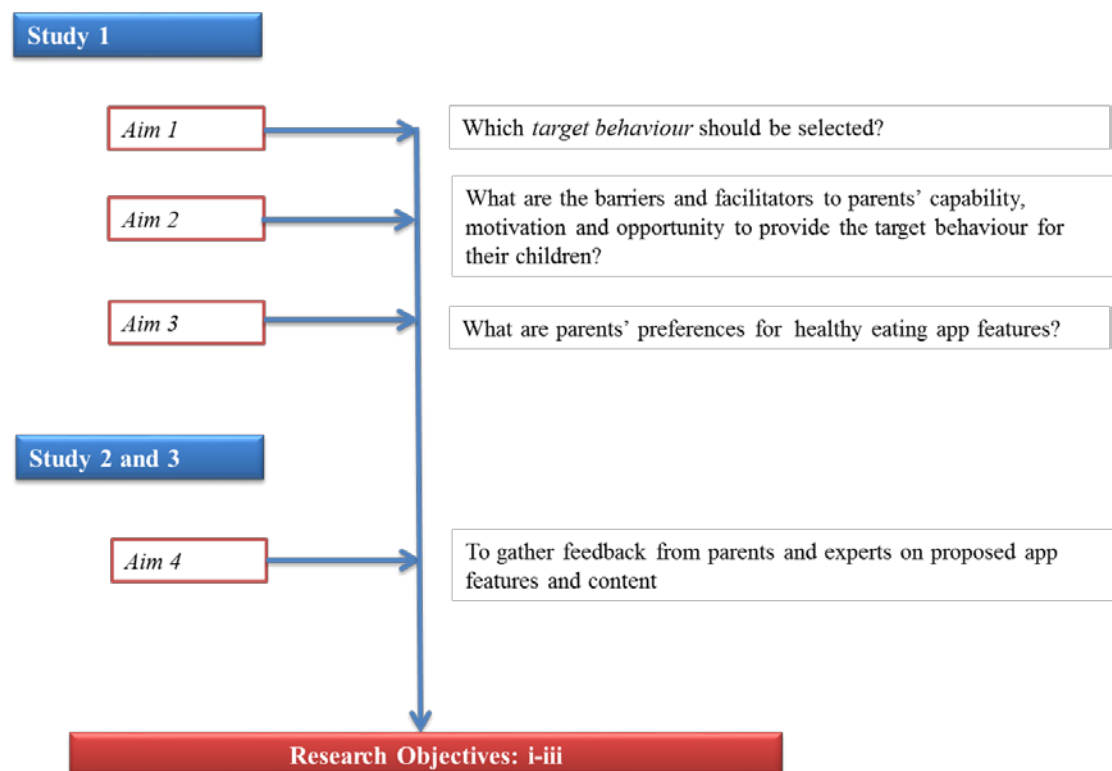
According to Tong, Sainsbury, Craig (2007), focus groups involve semi-structured group discussions ranging from around four to 12 participants that aim to explore a certain set of topics. For the current research, only one out of the nine focus groups came below this threshold with only three participants. A possible reason for this is identified later on (section 6.2).

Arguably, focus groups are a vehicle for empowering individuals and provide a supportive environment for individuals to share a common problem or goal (Basch, 1987). Parents were integral to the design process and a focus group design facilitated their role as experts (Levine & Zimmerman, 1996) in deciding which components should be in the app to support their dietary behaviours with their children. However, there are a number of limitations in using this research design. There is always the potential for some focus group members to feel intimidated and dominated by other group members which may impede their ability to share their opinions and ideas, which may reduce its generalizability (Basch, 1987; A. Lewis, 1992). However, the researcher made it clear at the start of the focus groups, that individuals who are talking more than others may be asked to stop in order to give other individuals a chance to contribute. Likewise, individuals who are silent will be probed to share their thoughts, in line with Krueger & Casey's (2000) principles to conducting focus groups. Participants were also encouraged to interact with each other so they could explore their own and shared experiences of the issues (Krueger & Casey, 2000). Another disadvantage of focus groups is that they may involve largely participants who are willing to share their ideas and opinions for research purposes (Basch, 1987). However, for the current research, the majority of participants were parents with overweight children who were already taking part in a family weight management programme which allowed direct access to a hard to

reach population. By conducting the focus groups while parents took part in this programme meant that they did not need to travel to another location and could share their ideas in a familiar and trusting environment (Basch, 1987). Furthermore, to help participants to feel more at ease and accustomed to the focus group process, the researcher followed principles in focus group research and ensured that broad questions were asked before moving onto more specific questions (Krueger & Casey, 2000).

### 3.4.3 Qualitative research aims

The empirical studies described in the previous section comprised four qualitative research questions shown in Figure 9, relating to all three research objectives (Section 2.9.1).

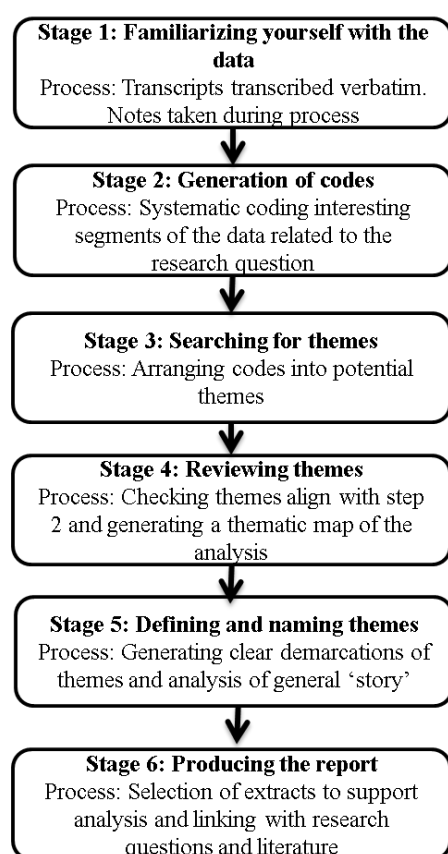


**Figure 9: Qualitative research aims**



### 3.5 Thematic analysis

With participants' permission, focus groups were audio recorded and transcribed verbatim and the raw data was then coded using a thematic analysis. Thematic analysis involves a systematic process for interpreting data where patterns are identified and analysed to provide 'illuminating descriptions of the phenomenon' (Smith & Firth, 2011:54). According to Clarke and Braun (2013), since the introduction of thematic analysis in the 1970s, there exists a number of different forms in psychology (e.g. Boyatzis, 1998; Tuckett, 2005) including the authors own method (Virginia Braun & Clarke, 2006) which was used to analyse both studies and is presented in Figure 10 below.



**Figure 10: The six stages of analysis adapted from Braun & Clarke (2006)**

Patterns of meaning are searched across the dataset and the analysis is seen as a 'recursive process' where the researcher can cycle back and forth between stages in the analytic process (Braun & Clarke, 2006:86). This is also characteristic of the overall app intervention development process wherein a feedback loop within (intra) and across (inter) different stages was essential (see Figure 8 in section 3.2).

Braun and Clarke (2006) argue that thematic analysis offers 'an accessible and theoretically flexible approach to analysing qualitative data' (2006:77). Furthermore, they object to the view that it is a tool to use across different methods (Boyatis, 1998) or a process used in prominent analytic traditions such as grounded theory (Ryan & Bernard, 2000) but rather it 'should be considered as a tool in its own right' (Braun & Clarke, 2006:78). They also maintain that thematic analysis is 'independent of theory and epistemology, and can be applied across a range of theoretical and epistemological approaches' (2006:78). This theoretical liberty expands its use as a research tool where it can provide both rich and detailed accounts of complex phenomena. However, the authors state that it is paramount that the theoretical framework chosen aligns with the research aims and that decisions in the process are acknowledged. Therefore, in this thesis, the COM-B model was chosen as an overarching theoretical framework that allowed assessment of behaviour change components that were modifiable using a mHealth app to help support parental dietary behaviours with their children.

### **3.5.1 Theoretical position and epistemology**

Data review and interpretation was approached using both deductive coding (driven by a theoretical framework) as well as inductive coding (strongly linked to the data). This implies that a combined essentialist or realist (reports an assumed reality of participants experiences and their meaning) and a constructionist (how reality is

created from the data where society has impacted on a variety of discourses) approach were used. For this reason it may be helpful to think of the current approach as a ‘contextualist method’ which resides between these two positions and thus ‘acknowledges the ways individuals make meaning of their experience, and in turn, the ways the broader social context impinges on those meanings, while retaining focus on the material and other limits of reality’ (Braun & Clarke, 2006:81). For the current study, thematic analysis was approached at the latent level (underlying assumptions, ideas and concepts that come with deductive coding) as well as semantic level (surface level meanings used with inductive coding).

According to Braun and Clarke (2006), prior to analysis, it is important to establish what counts as a theme. For the authors a theme ‘captures something important about the data in relation to the research question, and represents some level of patterned response or meaning within the data set’. However, it is also important to consider the prevalence of themes with regards to what counts as a theme and the extent of it e.g. one or two codes or many codes belonging to it. The authors argue that ideally themes should appear across the data set ‘but more instances do not necessarily mean the theme is more crucial’. Thus, the researcher must make decisions on how to determine themes in their research where it is more about flexibility than rigid rules. Furthermore, the significance of themes should not be dependent on quantifiable measures but ‘whether it captures something important in relation to the overall research question’ (2006:82). In this thesis, the interpretation of the data led to the identification of several themes relating to theoretical (Section 5.5) and user-centred components (Sections 5.6, 7.3 and 8.5) in app development which will be presented in later chapters. Wherever possible, quotes from participants are included to

illustrate their experiences within a theme in the context of parents' dietary behaviours with their children and the mHealth medium.

### **3.6 Qualitative research and rigour**

Despite its extensive use in numerous areas, qualitative research has been criticised for its lack of reproducibility, where the research is respective to the researcher's own interpretations making it difficult for another researcher to come to the same conclusions; its lack of generalisability; and researcher bias, where the research is 'an assembly of anecdote and personal impressions' (Mays & Pope, 1995:109). To address some of these challenges, it is important that researchers give an account of the method used to collect and analyse the data so that the study can be replicated by another researcher, resulting in essentially the same overall findings (Mays & Pope, 1995). In addition, various strategies can be employed to help limit researcher bias and enhance the reliability, rigour and validity of findings.

#### **3.6.1 Reliability and validity of analysis**

According to Golafshani (2003), establishing reliability and validity (where it has been argued that one cannot exist without the other) allows researchers to reduce bias and increase the truthfulness of their accounts.

With regards to the data collected and analysed using the COM-B and TDF framework, to ensure the 'retest reliability' of the analysis, audio recordings, transcripts and notes on the researcher's thoughts while transcribing were all collected along with providing a detailed account of the data analysis process. NVivo software was used to facilitate the coding of data from the focus group transcripts (Mays & Pope, 1995). In addition, for study one, the reliability of the qualitative data was further enriched by the use of an additional trained qualitative researcher who

was familiar with the BCW framework and theoretical domains framework, and who independently coded 10 percent of the data in order to establish inter-rater reliability. An agreement of 10/12 TDF domains was established where upon discussion, full agreement was reached. An inter-rater reliability of .83 is generally considered to be an acceptable rate (Salkind, 2013).

With regards to the selection of user preferences, reliability and validity was established through the use of (1) the application of a decision criteria for supporting decisions on which user preferences derived from study one to take forward (section 6.1); and (2) implementing and testing out these user-preferences using interactive mock-ups (study two) and screen shots of the prototype app with parents (study three) (Section 7.4 & 8.5).

Another method used for improving the validity and reliability of the qualitative research was through the use of triangulation (Patton, 2002).

#### **3.6.1.1 Triangulation of data**

It may be argued that ‘all research is selective - there is no way that the researcher can in any sense capture the literal truth of events’, hence, triangulation of data from different sources should be sought (Mays & Pope, 1995:109). Within social science, the term ‘triangulation’ refers to the search for a convergence between multiple sources of data to generate themes, validate findings, improve credibility and acquire greater overall understanding of the phenomena (Creswell & Miller, 2010; Rutherford et al., 2010). In the current study, data was collected from three different groups of participants: Change4Life advisors; parents with overweight children; and parents with healthy weight children on the barriers that parents face in providing healthier food, focusing on parental portion control behaviours. In addition,

consultation with multiple experts and a review of the evidence to help assess the external validity and effect of context on the findings (Malterud, 2001). For example, selecting the nutrition target behaviour involved a review of the literature, focus groups with parents with overweight children and consultation with experts (section 3.1.3.1).

### **3.6.1.2 Generalisability**

According to Firestone (1993) generalisation is ‘always based on extrapolation’ and is justified according to which research tradition one adheres to. For study one, generalizability refers to analytic generalisation as oppose to sample-to-population extrapolation. The former allows for more opportunities to ‘make links between cases and theories’ in contrast to the latter where the samples are often too small to generalise to a population (1993:21).

A ‘theoretical’ and ‘purposive’ sampling approach was used to recruit participants for the study as opposed to a randomised approach which is more suited to quantitative inquiries. Moreover, ‘statistical representativeness is not a prime requirement when the objective is to understand social processes’ where Change4life advisors, parents with overweight children and parents with healthy weight children were selected because they were relevant ‘to the social phenomenon being studied (Mays & Pope, 1995:110). For example, in this study, Change4life advisors allowed insight into important information regarding the context of childhood obesity and their experiences and thoughts on the barriers and facilitators to parents’ providing healthier food for their children. This allowed for a ‘preliminary theoretical explanation’ of the problem where Change4life advisors helped to make decisions regarding which data (e.g. which theoretical domains) should be explored further with parents. The following two focus groups with parents were also used to help

make decisions on which target behaviour to explore in the remaining focus groups and hence the 'relation between sampling and explanation is iterative and theoretically led' (Mays & Pope, 1995:311).

### **3.7 Local family weight management services**

Section 1.5.2 provided an overview of family weight management programmes that are available to the catchment population to be targeted by the app. In terms of recruitment of study subjects, the majority of the parents in the sample were recruited from Rugby Borough Council (RBC) and Nuneaton and Bedworth Leisure Trust (NBLT) family weight management programmes. These programmes aim to support families with overweight and very overweight children in increasing their exercise levels and improving their dietary behaviours. The focus groups took place from 5 and 6pm at spaces available in three primary schools and three community leisure centres within the boroughs of Nuneaton and Bedworth and Rugby.

#### **3.7.1 Involvement of programme managers**

For the sample of parents recruited from two local weight management programmes across both studies, two programme managers commissioned by Warwickshire County Council, notified parents of the opportunity to take part in the design of a healthy eating app, whilst attending the weight management programme. Therefore, the programme managers played a vital role in recruiting parents with overweight children for both empirical studies.

To ensure that parents were fully informed about the nature and procedure of the focus groups, programme managers provided information sheets to parents one week prior to the focus group. All participants were required to provide informed consent prior to taking part for both empirical studies, in line with University ethics. On the

day of the focus groups, programme staff arranged for the children to take part in sports while parents took part in the study.

### 3.7.2 Children's weight percentiles

The weight management programmes took measures of the height and weight of those children participating in the programme. The table below shows the UK90 reference (Cole, Freeman, & Preece, 1995) used by National Child measurement scheme for classifying children's weight for children aged four years and over.

**Table 2: UK90 childhood weight percentile ranges for children aged 0-23 years**

Weight Status Category	Percentile Range
<b>Underweight</b>	Less than the 5th percentile
<b>Healthy weight</b>	5th percentile to less than the 85th percentile
<b>Overweight</b>	85th to less than the 95th percentile
<b>Obese</b>	Equal to or greater than the 95th percentile

Using the information from the table, it was observed that for study one: participants recruited from the weight management programme had children ( $N = 15$ ) classified as obese (53%), overweight (33%) and healthy weight (7%). For study two: participants recruited from the weight management programme had children classified as obese (50%), overweight (27%) and healthy weight (33%). Table 3 shows children's demographics and weight classifications provided by programme



managers for those parents recruited from the family weight management programme. It also provides details of parental smartphone ownership which are presented later in study one (section 5.4) and study two (section 7.3).

**Table 3: Participants' children's weight percentiles**

Focus group no.	Total no. of Participants	Gender	Smartphone ownership	Children's demographics						
				Age range	Gender	Residential Borough	Height (M)	Weight (KG)	Percentile	Classification
2	3	female =3, male = 0	2/3 (1= iPhone , 1= Blackberry) (67%)	6	-	Nuneaton and Bedworth	1.40	37	91st	Overweight
				8	-		1.40	41	98th	Obese
				6	-		1.27	29	91st	Overweight
				9	-		1.45	51	99th	Obese
3	4	female = 3, male = 1	2/4 (1= iPhone, 1= Android) (50%)	-	male	Rugby	1.56	51	95th	Overweight
				-	female		1.28	39	99th	Obese
				-	male		1.23	31	99th	Obese
				-	female		1.39	44	99th	Obese
4	3	female = 2, male = 1	2/3 (1= Android, 1= Windows) (67%)	-	-	Rugby	1.41	33	58th	Healthy weight
				-	-		1.01	19	96th	Overweight
				-	-		1.40	44	95th	Overweight
5	4	female = 4	3/4 (1= iPhone, 2=, Android )(75%)	10	female	Nuneaton and Bedworth	1.40	43	95th	Overweight
				9	male		1.44	67	99th	Obese
				12	male		1.62	62	98th	Obese
				7	male		1.25	47	100th	Obese
7	8	female = 6, male = 2	4/8 (1 = Android, 1 = Windows, 1 = iPhone) (50%)	12	female	Nuneaton and Bedworth	1.29	24	9th	Healthy weight
										Obese
				10	male		1.31	41	98th	
				12	female		1.37	30	25th	Healthy weight
				9	male		1.48	48	98th	Obese
				9	female		1.40	40	91st	Overweight
				10	female		1.24	22	99th	Obese
				10	female		1.48	26	99th	Obese
8	7	female = 7	6/7 (3= Android x3, Blackberry, 2 = iPhone x2) (86 %)	-	male	Rugby	1.24	34	99th	Obese
							1.48	58	99th	Obese
				-	male		1.32	43	99th	Obese
				-	male		1.22	35	99th	Obese
				-	-		-	-	-	-
				-	-		-	-	-	-
				-	male		1.35	37	94th	Healthy weight
				-	male		1.08	17	19th	Healthy weight

### **3.8 Ethical Approval**

Ethical approval for all studies was sought and obtained (reference number: 174-01-2012 AM02 (32432) from the University of Warwick Biomedical and Scientific Research Ethics Sub-Committee (BSREC) in advance of the research being undertaken (Appendix 1D).

### **3.9 Summary**

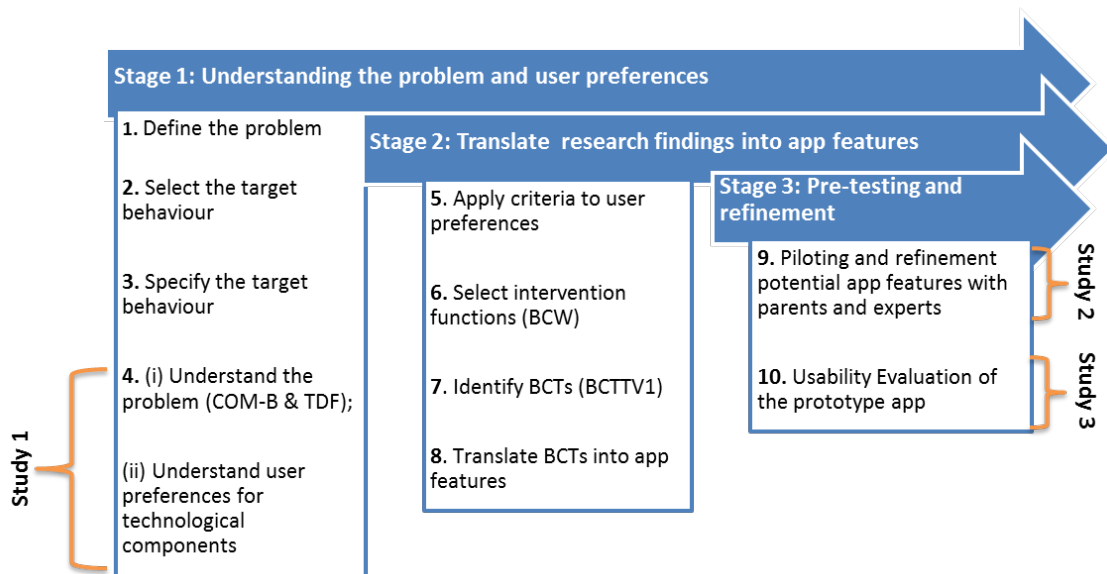
This chapter provided an overview of the methods followed to achieve the overall aim of this thesis. The overall intervention development process comprised of ten steps underpinned by the BCW framework and a UCD approach. Qualitative data was collected and used to inform the application of both approaches to developing the content of the app and producing a prototype app.

Data from Change4life advisors gave insights into the context of childhood obesity and helped to narrow down TDF domains to explore with parents where the majority of parents included in the sample had overweight children (the target population). However, in consideration of the app being used by the wider public and for the prevention of childhood overweight and obesity, parents with healthy children were also included in the research.

The following chapters will present the three stages followed in mHealth intervention development.

## Chapter 4 Selection of the target behaviour

Information in this and subsequent chapters (4 - 8), are divided into the following three broad stages (shown in Figure 10): Stage one ‘Understanding the target behaviour and user preferences’ (Steps one to four; Chapters 4 & 5); Stage two ‘Translating research findings into app features’ (Steps five to eight; Chapter 6); and Stage three ‘Pre-testing and refinement’ (Steps nine to 10; Chapters 7 & 8). The outcome of each step is also provided where applicable. Figure 11 below presents the sequence of steps followed in app development. For each step described hereinafter, this figure is used as a guide to show where the step is positioned in the intervention development process, along with the accompanying sub-steps that were followed.



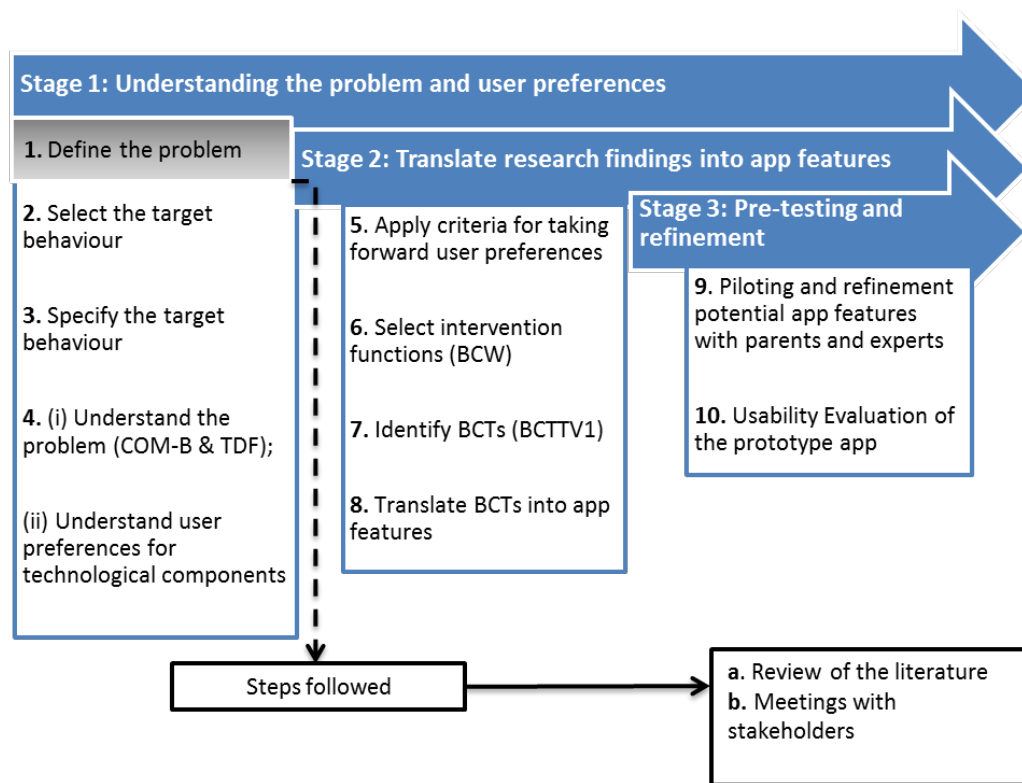
**Figure 11: mHealth app intervention development process**

## **Stage 1: Understanding the problem and user preferences**

The first stage in intervention development involved four steps starting from defining the public health issue in behavioural terms, through to formative research with Change4life advisors and parents. Therefore, data was collected on the theoretical, user-centred and technological components that should be considered in a healthy eating app targeting parental dietary behaviours with their children.

The steps for this stage comprised of: Step one - defining the public health problem; Step two - selecting the target behaviour; Step three - specifying the target behaviour; and Step four - understanding (i) the target behaviour and (ii) user preferences for technological components. It should be noted that steps two to four were carried out simultaneously and involved conducting focus groups which guided the data and sampling. The details in each step are presented in the following sections.

## 4.1 Step 1 Define the problem



**Figure 12: Step 1 - Define the problem**

The first step drawn from the BCW framework entailed defining the overall health problem in behavioural terms, taking the specific context into account. This entailed an extensive review of the literature to help make decisions as to which determinants of the energy balance equation to focus on (i.e. with regards to children's energy intake and/or energy expenditure).

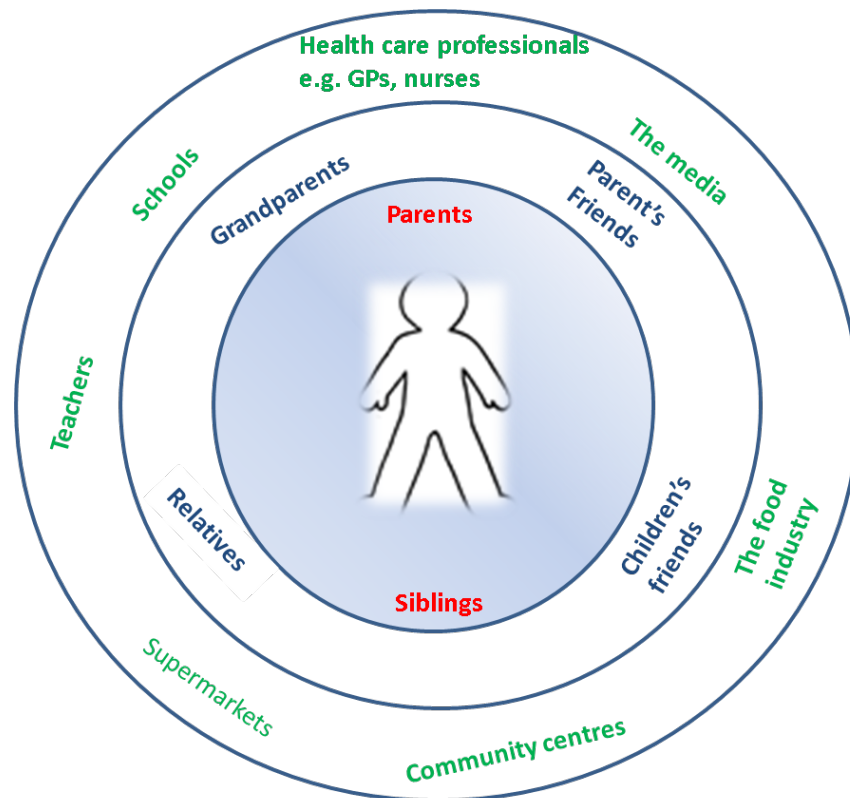
Overall, evidence provided greater support for focusing on improving children's diets in the intervention and reducing their overall energy intake (Section 2.1).

Simultaneously, following an intervention mapping approach, consultations with staff in the public health department led to the identification of a shortage of online

resources in the local area targeting parents to help them improve their family's diets.

With regards to exploring the use of apps for childhood weight management, additional reviews of: (i) evidence on the potential for mobile health applications to support parents' behaviour change (Section 2.3.3); (ii) content of existing paediatric weight management apps on the market (Section 2.3.2); along with (iii) information regarding the barriers to parents attending weight management programmes (Section 1.4), provided a strong rationale for delivering an intervention through this medium.

The next step involved taking into consideration all the individuals, groups, and populations that could potentially contribute to children's energy intake (Figure 13). It was necessary to conduct additional reviews of the evidence at this stage to determine which population should be targeted and at what level for the intervention. Therefore, both micro and macro environments were taken into account as shown in Figure 13 below.



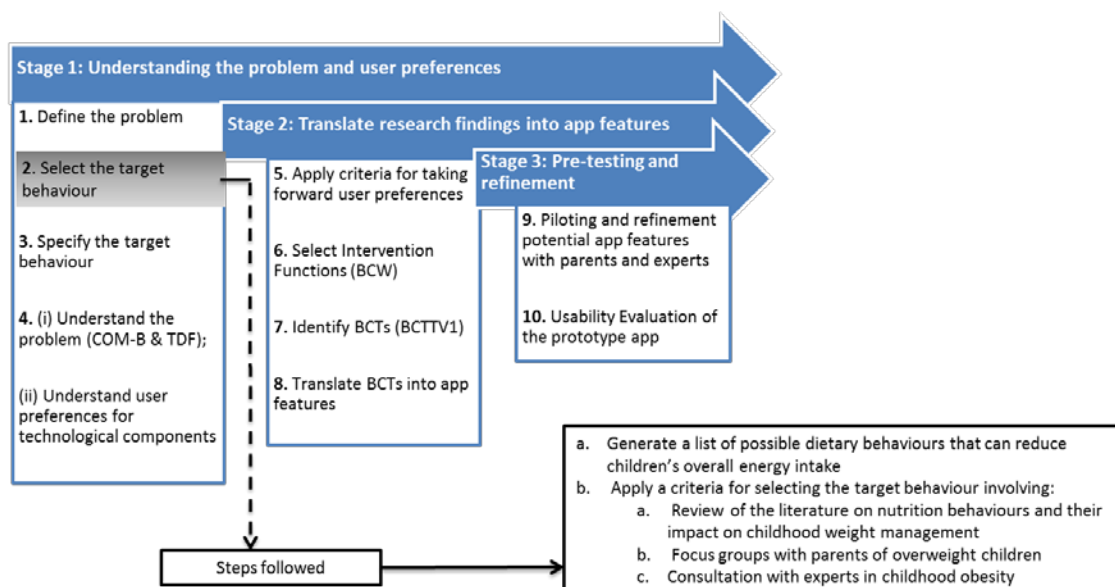
**Figure 13: Relevant individuals, groups and populations involved in children's energy intake**

#### **4.1.1 Outcome from Step 1**

The problem defined in behavioural terms was to improve the diets of families with overweight children in Warwickshire to help reduce children's overall energy intake. Furthermore, parents were identified as a practical and highly influential target group for the intervention and is also recommended by NICE obesity guidelines (NICE, 2010) and the wider literature (Section 2.2.2).



## 4.2 Step 2 Select the target behaviour



**Figure 14: Step 2 - Select the target behaviour**

Once the problem was defined in behavioural terms, the next step entailed selecting the target behaviour(s) to address this problem. Figure 14 presents an outline of the sub-steps followed to achieve this goal which is described in more detail hereafter.

### 4.2.1 Potential nutrition target behaviours

The first activity at this step required a consideration of all the specific behaviours to potentially target in the intervention (Table 4) before narrowing these down to just one or two. The BCW recommends a 'less is more' approach whereby it is more beneficial to start with small changes and build upon these incrementally (Michie, et al., 2014b:48). In addition, discussions with the family weight management services commissioner indicated that the app will be one element in a whole range of

activities offered as part of the local weight management services. Therefore, it was not necessary to incorporate all possible weight related behaviours into the current intervention at this stage.

**Table 4: Outline of potential nutrition behaviours**

Nutrition behaviours	
1	Increasing intake of fruit and vegetables
2	Reducing intake of saturated fat
3	Reducing intake of high energy density foods
4	Reducing intake of sugar
5	Reducing intake of sugary drinks
6	Reducing intake of unhealthy snacks
7	Reducing food portion sizes
8	Reducing intake of carbohydrates

The BCW framework also provides the following criteria to help with selecting the target behaviour: (1) The likely impact on reducing and/or managing children's weight; (2) How easy is the behaviour to change amongst parents? (e.g. parents' available resources, preference and acceptability of carrying out this behaviour; (3) Are there any positive or negative 'spillover' effects of carrying out this

behaviour?; (4) How easily can the target behaviour be measured in the app?; and (5) What are the competing behaviours? Although the BCW framework recommends selecting the target behaviour prior to conducting qualitative research with the target population, before each of these criteria could be fully considered, it was deemed necessary to conduct empirical research with the target population (refer to Section 5.2 for data and sampling methods), along with consultations with a paediatrician, dietician and two public health experts all working in the area of childhood weight management.

#### **4.2.2 Focus groups with parents with overweight children**

The first three focus groups with Change4life advisors and parents of overweight children (Section 5.1.2, Figure 18), were used to help identify which particular nutrition behaviour to target in the intervention so that remaining focus groups could focus on exploring the barriers and facilitators to parents carrying out this behaviour with their children. Focus groups helped to explore both: parental experiences of dietary behaviours they had found helpful in weight management for their children; and the acceptability of changing certain dietary behaviours. A full account of the methods employed to carry out the focus groups are provided later on in Step four (i), Section 5.2.

One particular dietary behaviour that was highlighted as having an impact on children's weight was their consumption of large portion sizes. This came from one mother who had been under the supervision of a NHS dietician and had received guidance on appropriate portion sizes.

### **Extract 1**

*P1: I learnt a lot about portion control in the last six months really, my (inaudible) son, they are quite big built, and I just thought portion control everyone is talking about it (as if she didn't think there was value in it) but it's not, I have noticed so much difference. My son has lost three stone now in the last six months*

*M: Just through portion control?*

*P1: Yeah. Portion control is really very important (Parent, FG3).*

This account was seen as important as although, studies have shown that large portions increase children's energy intake (see Fisher et al., 2003; Fisher & Kral, 2008), there is a lack of research that links this to children's BMI levels (Crocker, Sweetman, & Cooke, 2009). In addition, research suggests that portion sizes consumed in the home environment are increasing (Young & Nestle, 2002)(Nielsen & Popkin, 2015). In this regard, there is a need for long term studies confirming that targeting this nutrition behaviour and providing guidance on serving sizes is effective for weight management (Faulkner et al., 2012).

In addition, one Change4life advisor also reported that portion sizes were something that parents tended to ask for information on, along with what children's activity levels should be.

### **Extract 2**

*I think whilst each family is very different...parents generally understand they're meant to get 'five a day', whether they do it or not is obviously very individual but the 'five a day' message is out there..but it's very often*

*activity levels and portion sizes if they don't want me to actually visit the family* (Change4life advisor, FG1).

The extract above also provides insight to parental acceptability of certain nutrition behaviours. While parents are aware of the '5 a day' message, focus groups with parents indicated that this was not seen as an acceptable behaviour in changing.

### **Extract 3**

*People just haven't got the money to give five a day. I really think that is the problem at the minute. People haven't got..like..the money..* (Parents, FG2).

In line with the BCW framework, it is important to take into account the system of behaviours within which the target behaviours occurs and consider other behaviours that may compete with it (Michie et al., 2014b). Hence, within the current context of improving parents' dietary behaviours with their children, the research findings indicated that parents' purchase of low cost high energy density food is a strong competing behaviour compared to the purchase and preparation of healthier foods such as fruit and vegetables. The focus groups indicated that parents' dietary behaviours were related to their concerns regarding the cost of food and the time and effort required to seek out new healthier food items and to use them for meal preparation.

### **Extract 4**

*I think as a general rule, parents will presume it takes longer. I think there's still the view that it will be more expensive as well.* (Change4Life advisor, FG1).

Therefore, parental beliefs of the consequences of providing healthier food for the family are threefold: ingredients are more expensive, healthier meals take longer to prepare and they are less likely to be eaten by children.

#### **Extract 5**

*Yeah if they've gone to that time to prepare it and then it's not eaten so it then doubles the time if they then feel they would have to do something else*

(Change4Life advisor, FG1).

Similarly, Lorentzen, Dyeremose & Larsen (2012) reported in their phenomenological study of obese children and their parents that, while families have good knowledge of diet and exercise, difficulties arise in relation to the tight financial situation of families which is also supported in research with consumers (Vermeer et al., 2010, Shugoll Research, 2002, Faulkner et al., 2012). Therefore, it may be challenging to encourage parents to replace unhealthy foods with healthier foods when the food industry provides enormous variety, accessibility and marketing of cheap high energy density foods (including fast foods). Indeed, this has created a demand where consumers want larger quantities of foods for lower prices (Golan & Crow, 2004, Ledikwe et al., 2005, Andreyeva, Kelly & Harris, 2011). Therefore, with respect to the app, a decision was made to focus on parental behaviour with foods in the home environment as oppose to their food purchasing behaviours, where parents may be able exercise more control over the behaviour, i.e. the size of food portions that they provide for their children (the micro-environment).

### **4.2.3 Consultations with experts**

The decision to focus on the nutrition behaviour of helping parents to provide appropriate portion sizes for their children was also supported by experts working in the area of childhood weight management (Section 3.1.3.1). There was agreement among experts, that overweight children were consuming greater portion sizes and frequencies of mainly high energy density foods.

### **4.2.4 A review of the literature**

Overall, childhood weight management interventions have not been transparent enough in how they developed and implemented intervention content (Taylor et al., 2013). Consequently, current understanding of what causes childhood overweight and obesity is somewhat limited due to the lack of explicit information about the factors influencing behaviour change and how they were implemented in the intervention (Waters et al., 2011). However, there is growing evidence that large food portions are a strong determinant for increasing children's energy intake (Fisher, Rolls & Birch, 2003, Fisher & Kral 2008). For example, McConahy, Smiciklas-Wright, Mitchell & Picciano, (2004) conducted a multiple regression analysis adjusting for weight, on the dietary data (involving 24-hour recall of the primary food provider across two non-consecutive days) of a sample of 5,447 children aged between two and five years old. Results revealed that energy intake was positively related to the frequency of food intake, frequency of types of foods eaten (where they tested the 10 most commonly eaten foods by children) and portion sizes, equating to 38% to 39% of the variability. Interestingly, portion size as a

single predictor also accounted for the largest amount of variance in energy intake (16% to 19% variability).

There is evidence to suggest that, compared to one year old children, older children may not be able self-regulate their food intake as they are more susceptible to external food consumption cues irrespective of their energy requirements (McConahy et al., 2004). A study of 4,966 children in the US reported that children had a preference for larger portion sizes for items such as chips, crisps and meat. Factors associated with such preference were seen to be eating in front of the TV, eating more often in fast food restaurants, and those who had parents with unhealthy eating habits and less education (Colapinto et al., 2007).

#### **4.2.5 Practicality and measurement of the target behaviour**

The BCW framework recommends choosing a target behaviour that can be easily measured in the intervention to assess changes. According to Collins, Watson & Burrows (2010), measuring dietary intake remains a challenge wherein there is no consensus regarding which method of assessing dietary intake in children has the greatest validity (see Collins et al., 2010, for a list of measures with their advantages and disadvantages). Table 5 below summarises some of the measures that were considered for the current study, along with considerations regarding their validity for measuring children's dietary intake with regards to portion sizes.



**Table 5: Overview of potential methods to measure changes in food portion sizes**

Measurements	Source	Validity
Self-reports from children and parents of whether they have reduced their portion sizes	Literature	Subject to self-reported biases of food intake which may confound the results (Ainslie, Reilly, & Westerterp, 2003)
Pictures taken by parents and children of meals and snacks and rated by intervention developers and stakeholders trained in portion sizes	Consultation with app company and a review of the literature	High practicability (smartphones have in- built cameras). Quantification tools such as photos is an under-researched area that offers promise in improving validity of portion size estimation (Collins et al., 2010)
Food is weighed each day	Literature	High participant burden; Low practicability; time and resource intensive (Collins et al., 2010)

Considerations on how practical the target behaviour is to change using an app and how it can be measured also involved consultation with the app company. In light of the aforesaid limitations of existing measures summarised in Table 5, the camera functionality of a smartphone was seen to be the most practical method to measure changes in children's portion sizes and provides the opportunity for further research in evaluating the app discussed in Section 10.1.5. The camera is a method that can reduce the time between eating and recording food intake and therefore provides 'just-in-time food journaling' (Helander, Kaipainen, Korhonen & Wanskink, 2014:4). Indeed, research has found that the percentage of food entries recorded

within 15 minutes of consumption has been associated with weight loss where the ‘immediacy of the camera forced reflection at the point of consumption’ (Zepeda & Deal, 2008:696). Similarly, Brown et al. (2006) developed a dietary and exercise monitoring system for undergraduate students where the camera functionality on the mobile phone allowed users to upload pictures of food and beverages to a desktop computer. Formative evaluations including a think-aloud study indicated that participants found the camera phone food journal useful and photographs helped participants reflect on their dietary and exercise behaviours.

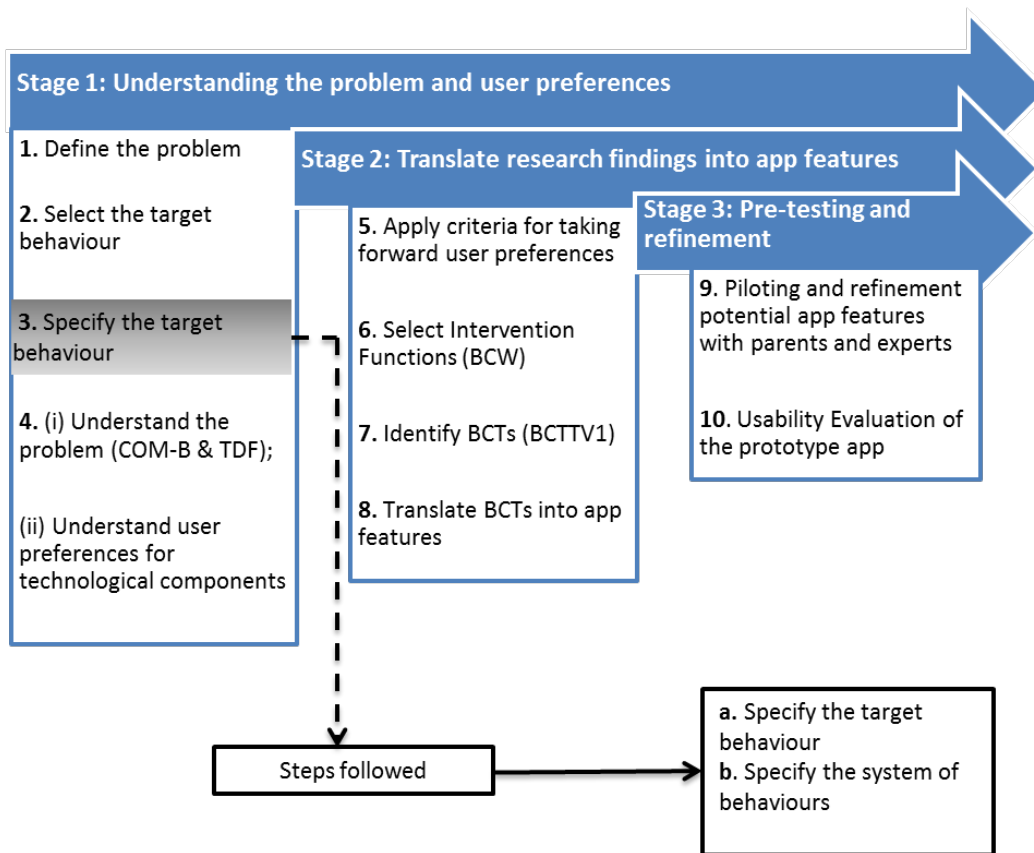
#### **4.2.6 Outcome of step two**

For the current study, helping parents to provide appropriate portion sizes for their children was selected as the target behaviour. According to the BCW framework, once the target behaviour has been selected, the next step involves specifying the behaviour and the context in which it occurs. Table 6 below summarises the criteria used to select this target behaviour for the current study.

Criteria	Method used to fulfil criteria	Outcome
<b>1. The likely impact on childhood weight management</b>	<ul style="list-style-type: none"> <li>a. A review of the literature</li> <li>b. Focus groups with parents</li> <li>c. Consultation with experts</li> </ul>	<p>Heterogeneity of childhood obesity interventions made it difficult to draw any firm conclusions (see section 1.4).</p> <p>Consultation with experts and focus groups with parents with overweight children identified children were eating greater portions than needed of mainly high energy density foods.</p>
<b>2. How easy is it to change the target behaviour among parents?</b>	<ul style="list-style-type: none"> <li>a. Focus groups with parents of overweight children</li> </ul>	<p>Focus groups with parents indicated that reducing portion sizes may be a more acceptable and easier to change compared to for example, increasing the purchase of healthier foods such as fruit and vegetables which may incur more costs and time for parents.</p>
<b>3. Are there any positive and negative spill over effects of the behaviour?</b>	<ul style="list-style-type: none"> <li>a. Focus groups with parents with overweight children</li> </ul>	<p>Reducing portion sizes may result in saving money and reducing waste, and could lead to greater consumption of low energy density foods such as fruit and vegetables to feel full.</p>
<b>4. How can the target behaviour be measured in the app?</b>	<ul style="list-style-type: none"> <li>a. Review of the literature</li> <li>b. Consultation with app developers</li> </ul>	<p>Self-report measures of portion size reduction, food weighing, and pictures of portion sizes (see section 4.2.5, Table 5).</p>
<b>5. What are the competing behaviours?</b>	<ul style="list-style-type: none"> <li>a. Focus groups with parents of overweight children</li> </ul>	<p>Parents' purchase of quantities of low cost high energy density foods.</p>

**Table 6: Overview of criteria used to select the target behaviour**

### 4.3 Step 3 Specify the target behaviour



**Figure 15: Step 3 - Specify the target behaviour**

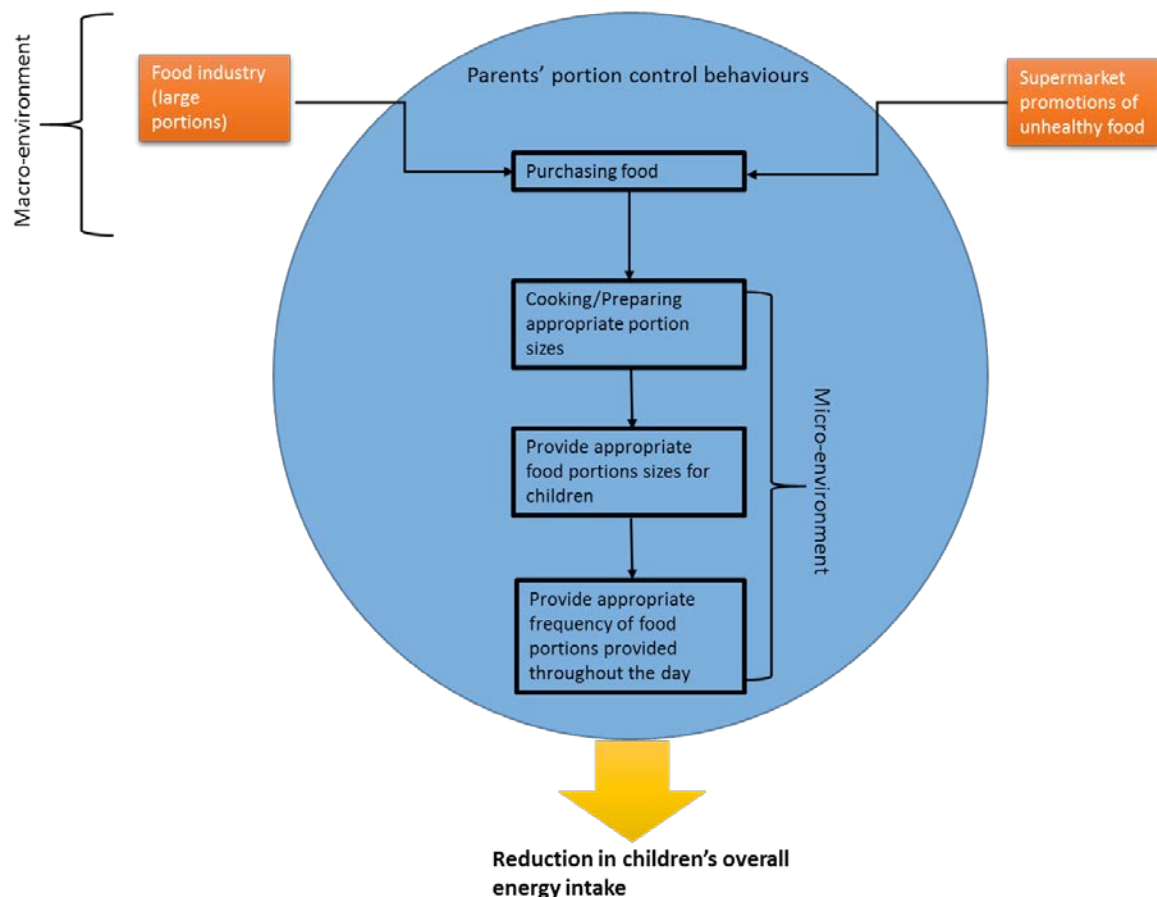
As a result of decisions made in step two, the target behaviour was specified within the context of the home environment, as summarised in Table 7.

**Table 7: How to specify the target behaviour – Source: Worksheet 3, The BCW A guide to designing interventions**

Details	
Target behaviour	Parental provision of appropriate portion sizes (including frequency of food) for their children across the five food groups: fruit and vegetables, protein, dairy, starchy foods, food and drinks high in sugar and fat (according to the eatwell plate)
Who needs to perform the behaviour?	Parents
What do they need to do differently to achieve the desired change?	Preparation, provision (age appropriate portion sizes) and monitoring of food portions
When do they need to do it?	At meal times & snack times
Where do they need to do it?	At home
How often do they need to do it?	Every day
With whom do they need to do it?	With their children
In what context do they need to do it?	The home environment

Figure 16 shows the behaviours that parents must carry out within the home environment in order for the overall target behaviour to occur. To support parents' provision of appropriate portion sizes for their children throughout the day, it is also necessary to take into account the frequency of food portions, as documented by other researchers in the field (McConahy et al., 2004). In returning to the energy balance equation, the aim of the intervention is to reduce overall energy intake and therefore, simply reducing portion sizes may not result in the desired outcome if we do not also reduce frequency of portions. Therefore, the target

behaviour is to reduce overall portion of food provided throughout the day which includes the size of food portions consumed at one time point as well as the frequency of food portions.

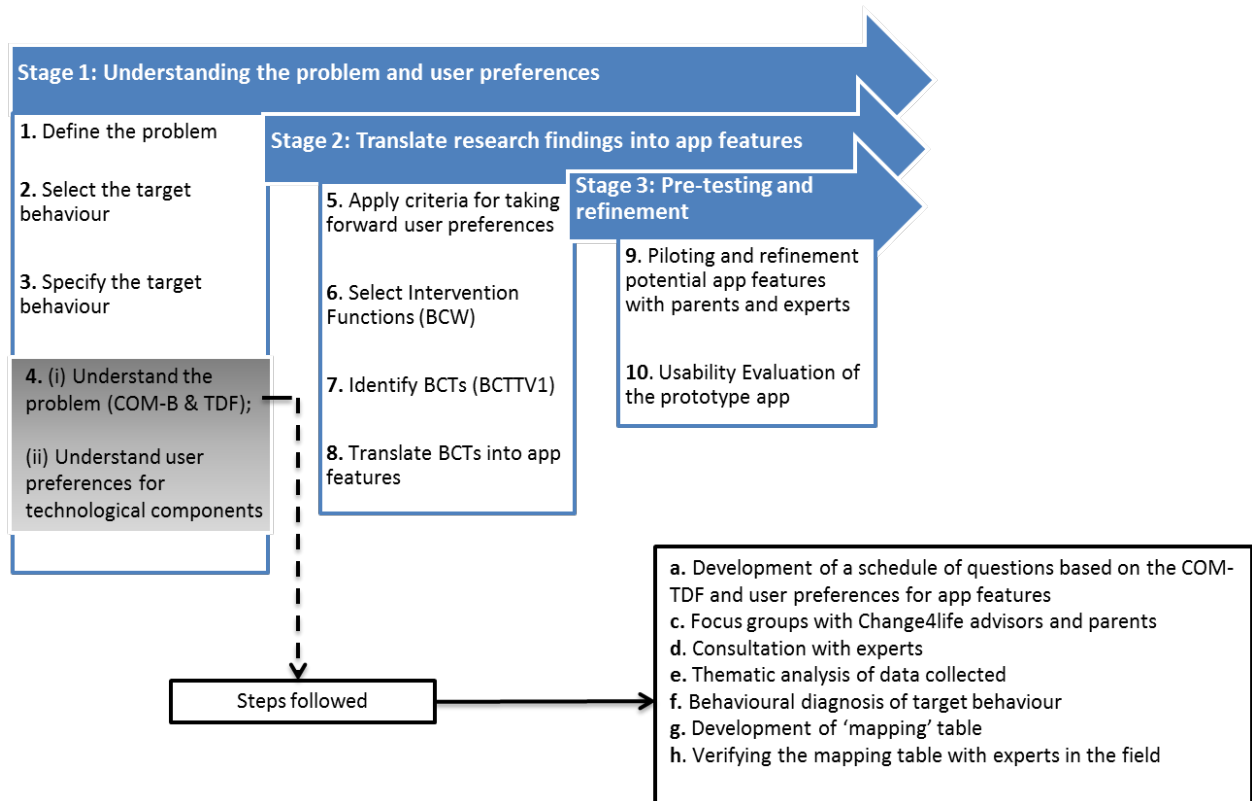


**Figure 16: Specifying parental portion control behaviours within the home environment**

Figure 16 also shows factors belonging to the macro-environment that may influence parents' purchase of large portion sizes (food industry) of food items as well as large quantities of cheap foods (supermarkets). However, the previous step indicated that purchase of these types of foods is a strong competing behaviour compared to not purchasing these foods. Therefore, at this stage in the intervention, the focus is on changing the system of behaviours that occur within the home environment, however targeting parental purchasing behaviours provides opportunity for further research (Section 10.1.1). This chapter carried out the first

three steps of the intervention development process following the BCW framework. First, a review of the evidence along with consultations with stakeholders and focus groups indicated a need to improve diets of children and families; next, the target behaviour was selected, i.e., help parents to manage portion sizes, which was also examined with respect to competing behaviours; and finally the target behaviour was specified in a way that it could be implemented within an intervention. The next chapter will examine the barriers and facilitators that parents might face when endeavouring to carry out the target behaviour, along with their preferences for healthy eating app features.

## Chapter 5 Understanding the barriers and facilitators to parents' provision of appropriate portions for their children



**Figure 17: Step 4 (i) – Understand the problem**

### 5.1.1 Introduction

There is a need for a broader understanding of the range of factors influencing parents' food portion behaviours within the context of childhood weight management. In this regard, a qualitative research design, with its roots in a 'naturalistic paradigm', is necessary for identifying relevant theoretical domains that potentially influence the target behaviour. In addition, qualitative research enabled insights into a nascent field involving parental preferences for healthy eating app features (Sousa, Driessnack, & Mendes, 2007:503). Therefore, an additional aim of the study reported in this chapter was also to inform the user-centred development of a healthy eating app.



The study also takes account of a number of limitations in previous qualitative research. In a systematic review of 21 qualitative studies, Pocock et al. (2010) synthesised available evidence regarding parental perceptions of healthy behaviours for childhood weight management in children under 12 years old. Results revealed that the majority of the studies were: based in the United States, Australia and Canada (only one was UK based); included parents of children less than five years old (62%) and; included parents who may or may not have had overweight children. In addition, most of the studies did not use theoretical frameworks or conceptual models to guide research and analysis and themes emerged from studies exploring a range of weight related behaviours including exercise (Pocock et al., 2010), making it difficult to understand which sources of influences on behaviours led to certain outcomes (Small et al., 2012). Therefore, this thesis aims to conduct research with a UK population of parents with overweight children above the age of five; guided by two theoretical tools: the COM-B model (Section 2.4.7) and TDF (Section 2.6.1) and; focusing on one main nutrition behaviour.

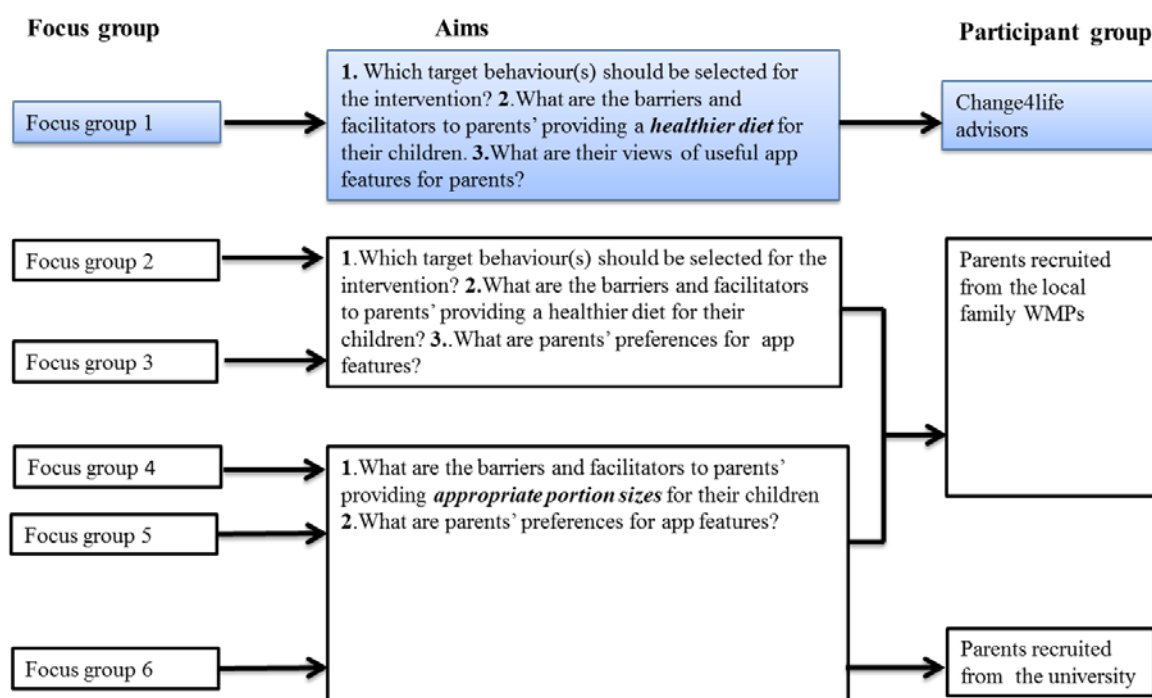
### **5.1.2 Overview of study one**

Study one was conducted as part of step four in the intervention development process and adopted a multidisciplinary approach wherein the COM-B and TDF tools, and a UCD approach, were used simultaneously to explore the research aims (Section 2.9).

UCD is necessary for gathering feedback from participants throughout the development process to ensure that the final app is easy to use, in line with users' needs and perceived as trustworthy among the target population (Buller et al., 2013). However, a theoretical approach is also needed to assess the theoretical elements that should be targeted in an intervention in order to support behaviour change. Hence, for step four (i) the COM-B and TDF theoretical tools were used to gain an in-depth understanding of the target behaviour which is a vital step before design of the intervention can occur (Michie et al., 2014b). For

step four (ii), a UCD approach was applied and focused on collecting data on parental preferences for healthy eating app features to support childhood weight management.

Study one primarily aimed to address the barriers and facilitators around parental dietary behaviours, with a focus on portion control; and parental preferences for healthy eating app features. However, as specified above, the data collected during this study also helped to make decisions regarding which nutrition behaviour to target in the intervention and thus simultaneously facilitated step two in the intervention development process (Section 4.2.2). Therefore, two of the focus groups helped to identify which nutrition behaviour to explore with parents in the remaining three focus groups. Figure 18 presents the aims for each individual focus group as well as information on which participant group was involved.

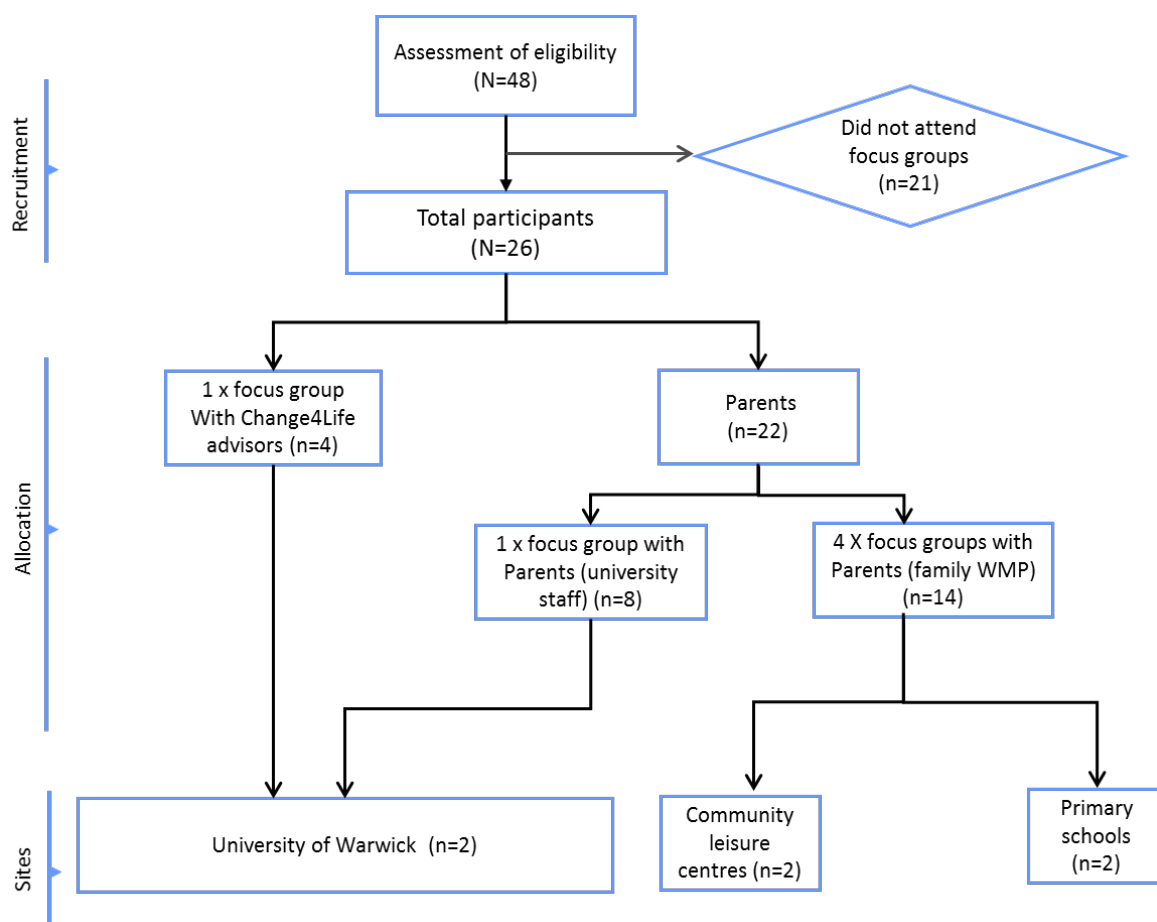


**Figure 18: Qualitative research aims for each focus group**

## 5.2 Methods

### 5.2.1 Focus group recruitment

Figure 19 shows the recruitment and allocation of participants for study one, and the sites for which the focus groups took place. The recruitment method for each participant group is explained in more detail below.



**Figure 19: Recruitment flow chart for study one**

#### **5.2.1.1 Change4Life advisors**

Stakeholder meetings (Section 3.1.1) indicated that Change4life advisors were a useful starting point to assess the barriers and facilitators to parental provision of a healthier diet for their children, due to their close working relationship with families with overweight children. The contact details were provided by public health staff for six local Change4Life advisors currently operating in the local area. An email was then sent out to all the advisors inviting them to attend a focus group on the barriers that parents face when providing a healthier diet for their children. Change4Life advisors were eligible to participate if they had been working with families with overweight children. Six Change4Life advisors responded to the email (i.e. 100% response rate), five of whom agreed to take part, and one declined as she had not yet started in her role.

A mock focus group and final focus group were conducted at the International Digital Laboratory, Warwick Manufacturing Group, The University of Warwick. The mock focus group was conducted with two Change4life advisors and two nurses to check that the questions were coherent and covered all the relevant areas that may be important to gather data on. One advisor who attended the pilot study was unable to attend the final focus group. Four Change4Life advisors took part in the final focus group.

The Change4Life advisors were all Caucasian females. The advisors had no prior experience of working in the area of family health. One advisor had completed an adult learning course in Psychology at The University of Warwick. Three of the advisors had been in their roles from the beginning of the programme while one advisor was quite new to the role.

#### **5.2.1.2 Parents recruited from the family WMPs**

Initially, leaflets were created inviting parents to take part in a focus group on children's healthy eating. These were then emailed to all of the local Change4Life advisors for

distributing to families. In addition, leaflets were emailed to WCC's Obesity Projects Co-ordinating team members to distribute to relevant community centres in Warwickshire.

However, this recruitment method was found to be unsuccessful, resulting in no responses from parents with overweight children. This recruitment method was therefore abandoned after two months. A new recruitment method was employed following consultation with one local Change4Life advisor who suggested conducting focus groups with parents who had already been recruited to two local weight management programmes.

Family weight management programme managers were contacted via emails wherein dates for four focus groups were arranged. Participant information sheets were administered to parents one week prior to focus groups taking place in either schools ( $n = 2$ ) or leisure centres ( $n = 2$ ) in the boroughs of Nuneaton and Bedworth and Rugby. Thirty-four participants were asked to take part in the focus groups. However, only fourteen participants attended the focus groups (comprising of twelve females and two males). Parents failed to attend the focus groups either because they were absent on the day of the family weight management programme ( $n = 19$ ) or because they opted out of the focus group ( $n = 1$ ). All focus groups took place between 5pm and 6pm at the time that the children were taking part in the physical activity session so that children were not present in the focus group with their parents.

Parents were eligible to take part in the study if they had at least one child who was classed as overweight or obese. For the sample of parents that took part in the focus groups, the weight percentiles for their children and other demographics were provided by the programme managers (Section 3.7.2).

### **5.2.1.3 Parents recruited from the university**

Emails were sent to all staff at Warwick Manufacturing Group (WMG) inviting them to participate in a focus group on a discussion of the barriers that parents face to providing their

children with a healthier diet. The criteria for inclusion in the focus groups were that participants were parents with at least one child aged above five years of age.

Eight staff members responded and were then sent participant information sheets. All eight took part in the focus group conducted during a lunch break at the International Digital Laboratory, Warwick Manufacturing Group, The University of Warwick. The parents were academics ( $n = 3$ ) and office administrators for WMG ( $n = 5$ ) and included female ( $n = 6$ ) and male ( $n = 2$ ) participants. They ranged from 35 to 55 years of age.

Two parents reported that they had children who were overweight and very overweight. The remaining six parents reported that their children were a healthy weight. Children's demographic information for parents included in the sample were provided by some participants (Section 3.7.2).

### **5.2.2 Ethical Considerations**

The context of childhood overweight and obesity is complex and requires a high degree of sensitivity when interacting and conducting focus groups with them. Participants were all administered participant information sheets and consent forms prior to taking part in the focus group and could opt out of taking part. They were free to withdraw from the focus group at any time if they wished to do so. In addition, parents were asked questions in the third person (e.g. what are your thoughts on parents' difficulty with measuring portions) to help to reduce parents' feelings of embarrassment and to reassure parents that these are also general problems that all parents may face. After each focus group had finished, participants were provided with de-briefing sheets which contained the principle investigator's contact details, including details of internet resources for healthy eating.

All consent forms were stored safely in a locked draw of a desk situated in the Institute of Digital Healthcare. The recordings were also transferred from the audio recorders to a folder in a password locked PC also situated in the Institute of Digital healthcare.

### **5.2.3 Design of study**

This was a qualitative research design where focus groups were conducted using open semi-structured questions. A total of six focus groups (ranging from between three and eight participants in each) were carried out until themes based on parents' responses achieved saturation. Ongoing analysis was conducted across focus groups and it became clear that no new codes were emerging from the data and therefore, recruitment for new participants ceased (Tong et al., 2007).

#### **5.2.3.1 Materials**

The materials for focus groups comprised of a MP3 audio recorder, participant information sheets (Appendix 1A), consent forms (Appendix 1B), focus group schedule of questions, and de-briefing sheets (Appendix 1C).

### **5.2.4 Focus group procedures**

All focus groups were facilitated by one researcher (the thesis author). Consent forms were administered and signed before the focus groups began. Krueger and Casey's (2000) principles for conducting a focus group were followed and the conversation was guided by a schedule of semi-structured open questions (Appendices 1E & 1F).

For each focus group, the researcher gave instructions on the ground rules (e.g. if someone is speaking too much they may be asked to let other participants speak, or asking someone to speak if they have not yet spoken, importance of confidentiality) before proceeding to a schedule of open-ended questions (see outline in Section 5.2.5, Table 8). Prompts helped to change direction or move the discussion forward.

For all focus groups, the researcher encouraged all participants to give input and asked them to expand on certain points to gain a deeper understanding. The focus group with Change4Life advisors lasted 120 minutes, while focus groups with parents lasted for 60 minutes. Upon receiving signed consent from participants, all focus groups were audio recorded and a note was made of each participant's make of phone where applicable. Subsequently, participants were thanked for their time and asked to get in touch if they had any questions. All participants were given de-briefing sheets.

### **5.2.5 Focus group questions**

#### **5.2.5.1 Change4Life advisors schedule of questions**

The schedule of questions used for the Change4Life advisors were designed following a review of parental factors influencing children's weight gain (Section 2.2.2). Questions were all pretested for clarity and comprehension in the mock focus group (Section 5.2.1.1) which led to refinement of questions prior to implementation. The sixteen topic areas shown in Table 8, were designed to elicit an in depth discussion of the barriers and facilitators to parental provision of a healthier diet for their children. In addition, due to the complexity of the problem, a wider approach was taken to provide context to parents' dietary behaviours with their children, helping to narrow down topic areas to focus on with parents as well as allowing a preliminary theoretical account of the problem (Section 3.6.1.2).

The questions (Appendix 1E) were also used for scoping the rationale for the use of an app targeting parents. For example, the topic of family weight management programmes was included to gain an understanding of current barriers to parental attendance. Questions also helped to determine whether it was mothers (as indicated in the literature and cultural norms) or fathers who were most involved in child feeding behaviours from the families that advisors worked with. Topics of parental recognition of children's weight status; parental knowledge



of healthful and unhealthful food and beverages and portion sizes; parental intentions to make changes; parental emotional barriers; and parental psychosocial stressors were included. In addition, a question was also included on what parents ask Change4life advisors most for help with which helped with selection of the target behaviour (Section 4.2.2). The remaining topics focused on mobile health apps and useful features to include in an app and how best to conduct research in this area with parents.

#### **5.2.5.2 Parents schedule of questions**

The following nine TDF domains were explored with parents: Knowledge, Behavioural Regulation, Beliefs about Capabilities, Beliefs about Consequences, Skills, Reinforcement, Emotion, Environmental context and resources and Social influences (see schedule of questions in Appendix 1F). Table 8 presents the schedule of topics for focus groups with Change4life advisors and parents.

**Table 8: Schedule of topics for study one\***

	Topic
1	Parents' recognition of children's overweight status
2	Mothers' and fathers' role in child feeding
3	Parents' weight status
4	Parents' intentions to make changes/readiness to make changes
5	Parental barriers to attending family WMPs
6	Issues that parents ask for help with
7	Parents' knowledge of healthful foods and age appropriate portion sizes
8	Parents' monitoring of children's eating habits
9	Parents' interpersonal skills around healthy eating and weight issues
10	Parents' beliefs about the consequences of childhood overweight
11	Parents' beliefs about their capabilities in changing children's dietary habits
12	Reinforcement with regards to unhealthy food consumption
13	Parents' emotional barriers
14	Other people in parents' environment that may hinder their ability to provide healthier portions
15	Parents' use and preferences for existing health apps
16	Parents' preferences for app features

\*Topics 1-16 were explored with Change4life advisors whereas only topics 6-16 were explored with parents

After consultation with experts on which nutrition behaviour to focus on in the intervention (Section 4.2.3), the schedule of the topics for the remaining three focus groups were adapted towards the target behaviour – parental food portion behaviours with their children.

The remaining topics for all focus groups referred to the digital environment: parents use of websites and health apps in relation to healthy eating. These topics also aimed to gather information on parental preferences for healthy eating app features.

### **5.3 Analysis of focus groups**

The data was analysed using Braun and Clarke's (2006) principles for conducting a thematic analysis in psychology (Figure 10, Section 3.5). The first stage in the analysis involved transcribing the data verbatim (the first four focus groups were transcribed by the thesis author and the remaining two were transcribed by a professional transcriber) to allow for analysis and to gain familiarity with the data. Thoughts emerging during the transcription process were recorded in a Microsoft word document. The transcripts were then uploaded to NVivo 10 for coding. The second stage comprised of generating initial codes from the data with the aim of describing the basic meaning of the segment of data. Subsequently the barriers and facilitators to parents providing a healthier diet for their children (including a range of nutrition targets) were systematically coded across the entire dataset.

The third stage involved deductive coding where codes were applied to the TDF and Com-B theoretical domains (Appendix 1G) and inductively where codes emerged from the data in relation to user preferences. According to Francis et al., (2012), the TDF can be used as a framework for coding the data. In other words, codes can be arranged under the relevant theoretical domain.

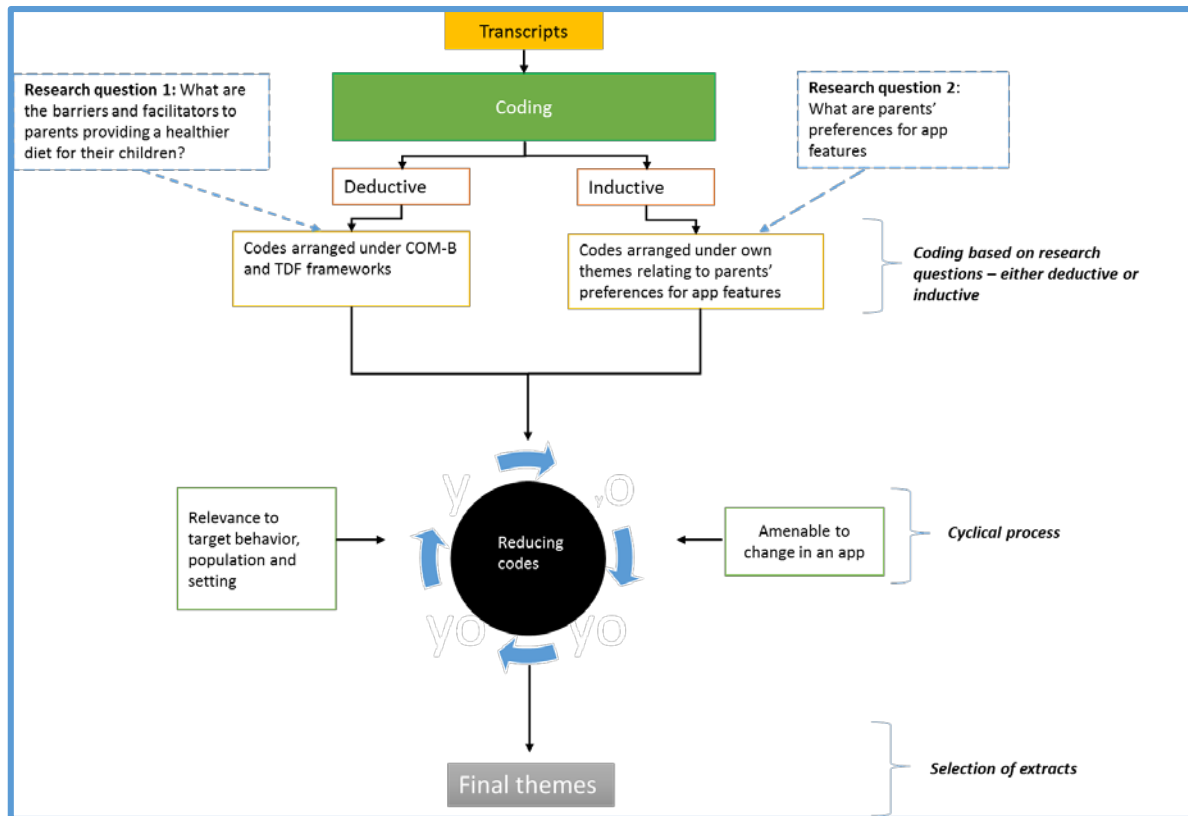
The fourth stage involved reviewing and refining the themes. This stage allowed for the collapsing of TDF domains and sub-themes into each other and breaking down any themes that required separation. This stage also required re-reading all of the coded extracts for each theme to ensure that they accurately represented and built a coherent picture of each theme. Thus, some codes were discarded at this point if they did not fit with any of the themes or warranted creation of a new theme. The fifth stage involved the final refinement of themes and names of themes. Themes that were too complex or overlapped with other themes, were broken down further and collapsed into new or existing themes.

### **5.3.1 Process of Analysis**

Figure 20 shows how the data was approached using both deductive and inductive coding. As previously mentioned in Section 5.2.5.1, focus group questions with Change4life advisors also aimed to provide an understanding of the context of local weight management services. Therefore, initial coding of data also included barriers relating to parents' attendance to the weight management programmes and advice from other health care professionals (see appendix 1H). However, after consultation with a health psychologist's (LA) in relation to how to manage the large dataset for intervention development, the data was reduced after applying the following recommended criteria:

1. Relevance to the target behaviour, population and setting (parental provision of appropriate portion sizes within the home environment)
2. Whether the component was amenable to change in a smartphone app

Following this, verification of the thematic coding and data extracts was obtained from consultations with two health psychologists to ensure there was agreement with the process (Section 3.1.3.2). In addition, a third health psychologist trained in qualitative research, independently coded ten percent of the data in order to establish inter-rater reliability (Section 3.6.1). Lastly, a decision criteria (Section 6.1) was applied to the user preferences that resulted in further decisions regarding which components to take forward for app development (Section 6.2).



**Figure 20: Process of analysis**

## 5.4 Results

An analysis of smartphone ownership among participants revealed that 72% of the sample reported owning a Smartphone (39% Android, 28% iPhone, 17% Blackberry and 11% Windows). Additionally, participants recruited from the weight management programme had children ( $N = 15$ ) classified as very overweight (53%), overweight (33%) and healthy weight (7%). Four children from the healthy weight group had missing information with regards to BMI (Table 2, section 3.7.2).

This section provides the final stage of thematic analysis (Step six: Braun & Clarke, 2006), where a report is produced of the results containing relevant quotations and a discussion of the findings in relation to the extant literature. The results of the thematic analysis directly informed the theoretical and user-centred components guiding app development. This section

presents the theoretical findings in relation to the TDF and COM-B tools followed by a thematic report of the findings on parental preferences for app features (Section 5.6).

## **5.5 Thematic report & Behavioural diagnosis**

### **5.5.1.1 Overview**

Application of the BCW framework requires identification of components of the COM-B behavioural system that need to change in order to achieve the target behaviour (Michie et al., 2011a). The findings provide an understanding of how the COM components vary according to the behaviour (regulation of portion sizes), population (parents) and context (childhood weight management) (Michie et al., 2014a). All of the COM-B components were identified as important for supporting parents in achieving the target behaviour apart from parents' physical capability. These components were delineated into twelve of the TDF domains as follows: *Psychological Capability*: Knowledge, Memory, attention, and decision making processes, Skills, Behavioural regulation; *Automatic Motivation*: Emotion; Reinforcement; *Reflective Motivation*: Beliefs about capabilities; Intentions, Beliefs about consequences; Social identity; *Physical opportunity*: Environmental context & resources and *Social Opportunity*: Social influences.

### **5.5.2 Capability**

Capability may refer to parents' physical (e.g. physical skill, strength or stamina) or psychological (e.g. knowledge, strength or stamina to engage in mental processes) skills (Michie et al., 2014b). Discussions associated with this component focused on the psychological aspect and largely on parental knowledge of appropriate portion sizes; their perceptions of the healthiness of foods; their ability to judge and measure appropriate portion sizes and; their monitoring of their children's food consumption. Therefore, parents'

capability was further delineated into the TDF domains of: *Knowledge, Memory, Attention, and Decision making processes, Skills and Behavioural Regulation.*

#### **5.5.2.1 Knowledge**

The TDF defines knowledge as ‘an awareness of the existence of something’ and includes constructs such as knowledge, procedural knowledge and task knowledge (Cane, O’Connor, & Michie, 2012:13). Focus group discussions within this theme comprised parental knowledge of appropriate portion sizes, nutritional value of food groups, and strategies for portion control.

There was consensus among parents regarding their lack of knowledge of appropriate adult and child portion sizes.

#### **Extract 1**

*Until I came here, I didn't really know much about portion sizes at all, but they've given us some leaflets on children's portion sizes and more recently tonight adults' portion sizes (Parent, FG4).*

Responses also highlighted that parents did not typically pay much attention to the management of portion sizes and were not unaware of any guidance.

#### **Extract 2**

*I don't think there is any guidance for portion sizes, I mean until you mentioned it and I felt oh actually yeah I think that's an issue with our house. I don't think we'd ever really thought about it (Parent, FG5).*

Parents agreed that instead of using scales to help with weighing ingredients for cooking, they tended to guess the amount of ingredients to use.

### **Extract 3**

*P3: Because if they put everything in weight. I don't have scales so I just..*

*P2: You guess weight. (Parents, FG4).*

In some instances, parents described certain knowledge gleaned from grandparents and adult weight management programmes, regarding the use of household objects to measure portions.

### **Extract 4**

*P4: The way my grandmother taught me is a spoon of flour is an ounce, you know, and that's the way I still weigh things out.*

*P1: It's like rice ... when we used to go to Weight Busters which we do, she measured like a cup with rice and for one portion (Parents, FG5).*

There was consensus among Change4life advisors regarding parents' lack of knowledge around the relative portions of different food groups required for a healthy diet, as illustrated in visual recommendations in the 'eatwell plate' (Public Health England, 2013).

### **Extract 5**

*You often don't get the families that understand the balance do they of foods..you know you get the 'eatwell' plate with tiny portions of fats (Change4Life advisor, FG1).*

Change4life advisors cited that often parents are not aware to what extent certain foods and beverages are 'unhealthy'. For example, there was indication from both parents and advisors that parents are often unaware of the amount of sugar and/or fat in some foods and beverages, therefore, requiring smaller portions of these.



### Extract 6

*I just don't think they understand how much one chocolate bar actually is or how much fat is actually in a portion of chips, it's very hard to try and get that across I think. (Change4Life advisor, FG1).*

*I won't buy that again. I am surprised, Ribena had as much sugar in it as Coke and I had never known that. (Parent, FG4).*

Change4Life advisors also reported that some of their families were eating healthy food but in greater amounts than needed. This further highlights parents' confusion around appropriate portion sizes relating to certain types of foods. For example, fruit contains more sugar when it is dried and therefore portions need to be limited.

### Extract 7

*...they do have the understanding and it's just got a bit confused...they do eat more than five a day but they're eating a bit too much of it....one little girl, a five year old was having, I think she was having two Weetabix, a yogurt and dried fruit for breakfast before she went to school and then she had some dried fruit and the fruit she had at break time and then she was having her school dinner and then she was coming home and she was having like a bag of dried apricots and some raisins. (Change4Life advisor, FG1).*

Responses suggest that parents may have difficulty in gauging the nutritional content of certain foods, where foods perceived as 'healthy' may not be subject to portion control, as shown in previous research with consumers (Spence et al., 2013). This overlaps with the theoretical domain of *Memory, attention, and decision making processes* defined as 'the ability to retain information, focus selectively on aspects of the environment and choose between two or more alternatives' and includes constructs such as memory, attention, decision making and cognitive overload/tiredness (Cane et al., 2012:14). It became evident from focus groups discussions that parents require a basic knowledge of the nutritional

content of all food groups to support their portion control behaviours.

These findings support previous research highlighting that parents require specific information on the type and amount of food they should provide their children (Sealy et al., 2012), where research has found that most parents report difficulty making decisions on healthful options of food for their children (Thomas et al., 2012). Furthermore, there is evidence to suggest that parents who lack nutritional knowledge, are more likely to have overweight children (Variyam, 2001). The current research appears to support Variyam's (2001) proposal that this is partly because parents require nutritional knowledge for monitoring children's eating habits and identifying high energy density foods they need to limit portions in.

In addition to describing barriers to managing appropriate portions of food, several parents had acquired knowledge of certain strategies that can enable portion control. Parents' responses identified five strategies they could use during their provision of a meal for their children. For example, one mother reported that substitution of certain high energy density foods with lower energy density foods, allowed her child to feel full.

### **Extract 8**

*I put some fruit in. he hasn't noticed that... because I used to just put half a banana... we used to share a banana but now I put him a whole one, well three-quarters of it [inaudible 0:04:01.9] so I know he's going to... he's full but he's having less and probably more fruit. (Parent, FG4).*

Other facilitators identified to help with children's portion regulation included: using a smaller plate to serve food on; ensuring children eat more slowly; provision of lower energy density food (e.g. salad) before children's main meal; encouraging children to drink water

before a meal and; ensuring children wait for their food to settle before allowing them to have a second helping.

#### **Extract 9**

*I think one thing that we have got rise to, quite often if they, they'll eat their food and say 'right I'm still hungry' and what we'll say is 'come back in 15 or 20 minutes if you're still hungry and by that time, generally, the food's settled in their stomach and they're fine (Parent, FG4).*

It should be noted that the majority of these strategies were acquired during parents' participation in the weight management programme and/or from those parents who were engaged in weight management practices themselves. Nevertheless, they provide useful insights into portion control strategies that can be recommended to parents via the app.

#### **5.5.2.2 Skills**

The TDF defines skills as 'an ability or proficiency acquired through practice' and covers constructs such as the development of skills, competence, practice and interpersonal skills (Cane et al., 2012:13). Within this theme, *skills* were identified in relation to parental ability, competence and procedural knowledge for measuring appropriate food portions (which overlaps with the theoretical domain of *knowledge*) and their interpersonal skills for discussing dietary and weight issues with their children.

In some instances, parents described their difficulty in assessing the quantity of servings specified in metric measurements during cooking.

#### **Extract 10**

*Yeah it's also difficult to assess the portion size. If you make something how do you know whether its 80 grams or a 100 grams? (Parent, FG5).*

Similar findings have also been found in other studies reporting that along with difficulty recognising metric measurements, participants also expressed their struggle to retrieve guidance on ‘meaningful amounts which could be easily remembered’ (Spence et al., 2013:4).

Parents and Change4life advisors were unanimous in agreeing that parents tended to use their own portion sizes of food as a guide for measuring their children’s portion sizes.

Consequently, they may not differentiate between adult and child portions.

#### **Extract 11**

*For me, I find it particularly difficult dishing out the correct portion size for children and for adults, I suppose. I just tend to give everybody the same amount...(FG3, parent).*

*But when I say to people what’s your child’s portion size in relation to yours..I mean one dad, said ‘well actually she eats the same as me’ cos they’ve had a Sunday dinner and the daughter who is 11 would have the same size meal as him (Change4Life advisor, FG1).*

Across all focus groups, parents recalled their struggle in communicating with their children around dietary issues. For example, several parents expressed their difficulty in helping their children understand the reason why they should have a smaller portion of food compared to adult portions.

#### **Extract 12**

*Yeah, I think if you give them a smaller portion size, then [child’s name] will say why have I got less and doesn’t really understand that she’s got a smaller body and needs less than adults do (Parent, FG3).*

In addition, both Change4Life advisors and parents felt that it was more challenging for parents to discuss dietary and weight related issues with older children. Typically, this

challenge coincided with their fears of causing their children to have anxieties about their weight which is discussed later on in relation to the TDF domain of *Emotion* (Section 5.5.4.2

### **Extract 13**

*Yeah..I was going to say that happens quite regularly but also when you're contacting year 6 parents where the young people are overweight..the parents don't necessarily want to bring up the subject because of their age* (Change4life advisor, FG1).

Indeed, previous research indicates that greater BMI is associated with poor parent-child communication (Skouteris et al., 2012). In addition, Sealy et al., (2012) reported parental frustrations with the poor level of family communication around overweight and obesity. Parents in their study also expressed the need for specific information around ways to talk to their children about weight and nutrition without harassing them or lowering their confidence.

#### **5.5.2.3 Behavioural regulation**

The TDF defines behavioural regulation as 'anything aimed at managing or changing objectively observed or measured actions' and includes constructs such as self-monitoring, action planning and habit breaking (Cane et al., 2012:14). Within this theoretical domain barriers relating to: parental monitoring of their own eating behaviours and monitoring of their children's eating behaviours were identified.

There was agreement among Change4Life advisors and parents undertaking the family weight management programme, that the food frequency questionnaires given to children during the programme, provide valuable insights for parents.

#### **Extract 14**

*...the question is good because it helps us but also gets the parents to like you say, reflect and actually 'gosh well I didn't know there had been this many chocolate biscuits' (Change4Life advisor, FG1).*

*Yeah.. [Child's name] has just said when he was writing his meal for yesterday, bearing in mind that I thought I was with him all day yesterday, because we all live with my parents, and he said 'I had a penguin' and I said 'when did you have that? Did Nanny give it ya?' 'Yeah' (Parent, FG2).*

Focus group responses suggested that some parents may not always be aware of exactly how much food their children are consuming.

#### **Extract 15**

*..although at home she always asks..apart from last night I found her with a little chocolate bar when I went upstairs (Parent, FG4).*

Existing research suggests that an inability to accurately monitor food intake is one factor that leads to consuming larger portions (Steenhuis & Vermeer, 2009). However, it was evident from focus groups with parents that they may be more likely to monitor their own portion sizes when they were on a diet.

#### **Extract 16**

*I suppose I've, sort of, justified that in a way that I'm dieting so I'm actually having less of a portion size, so hers was equal to mine and that's the way I, sort of, justified it in my mind, but that's probably not the right way to do it. (Parent, FG4)*

This extract also suggests that parents who are dieting may also base their children's portion sizes on these amounts. Furthermore, one parent felt that if she had continued to apply the

skills in weight management that she had acquired through an adult weight management programme, she may have been able to prevent her family's weight gain.

#### **Extract 17**

*And how we treat ourselves is more important too because if we have the education first then we would have because I went to weight watchers school, this was 10 years ago before I was 40 and I lost all weight but I didn't apply it to family. I let them carry on..those days and so then I caught the weight back on and I was thinking if I'd done like I have now we are doing it together then I wouldn't have this..* (Parent, FG4).

While parents may feel that some adult weight management practices are useful for managing their children's eating behaviours, there was agreement among Change4life advisors that some parental dieting behaviours and experiences may impact negatively on children.

#### **Extract 18**

*Say with modelling, when you get the mum's that say they've tried all these diets, I say 'do you talk like that in front of your daughter or son' because that can't be helpful when you got the mum constantly on another diet and not succeeding* (Change4life advisor, FG1).

Existing research suggests that children's ability to self-regulate is linked to parental eating habits in regards to modelling of out of control eating and dieting (Skouteris, 2012; Birch & Fisher 1995; Kral & Rauh, 2010). This is congruent with the SCT (Section 2.4.3), thus illuminating how parental dietary behaviours may exert strong modelling effects on their children's eating behaviours. This provides a rationale for interventions to encourage parents, to change their own diets and adopt a 'do as I do, not what I say' approach (Brown & Ogden 2004:270), as recommended by the National Institute for Health and Care Excellence (NICE, 2006). Therefore, in agreement with Fassihi, et al., (2012), interventions need to be more

effectively tailored to parents who are overweight to help them change their own weight related behaviour as a way to support children.

### **5.5.3 Opportunity**

Opportunity refers to both the physical (e.g. resources) and social (e.g. people) opportunities afforded to people in their environment that either hinder or facilitates their behaviour (Michie et al., 2014b). Focus groups discussions relating to this component identified factors such as the resources parents have available in their environment to help them with measuring food portion sizes, the food environment pertaining to supermarkets and schools, media influences around healthy eating and the people in parents' and children's environments that impact on provision and consumption appropriate portion sizes. Therefore, this component was further delineated in the TDF domains of *Environmental context and resources* and *Social influences*.

#### **5.5.3.1 Environmental context and resources**

The TDF defines environmental context and resources as 'any circumstance of a person's situation or environment that discourages or encourages the development of skills and abilities, independence, social competence, and adaptive behaviour' and includes constructs such as resources, a person's interaction with the environment, environmental stressors and barriers and facilitators (Cane et al., 2012:14). Within this theme, focus group discussion content related to resources parents used for measuring portions, the media, supermarket promotions, parental working schedules, their limited time for making dietary changes and schools.

There was a common preference among parents for using house-hold objects such as a plate, spoon or bowl to measure portion sizes instead of using scales.



### **Extract 19**

*P1: I wouldn't measure.. I would just use the plate size and just yeah.. make sure that there was a good combination of carbohydrate and vegetables or protein and vegetables on the plate but not really use any specific measurements (Parent, FG5).*

However, parents had mixed accounts on whether household objects were a hindrance or an enabler in the case of measuring portion sizes. For example, household objects such as a spoon or a cup were described as a facilitator for measuring food portions.

### **Extract 20**

*P2: I was cooking rice I didn't measure nothing I just put the water in, put the rice in and I'd end up with a big pan full of rice and I chucked it away because it was wasted. You know so now I sort of like when I'm measuring out I get a cup or even pasta, put in a cup first so I know that that's going to be enough for me if I were doing it for myself or if I'm doing it for like three of us I'll put a whole cup in*

*P1: I bought a tablespoon specifically for measuring cereals (Parents, FG5).*

Whereas, there was an indication that adult sized plates and bowls make it difficult to judge appropriate child food portion sizes.

### **Extract 21**

*..he is using pasta bowls that's adult size deep dish bowls that go on forever.. (Parent, FG6).*

Parental preference for using household objects is well documented in consumer research (Britten, Haven & Davis, 2006; Brown & Timotijevic, 2011; Pollard, Dally & Bins, 2009; Institute of Grocery Distribution, 2009). As the current findings suggest, the size and shape of dinnerware, glasses and utensils may act as a prime to consumption responses (Rothman, Sheeran, & Wood, 2009), where previous research has shown that larger dinnerware leads to

serving and consuming larger portions (Faith et al., 2012; Wansink, van Ittersum & Painter, 2006). Van Ittersum & Wansink, (2012) demonstrated empirical support for the use of Delboeuf illusion to explain why the size of dinnerware may cause biases in serving size perceptions and behaviour and consumption. The Delboeuf illusion is an optical illusion where there is a perceived difference in the size of two identical circles when one is encircled with a larger circle and the other one is encircled by a marginally larger one. Taken within the context of dinnerware, results found that a larger gap between the sides of a serving plate or bowl and the food, lead to participants perceiving greater contrast and overserving. However, the opposite effect was observed for a smaller gap. Hence, the results of their study also provide support for why smaller plates or eating off half the plate was identified by parents in the current study as a facilitator to reducing portion sizes.

#### **Extract 22**

*I mean I've just lost recently 4 stone.. Yeah, and that is by eating off half the plate.* (Parent, FG3).

This supports previous research where participants reported that smaller plates served as visual cue and a norm towards eating smaller portions (Vermeer et al., 2010). Indeed, some parents in the current study reported using a child plate for helping them to measure appropriate child food portions. However, there was recognition among several parents that the difficulty in estimating appropriate portion sizes for their children begins when they start serving food on adult plates.

#### **Extract 23**

*..because I did exactly the same - started her on a small plate and then my daughter has gone to a larger plate as she got older. When it gets to a larger plate then that's when it get it bit out of hand (Parent, FG5).*

Another environmental factor that was prevalent in discussions with parents was their lack of time to measure appropriate portion sizes.

#### **Extract 24**

*And even on, you know when you buy..I don't know pasta, where it's such as big quantity but you wouldn't use all it all and it will say 'per portion' and I'm thinking, that's per 'your' portion and I don't weigh out my portion to know what it is..or even if they say per so many grams, I still don't have the time to figure out..I just don't want to (FG2, Parent).*

Lack of time was also cited as an important barrier among Change4Life advisors regarding parental communication abilities with their partners, particularly for those who work in shifts.

#### **Extract 25**

*P3: They only see each other at certain times*

*P2: Yeah*

*P3: Sometimes you can have parents that work at different times so that child care is easier so it might be a time aspect as well. (Change4life advisors, FG1).*

Consequently, limited time to discuss healthy eating issues with partners may prevent parents from communicating the importance of serving appropriate portion sizes.

#### **Extract 26**

*And this is what my issue with my husband giving them far too much is that he is using pasta bowls that's adult size deep dish bowls that go on forever. I need to stop him from doing that (Parent, FG6).*

There was also concurrence among parents regarding limited time for food shopping. Parents recognised that lack of time, together with the availability of cheap unhealthy food on promotion, impacted negatively on their shopping habits.

#### **Extract 27**

*P2:I think at the minute it is..you don't.. you pick up a lot of things cos they are on promotion, the rubbish things are more on promotion than..*

*P1:And like you said.. (inaudible) promotion, you've only got half hour to run around doing your shopping you're going to grab the ones that are at arm's length rather than go up and down the isles scanning for stuff (Parents, FG2).*

Parental susceptibility to supermarket promotions was further echoed by Change4life advisors accounts.

#### **Extract 28**

*I came she had just done the shopping and it was all in the sitting room and before she had a chance to move it all I saw the 24 multi pack bags of crisps and everything else and I thought well, we've been through it all and I know that they're all cheap and on offer and she's aware because we've been through it what's healthy..old habits die hard and it's the availability and cheapness of the food (Change4life advisor, FG1).*

Change4life advisors also drew attention to the environmental context of supermarket promotions and linked this with parents' emotions towards their children in the case of food provision.

#### **Extract 29**

*P2: I was going to say I have some children under our care and it is really.. I love you to death..you know that child is so –*

*P1: Especially when you can buy them on special offer like you know 4 Mars bars for a pound.*

*P3: Yeah (laughs)*

*P2: And doughnuts, buy one pack and get one pack free (Change4life advisors, FG1).*

Parents also felt that supermarkets deliberately position unhealthy foods in the path of other everyday items, creating further temptation to buy these products.

### **Extract 30**

*P3: .... sometimes you have to go through the sweets to get to the bread.*

*P2: To get your bread you have to go through the cake bit.*

*P4: Yeah, well if you go into (Supermarket) you've got a whole wall of and seasonal goods that are in there like hot cross buns or doughnuts in trays and that's always going to be there.*

*P: Yes and the smell. (Parents, FG5).*

Frequency of portions also emerged as important in reducing quantities of food consumed.

These responses underscores the challenge created by the availability of large quantities of high energy density food in supermarkets. Arguably, the purchase of these foods are likely to increase their availability and consumption in households for children and other family members.

Parents and Change4life advisor agreed that marketing claims on food packaging can also make it challenging for parents to ascertain the healthiness of some foods.

### **Extract 31**

*P1: Difficult with the marketing claims*

*(All agree)*

*P3: Like I say with the smoothie drinks, in my mind I was thinking that's good but when you actually look at it, it's not actually (Parents, FG2).*

There was also agreement among some parents that unhealthy food is promoted to children.

### **Extract 32**

*And it seen as children food, you know sweets and MacDonald's and even cereals that high in sugar, everything it seems that's sort of pushed onto children are things that are unhealthy (Parent, FG5).*

Parental tendency to purchase foods on promotion may also suggest that parents are concerned with the cost of food. Both the cost of food and parental struggle with money was cited as an important barriers among parents to changing their shopping habits.

### **Extract 33**

*P1: it's time and money..people are working more to get the money and because the money isn't going far enough you are then in a cycle because you're always at work to try get the money, the money's not enough, you haven't got the time..it's just that..*

*P2: People..we care about what kids eat but we're thinking we ain't got the money to give them '5 a day' really, I know..I'm saying this because I do..try my best but it is really hard to feed your kids 5 portions of fruit and veg a day and it not be expensive (Parents, FG2).*

Parental accounts of their lack of time and money to provide healthier food has been reported in other qualitative research with parents (Hart, Herriot, Bishop & Truby, 2003; Etelson et al., 2003; Rodríguez-Ventura, 2014). Research indicates that large portions of food are seen by consumers as providing greater value for money (Steenhuis & Vermeer, 2009). Furthermore,

evidence suggests that even just the presence of large quantities of food in the form of larger packs can lead to overconsumption (Spence et al., 2013). Consumers are continuously exposed to larger food portions so they become the norm. Therefore, it is not surprising that many people have a propensity towards overeating high energy density foods, without conscious intent (Steenhuis & Vermeer, 2009).

There was agreement among parents that although they were driven by promotional offers, one way to benefit from them is to freeze certain foods so they can consume them later.

#### **Extract 34**

*P3: I write a list of the things I don't normally buy but I am driven by offers..you know if the fresh chicken is on offer or something like that*

*P1: Yeah..oh yeah*

*P3; I will buy..stick it in the freezer or something you know (Parents, FG4).*

Parental recommendations of freezing segments of the food and buying food already sold in portion controlled packages is also reported in previous research with consumers (Spence et al., 2013).

Some parents felt that media reports on healthy eating acted as a barrier because of the volume of conflicting information. Some parents suggested that they tended to ignore healthy eating media reports. Indeed, this may explain why they were not aware of guidance on portion sizes for a balanced diet.

#### **Extract 35**

*I think there's too many people doing too much research..too many different departments doing it, that they're all just mix and match... I think that the Government have just gotta look at one thing and say this is what were saying and this is what we got to do (Parent, FG2).*

This adds to previous research with parents and consumers where information from the media, food manufacturers and the government were reported as confusing, biased and unrealistic thus reducing its overall effectiveness (Hart et al., 2003; Spence et al., 2013). Furthermore, parents in one study also criticised the ‘prescriptive’ nature of existing nutritional guidelines (Hart et al., 2003).

Some parents suggested that they used their parents as a guide on which food is harmful to health and which is not.

### **Extract 36**

*And I think as well, people are going back to, ‘you know what’, like back to Grandparents, ‘This didn’t harms us, we haven’t got any health problems’, ‘Really...’, there’s so much seesawing, this is good for you one week, the next week it’s really bad for you. I know it’s a bad example, but you know like the red wine, yer red wine’s good for you the one week and the next week it’s going kill yer (Parent, FG2).*

Parents indicated that they were also frustrated with media reports warning them against certain foods and not providing suggestions of foods to replace these with. This is relevant to portion control because it entails eating a balance of food groups and therefore parents will need to replace certain foods with others to achieve this balance e.g. replacing meat burgers with lentil, fish or vegetarian burgers for example if they are eating too much meat.

### **Extract 37**

*P8: You are talking about meat and you wondering, less meat you have in your diet the better probably if you’ve got a bit of options.*

*P6: Yeah.*

*P8: Yeah, yeah as long as it’s balanced we’d like some options.*



*P5: In the reports they never say instead of this why don't you replace with this. They just say don't do this. (Parents, FG6).*

Schools were also cited as a barrier for portion control by parents and Change4Life advisors.

#### **Extract 38**

*..her child was choosing the stodgy foods and wasn't choosing the yogurt or fruit for her dessert she was choosing the cake every day with custard and it is quite a big bit of cake that they get it's not just a like little Mr Kipling size it's.. (Change4life advisor, FG1).*

Children spend a considerable amount of their time at school and therefore school meal provisions are an important factor in helping to prevent childhood overweight and obesity (Weisberg, 2002). Parents reported that some schools sell unhealthy food and beverages for children to purchase.

#### **Extract 39**

*..they can buy their own lunch which includes fizzy drinks (Parent, FG6).*

Some parents also felt that children were exposed to greater levels of unhealthy food in secondary schools.

#### **Extract 40**

*The only thing he mentions is that there's pasta and meatballs on Tuesday on the second week and the rest is either a hot dog... I mean they even do... mind you it's for kids that perhaps haven't had breakfast, they do bacon and sausage sandwiches for mid-morning, like 11 o'clock (Parent, FG5).*

These findings are supported by research in the US suggesting that the school food environment has changed considerably over the past decades where there is an increased availability of soft drinks and vending machines and the provision of canteen meals high in saturated fat (Anderson & Butcher, 2006; Weisberg, 2002). Within the UK, the

unhealthfulness of school meals has been highlighted publicly by Jamie Oliver who was outraged by the level of junk food available in schools. This led to the ‘Feed Me Better’ campaign aimed at the increasing the nutritional content and quality of school meals and removing availability of junk food (BBC news, 2006). Interestingly, portion sizes has not been highlighted in the research and news on school meals, which may provide an opportunity for targeting in school-based interventions (see section 10.1.1).

### **5.5.3.2 Social Influences**

Social influences can be defined as ‘interpersonal processes that can cause individuals to change their thoughts, feelings, or behaviours’ and includes constructs such as social norms, social comparisons, modelling, social support and social pressure (Cane et al., 2012:14).

Within this theme, focus group discussions centred on the people that parents and children interact with in their environment including: peers, partners and grandparents.

Peers were cited by parents as important social influences on children’s eating behaviours outside of the family environment. Parents agreed that it was difficult to control portions of sugary snacks as these were available from their peers during school times.

#### **Extract 41**

*I desperately tried to make sure that he wasn’t having any sweets or sugary stuff outside of the school day and found impossible because every five minutes somebody was giving them sweets at school because of a birthday (Parent, FG6).*

In addition, parents agreed that children’s peers influenced their desires for certain foods, particularly through lunch boxes.

#### **Extract 42**

*I think you do feel a bit because 'they've got that in that lunch box..and I've got that' and they feel a bit peer pressured and (inaudible) why they haven't got a chocolate bar (Parent, FG2)*

There was also a sense that parents felt guilty for not permitting their child to have the same types of food in their lunch boxes as other children. For example, one parent reported their difficulty in attempting to improve their children's lunch box and their concern that their child may be dismayed if they observe healthy weight children eating food they are not permitted to have.

#### **Extract 43**

*..he's never had crisps in his lunchbox but a lot of his friends do..when they came here and he was thinking about his thin friends and what they ate, he was saying 'well Darren has mayonnaise on his sandwich, he has crisps and he has chocolate in his lunchbox', you know. It isn't always fair. It isn't as easy as 'don't eat these things you'll be skinny..' (Parent, FG5).*

This highlights the emotional aspects of limiting unhealthy snacks such as chocolate bars and crisps which is discussed further in *Emotion* (section 5.5.4.2.).

There was agreement among Change4life advisors that less overweight children who appear to have unhealthy eating habits, also affect parents with overweight children's' willingness to make changes.

#### **Extract 44**

*Well again back to the fact that one mom had discovered that a child's friend had come into the healthy weight category but actually she eat badly so that for her..kinda..the fact that her child was in the overweight category but she eat fruit and vegetables, it kind of diminished that category almost because her daughters*

*friend was in the healthy weight category but actually drank a lot of coke and eat a lot of chips and burgers and things so that..that for her was a reason not to act on making changes.. (Change4life advisor, FG1).*

There was consensus among both Change4life advisors and parents that encouraging children to eat more healthily becomes more challenging as children grow older. There was agreement that for older children, peers are particularly influential.

#### **Extract 45**

*..it's harder when they get into 12, 13... They tend to do what their friends are eating and friends are doing aren't they? (Parent, FG5).*

Another important construct that resonated throughout discussions with both parents and Change4life advisors was 'social comparison'. For example, parents with overweight children tended to compare their children's weight to children with greater weight.

#### **Extract 46**

*I've had parents that have said..'well so and so is bigger'...so they are comparing their child to other children they see as bigger than theirs so they don't think their child is overweight.. (Change4life advisor, FG1).*

This has also been found in previous research on negative parental reactions to receiving news from the NCMP that their child is overweight. Gillison, Beck & Lewit, (2013) reported that some parents were not concerned about their children's weight because they were aware of children that were much 'fatter' than their child (Gillison et al., 2013:990). This can be seen as an indirect barrier to parental dietary behaviours with their children, where parents may be less likely to make changes if they do not accept their child's weight is an issue. This barrier is again inextricably linked with parents' emotional barriers to weight management that are discussed in *Emotion* (Section 5.5.4.2.).

With regards to direct effects on portion control, social comparison can also have a positive impact. For example, one parent described the positive impact her own portion control behaviours can have on other parents.

#### **Extract 47**

*And my friends, when I go round there, they like ‘do you want to put the meals out for your children’ as they are not sure how much we are having. And then my friends are looking at how much we are eating and think maybe ‘we should cut down portion sizes’ (Parent, FG3).*

In addition, one parent described how teachers could impact negatively on children’s eating behaviours when they were at school.

#### **Extract 48**

*Like at school... there was a Mother’s Day school event where the children made scones for their mothers and then they ate together. It was my mum that went with her and [child’s name] had one scone and that was okay. Then someone said ‘have another one, [child’s name]’ and she would have had another one and my mum said to her, ‘well, I think you’ve probably had enough and I’m not going to have another one. You need to try to make that decision yourself’. And she didn’t have one but my mum said you could see it, ‘why can’t I have another one?’ And it was the teachers that were offering, ‘come on you can have another one, it’s fine, you can have another one’. And that’s really quite a hard (Parent, FG5).*

Peer influence and the school environment have been cited as important influences on children’s eating behaviours in previous reviews of the literature (Flynn et al., 2006; Salvy, Haye, Bowker, & Hermans, 2013; Stein, Weinberger-Litman, & Latzer, 2014). Systematic review evidence shows that the presence of peers increases children’s energy intake through modelling and or/ conforming to social norms (Salvy et al., 2013). However, as demonstrated in section 1.4, few school-based interventions have had a significant impact. One possible

reason for this is that broader social networks and peer influences are much harder to manipulate, which is why targeting familial supportive networks may be more effective and could facilitate generalisation of healthier eating behaviours into the wider community (Salvy et al., 2013).

Focus group discussions revealed that prevalent *Social influences* impacting both the frequency and size of portions within the home environment, encompassed partners and grandparents. Change4Life advisors described how grandparents in particular, can make it difficult for parents to ensure their child is eating healthily and that they may ‘undo’ parent’s good work.

#### **Extract 49**

*mmm..and on a positive notes..um..some of my families..they are really trying to make this change but Grandma..they go over to Grandma’s and Grandma is giving them ALL THIS STUFF! (Change4Life advisor, FG1).*

One mother also indicated that their mother refrained from saying anything to their grandchild about their weight because they have also struggled with their own weight.

#### **Extract 50**

*My mom has always dieted on the side so she wouldn’t say anything (Parent, FG5).*

This supports previous research reporting a significant relationship between grandparent and grandchild BMI (Polley, Spicer, Knight & Hartley, 2005).

It was evident from focus group discussions with parents and Change4life advisors that some families are dependent on children’s grandparents for child care. Indeed, several parents recalled their fear of causing conflict with grandparents over food issues.

#### **Extract 51**

*It's got to the point now that's there's no point because it will just cause an argument. There is no point in me, I think there's a difference between living with each other and not. Because you can sort of keep them away from..just send them to Nan's when they can have a treat and I think that's the easy option. When you're living in that situation it's just easier not to discuss it..(Parent, FG2).*

Grandparents have been cited as important influencers on families' food consumption in previous research (Hart et al., 2003; Lorentzen et al., 2012). According to Faith et al., (2012), grandparents can influence the home food environment, attitudes and family values. Indeed, the previous section shows that parents consult grandparents for justification of media reports on food as well as household measuring objects.

Partners were also identified as an important barrier to providing healthier food options and appropriate portion sizes for their children.

## **Extract 52**

*Well I'm relying on the kids now to say to daddy you need to put some vegetables on the plate because I've given up trying to tell him (FG4, Parent).*

*And this is what my issue with my husband giving them far too much is that he is using pasta bowls that's adult size deep dish bowls that go on forever. I need to stop him from doing that. (Parent, FG5).*

Notably, it was the mothers in the focus groups that described their frustrations with their partner's failure to support them in making changes. This highlights the need to involve the whole family in making changes to eating habits and not just the individual child.

### **5.5.4 Motivation**

According to the COM-B model, motivation involves both automatic and reflective processes. While 'automatic motivation' refers to our drives and unconscious automatic processes, 'reflective motivation' involves our conscious and reflective processes that

motivate our behaviour (Michie et al., 2014b). Parental dietary habits and emotional barriers emerged as important in relation to automatic motivation. Reflective motivation related to parental beliefs surrounding the target behaviour, exercise and overweightness, intentions to make dietary changes, role as parents and confidence in their ability to make changes. Therefore, this component was further delineated in the theoretical domains of *Reinforcement, Emotion, Intentions, Beliefs about consequences, Social identity and Beliefs about capabilities*.

#### **5.5.4.1 Reinforcement**

Reinforcement can be defined as ‘increasing the probability of a response by arranging a dependent relationship, or contingency, between the response and a given stimulus’ and comprises of constructs such as sanctions, incentives and rewards (Cane et al. 2012:13).

Within this theme parental consumption and shopping habits along with their children’s behavioural problems, appeared to reinforce parents’ dietary behaviours with their children.

Focus group discussions revealed how parental eating habits and food preferences may act as barrier to changing their dietary behaviours with their children.

#### **Extract 53**

*..a couple of years ago I did some voluntary work in an early years centre and I went in with someone else and it was like a taste and eat session and the amount of parents who have said ‘oh I don’t like that’ right in front of the children so you’re on to a bad thing before you even start really. (Change4Life advisor, FG1).*

Change4life advisors agreed on the importance of encouraging parents to try different foods, so that children are not in isolation in making changes to their eating behaviours.

#### **Extract 54**



*...so it's getting the parents really, to try these different things because we want this as a family thing..not just for the specific child (Change4life advisor, FG1).*

From Change4life advisors perspectives, greater difficulty for children arises when their parents are not simultaneously changing their own eating habits.

#### **Extract 55**

*You get the families where it's the child that's trying really really hard and you can see they're trying really hard but the mum and dad do have the full sugar coke in the fridge and 'we eat all of that, so that child's trying the best that they can but aren't..*

*I've got families as well where the child's really trying and they are you know..14 ½ stone but Mum's still got the 'Clover' you know..so he's trying but she's still buying the full fat things..you know..so it's hard for them (Change4life advisors, FG1).*

There was agreement among some parents that their own eating habits influenced their children's eating preferences and exposure to these foods; wherein parents were less likely to provide food for their children that they disliked.

#### **Extract 56**

*Yeah I think also when planning it's also by your own eating habits. So if you don't like vegetables then you will be less likely to cook vegetables for your kids (Parent, FG3).*

The current research validates existing research showing that parents often serve and provide food based on their own food preferences (Kral & Rauh, 2010). However, according to Rothman, Sheeran & Wood, 2009, habits override 'conscious action control and automatically maintain dietary behaviors' (Rothman et al., 2009:11). In this regard, according to the authors, overcoming habits require effort, wherein the current study shows that environmental factors such as time, money and supermarket promotions can make it

difficult to override these habits. However, according to Spence et al. (2013), implementing family-based interventions that encourage good portion size practices from an early age can help to break these habits. This is particularly important in light of research showing that portion size habits become ingrained from mothers' portion size practices (Spence et al., 2013).

#### **5.5.4.2 Emotion**

The TDF defines emotion as 'a complex reaction pattern, involving experiential, behavioural and physiological elements, by which the individual attempts to deal with a personally significant matter or event' and includes constructs such as fear, anxiety, stress, positive/negative affect and depression (Cane et al., 2012:14). The subject matter of childhood overweight is a highly emotive issue for parents where focus groups provided insight into a number of emotional barriers, including parental fear, guilt, denial and stress. These different types of emotions may directly or indirectly impact on their dietary behaviours with their children.

Focus group discussions repeatedly underscored the parental fear of causing their child to feel anxious about their weight if they attempted to talk to them about it.

#### **Extract 57**

*Well he's only just joined the senior school so I don't want to overload him with too many worries because I know he would have anxiety through joining senior school so now he's half way through his first year, we might try and tackle it a little bit, try discuss it with him..but we don't want him to go the other way and you know..have anxieties about that (Parent, FG3).*

There was agreement among Change4life advisors that parents feared the onset of eating disorders if they share results from the National Child Measurement Programme (NCMP) with them.

### Extract 58

*So..It's such a sensitive subject isn't it? And um.. a lot of families don't want to share the results with the children because they worry about the effects its going to have on the child..whether their going to become anorexic or whether they become bulimic. (Change4life advisor, FG1).*

Similar findings have also been reported by Hart et al., (2003) where parents reported their fear of eating disorders as largely responsible for their use of covert strategies to manage their children's weight. In addition, parental fear of eating disorders has been highlighted in research into the NCMP from secondary data from schools nurses (Statham, Mooney, Boddy & Cage, 2011) and primary data on why some parents opt-out of the NCMP (Grimmett, Croker, Carnell & Wardle, 2008). Furthermore, Gillison et al., (2013), reported that even when some children has been already been subjected to teasing and bullying with regards to their weight, parents reported that they still avoided talking to them about their weight for fear or causing further distress. The authors propose that these shows 'the scale of parents' concern in relation to eating disorders' (Gillison et al., 2013:991).

Parental emotions towards their children's weight gain appeared to be heightened through parents' own feelings and experiences of being overweight when they were younger.

### Extract 59

*I mean sometimes the mum will say "oh I've tried in the past to lose weight.." ..what's quite interesting is that you're on the phone with them and obviously you've struck a chord with them cos they say when they were young..and one mum said "oh well I hope you're not going to say what my mum said to me when I was young" (Change4life advisor, FG1).*

Other types of fears that emerged from focus group discussions related to the consequence of parental restriction of children's snacks and encouragement of healthier eating behaviours

(which also overlaps with *beliefs about consequences*). There was concordance among some Change4life advisors and parents that these behaviours may result in a number of consequences such as not being liked by their child, being perceived as mean and causing unhappiness or stress to their child.

#### **Extract 60**

*I think some families its more..I love you to death..cos they don't stop their child from having that chocolate bar and saying to them 'you can't have that chocolate bar but you can have a piece of fruit instead'. They haven't got that strength in them because they feel like they are being mean (FG1, Change4Life advisor).*

*I think those issues around parents wanting to be liked by their children, is another problem I have. So if they say they don't like something or they don't want to make them unhappy or stressed by forcing them to eat stuff. So I think there is a bit of cycle of that for some parents. (Parent, FG2).*

Steinsbekk, Ødegård & Wichstrøm (2011) reported that parental perceived emotional barriers (such as their guilt with regards to restricting food), predicted change in total body fat after 6 months despite no differences at base line. The study also found that perceived emotional barriers were a more important predictor compared to parental self-efficacy, subjective norms and attitudes towards childhood weight management. This further supports the use of the COM-B model which accounts for emotional factors in contrast to existing social cognitive theories of behaviour change (section 9.2.2).

Change4life advisors also suggested that some parents may be in denial of their children's weight, which may be seen as a maladaptive coping strategy (Abraham, Sheeran, Abrams & Spears, 1994).

#### **Extract 61**

*I think..they don't actually admit they're overweight..they just say I'm overweight, they've got my build..bit of denial (Change4life advisor, FG1).*

According to Lorentzen et al.,(2012), parental denial of the problem and reluctance to take responsibility may also be reflected in some parents' tendency to blame their children's weight gain on external factors such as grandparents (section 5.5.3.2), lack of money and time, schools and the food industry (section 5.5.3.1). The authors suggest that this gives a sense of parental guilt and shame in being responsible for their children's weight. Similar findings were also reported by Gerards et al., (2012), who conducted focus groups exploring some of the barriers to successful recruitment of children to a weight management intervention with youth healthcare (YHC) professionals (comprised of doctors and nurses). In the study, YHC professionals reported that parents were in denial of the problem and reluctant to discuss weight issues prompting the authors to conclude that parents with overweight children have a 'low perceived responsibility' for their children's overweight status (Gerards et al., 2012:5).

#### **Extract 62**

*P2:You know sweets and MacDonald's and even cereals that high in sugar, everything it seems that's sort of pushed onto children are things that are unhealthy*

*P4:I would say it's more like school and the peer pressure that I was saying earlier about how it affects things and also the after school club don't offer healthy snacks. (Parents, FG5).*

The final emotion in this domain refers to parental stress. It became evident in discussions with Change4life advisors, that parental stress may limit their ability to manage children's eating behaviours.

#### **Extract 63**

*..parents have got too stressed with other problems to be able to concentrate..maybe just on the food, they've got other things to deal with*  
(Change4life advisor, FG1).

Change4life advisors also suggested that unhealthy snacks may be used to distract children, allowing parents to be alone or to concentrate on another task. This again highlights that other issues may take more of a priority over food matters.

#### **Extract 64**

*If it's something like 'go and get one out the cupboard' not go away but 'leave me alone to deal with this' kinda thing* (Change4life advisor, FG2).

Focus group discussions with parents also accentuated how the task of trying to encourage children to eat more healthily may also be a stressful event in itself.

#### **Extract 65**

*I know I give in too easily. Like, he won't eat breakfast at all. Breakfast's a big push for us in the morning because he's not ready. I says well we could eat early in the evening and then he won't be full... cut anything out... oh the tantrums we have over that. Trying to change anything, it's unbelievable* (Parent, FG4).

*I think parents just give up. If they ain't going to eat it, they ain't going to eat it*  
(Parent, FG2).

There was consensus among Change4life advisors that familial stress relating to divorce and separation of parents may also create conflict over food matters.

#### **Extract 66**

*I think divorce and separation because you might get one parent saying 'we eat healthily but she doesn't' or 'he doesn't'. So you've got this conflict between the two different camps and who is the most healthy of the two of them which can't be good for the children.* (Change4life advisor, FG1).

Furthermore, Change4life advisors agreed that parents may also use food to keep children satisfied during times of familial stress and conflict, which may worsen the conflict between parents as each one attempts to surpass the other.

#### **Extract 67**

*It can also add to the conflict that's within it too, if each parent is trying to keep that child happy by allowing or not allowing different food types or habits*  
(Change4life advisor, FG1).

#### **5.5.4.3 Beliefs about capabilities**

Beliefs about capabilities are defined as 'acceptance of the truth, reality, or validity about an ability, talent, or facility that a person can put to constructive use' and include constructs such as self-confidence, self-esteem, empowerment, and perceived behavioural control (Cane et al., 2012:13). Focus group discussions relating to this theme centred on parental confidence in making changes to their children's diets and weight status and their own experiences of trying to manage their weight.

Some parents with overweight children admitted that they had low confidence in their ability to make changes to their children's diet.

#### **Extract 68**

*M: And what are your thoughts on how confident you feel towards changing your children's eating habits?*

*P3: I'd give in too easily.*

*P8: Not very confident. (Parents, FG4).*

Change4life advisors believed that parents' lack of confidence may stem, in part, from their own unsuccessful attempts at losing weight, which also represents an *emotional* barrier.

#### **Extract 69**

*I think if you've got..I mean I've spoken to mums and they've still tried to lose weight in the past and tried every diet going so they've tried it all for themselves. How will are they to try it for their child? (Change4Life advisor, FG1).*

One parent described how her confidence had increased once she lost weight and was able to buy new clothes.

#### **Extract 70**

*Change of lifestyle I suppose, so if you are doing healthier eating, your lifestyle is going to change as well, I have, I've lost 6 stone in the last year, my lifestyle's changed loads, I had to go out and buy a whole new wardrobe and I'm able to go and do more activities with the children and I feel more confident and comfortable with myself now (Parent, FG3).*

This highlights the importance of interventions supporting parents in managing their own weight so that they feel more confident that they can help their children. This was echoed by Change4life advisors who agreed that increasing parental self-esteem was key to helping them to make changes towards their children.

#### **Extract 71**

*Self-esteem I think is..if you can encourage somebody to increase their self-esteem, then their willingness to make any sort of change grows quite rapidly doesn't it? (Change4life advisor, FG1).*

Participants' low confidence in successfully making changes to their children's dietary behaviours supports previous research (Brown et al. 2014). According to self-efficacy theory (Bandura, 1977), parents' confidence in their ability to successfully carry out a behaviour will determine whether they try or not, which has been supported in empirical research (Golan & Crow 2004) and Change4life advisors' accounts.

#### **Extract 72**



*I think that's a really big factor in whether...cos if they don't believe that they can't make a change anyway then their opportunity to try is a lot smaller or their willingness to try* (Change4life advisor, FG1).

#### **5.5.4.4 Beliefs about consequences**

Beliefs about consequences is defined in the TDF as the 'acceptance of the truth, reality, or validity about outcomes of a behaviour in a given situation' and includes constructs such as beliefs, anticipated regret, and outcome expectancies (Cane et al., 2012:13). Focus group discussions concentrated predominantly on parental beliefs around: the consequences of measuring food portions; the role of exercise and; the consequence of overfeeding from cooking excess food. Furthermore, an indirect impact on the target behaviour appeared to be parental beliefs around the consequences of being overweight as a child and adult.

Some parents held the belief that measuring appropriate portion sizes, as recommended on food packaging, requires too much time.

#### **Extract 73**

*I still don't have the time to figure out...I just don't want to* (Parent, FG2).

The parental belief that measuring appropriate portion sizes requires too much mental effort is supported in previous research with consumers also comprising of mainly female participants (Vermeer, Steenhuis & Seidell, 2010). In contrast, Slater et al. (2010) reported that parents were least likely to report this as a barrier to making changes to their dietary behaviours. Although, it should be noted, the survey tool used in their research did not differentiate between healthy eating behaviours. However, parental reluctance to make an effort in measuring portion sizes may also relate to their levels of self-efficacy, which were appeared to be low among some parents in the previous section (section 5.5.4). In applying

Self-efficacy theory (Bandura, 1977), parental beliefs in their capability of measuring portion sizes may influence the amount of effort they will make towards this behaviour.

Change4life advisors concurred that parents are more likely to make changes to their children's diets if they believe it will be worth the effort and would make a difference to their children's weight.

#### **Extract 74**

*I think time and feeling that what they are going to try to change is worth the effort (Change4life advisor, FG1).*

A pervasive belief among several parents was that they did not need to change their children's eating habits if they were engaging in more exercise. This was reinforced by Change4Life advisors, who emphasised that parents often provided extra food for their children when they were exercising, a finding noted elsewhere (Spence et al., 2013).

#### **Extract 75**

*Yeah..we're just trying to get him more active, badminton, squash and cycling, stuff like that. With the weather coming..so we're hoping to exercise it off him (laughs) rather than doing anything too drastic with his diet, we're putting more veg on (Parent, FG4).*

*..they do quite a lot of exercise and so they feel they're doing really well when actually even the people who do go to football or Rugby three times a week, they're only doing what they should be doing anyway....and they're then giving that food extra food which they don't need (Change4life advisor, FG1).*

It was evident from focus groups with parents that the majority of parents held the belief that if they cooked too much food, they will overfeed. There was strong agreement among parents that this was due to their preference of not wasting food.

#### **Extract 76**

*So if you've over cooked, you will overfeed.... I don't like to throw it in the bin the so it goes on the plate (Parent, FG4).*

The finding that parents were concerned about wasting food, is also reflected in the extant literature (Vermeer et al., 2010; Institute of grocery distribution, 2009; Dietary Guidelines Alliance 2002). Indeed, research suggests that parents' core values in relation to food waste are often instilled during their own childhood, where it is expected that all food should be eaten on the plate (Spence et al., 2013).

Parental beliefs around the consequences of being overweight in general (e.g. as children and/or adults) may indirectly impact on parental reflective motivation towards changing their own and their families' dietary behaviours. Change4Life advisors described parents' difficulty in linking adult overweight with health problems.

#### **Extract 77**

*P3: mmm..I do kinda think it..I don't know, I've got one family where mom's got diabetes, dad's dad died of a heart attack really young, his brother had died really young, he wasn't in good health at all, mom wasn't in good health. The one day I went for a visit and her sister had just been taken into hospital with a heart attack but they couldn't relate that to any sort of..*

*M: being overweight*

*P3: No and they couldn't even see that it was something they could make preventative measures towards her.. (Change4life advisor, FG1).*

In addition, Change4Life advisors agreed that part of this difficulty that some parents have in understanding the impact of their behaviour on later health problems is because they prioritise the present over the future.

#### **Extract 78**

*..I think it's also difficult for some families to anticipate the future isn't it...so if they're living very much day to day, week to week, explaining to them that the health implications for their future aren't good isn't always something that they can relate to..(Change4Life advisor, FG1).*

This was reflected by parental reports across all focus groups wherein they were most concerned with the risk of their child being teased as a consequence of being overweight. Arguably, parental concerns towards weight-related teasing are justified when we take into account that appearance-related teasing is the most widespread among children, and overweight children experience higher levels than non-overweight children (Cash, 1995; Hayden-Wade et al., 2005). Furthermore, this concern may also relate to parental experiences of teasing at school with regards to their weight.

#### **Extract 79**

*I think for me it's the teasing, you know, the peer pressure because I was teased really badly at school for being overweight and that's my main memory of secondary school just being told you're fat and you know and I don't want them to go through that. (Parent, FG3).*

Similar findings were reported in a systematic review conducted by Pocock et al. (2010), showing that parents' perceived overweight and obesity as issues for the future and were more concerned with cosmetic appearances compared to health consequences which is further supported in other qualitative research with parents (see Bolling, Crosby, Boles, & Stark, 2009; Gerards et al., 2012).

These findings would suggest, as proposed by Hart et al. (2003), that interventions need to steer away from disease related messages such as linking diet to heart disease, and focus more on immediate consequences such as bullying, asthma, dental health and school performance.

Focus group discussions also revealed a number of parental perceptions regarding their children's weight. For example, some parents failed to recognise that their child was overweight.

#### **Extract 80**

*..maybe some parents (inaudible).. they're not seeing it. They've got blinkers on and they can't see that their kids are overweight and I think that is a problem because I wouldn't have said my son is overweight (Parent, FG2).*

Change4life advisors also agreed that parents may fail to recognise their children's weight because they are in denial, suggesting an emotional barrier may prevent parents from accepting the problem. It could be argued that without recognition and acceptance of the problem, parents may be less likely to make these changes in the first place (this therefore overlaps with *emotion* (Section 5.5.4.2).

Change4life advisors suggested that it was difficult for parents to gauge their child's overweightness if they were only borderline overweight. However, some Change4life advisors reported that parents with very overweight children still fail to recognise their child's overweight status.

#### **Extract 81**

*Yeah..um..even some of the parents where like their BMI is not on borderline, some of the children that do weigh 12 stone.. 11 stone..you have the parents say that still they're not overweight or if they're 9 1/2 stone ..they still say they're not overweight. (FG1, Change4Life advisor).*

Parental non-recognition of their children's weight has also been identified other studies indicating that parents of overweight children tended to underestimate their children's weight (Etelson et al., 2003) and were unaware of their children's overweight status (Gerards et al.,

2012; Santiago, Zazpe, Cuervo, Martínez, & Años, 2012). In a similar vein, Slater et al., (2010) in their study involving a telephone survey of 1202 randomly selected parents of children ages two -16 years in Australia, found that parents did not classify their children as overweight. The authors posit that this may be because parents expect their children to grow out of it which is consistent with the reports of the Change4life advisors.

#### **Extract 82**

*A lot of children do have puppy fat it's just the way they are. I mean when they start growing their body evens out (Parent, FG5).*

Change4life advisors indicated that some parents perceive their children as having the same build as themselves or their siblings and use language such as 'chunky' to describe their children's physique.

#### **Extract 83**

*P2: They don't believe they're overweight ..they're just like their brothers and sisters*

*P1: words like chunky..or*

*P2: Often they say because they've got my build so because the parents are overweight they just accept the fact that the child's going to be overweight.. (FG1, Change4Life advisors).*

Parental perceptions of their child as 'chunky' and the belief that their child will grow out of their weight has been found in previous research (see Lemelin et al., 2012).

Change4life advisors agreed that some parents perceived their children's weight as inevitable due to parental overweight.

#### **Extract 84**

*often they say because they've got my build so because the parents are overweight they just accept the fact that the child's going to be overweight..I think..they don't actually admit they're overweight..they just say i'm overweight, they've got my build..bit of denial (Change4life advisor, FG1).*

Further support can be found in a review of 15 studies reporting that fatalism was associated with parental perception of weight gain in children (Mareno, 2013). The review also identified societies' normalisation of overweight as another important antecedent to parents' perception of their child's weight where the use of euphemisms such as 'big-boned' are used by parents to describe their children's weight (Mareno, 2013).

#### **5.5.4.5 Social Identity**

*Social identity* refers to 'a coherent set of behaviours and displayed personal qualities of an individual in a social or work setting' and includes constructs such as social identity and identity (Cane et al., 2012:13). Discussions within this theme focussed on mothers' identity as the primary caregiver and how this can impact on their willingness to make changes to manage their children's eating behaviours and weight.

Change4life advisors suggested that it was predominantly mothers who made decisions on whether they wanted their children to participate in the Change4life programme or not.

#### **Extract 85**

*Even when you phone up they are like 'oh you need to speak to my wife about that' or mother about that..it's like they can't make a decision..or they don't want to deal with it (Change4Life advisor, FG1).*

Change4Life advisors maintained that mothers perceive themselves as the primary caregivers for their children. This was reflected in the degree of attendance by mothers at the weight management programme and focus groups compared to fathers (there were 12 mothers compared to two fathers). Angry responses are not therefore uncommon from mothers when they are approached about their children's weight. The findings appeared to support previous research showing that mothers take the lead on household and parenting issues, where fathers tend to take a passive role (Anti, Laurent & Tompkins, 2015). However, mothers cited fathers as a barrier to supporting their dietary changes with their children. Research indicates that fathers who are unsupportive of healthier dietary intake and do not model healthier eating habits had children with higher BMIs (Berge, Wall, Bauer & Neumark-Sztainer, 2010).

#### **Extract 86**

*And then the wife phones back quite angry..and I perceive that as actually it is mum who's doing the cooking and therefore its mum who takes it a little bit more personally..for dad it can be kind of a little bit about someone else making a change.. (Change4Life advisor, FG1).*

Change4life advisors suggested this may limit mothers' willingness to engage with the Change4life programme.

#### **Extract 87**

*they get quite offended..you know..the child's overweight..that they are that rigid..you know (Change4life advisor, FG1).*

A rapid review of studies assessing the delivery of the National Child Measurement Programme (NCMP) which entails notifying parents of their children's weight status, found a small proportion of parents reported negative impact of receiving the letters resulting in anger and upset (Boddy, 2011). Similarly, Gerards et al., (2012) also found both resistance and anger from parents, when healthcare professionals attempted to discuss their children's



weight issue. For this reason, Change4life advisors agreed that it was important to work to engage mothers in particular in the programme and towards making changes to their children's diets which relates to the next section.

#### **Extract 88**

*It's actually engaging the parents isn't it? When I meet with the parents..with the families, I really want mum to engage, because as the end of the day, mum buys the food, you know, the child don't go out and buy the food. I encourage the child to go shopping with the Mum so they make those choices together..um..but it's very hard if mum doesn't engage. (Change4life advisor, FG1).*

#### **5.5.4.6 Intentions**

Intentions are defined in the TDF as a 'conscious decision to perform or resolve to act in a certain way' where intention stability is a property of intentions (Cane et al., 2012:14). Focus group discussions within this theme centred on parental readiness to make changes to their dietary behaviours with their children.

Both parents and Change4life advisors were unanimous in agreeing that parents, particularly mothers, had to be ready and in the right frame of mind before they could make dietary changes.

#### **Extract 89**

*..if mommy is ready and I do think it's more..in a really large proportion of households even when mom doesn't necessarily do the shopping, I think it still comes back to Mom to kind of cook and prepare the food. I think if she's in a place where she wants to make a change then I do think that has a really big impact, if mommy isn't then I think that motivation is very small (Change4life advisor, FG1).*

*But you have to be in the right frame of mind (Parent, FG5).*

*I think it has to be a personal thing really. I think most people can say to me, I think you should be doing this. I think the two.. (Parents, FG4).*

Change4life advisors suggested that parental intentions to make changes to their children's diet may be influenced by a number of interlinking factors. For example, advisors agreed that some parents were not interested in making changes which they considered to be a consequence of parents' denial of the problem (which overlaps with *Emotion*).

#### **Extract 90**

*Some parents just don't want to know do they? And you just..you know you can't do anything else. They have the booklet but they are just in denial..don't really..um..want to know* (Change4life advisor, FG1).

Combining the findings from previous sections appear to suggest that parental emotional barriers (e.g. denial of the problem), beliefs about their capabilities in successfully making changes to their children's dietary behaviours and weight, social norms relating to other children who are more overweight, and beliefs about the consequences of childhood overweight may all influence parental intentions to make changes. Similarly, Andrews et al., (2010) found that parental 'perceived behavioural control', attitudes and social norms influenced their intentions to track their children's food intake. In addition, Rhee, De Logo, Arscott-Mills, Mehta & Davis, (2005) found that parental beliefs around the health risks of childhood overweight or recognition that they themselves are overweight, were associated with their readiness to make changes for their child. Furthermore, similar to the current findings, parents were more likely to be ready to make changes if their child was above or equal to eight years old. However, before this age, they believed children would grow out of their overweightness (Rhee et al., 2005).

Change4life advisors highlighted that some parents were reluctant to take responsibility for their children's weight gain, which in turn meant they lacked intentions to make changes.

#### **Extract 91**

*I think it's also about people need somebody to blame for things don't they?  
Rather than accept responsibility for themselves.. (Change4life advisor, FG1).*

Furthermore, some parents' expressed their dislike of the Change4life media campaign (which also overlaps with environmental context of parental mistrust of the media and emotions) which appeared to reduce their intentions to make changes.

#### **Extract 92**

*P1: Why would I listen to them and what do they know, this is, I know what's good for me and what's good for my kids and it's a bit bloody minded really isn't it?  
(Parent, FG4).*

With regards to parental weight status, one parent felt that parents who were overweight, were less likely to be concerned about their children's overweight status.

#### **Extract 93**

*I think health is more when you put your mother's head on and skip forward to 10 years and thinking I don't want that..but this is for people who are bothered..this is what I'm saying. Bigger kids who have got bigger parents aren't bothered. The parents aren't bothered, therefore why are the kids going to be bothered? I've noticed..not personally..but I've noticed looking on..when you sit and chat you know with other parents, it's just 'ah well, I'm big he's going to be big isn't he', it's quite dismissive and in all fairness (Parent, FG2).*

Further support was gleaned from Change4life advisors' experiences of the differences between overweight parents and healthy weight parents. Advisors emphasised that healthy weight parents were likely to accept help from advisors and more willing to make changes towards their children's diet, compared to overweight parents.

#### **Extract 94**

*Um...some of the ones that I do felt accept the help more are the parents where they're not overweight...the parents aren't overweight but they can see that their child is overweight and I think there that one's that accept my...our... services more then when the whole family's overweight..*

*The parents who are keen are the ones that aren't overweight but the children are...um...but most of the families that I've been to see the parents are overweight as well (Change4life advisors, FG1).*

There was agreement among Change4life advisors that the majority of the families they visit had overweight parents mirroring current evidence that children from families where both parents were overweight were six times more likely to be unsuccessful in weight management programmes (Fassihi et al., 2012). According to Bartz & Freemark (2012), parental overweight status exert strong effects on children's BMI both behaviourally and genetically and the health behaviour of parents are critical influences on children's weight status.

It was evident from discussions with Change4life advisors, that parental intentions to make changes to their children's diet decreased if they did not have the belief that they could successfully make changes to their children's diet. This overlaps with the TDF domain of *Beliefs about capabilities* (Section 5.5.4.3).

#### **Extract 95**

*if they don't believe that they can't make a change anyway then their opportunity to try is a lot smaller or their willingness to try (Change4life advisor, FG1).*

Change4life advisors stressed that parents would be reluctant to make changes if they perceived their children to be greatly overweight, requiring 'too much change' to their weight related behaviours.

#### **Extract 96**

*P3: Yeah. I just wonder whether it would be helpful to show the BMI chart and where they are but rather than it being a bit scary if it is very much off the chart, kinda show them that if they were to grow but stay that same weight, what impact that would have so they can actually see that small changes would make a big difference. Because for some parents if they all of sudden see that their child is massively off the chart -*

*P1: It's too much to cope with*

*P3: that might be too much change to make whereas if they could see –*  
(Change4life advisors, FG1).

### **5.5.5 Summary**

The COM-B analysis of focus group findings led to the identification of determinants appearing to influence parental provision of appropriate portion sizes in all three COM-B conditions (Capability, Motivation and Opportunity). The theoretical domains appearing to impact on the target behaviour were found within 12 of the 14 domains including: *Memory and attention and decision making processes, Knowledge; Skills, Behavioural regulation, Social identity; Environmental context and resources and Social influences; Reinforcement; Emotion; Intentions; Beliefs about capabilities; and Beliefs about consequences.*

The focus groups revealed a number of findings that are important with respect to intervention development. Firstly, with regards to parental *capability*; research findings revealed that parents have gaps in their knowledge regarding appropriate portion sizes and the nutritional content of food. They also expressed difficulty in their skills and judgment towards providing age appropriate portion sizes at meal times where some parents tended to serve the same amount as adult portions. Parental eating habits and monitoring of children's eating habits also play a role in their ability to manage their children's eating behaviours. With regards to their interpersonal skills, parents found it challenging to communicate with their children and partners around food and weight related issues.

In terms of parents' *opportunity*; findings suggested that the parental preference (and automatic habits) of using household objects to measure food portions such as plates may distort portion sizes. With regards to social influences, parents identified the media, schools, peers, grandparents and partners as barriers to managing their children's dietary behaviours. Findings also revealed how the obesogenic environment in terms of the availability of cheap unhealthy food in supermarkets and foods available at schools, along with the context of families' tight financial situations are clear barriers to parents changing their shopping habits. For this reason, targeting the home environment and how parents distribute food to their children is a good starting point for an intervention where parents have more control over this environment.

Finally, with regards to parental *motivation*, the findings suggest that automatic processes comprised of parents' emotions (e.g. denial of the problem), own dietary and shopping habits and response to children's behavioural problems appear to play a role in their food portion size behaviours. With regards to reflective processes, parental beliefs around the time and effort to measure food, the consequences of childhood and adulthood overweight and parents' confidence and readiness in making changes to their children's eating behaviours emerged as important targets for change.

## **5.6 Step 4: Understanding (ii) Users' preferences for app features**

So far focus groups have facilitated the decision making process for which nutrition behaviour should be targeted in the intervention (Aim one) and identified key theoretical domains to elicit change in order for this target behaviour to occur (Aim two). Next it is important to consider how these can be implemented in an app through exploring parental preferences for healthy eating app features to support them in childhood weight management

(Aim three). This aim aligns with the first stage of Preece et al's., (2002) UCD approach to development (section 3.3)

There were several themes identified in relation to parental preferences for app features including (i) *Increasing parents knowledge of recipes and healthier foods*, (ii) *Time saving and convenience*, (iii) *Visual aids*; (iv) *Communication tool to use with their families*, (v) *Gamification*, and (vi) *Parental monitoring of children's weight and food intake*. Valuable input was also provided by Change4Life advisors on suggestions for app features and behaviour change techniques that would be useful for parents in a healthy eating app with regards to (vii) *Goal setting*. Furthermore, (viii) *Parent's use of existing mHealth apps and relationship with their smartphones* were also extracted from the data. These themes are described in more detail next.

#### **5.6.1 Increasing parental knowledge of recipes and healthier foods**

Analysis of focus group discussions revealed parents' preference for an app that they could input food data into (e.g. of items from their fridge and/or cupboards) and receive feedback from the app with regards to suggestions for recipes.

##### **Extract 1**

*I would love to have an app on my phone that says, I have this food, what can I do with it..If you could take a photo of the fridge and 'right that's what I've got, what do you suggest (laughs) (Parent, FG2).*

Parents also expressed the need for ideas for healthy meals.

##### **Extract 2**

*Yeah..just ideas..ideas for quick meals that are healthy as well... things like beans on toast and scrambled egg..(Parent, FG3).*

Indeed, both Change4Life advisors and parents' expressed the need for more ideas on healthier alternatives to foods and beverages. As previously mentioned (Section 5.5.3.1), parents' expressed frustration when there were news reports warning against the consumption of certain foods without providing information on what they could substitute this food with.

### **Extract 3**

*In the reports they never say instead of this why don't you replace with this. They just say don't do this. (Parent, FG5).*

Hence, both Change4life advisors and parents felt that it would be useful for the app to suggest healthier alternative to meals which would help them to increase their *knowledge* of healthier food.

### **Extract 4**

*That would be something that would be useful in an app to be able to say I want all these sausages and I want a sausage meal tonight what's a good alternative that would be more healthy, a similar sort of ... (Parent, FG4).*

One parent also liked the idea of the traffic light system for feedback on foods that they enter into an app, which they felt could potentially help to engage children in a mHealth intervention.

### **Extract 5**

*I mean if it incorporated that traffic light system, I mean scan the food and it will give you a green or red or orange then that would be very fun with... the children would love that (Parent, FG2).*



### 5.6.2 Time saving and convenience

Parental suggestions for healthy eating app features described in the previous section also included their requirements for these to be quick, simple and convenient to use, findings that are also supported in other mHealth app UCD research (Buller et al., 2013, Cafazzo et al., 2012).

#### Extract 6

*Yeah..just ideas..ideas for quick meals...(Parent, FG3).*

*.. it would have to be quite simple I think. If it got too complicated I just wouldn't use it.. (Parent, FG5).*

In addition, there was a reluctance on the part of parents in having to provide too much detail (e.g. entering the brands of food items) when logging food which would impact on their time.

#### Extract 7

*.. if you could just put what it is rather than, who made it, what, this, that and the other and trying to do all that research because that takes ages (Parent, FG2).*

Similarly, in a systematic review of using mHealth technologies to support childhood weight management conducted by Turner et al. (2015), studies included in the review recommended the importance of reducing participant burden when it came to tracking diet and exercise.

This can help to reduce the demand on their cognitive resources that may lead to them falling back on their current portion size habits (Rothman et al., 2009).

Parents also felt that following portion recommendations on food packaging required too much effort, which according to Change4life advisors, represents a barrier to making changes.

### **Extract 8**

*I still don't have the time to figure out..I just don't want to* (Parent, FG2).

*I think the effort as well. If they think it's going to be a lot of effort, is what might happen in the long term, worth all the effort that you're doing now* (Change4life advisor, FG1).

Such a finding has also been reported in other studies wherein the degree of effort required was an important influence on app usage (Dennison, Morrison, Conway & Yardely, 2013). In this regard, it is important that the app involves a portion guide that is simple and effortless in its approach to measuring portion sizes. This also links with the theoretical domains of:

*Memory, attention and decision making processes* and *Beliefs about consequences* (Section 5.5.4.4) wherein parents' believe that measuring appropriate portion sizes for their children demands too much cognitive effort and time. In addition, this also links with theoretical domain of *Environmental context and resources* (Section 5.5.3.1), wherein parents cited lack of time an important barriers to making changes to their children's diets.

### **5.6.3 Parental monitoring of children's weight and food intake**

Parents' expressed their need for information that showed comparisons between their child's weight and an ideal healthy weight of a child. As previously mentioned, in accordance with the National Child Measurement Programme (NCMP), parents receive letters from their

children's school regarding their child's weight status. In this regards, parents felt that the current letters from the NCMP provided limited information which could be used by parents to make relevant improvements.

#### **Extract 9**

*P3: But then there's nothing..like with the letters and the information there's nothing you've got to sort of measure it to is there? They just say your child is overweight and what does an average child supposed to be?*

*P1: Yes I would like to have something like that in the app (Parents, FG1).*

While recognising the need for more information, the Change4Life advisors nonetheless warned against overwhelming parents if they saw that their child was very overweight.

#### **Extract 10**

*I just wonder whether it would be helpful to show the BMI chart and where they are but rather than it being a bit scary if it is very much off the chart, kinda show them that if they were to grow but stay that same weight, what impact that would have so they can actually see that small changes would make a big difference. Because for some parents if they all of sudden see that their child is massively off the chart - (Change4Life advisor, FG1).*

Change4Life advisors also suggested that the app could support parental monitoring of their child's food intake. Advisors reported that parents were often surprised at the foods and drinks their children wrote down in the food questionnaire they receive as part of the Change4life service.

#### **Extract 11**

*So from a parent's point of you, it kinda opens their eyes as well..thinking 'oh yeah, I didn't realise that..they are drinking a lot of those'..you know..sugary*

*drinks* (Change4Life advisor, FG1).

#### **5.6.4 Goal setting**

Change4Life advisors also reported that it may be useful for parents if the app could help parents to break things down into smaller, more manageable goals.

#### **Extract 12**

*I think breaking things down into small goals and being able to reach that target so perhaps having some way of setting yourself a goal..but encouraged to do a small goal that is attainable so that you know..because obviously the more that you can achieve the more* (Chage4Life advisor, FG1).

The Change4Life advisors also highlighted the importance of families being able to choose different goals to suit their needs as every family's needs and preferences to tackle healthy eating might be different.

#### **Extract 13**

*yeah.. obviously with every family being very different so for one family it might just actually be going to the supermarket and trying something new* (Change4Life advisor, FG1).

#### **5.6.5 Visual aids**

Both parents and Change4Life advisors agreed that it was important to have visuals of foods in the app as to oppose to text based content. According to the Change4life advisors, visuals in the app could illustrate the amount of sugar in foods as well as having a rainbow colours of different fruits and vegetables which may encourage families to increase the variety of these foods in their diets.

#### **Extract 14**

*And it's actually this much sugar..Visual aids..you know..it's a very powerful tool..a rainbow that can help them to look and see to try different colours and so trying to broaden the nutrients that they get that way' (Change4Life advisors, FG1).*

Whereas parents' expressed their desire for a quick visual reference guide for different foods they can prepare meals with.

#### **Extract 15**

*Well it's gonna be a visual database isn't it so it's going to have, I would of thought, lots and lots of different things, um and basically you are drilling into something that suits yourself (Parent, FG4).*

Similarly, people's preference for graphics over text has also been reported in other mHealth research adopting a UCD approach (Buller et al., 2013).

With regards to the target behaviour one suggestion was to illustrate age appropriate portion sizes using plates.

#### **Extract 16**

*.. pictures were given in the group of the portion sizes of what food groups you should have.. what quantity of.. and we've got that on the dining room table and the kids actually say that's me chicken and that's me veg.. and we try to visualise that on the plate so we get roughly the amounts right...I think that would help (Parent, FG3)*

Using plates to provide visual cues for portion sizes may not be practical in an app. Such a feature would be difficult to implement accurately as the plate size shown in the app may not be representative of the actual size plates families have in their households. In addition, there is likely to be variations between families' household plates, where they have increased in size over time.

#### **5.6.6 Communication tool**

Both parents and Change4life advisors highlighted the difficulty that parents had in communicating to their children (Section 5.5.2.2) and partners (Section 5.5.3.2) in regards to issues around healthy eating and weight.

#### **Extract 17**

*A couple of the parents.. have said that if we had anything aimed at the children because they've tried to make small changes but the child isn't really taking it on board or hasn't got the motivation..or they don't feel the child understands so if we had anything..any booklets aimed that age child for them to give to the child to read.. (Change4life advisor, FG1).*

Consequently, parents felt that it would be helpful if the app could facilitate communication around issues of healthy eating, without triggering arguments among family members.

#### **Extract 18**

*..within the family as well you could challenge you know doing it together.. just to help with communication as well (Parent, FG5).*

*I think that would be a bit more a benefit of an app because it is agonizing and one has to argue about one more where one has already argued about putting on clothes and all this kind of things (Parent, FG6).*

### 5.6.7 Gamification

Parents and Change4Life advisors suggested several fun features to engage families in changing their behaviour which related to attributes of gamification defined as ‘the use of game design elements in non-game contexts’ (Deterding & Dixon 2011:1). Within gamification, which when applied to health behaviour change interventions can be referred to as ‘gamified health’, desired behaviours are incentivised and rewarded to help increase people’s motivation and to support maintenance of their habits over time (Lister et al., 2014:9). According to Nicholson (2012), a common application of gamification relates to the scoring elements of video games including points, levels and achievements and applying these in an educational or organisational setting. For the current research, suggestions included a challenge that families could compete in together and a point system for healthy eating behaviour. Parents felt that children would enjoy these kinds of interactive components and would experience it as almost a game.

#### Extract 19

*Or you could have something that you could add, what have you had today? Yes I have had one of those, one of those right you get 50 points but I’ve also had one of those, deduct 20 points (Parent, FG5).*

In addition, parents also felt that the app could function as a challenge involving the whole family.

#### Extract 20

*.. within the family as well you could challenge you know doing it together.. (Parent, FG5).*

Parents were asked to expand on this idea in regards to whether they would like to compete with other families. However, parents reported that they would be hesitant to compete with people outside of the family. One parent felt that this could expose their children to ‘cyber bullying’ amongst their peers.

#### **Extract 21**

*Might be safer in families. Cyber bullying if they start doing it with the friends..*  
(FG5, Parent).

This also suggests that parents have a preference for keeping their families health information private which is also supported in other research on mHealth intervention design (Dennison et al., 2013).

Other elements of gamification related to Change4life advisors suggestions for inclusion of a Quiz that could provide tips for healthy eating.

#### **Extract 22**

*You could have little quizzes or something, ‘if you’re feeling a bit low or needed a quick fix, what would you go for?’* (Change4life advisor, FG1).

Parents also reported that if game features were to be implemented into the app, it was important that the information the game provided was personal to them, as well as attractively displayed.

#### **Extract 23**

*P3: If it was a game.*

*P2: If it’s personal information to them ...*

*P7: Yeah.*



*P2: ... and it's giving them information then it needs to be attractive for them as well. (Parents, FG5)*

The above extract highlights the importance of 'meaningful gamification' which according to Nicholson (2012), refers to information that is meaningful to the user, and in turn, triggers their internal motivation to engage in a game. In this case, there is less need to implement external rewards to increase users' motivation (2012:1).

Gamification techniques have been used in industry for some time now with regards to helping to improve employees productivity e.g. employee rewards and incentive programmes, and have grown significantly in the last few years with applications now in finance, health, education, news and entertainment (Deterding & Dixon, 2011). Although gamification in mobile apps has become a fashionable strategy within both industry and academia for influencing users' behaviours, there is a paucity of research confirming its effectiveness and functionality (Lister et al., 2013). Nevertheless, in a recent review of health apps in Apple's App store, Lister et al., (2013) found that firstly, the use of gamification in health apps has become prevalent; 52.5% (137/261) of health apps in their sample contained at least one element of gamification and 23.8% (62/261) contained at least half of the 6 most commonly used elements of gamification. Secondly, the purpose for the use of gamification was coded as encouraging users to interact with the app more (14.4%) and encouraging users to complete tasks (32.6%) or both (43.2%).

#### **5.6.8 Parental use of mHealth apps & relationship with their smartphone**

With regards to parental use of mHealth apps, 'MyFitnessPal', 'MapMyRun', 'Nike FuelBand' and the 'Slimming World' apps were cited.

#### **Extract 24**

*There is a really good app on MapMyRun, there's nutrition app attached to map my run...um..you can log your calories, it logs your run as a negative and then it logs the amount that you have eaten as a positive and then you can see how many calories you've got left for the day, so you don't have to be on a diet, you can just keep an eye on you know.. (Parent, FG3).*

It is important to acknowledge that parents discussed the use of mHealth apps to address their own weight issues rather than their children's weight issues. This could suggest that parents may be more preoccupied with their own weight compared to their children's weight, and/or there are a lack of mHealth apps targeting parents for childhood weight management, as reported in recent research (Schoffman et al., 2013) (Section 2.3.2).

Lastly, it emerged that parents may not want to be 'hassled' by automated email alerts if they were not regularly using the app.

#### **Extract 25**

*P3: I use it a bit and then stop..and then go back to it..*

*M: What makes you go back to it?*

*P3: I don't know it's just I haven't sort of checked in a while or*

*M: Does it send you an email alert?*

*P3: Oh no.. Oh no it doesn't hassle you, it's a free app..so no it doesn't hassle you (Parent, FG3).*

The extract above also suggests that people may use apps intermittently and make their own decisions as to whether to start using them again, as opposed to responding to emails prompting them. Hence, the app may need to employ other strategies to engage parents in using the app other than email alerts.

Although most of the parents in the focus groups had a smartphone, parents interacted with their phones at different levels. Some parents commented that they had minimal use of their smartphone and only used it to answer calls, while other parents were more engaged with their smartphones and felt that it was difficult to live without it. As previously mentioned above, some parental use smartphones as tools for supporting their own nutrition and exercise behaviours.

#### **Extract 26**

*P7: I think mine is a smart phone but I don't use it. I don't go on ... for only a minute at a time...I don't know what it does. I just answer the phone.*

*P3: I'd be lost without my phone.*

*P6: Well that makes two.*

*P5: Yes, we know [parent's name]... (laughs) (Parents, FG4).*

### **5.7 Summary of parental preferences healthy eating app features**

Analysis of focus group discussions involving parents and family weight management caseworkers revealed several important findings that have implications for the proposed healthy eating app. One of the main features that parents wanted in a family healthy eating app was a tool that provided recipes and ideas for meals that they could prepare with their household ingredients. In addition, parents felt that it was useful to receive information on the healthiness of food and where a traffic light system could be used to indicate the healthfulness of selected foods. With regards to usability, parents felt that it was important that the app was quick and easy to use with minimal data input and where visual aids for food were provided for quick reference. Both Change4life advisors and parents also felt that

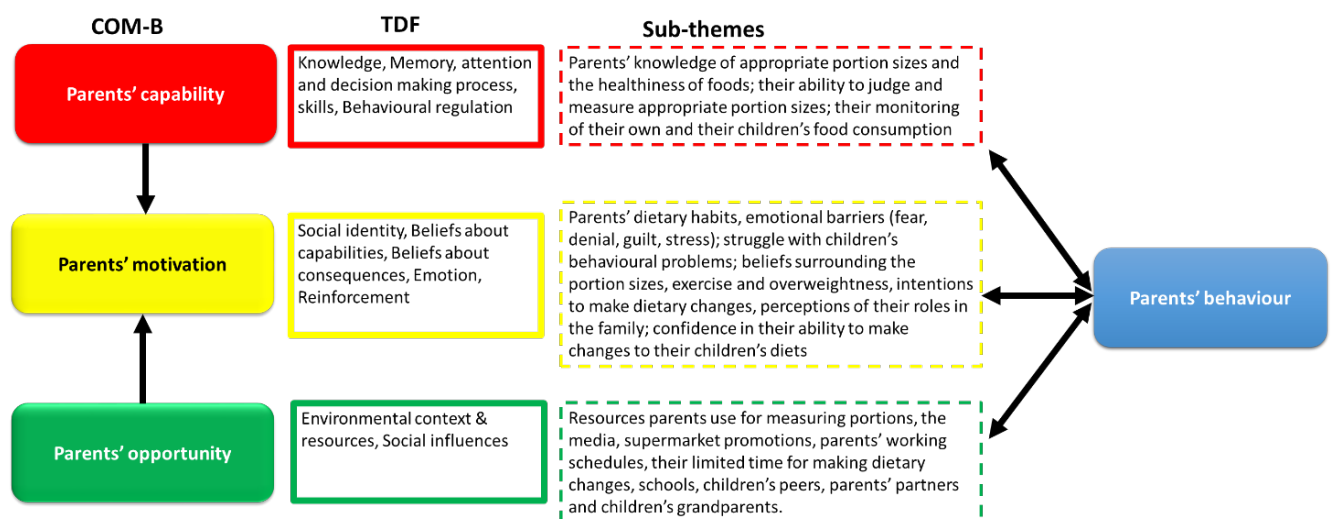
‘gamifying’ the app would make it a fun app for the family to engage with, including potentially increasing children’s involvement with the proposed mHealth intervention. Parental use of existing mHealth apps related more to their own eating behaviours, which in part, reflect the market which is saturated with adult weight management apps. Lastly, parents’ relationship with their smartphones ranged from simply making calls, to supporting their nutrition and exercise behaviours.

## **5.8 Discussion**

In addressing the gap of few theory-led research studies in this area, this study represents the first UK study to apply the COM-B model and TDF to help explore parental portion size behaviours with their children. The majority of participants were also on family weight management programmes which afforded the chance to explore their insights into the issue (i.e. where parents were more able to reflect on what their barriers have been up to now). Therefore, the study is the first to provide comprehensive detail on parental regulation of their children’s food intake considering rational and automatic processes, capabilities and external influences on the food gatekeepers. The use of a UCD approach also provided insights into parental preferences for healthy eating app features which has not been researched before at the time of writing and will help to translate these theoretical findings into acceptable and engaging app features (Chapter 6).

The theoretical findings suggest that parental food portion behaviours are influenced by habitual, emotional, reflective and environmental processes, which challenges the appropriateness of existing theories and models for guiding intervention development. Taking into account that the complexity of childhood weight management is amplified when attempting to target and understand parental influences on children’s behaviours (Skelton et al., 2012), conducting a COM-B analysis of parental portion control behaviours has allowed a

more in depth and comprehensive understanding of the intricacies of childhood weight management which has not been possible with prevailing theories of behaviour change (e.g. TPB) and family functioning (e.g. EST). As shown in the thematic report, various aspects of the model was supported by the literature which provides further support for the influences of these psychological components in addressing childhood weight management. Now for the first time, using the COM-B and TDF theoretical tools, the thesis is able to provide a conceptual model (Figure 21) on the determinants influencing parental portion behaviours with their children.



**Figure 21: COM-B & TDF analysis of parental food portion behaviours within the context of childhood weight management**

Further contributions to knowledge will be discussed in the main discussion section of the thesis for the first part of this study using the COM-B and TDF theoretical tools (Section 9.2.2) and the second part of this study on parental preferences (Section 9.2.3).

There are however, a number of limitations that provide opportunity for future research. Firstly, the sample was homogenous in that the majority of parents of overweight children (main target population) were white British; and recruited from existing family weight management programmes (WMPs) that they were already enrolled in. Change4life advisors

were initially used a way to recruit families but this conflicted with another study they were recruiting for, a problem reported in other research attempting to recruit children from public health service staff (Schlarmann, Metzger-Blau, & Schnepp, 2011). However, as noted in review of recruitment in research, the recruitment phase often takes more time or is more challenging than expected (McDonald et al., 2006). Consequently, the current research was reliant upon the WMPs demographic of parents, their attendance to the programmes and the locations in which they took place. Indeed, there were often high non-attendance rates into the weight management programme, a well-documented limitation of existing WMPs (Section 1.4).

Issues of missing data were also limitations in this study. For example, demographic data pertaining to parental socio-economic indices (age, income, levels of education, total numbers of children in the household, marital / partnership status, family received public assistance etc.) or parental BMI and health status were not included in the study as these were not provided by the WMPs. The only data that the WMP's collected and could provide for the current study were a limited set of demographics and child measurement information (e.g. age, gender, height, weight). However, there was also missing data for children's demographics across all focus groups where parents recruited from the WMPs either missed the session where children were measured and parents recruited from the university refrained from providing this information when requested. For the latter, this highlights again the sensitivity of the issue as some parents in the 'healthy group' may have had overweight children and did not want to share their height and weight measures. At the same time, these factors provide opportunities for further research with diversified sampling both in terms of race/ethnicities and income groups. Moreover, due to the study design, the results are subject to parents own perceptions of the influences of their behaviours, including possible 'attributional biases' and therefore may not actually represent the actual determinants of their

behaviour (Francis et al., 2012:7). However, to mitigate the effects of potential mismatch between participants' self-reported attitudes, intentions and their actual behaviour (Gallagher & Updegraff, 2012), triangulation of data was obtained from a focus group with Change4Life advisors to help verify, contrast, and expand on parental perceptions as well as their behaviour. In addition, a review of the literature helped to support some of the findings.

## Chapter 6 Translating research findings into app features

The last two chapters explored the first stage in the intervention development process. While the COM-B and TDF tools were used to identify the theoretical domains to target in the intervention, a UCD approach was used to gather information on parental preferences for app features. Qualitative data on parental preferences could then be used to translate the identified theoretical domains (and BCTs identified in Section 6.5) into app features. However, translating research findings into app features also requires a consideration of the feasibility and practical context of the intervention, necessitating the need for an iterative approach (Brendryen, Johansen, Nesvåg, Kok & Duckert, 2013). A decision making criteria was developed in Step five to ensure that a systematic method was used pertaining to which user preferences could be taken forward in the next stage of the development process.

### 6.1 Step 5: Criteria for selection of user preferences

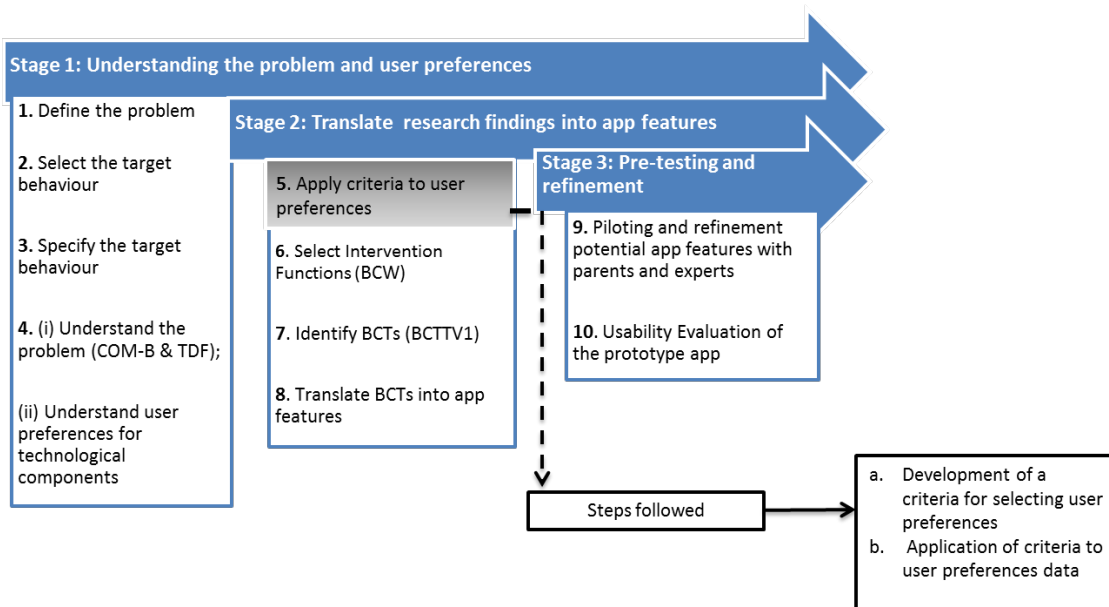


Figure 22: Step 5 - Development and application of criteria to select user preferences



Each ‘user preference’ within the themes identified in Step four (ii) (Section 5.6) were either ‘rejected’, ‘partly accepted’, or ‘accepted’ depending upon their alignment with each of the following criteria: (i) Relevance to the target behaviour (parental provision of appropriate portion sizes for their children and themselves); (ii) Availability online (e.g. already apps available with these features); (iii) Ease of implementation (e.g. development time and cost); (iv) Alignment with usability and user experience recommendations (Preece et al., 2002) and (v) Support from theoretical findings and/or literature. A positive value (+) was assigned to the user preference if it aligned with the criterion, whereas a negative value (-) was assigned if it did not.

Relevance to the target behaviour was seen as crucial and hence, some of the user preferences were partly accepted where the user preference was adapted to the target behaviour. For example, parents’ expressed the desire for a feature involving the whole family in cooking and this was therefore adapted to involving the whole family in portion control.

A total of 20 user preferences were extracted from the focus group discussions. Of these, three appeared across more than one participant group (e.g. Change4Life advisors, parents recruited from a family WMP and parents recruited from a university). Of the 20 user preferences, three were rejected, five were partly accepted and twelve were accepted. An excerpt of the user preferences are shown in Table 9 below where (+) or (-) values are applied to each criterion to indicate why each user preference was rejected, half-accepted or accepted. The complete table of this process can be found in Appendix 2A.

**Table 9: Excerpt of decisions for rejecting/accepting user preferences**

Themes	Codes/user preference	Participant Groups	Rejected/ Accepted	Reason
<b>Increasing parents' knowledge of recipes and healthier foods</b>	Recipe output of household ingredients	Parents (FG2-5)	Rejected	(i)Not relevant enough to target behaviour (-); (ii)Already on the market (-) (iii) Not within budget (-); (iv) Aligned with user experience goals (+); (v) Not supported by research findings (-)
<b>Parental monitoring of children's weight and food intake</b>	Useful to have a chart to show children's weight and the difference small changes can make	Parents (FG2-5), Change4Life advisors (FG1)	Rejected	(i)Not relevant enough to target behaviour(-); (ii)Already on the market (-) ; (iii) Aligned with user experience goals (+), (v) Do not want to position the app as a weight management app which may induce stigma in using the app (-) (emotion, Section <b>Error! Reference source not found.</b> ), (v) supported by theoretical findings and literature (parent's find it difficult to recognise their child is overweight) (+)
<b>Goal setting</b>	Every family is different so need different choices of goals	Change4Life advisors (FG1)	Accepted	(i)Relevant to target behaviour(+) ; (ii)Not already on the market (+); (iii) Within budget (+); (iv) Aligned with user experience goals (+); (v) Supported by literature (-) (section 3.3)
<b>Time saving and convenience</b>	Needs to be minimal data input	Parents (FG2-6)	Accepted	(i)Relevant to the target behaviour (+) (e.g. high sugar content means you have to have smaller portions of it); (ii) Already on the market (-); (iii) Within budget (+); (iv) Aligned with usability goals (+); (v) Parents perceived time constraints as an important barrier (+)
	Having an Eatwell plate that allows you to choose food style	Change4Life advisors (FG1)	Partly accepted	(i) Aligned with the target behaviour - Some form of the eatwell plate should be included but for the purpose of portion sizes and food frequency instead of different culture foods and style (+)
	Portions of foods shown on plates	Parents (FG2)	Rejected	(i)Relevant to the target behaviour (+); (ii) Not already on the market (+);(iii) Difficult to implement as household plates differ in size (-); (iv)Aligned with user experience goals (+);
<b>Communication tool</b>	A way to help parents talk to their children about food	Parents (FG6)	Accepted	(i)Relevant to the target behaviour (+); (ii) Not already on the market (+);(iii) can be implemented (+); (iv)Aligned with user experience goals (+); (v) Supported by theoretical findings (+). The App itself can function as communication tool between families.
<b>Gamification</b>	A challenge for the whole family to compete in	Parents (FG6)	Accepted	(i)Relevant to the target behaviour (+); (ii) Already on the market (-) (iii) Within budget (+); (iv) Aligned with user experience goals (+), (v) supported by theoretical findings and literature (helping families to work together) (+)

Key: i) Relevance to the target behaviour; (ii) Availability online; (iii) Ease of implementation (e.g. development time and cost); (iv) Alignment with usability and user experience recommendations; (v) Support from theoretical findings and/or literature.

### **6.1.1 Criterion (i) Relevance to the target behaviour**

Any preference for app features not directly related to the overall target behaviour which could not be adapted to fit the target behaviour, was rejected (apart from those relating more to the usability and user experience of the app e.g. quick and easy to use). In addition, consultations with the app company led to concerns that offering too many features not related to the target behaviour may dilute the overall aim of the app (with regards to a focus on portion control) and that it was more beneficial to retain the app's simplicity.

For the target behaviour to occur, parents require an understanding of (i) the relative balance of food groups; (ii) the frequency of daily portions recommended in each food group; and (iii) the size of portion sizes. For example, many parents indicated a preference for an app that could provide recipes based on household ingredients.

However, although the app could offer a recipe tool that provides guidance on portion sizes as well, this may not have resulted in parents and children understanding the relative balance of food groups and their relative portions.

The idea for a chart to show children's weight percentiles (refer to Table 9) was also rejected because decisions were made to position the app as a healthy eating app as opposed to a weight management app to help reduce parental concerns in relation to their children becoming anxious about their weight (Section 5.5.4.2). With regards to the child, it is important that the app does not stigmatize them and/or cause them to experience anxiety about their weight.

Parents and Change4Life advisors also reported a preference for an area in the app that could provide information on healthier substitutes to foods e.g. turkey sausages instead of pork sausages. This was not taken forward at this stage because the focus

of the intervention was not on changing the content of the diet but rather on the relative portions of the existing diet, however this user preference that was revisited in study two (Section 7.4.2.1).

### **6.1.2 Criterion (ii) Availability online**

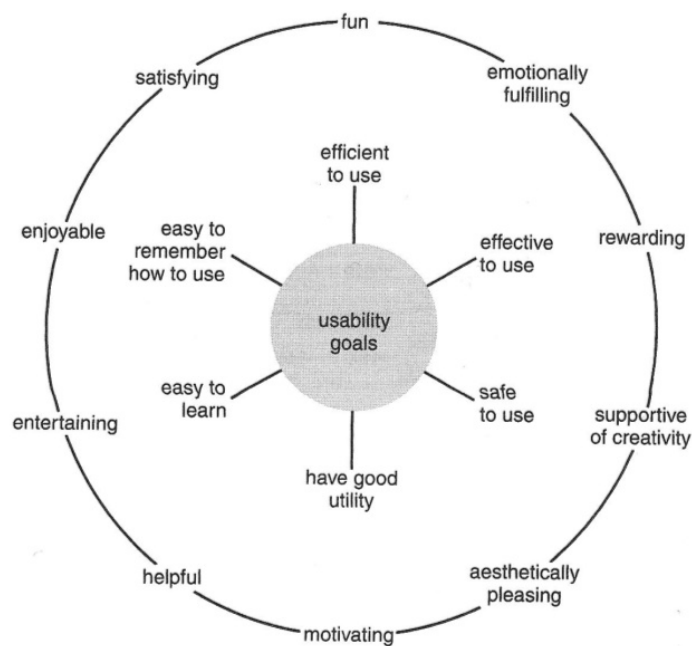
It became clear after reviewing existing websites and apps available to consumers, that the market is saturated with online resources (including both websites and apps) for healthy recipes including the new Change4Life app aimed at families. In addition, the review also found websites and apps (e.g. MyFridgeFood & GroceryHero) relating to parents' desire for a recipe tool using their household ingredients (Section 5.6.1). Therefore a decision was made to provide links to these resources instead of reproducing a similar tool in the app them.

### **6.1.3 Criterion (iii) Ease of implementation**

Consultations with the app company facilitated decisions on whether user preferences were: (i) practical to implement in an app and; (ii) whether their implementation was in line with development time and cost. For example, parental preference for providing examples of different age appropriate food portions on a plate (Section 5.6.5), would be difficult to implement with regards to representing the recommended size of portions in an app where household plates vary in size. Instead, there needs to be a visual cue that has less variability than the objects in their environment.

#### 6.1.4 Criterion (iv) Alignment with usability and user experience recommendations

The model of usability and user-experience goals developed by Preece et al., (2002), was applied to the data to help to support decisions on which user preferences aligned with important usability and user experience factors identified in Figure 23 below.



**Figure 23: Usability and User Experience Goals (Preece et al., 2002)**

According to Rogers et al., (2011), usability refers to whether interactive products are easy and efficient to use where the usability goals are shown at the centre of Figure 23. For example, parents felt that it was important that the app was quick and simple to use which aligns with the usability goals of 'easy to learn' and 'easy to remember how to use'. The outer circle shows the user experience goals which cover a range of subjective qualities relating to users' emotions and experiences of using the product. For example, both parents and Change4life advisors expressed their desire for fun visuals of food portions which aligned with the user experience goals

of ‘fun’, and ‘aesthetically pleasing’. However, at this stage in development, the model was only applied loosely to the existing data to gain an overall picture of the user preferences that may align to usability and user experience goals. The model was explored further with parents in Study two, where it was used to structure questions to gain feedback on potential app features with parents (Section 7.2.5).

#### **6.1.5 Criterion (v) Supported by theoretical findings and or evidence**

This criterion was important for linking the user preferences to the theoretical findings in Step five. For example, parents reported a preference for a tool that could help them communicate with their children regarding food matters, without causing an argument. This reflected the theoretical finding regarding parents’ difficulty in their interpersonal skills with their children (Section 5.5.2.2).

### **6.2 Implications for mHealth development**

Focus group discussions revealed a number of barriers towards parental dietary behaviours with their children along with a number of parental preferences for healthy eating app features. Decisions regarding which sub-themes (i.e. sub-themes relating to TDF themes) to retain for app development depended on their relevance to the target behaviour, setting and population. Consultations with the app company also helped to make decisions on whether they were amenable to change in an app. Furthermore, collecting data on parental preferences where participants provided ideas on how to implement some of these themes (e.g. a graph for targeting parental recognition of their child’s weight), resulted in further decisions.

This resulted in the exclusion of the following sub-themes which were either (1) related to the macro-environment as oppose to the home environment including: the media, supermarkets, food packaging, recipes, peers, teachers, schools; (2) not as

amenable to change in an app and out of the scope including: parental stress and children's behavioural problems (which relates more to the topic of familial stress and parenting, requiring a different intervention) and; (3) not related to the target behaviour of managing portion sizes and which were seen as more relevant to the childhood weight management programmes including: social comparison, parental denial of the problem and parental recognition of children's weight (a list of codes taken out can be found in Appendix 1H). The themes that were taken forward for app development are presented in the Intervention Mapping Table (Table 10).

### **6.3 Intervention Mapping Table**

The results of the thematic analysis presented in Table 10 below, allow for a behavioural diagnosis of the problem where components of COM-B and TDF are clearly mapped together and supported by quotes from the dataset. This table represents a vital output of the qualitative data analysis that became a tool for the intervention content development. It was expanded on at each stage of development and also revisited several times and modified based on results from each stage in the process. For example, it was not always clear which theoretical determinants could be sufficiently targeted in an app until they were operationalised. In addition, the UCD approach helped to make decisions on certain aspects to exclude such as the construct of 'social comparison' as a result of parents' preference not to compete with other families or allow their children to see their weight on a chart compared to other children.

**Table 10: Intervention mapping table showing behavioural diagnosis**

Com-B	TDF	Sub-themes	Example quotes – Change4Life advisors (Focus group 1)	Example quotes - Parents (Focus groups 2-6)
Psychological Capability	Knowledge, Memory, attention and decision making processes	<i>Parental lack knowledge and have a difficulty in making decisions on appropriate portion sizes</i>	But when I say to people what's your child's portion size in relation to yours..I mean one dad, said 'well actually she eats the same as me' cos they've had a Sunday Dinner and the daughter who is 11 would have the same size meal as him	Until I came here, I didn't really know much about portion sizes at all
		<i>Parental lack knowledge on the balance of food groups</i>	You often don't get the families that understand the balance do they of foods..you know you get the 'eatwell' plate with tiny portions of fats..and..I don't know if everyone went to training last week but the 'naughty but nice' section. (laughs).I just don't think they understand how much one chocolate bar actually is or how much fat is actually in a portion of chips, it's very hard to try and get that across I think..	P3: It's difficult isn't it? I think maybe, well what we've done, the picture were given in the group of the portion sizes of what food groups you should have what quantity of and we've got that on the dining room table and the kids actually say that's me chicken and that's me veg and we try to visualise that on the plate so we get roughly the amounts right, the portion's too big but the ration is roughly right but i think if there was like a poster or a plastic plate that you could get for a 6 year old,



				an 8 year old and a 10 year old, so that you knew, roughly what you should be giving and i think that would help
	<b>Skills (ability)</b>	<i>Parents' difficulty in measuring food portions</i>	But when I say to people what's your child's portion size in relation to yours..I mean one dad, said 'well actually she eats the same as me' cos they've had a Sunday Dinner and the daughter who is 11 would have the same size meal as him	For me, I find it particularly difficult dishing out the correct portion size for children and for adults, I suppose. I just tend to give everybody the same amount. I suppose I've, sort of, justified that in a way that I'm dieting so I'm actually having less of a portion size, so hers was equal to mine and that's the way I, sort of, justified it in my mind, but that's probably not the right way to do it
	<b>Skills (interpersonal)</b>	<i>Parents' difficulty in communicating with their children and partners around eating and weight issues</i>	I actually think they find it quite difficult, especially at Year 6 when the young people are starting to formulate their own habits and they do have a lot of opportunity to kind of go against what parents are advising as well really, and I think it's quite difficult to get the message	Yeah, I think if you give them a smaller portion size, then Daisy will say why have I got less and doesn't really understand that she's got a smaller body and needs less than adults do.

Reflective Motivation			across and encourage that health change behaviour without becoming something else that is a bit of a battle	
	<b>Behavioural regulation</b>	<i>Parental regulation of their own portion sizes and their children</i>	But when I say to people what's your child's portion size in relation to yours..I mean one dad, said 'well actually she eats the same as me' cos they've had a Sunday Dinner and the daughter who is 11 would have the same size meal as him	From my own experience, you tend to give them what you see as adequate, that's your mind thinking more about you more than the kid, so I know for a fact we give our kids too large portions, far too big, but when we do measure them out and put them in the bowl it doesn't seem much but it's adequate for them so in effect we are over filling them
	<b>Social identity</b>	<i>The role of the mother</i>	Even when you phone up they are like 'oh you need to speak to my wife about that' or mother about that..it's like they can't make a decision..or they don't want to deal with it	All that takes time to prepare and you don't have that time.

	<b>Beliefs about capabilities</b>	<i>Parents have a lack of confidence in their ability to make changes to their children's dietary behaviours and weight</i>	I think if you've got..I mean i've spoken to mum's and they've still tried to lose weight in the past and tried every diet going so they've tried it all for themselves. How will are they to try it for their child?	What are your thoughts on how confident you feel in successfully making changes to your children's diet?  'I'd give in too easily' 'Not very confident'
	<b>Beliefs about consequences</b>	<i>Parents' difficulty in linking childhood and adulthood overweight with health risks</i>	P3:I've got one family where mom's got diabetes, dad's dad died of a heart attack really young, his brother had died really young, he wasn't in good health at all, mom wasn't in good health. The one day I went for a visit and her sister had just been taken into hospital with a heart attack but they couldn't relate that to any sort of.. M: being overweight P3: No	I think for me it's the teasing, you know, the peer pressure because I was teased really badly at school for being overweight and that's my main memory of secondary school just being told you're fat and you know and I don't want them to go through that.

		<i>Parents' belief that portion sizes take too long to measure</i>	N/A	I don't weight out my portion to know what it is..or even if they say per so many grams, I still don't have the time to figure out..I just don't want to
		<i>Parents' belief that they do not need to change children's eating behaviour if they do more exercise</i>	..they do quite a lot of exercise and so they feel they're doing really well when actually even the people who do go to football or Rugby three times a week, they're only doing what they should be doing anyway....and they're then giving that food extra food which they don't need	Yeah..we're just trying to get him more active, badminton, squash and cycling, stuff like that. With the weather coming..so we're hoping to exercise it off him (laughs) rather than doing anything too drastic with his diet, we're putting more veg on
<b>Automatic Motivation</b>	<b>Reinforcement</b>	<i>Parents' eating and shopping habits</i>	Yeah I think also when planning it's also by your own eating habits. So if you don't like vegetables then you will be less likely to cook vegetables for your kids	You get the families where it's the child that's trying really really hard and you can see they're trying really hard but the mum and dad do have the full sugar coke in the fridge

	<b>Emotion</b>	<i>Parents' guilt of restricting food</i>	I think some families its more..I love you to death..cos they don't stop their child from having that chocolate bar and saying to them 'you can't have that chocolate bar but you can have a piece of fruit instead'. They haven't got that strength in them because they feel like they are being mean	I'll just make anything into a guilt trip for myself I think that's all. So food is one of those.
		<i>Parents' fear of child becoming anxious about weight/eating disorders</i>	<i>when you're contacting year 6 parents where the young people are overweight..the parents don't necessarily want to bring up the subject because of they're age.</i>	Well he's only just joined the senior school so I don't want to overload him with too many worries ...we don't want him to go the other way and you know..have anxieties about that

Physical Opportunity	Environmental context and resources	<i>Parents' resources for measuring portion sizes</i>		<p>yeah tea cup and then it would be so much easier..</p> <p>And this is what my issue with my husband giving them far too much is that he is using pasta bowls that's adult size deep dish bowls that go one forever..</p>
		Not enough time to figure out portion sizes		I don't weight out my portion to know what it is..or even if they say per so many grams, I still don't have the time to figure out..I just don't want to
Social Opportunity	Social influences	Grandparents	..On a positive note..um..some of my families..they are really trying to make this change but Grandma..they go over to Grandma's and Grandma is giving them all this stuff!!	When he was writing his meal for yesterday, bearing in mind that I thought I was with him all day yesterday, because we all live with my parents, and he said 'I had a penguin' and I said 'when did you have that? Did Nanny give it ya?' 'Yeah'.

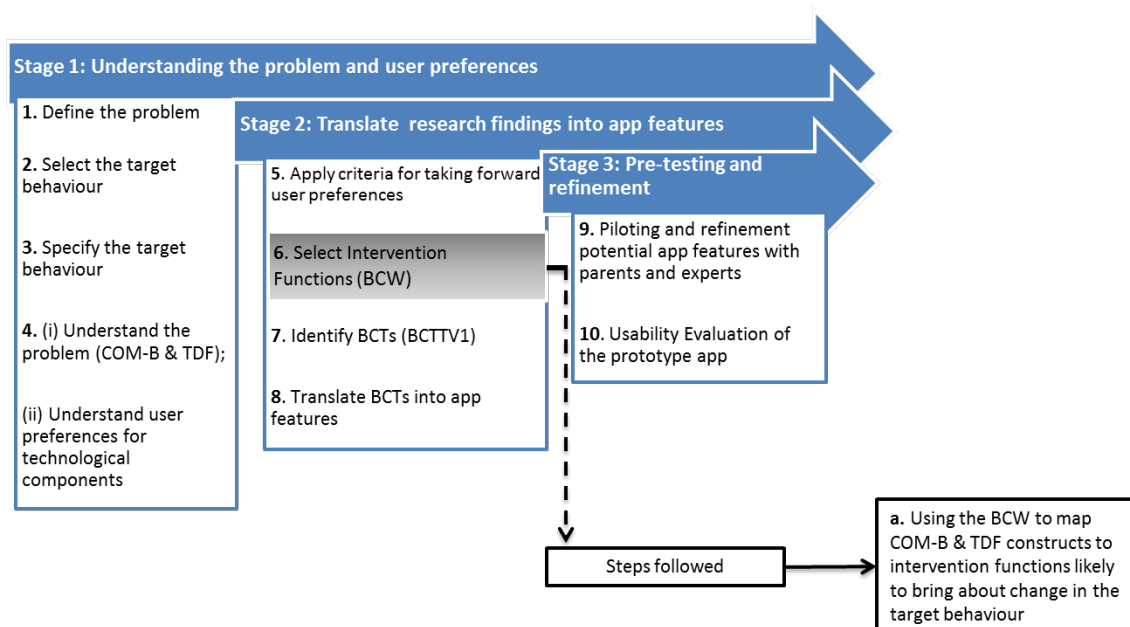
		Partners		Well I'm relying on the kids now to say to daddy you need to put some vegetables on the plate because I've given up trying to tell him..
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### **6.3.1 Consultation with Health Psychologists**

Before moving onto the next stage of intervention development, Table 10 was also reviewed by two health psychologists specialising in behaviour change and familiar with the BCW framework. This helped to verify that the mapping process was valid and that each quote represented the relevant TDF domain. This process yielded no disagreements and therefore no amendments were made to the table.



## 6.4 Step 6 - Select Intervention Functions (IFs)



**Figure 24: Step 6 - Select intervention functions**

According to Michie et al. (2013) the ‘behavioural diagnosis’ drawn from the COM-B and TDF tools for understanding the behaviour represent the foundations for intervention design. Once the ‘profile’ of COM-B and TDF domains have been identified as important ‘levers for change’ (Michie et al., 2013: 36), the next stage is to select from a range of intervention functions provided by the BCW framework (Michie et al., 2014b).

The BCW framework provides a table mapping relevant intervention functions likely to bring about change in specific COM-B and TDF domains to help conduct this task. However, it was also necessary to review the behaviour change techniques that the BCW has mapped to intervention functions to see how they align with the TDF

domains identified. Therefore, the mapping process underwent a cyclical process where BCTs were mapped back to intervention functions.

This activity resulted in the identification of five key intervention functions:

Education, Training, Persuasion, Environmental restructuring and Enablement as shown in Table 11. The following four intervention functions were not selected at this stage: Incentivisation - not selected because the BCW maps this to the Motivation domain of the COM-B model and Training and Enablement accounted for the BCTs that were relevant for bringing about change in the TDF domain of Behavioural Regulation; Coercion – not selected because this related to no BCTs and is unlikely to be acceptable for parents within this context; Restriction – not selected because this is not practical within the context of an app; and Modelling – not selected at this stage as parents are not modelling anyone, however, this is considered an intervention function in the case of children modelling their parents.

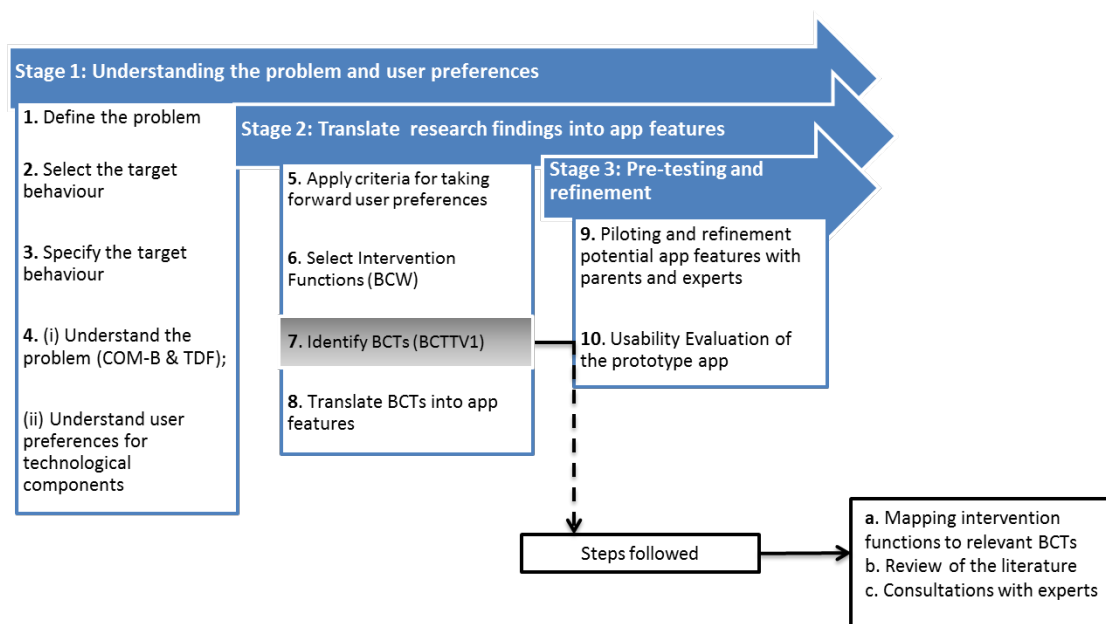
The results from this step are shown in Table 11 below where IFs have been mapped to the findings from Stage one: Step four (i), in the intervention development process. Examples of how IFs can be implemented within the context of supporting parents in childhood weight management are also provided.

**Table 11: TDF and IF mapping table**

Stage 1 (Steps 1-4)			Stage 2 (Steps 5-7)	
COM-B	TDF	Sub-themes	IFs	Example
<b>Psychological Capability</b>	Knowledge, memory, attention and decision making processes	Parents lack knowledge and have a difficulty in making decisions on appropriate portion sizes	<b>Education, Training</b>	Educate parents on appropriate portion sizes for children
		Parents lack knowledge on the balance of food groups	<b>Education, Training</b>	Educate parents about the balance of food groups
	Skills (cognitive)	Parents' difficulty in measuring food portions	<b>Training</b>	Train parents to measure portion sizes
	Skills (interpersonal)	Parents' difficulty in communicating with their children and partners around healthy eating and weight issues	<b>Environmental restructuring</b>	Provide a tool and cues for parents to communicate with their children and partners
	Behavioural Regulation	Parents' regulation of their own and their children's portion sizes	<b>Training, Persuasion, Enablement</b>	Train, persuade and enable parents to monitor their children's food portions
		Parents' eating and shopping habits	<b>Training, Persuasion, Enablement</b>	Train, persuade and enable parents to break their dietary habits
<b>Reflective Motivation</b>	Intentions	Parents' intentions to make changes to their children's dietary behaviours	<b>Persuasion</b>	Persuade parents to commit to making changes to their children's portion sizes
	Social identity	Role of the mother as primary caregiver	<b>Persuasion (functions as modelling for their children)</b>	Persuade parents to identify themselves as role models for their children
	Beliefs about capabilities	Parents have a lack of confidence in their ability to make changes to their children's dietary behaviours and weight	<b>Education, Persuasion, Enablement</b>	Educate, persuade and enable parents to increase their self-confidence in making changes to their children's eating habits.
	Beliefs about consequences	Parents' believe that portion sizes take too long to measure	<b>Education, persuasion</b>	Educate and persuade parents of the short time it takes to measure food portions
		Parents' belief that they do not need to change children's eating behaviour if they do more exercise	<b>Education, Persuasion</b>	Educate and persuade parents that children do not necessarily need extra food when they exercise
		Parents' belief that if they overcook, they will overfeed their families	<b>Education, persuasion</b>	Educate and persuade parents not to cook too much which will help to reduce waste
		Parents' difficulty in linking childhood overweight with health risks	<b>Education, persuasion</b>	Educate and persuade parents of the health risks of childhood and adulthood overweight
<b>Automatic Motivation</b>	Emotion	Parents' guilt of restricting food	<b>Persuasion</b>	Persuade parents of the emotional benefits of balancing food portion sizes to maintain a healthy weight
	Reinforcement	Parents' dietary habits	<b>Training</b>	Train parents to break unhealthy habits and develop new healthier ones
<b>Physical Opportunity</b>	Environmental context and resources	Parents' resources for measuring portion sizes	<b>Environmental restructuring</b>	Restructure the environment to provide a tool for measuring food portions
<b>Social Opportunity</b>	Social influences	Grandparents	<b>Enablement</b>	Enable family members to offer support to one another in balancing their portions of food throughout the day
		Partners	<b>Enablement</b>	

The next step involves delineating these intervention functions into specific behaviour change techniques (BCTs). The authors of the guide purposely used the term ‘functions’ to indicate that BCTs can have more than one intervention function (Michie et al., 2014b).

## 6.5 Step 7: Identify Behaviour Change Techniques (BCTs)



**Figure 25: Step 7 - Identify BCTs**

According to Michie et al., (2013) a behaviour change technique (BCT) refers to an ‘active ingredient’ and mechanism of change that is an ‘observable, replicable and irreducible component’ of a behaviour change intervention (Michie et al., 2013: 82). Mapping BCTs to IFs involved two steps: First, the BCW table for mapping intervention functions to relevant BCTs provided a candidate list of BCTs to use for the intervention. As previously mentioned, selecting intervention functions also required looking forward to ascertain which BCTs that the BCW maps to intervention functions, aligned with the TDF domains and context of an app. Therefore, some BCTs were already selected if they were relevant to bringing about

change in the TDF domain. Second, to help narrow down this list, a review of the literature of effective BCTs for childhood weight management (Section 2.6.2) was conducted. Table 12 presents the final BCTs selected from this process and their corresponding COM-B, TDF and intervention functions.

**Table 12: Mapping IFs to BCTs**

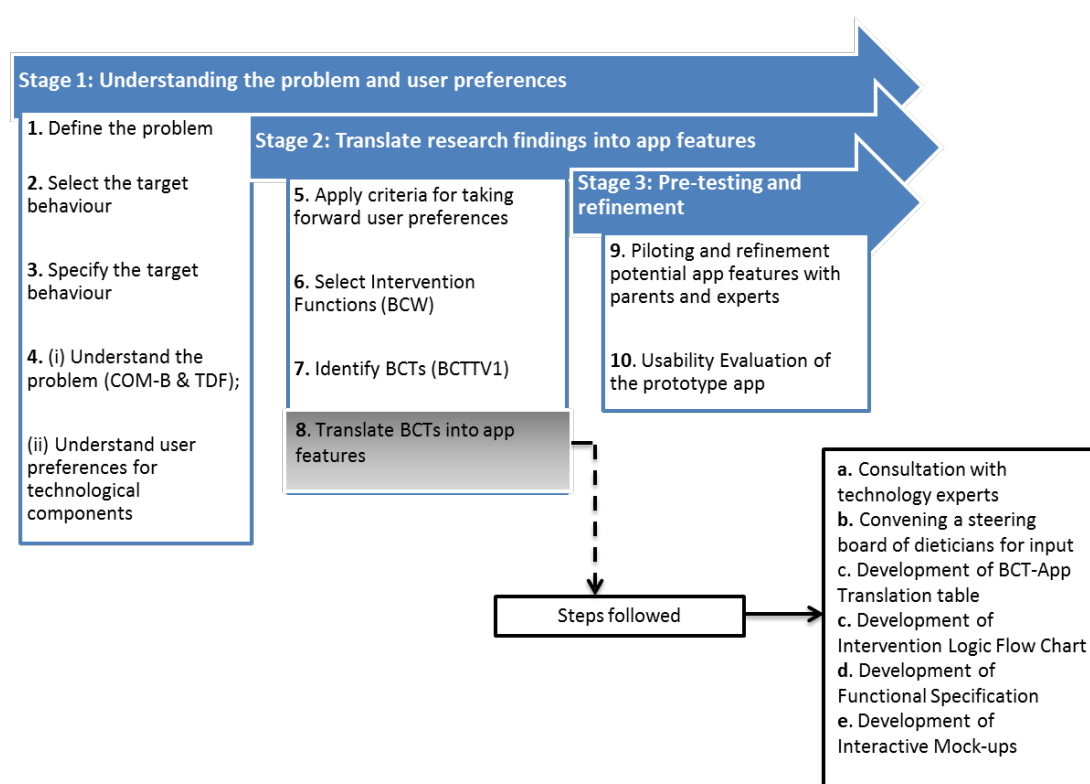
Stage 1 (Steps 1-4)		Stage 2 (Steps 5-8)	
COM-B	TDF	IF	BCT*
Psychological Capability	Knowledge	Education	4.1 Instruction on how to perform the behaviour, 8.3 Habit formation
	Memory, attention and decision making skills	Training	4.1 Instruction on how to perform the behaviour, 8.1 Behavioural practice/rehearsal/8.3 Habit formation
	Skills (cognitive and interpersonal)	Training	4.1 Instruction on how to perform the behaviour, 8.1 Behavioural practice/rehearsal/8.3 Habit formation, Habit reversal
	Behavioural Regulation	Training, Enablement, Modelling	2.1 Monitoring of behaviour by others without feedback, 2.3 Self-monitoring of behaviour, 2.2 Feedback on behaviour, 1.4 Goal setting
Reflective Motivation	Intentions	Persuasion	1.9 Commitment
	Social Identity	Persuasion, Modelling	13.1 Identification of self as role model, 13.4 Valued self-identity,
	Beliefs about capabilities	Persuasion, Training	4.1 Instruction on how to perform the behaviour, 1.4 Goal setting, 2.2 Feedback on behaviour, 7.1 Prompts/cues
	Beliefs about consequences	Education, persuasion	5.1 Information about health consequences, 5.3 Information about social and environmental consequences, 15.1 Verbal persuasion about capability
Automatic Motivation	Reinforcement	Training	4.1 Instruction on how to perform the behaviour, 8.1 Behavioural practice/rehearsal/8.3 Habit formation, 8.4 Habit reversal
	Emotion	Persuasion	5.3 Information about emotional consequences, 5.5 Anticipated regret
Physical opportunity	Environmental Context & Resources	Environmental restructuring	13.1 Adding objects to the environment, 12.1 Restructuring the physical environment
Social opportunity	Social influences	Enablement	3.1 Social support (unspecified), 3.2 Social support (practical)

\*The BCTs are listed with the numbers that they appear in the BCTT (v1) manual (Michie et al., 2014b)

### 6.5.1 Consultations with Health Psychologists

Table 12 was then sent to the same two health psychologists who reviewed the COM-B behavioural analysis, to make sure that the intervention functions appropriately corresponded to the TDF domains and the BCTs appropriately corresponded to the intervention functions. There were a few amendments made based on their comments, where information provision was replaced with ‘instruction on how to perform the behaviour’ for the intervention function of education. However, this was later added back in because it was felt that it was important to provide knowledge on appropriate ratios of food groups, nutritional content of food and appropriate portion sizes.

## 6.6 Step 8: Translate BCTs into app features



**Figure 26: Step 8 - Translate BCTs into app features**




Once a list of potentially effective BCTs were identified, the next step involved liaising with the app company on their implementation. However, before the app company could give guidance on these elements, it was first necessary to help the app company to understand how BCTs are currently operationalised in some existing apps available to consumers.

#### **6.6.1 Behaviour Change Technique to mHealth app Translation Table**



Ten of the highest ranked free adult weight loss and exercise apps in the Google Play store were reviewed and coded using the BCTT (V1). Although app stores do not reveal the exact algorithms used to rank apps, there is general consensus among app developers that the total number of downloads, user activity (e.g. active or non-active) and user reviews and rating (five-star scale) are used to determine their rank (Azar et al., 2013). This allowed descriptions of app features relating to individual BCTs to be presented in a table for members of the app company, illustrating how certain BCTs are operationalised in existing apps on the market. An excerpt of the data is shown in Table 13 below where examples of BCTs and app features are presented within fourteen categories of BCTs identified in adult weight loss and exercise apps (see full table in Appendix 3B). BCTs that had been identified in the literature as effective for childhood weight management along with those resulting from the mapping process (i.e. empirical research findings), and gamification techniques were also highlighted in the table.



**Table 13: BCT - mHealth app Translation Table**

BCTs	Definition (Behaviour Change Technique Taxonomy V1)	How can this be operationalised in an app?	Example app
<b>Goals and planning</b>			
<b>Goal Setting (behaviour)</b>  	Set or agree a goal defined in terms of the behaviour to be achieved	App sets max daily calories that can be consumed to reach target weight	Myfitnesspal
<b>Feedback and monitoring</b>			
<b>Monitoring of behaviour by others without feedback</b> 	Observe or record behaviour with the person's knowledge as part of a behaviour change strategy Note: if monitoring is part of a data collection procedure rather than a strategy aimed at changing behaviour, do not code; if feedback given, code only	GPS	Runkeeper
<b>Social Support</b>			

<b>Social support (unspecified)</b>	Advise on, arrange or provide social support (e.g. from friends, relatives, colleagues, ' buddies' or staff) or non-contingent praise or reward for	Access to online community (can post on each other's wall, send messages, review progress)	Myfitnesspal
<b>Shaping Knowledge</b>			
<b>Instruction on how to perform the behaviour</b>	Advise or agree on how to perform the behaviour (includes 'Skills training')	Tips section provide information on healthy eating	Noom weight loss coach
<b>Natural Consequences</b>			
<b>Information about social and environmental consequences</b>	Provide information (e.g. written, verbal, visual) about social and environmental consequences of not performing the target behaviour	<i>The app can provide persuasive messages informing parents of the risks of bullying when children are overweight</i>	No examples
<b>Comparison of the behaviour</b>			

<b>Demonstration of the behaviour</b>	Provide an observable sample of the performance of the behaviour, directly in person or indirectly e.g. via film, pictures, for the person to aspire to or imitate (includes 'Modelling')	The app links to videos on YouTube demonstrating each exercise	30 day ab challenge
<b>Associations</b>			
<b>Prompts/cues</b> 	Prompts/cues Introduce or define environmental or social stimulus with the purpose of prompting or cueing the behaviour. The prompt or cue would normally occur at the time or place of performance	The app prompts users to log their food three times a day	My Fitness Pal
<b>Repetition and substitution</b>			
<b>Behavioural practice/rehearsal</b> 	Prompt practice or rehearsal of the performance of the behaviour one or more times in the context or a time when the performance may not be necessary, in order to increase habit and skill	App prompts you to carry out Ab exercises	30 day ab challenge

Comparisons of outcomes			
<b>Credible source</b>	Present verbal or visual communication from a credible source in favour of or against the behaviour	Well known programme	Weight Watchers app
Reward and Threat			
<b>Non-specific reward</b>	Non-specific reward Arrange delivery of a reward if and only if there has been effort and/or progress in performing the behaviour (includes 'Positive reinforcement')	Points awarded for making progress in healthy lifestyle challenges, learning new diet skills and contributing to 'My diet Coach community'	My Diet Coach
Regulation			
<b>Conserving mental resources</b>	Advise on ways of minimising demands on mental resources to facilitate behaviour change	Provides food calories and food colour so can help to make food choices	Noom weight loss Coach
Antecedents			

<b>Restructuring the physical environment</b>	Change, or advise to change the physical environment in order to facilitate performance of the target behaviour or create barriers to the unwanted behaviour	The app can offer tips such as: provide a bowl of salad or vegetables with the main meal to prevent you and your child from eating too big portions	No examples
<b>Identity</b>			
<b>Identification of self as a role model</b>	Inform that one's own behaviour may be an example to others	<i>The app can provide persuasive messages informing parents that if they eat healthily, they will be setting a good example for their children</i>	No examples
<b>Self-belief</b>			
<b>Verbal persuasion about capability</b>	Tell the person that they can successfully perform the wanted behaviour, arguing against self-doubts and asserting that they will succeed	<i>The app can provide persuasive messages telling parents that they can reduce portion sizes easily when they use the portion guide tool</i>	No examples

**Key:** ■ BCTs identified from a review of the literature ■ BCTs identified in the mapping process ■ Gamification technique

This stage involved extensive communication with the app company where the intervention mapping table comprising of the findings hitherto, was sent to the app company. Skype video calls facilitated discussions on the table, prior to a face to face meeting with the app company representatives. The face to face meeting involved brain storming potential ideas of how the theoretical elements could be implemented in the app, where Table 13 (giving examples of how BCTs have been translated in existing apps) was used to facilitate the process. The thesis author also generated a list of key app objectives based upon the behavioural diagnosis presented in Table 14 below.

**Table 14: List of app objectives drawn from the behavioural diagnosis**

	App objectives
1	Support parents in reducing their own and their children's portion sizes
2	Function as a family communication tool around portion sizes
3	Increase parents' confidence in their ability to make changes to their children's portion sizes
4	Take into account mothers' feelings as the main child carer
5	Increase parents' sense of control and responsibility for their children's eating habits
6	Ensure that the app is a fun tool for the family to use together
7	Reduce parents' emotional barriers

### **6.6.2 Combining theoretical and user-centred components to create app features**

Consultation with the app company facilitated the process of how the BCTs identified in Step seven (Section 6.5) could be meaningfully combined with findings on user preferences identified in Step four (ii) (Section 5.6). Table 15 below

provides an example of this process, where each BCT is mapped to each user preference and app feature. This was later updated when decisions on the final app features were made in Step 10 (See full table in Appendix 2C).

**Table 15: Excerpt of theoretical components and user-centred components in the development of app features**

BCT	User preferences	App features
Commitment	Gamification	Parents must agree to help their children achieve the target behavior before they begin the challenge
Information provision	Time saving and convenience, Visual aids, Communication tool	Portion measure
Instruction on how to perform the behaviour	Time saving and convenience, Visual aids	Portion measure
Self-monitoring of the behaviour	Monitoring, Gamification	Food logging section, points for logging food
Feedback on the behaviour	Time saving and convenience, Visual aids,	Visual feedback of food groups to target in the following week
Non-specific reward	Gamification	Points and awards for completing activities

### 6.6.3 Gamification techniques

In response to focus group participants' requests for a tool that could be used by the whole family, as well involving a game and a competition, the decision was made with the app company to apply elements of gamification (Section 5.6.7), to encourage families' engagement with the intervention. In particular, the BCT 'Non-

specific reward’ was highlighted as the BCT related to gamification techniques such as points, levels and badges.

There were several gamification techniques recommended by the app company that could be used to increase parent’s motivation in completing tasks such as logging food and answering quiz questions that were related to specific behaviour change techniques. However, they also delivered BCTs relating to each of the COM-B domains as shown in Table 16 below. In addition, applying elements of gamification also related to other aspects such as customisation (e.g. selecting profile colours) and novel information (e.g. new information in the quiz and notifications) that may potentially increase families’ engagement with the app.

**Table 16: Gamification techniques**

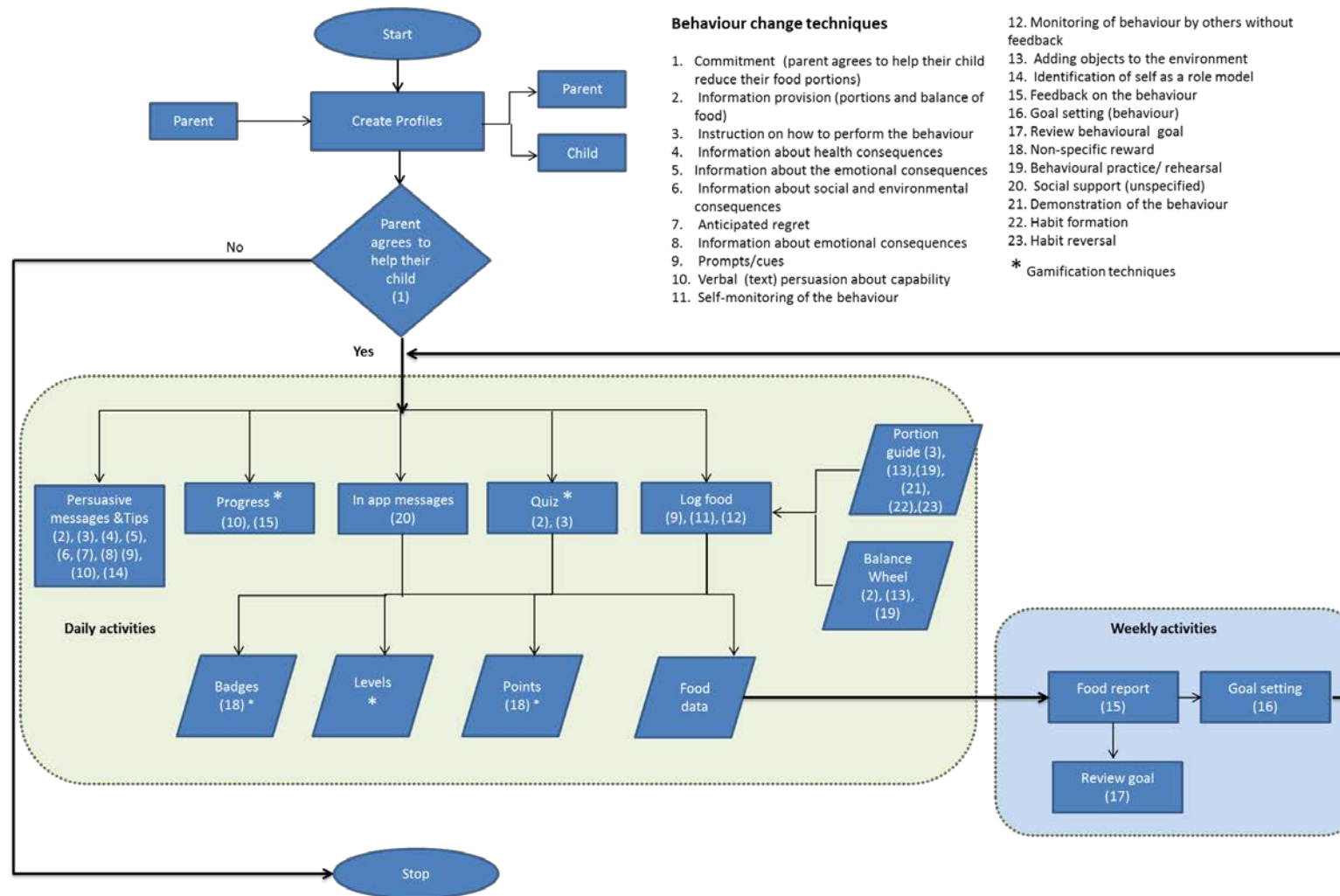
COM-B	TDF	IF	BCT	GT*
<b>Psychological Capability</b>	Knowledge	<i>Education</i>	<i>Information provision</i>	Quiz
	Skills	<i>Training</i>	<i>Instruction on how to perform the behaviour</i>	Quiz
<b>Reflective Motivation</b>	Beliefs about capabilities	<i>Education, Persuasion</i>	<i>Feedback on the behaviour, non-specific reward</i>	Quiz, Achievements, Progress bars, Points
	Beliefs about consequences	<i>Education, persuasion</i>	<i>Information about health consequences</i>	Quiz
<b>Social Opportunity</b>	Social influences	<i>Enablement</i>	<i>Social support, non-specific reward</i>	Points received for supporting family members in portion control

\*GT = Gamification Technique



#### **6.6.4 Intervention logic flow chart**

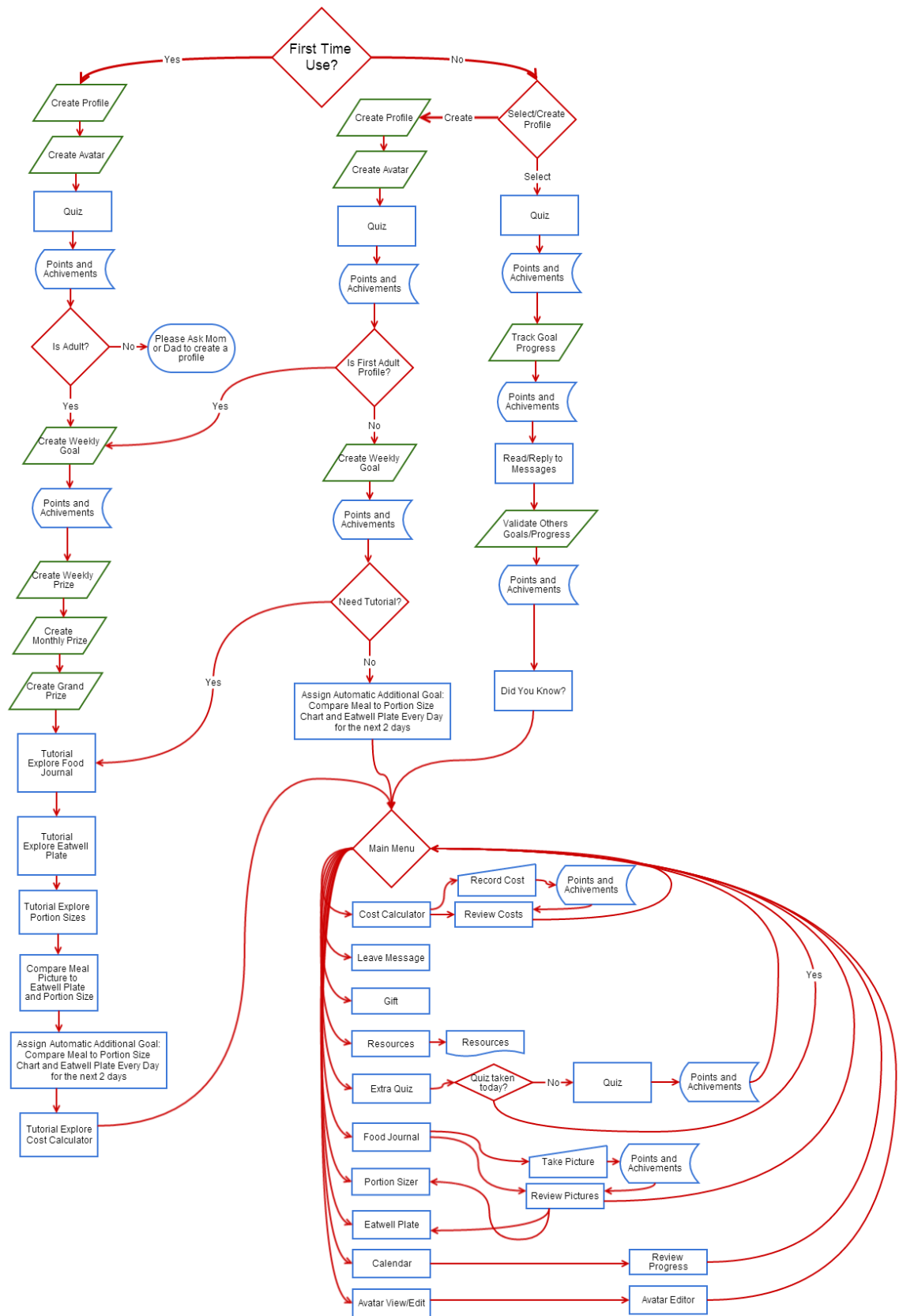
Based upon consultation with a software engineer at the university, an intervention logic flow chart (Figure 27) was developed to show the possible user journey and overall concept of the app. The first diagram was developed to help map the specific BCTs on to the app features. However, as intervention development followed an iterative and cyclical process, this diagram was revisited several times (after parental feedback) before exact BCTs were decided upon.



**Figure 27: Intervention logic flow chart**

### **6.6.5 Conceptual Specification**

As part of the second stage in Rogers et al., (2011) UCD approach to development (Section 3.3), the app company generated a conceptual specification of the app as shown in Figure 28 below. Additional discussion with the app company led to further amendment to the design (Appendix 2D).

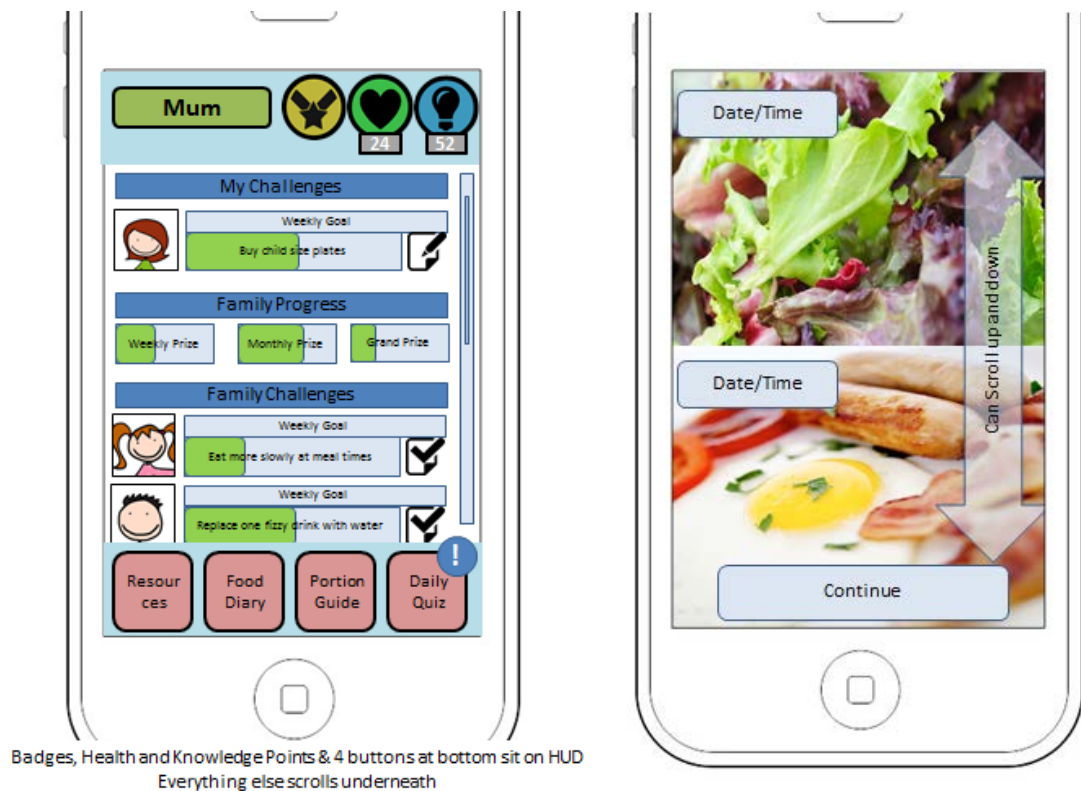


**Figure 28: Conceptual specification**

## 6.7 Building interactive mock-ups

This step involved the third stage of the UCD approach to development (Section 3.3), where interactive mock-ups were built (Appendix 2E). Interactive-mock ups refer to wireframing software that can help designers to develop prototypes of interactive products such as websites or smartphone apps. They allow users to interact with them by clicking on icons and images that take them through to another area in the design, reflecting how it would work in practice. Hence, these mock-ups shown in Figure 29, were developed by the app company to reflect both the discussions and subsequent intervention flow chart and conceptual specification, on the concept of the app and the required features. These mock-ups were then updated by the thesis author (see Figure 33, Section 7.4.2.5) based on the feedback from parents which will be discussed in more detail in Chapter 7.





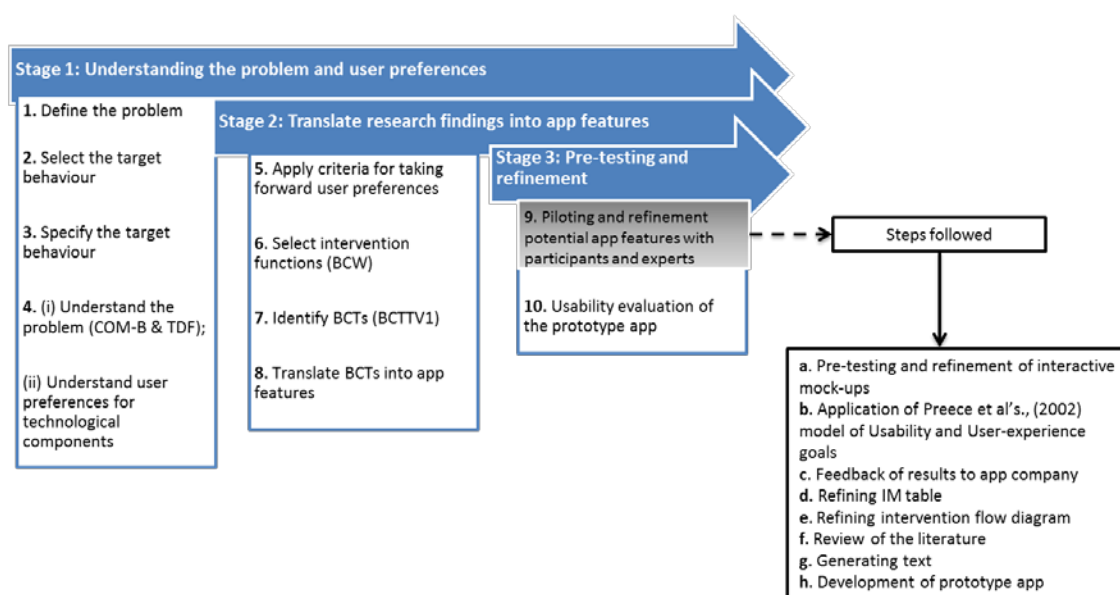
**Figure 29: Interactive mock-ups examples of the family healthy eating app**

## 6.8 Dietary steering board

The final activity in this step involved convening a steering board to provide input and advice on the dietary content of the app (Section 3.1.3.5). In particular, the board gave advice on age appropriate portion sizes whereupon a leaflet was sent by one of the NHS dieticians containing their current recommendations for families in Warwickshire. This portion guide resource was then piloted with parents in the third focus group in study two described next.

## Chapter 7 Pre-testing and refinement

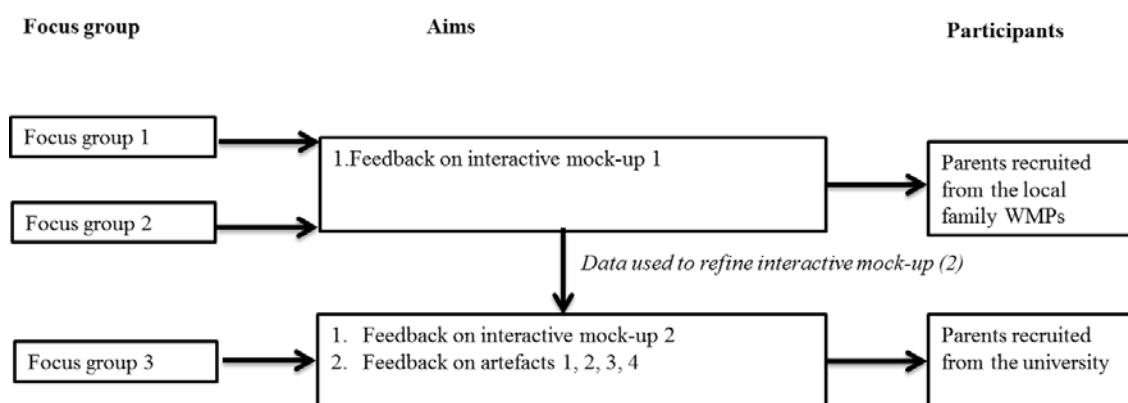
The final stage in the app development process involved pre-testing and refinement of the app's content and features. This process can continue for as long as there is resources (e.g. money and time) available to continually refine the app, and can involve a variety of methods including focus groups, retrospective interviews, observational studies of participants interacting with the app (and encouraging them to 'think aloud' as they move through the intervention) or diary studies (Blandford, 2014). The following sections provide details on the methods used to progressively refine the mHealth intervention in the form of piloting interactive mock-ups (Step nine, presented in this chapter) of the app and testing the usability of the prototype app (Step 10, Chapter 8).



**Figure 30: Step 9 - Piloting and refinement of potential app features**

## 7.1 Overview of study two (Step nine)

The second study involved three focus groups wherein the qualitative research aims for each of these are presented in Figure 31 below.



**Figure 31: Qualitative Research Aims for Study two**

The first two focus groups were used to gain feedback on the initial interactive mock-up developed by the app company. Based upon this feedback, iterations were made to the interactive mock-up, and presented to the third focus group along with a number of artefacts for review.

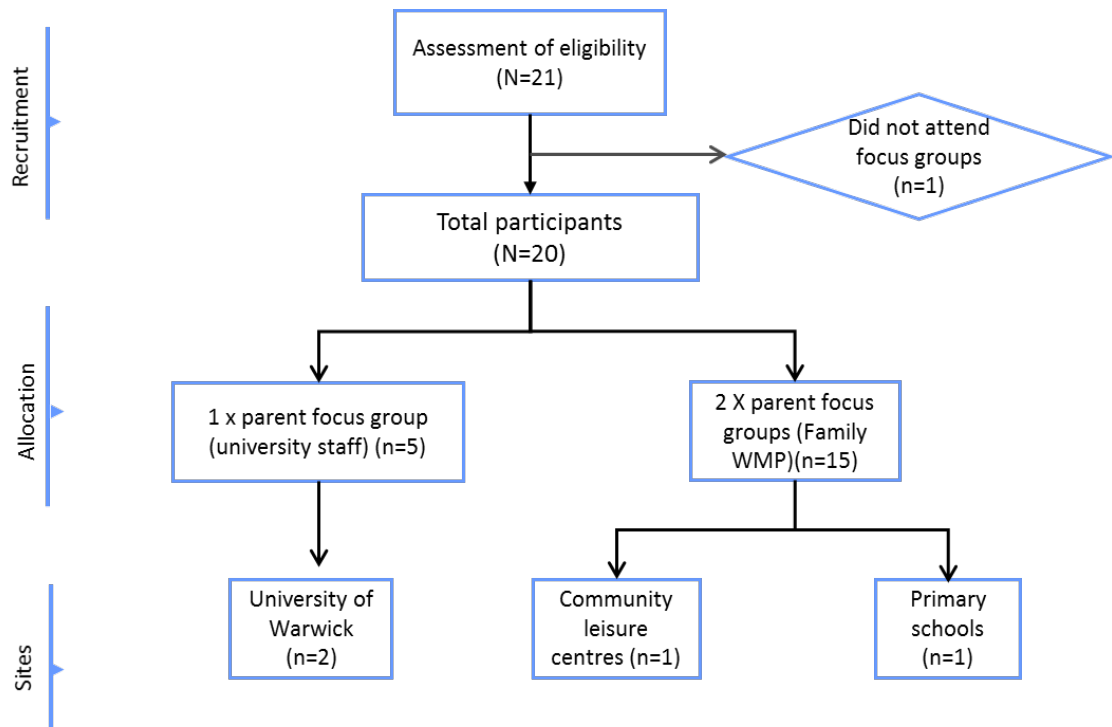
## 7.2 Methods

### 7.2.1 Focus group recruitment

For the first two focus groups, two local family weight management programme managers were contacted and invited to take part in the research again and upon agreement, dates for two focus groups were agreed. The programme managers helped to recruit parents and informed them of the nature of research. They distributed participant information sheets for the parents to read a week prior to focus group implementation. A total of 21 parents were contacted, of which 20 agreed to participate yielding a response rate of a little over 95%. Around 75% of the



participants were from the local weight management programme and the rest, 25%, were recruited from the university.



**Figure 32: Study two recruitment flow chart**

Figure 32 details the recruitment flow chart for study two where the first two focus groups took place with parents recruited from the family weight management programme. All parents who were taking part in the family weight management programmes ( $N = 15$ ) took part in both focus groups. The first focus group consisted of mothers ( $n = 6$ ) and fathers ( $n = 2$ ), while the second focus group consisted of only mothers ( $n = 7$ ).

For the third focus group, emails were sent out to all WMG staff inviting them to take part in a research project on a healthy eating app. From this, six parents

responded but only five were available on the agreed day of the focus group. Written consent was obtained from all participants prior to conducting the focus groups.

### **7.2.2 Ethical considerations**

All participants were administered participant information sheets (Appendix 1A) and consent forms (Appendix 1C) prior to taking part in the focus group. They were also free to withdraw from the focus group at any time should they wish to do so. After the focus group had finished, participants were provided with de-briefing sheets (Appendix 1E) which contained all the necessary contact details and provided internet resources for healthy eating.

### **7.2.3 Focus group procedures**

Focus group discussions were facilitated by one researcher (thesis author) and consent forms were administered and signed before focus groups began. Krueger and Casey's (2000) principles for conducting a focus group were followed and the conversation was guided by a schedule of semi-structured open questions.

The first focus group located at the school was conducted in the sports hall. The researcher divided the group into two groups of four participants. One group was provided with a laptop while the other group was provided with an iPad to review the interactive mock-up on (Appendix 2E). All participants were then encouraged to move through the user journey of the app using the device provided. At the points where the groups were unsure of the next step to take with the interactive mock-up, the researcher helped to guide them through the slides and explained the user journey in more detail. However, parents' expressed difficulty in navigating through the interactive mock-up so the method for presenting the interactive mock-up for parents

was modified for the remaining two focus groups where projector screens were used instead.

The second focus group was conducted in a room in a leisure centre where the researcher used a laptop and projector to present the interactive mock-up. The last slides of the interactive mock-up also simulated the quiz. The slides were presented for around 15 minutes before the researcher began the discussion on the feedback on the app.

The third focus group was conducted in a university meeting room where a projector was used to present the modified interactive mock-up (Appendix 3G) and the user journey of the app. This lasted 15 minutes before the researcher encouraged feedback from participants on the app. They were then asked to examine several artefacts (Section 7.2.4.1) which were placed on the table in front of them.

For all focus groups, the researcher encouraged all participants to give input on the interactive mock-ups and asked them to expand on certain points to gain a deeper understanding. Focus groups with parents lasted for 60 minutes and were audio recorded. Upon receiving signed consent from participants, all focus groups were audio recorded and a note was made of participants' operating system on their phones where applicable. Subsequently, participants were thanked for their time and asked to get in touch if they had any questions. All participants were given debriefing sheets

#### **7.2.4 Focus group materials**

The materials for focus groups consisted of a laptop, iPad (Focus group one), projector screen (Focus groups two and three), audio recorders, consent forms,

participant information sheets, interactive mock-ups of the app, schedule of questions and de-briefing sheets.

#### 7.2.4.1 Artefacts

Currently there are no standard recommendations for portion sizes within the UK (Faulkner et al., 2012). Therefore, it was deemed important to test out different approaches to presenting portion size recommendations in the app (artefacts one and two). The portion ratios of food recommended for a healthy diet are also important for achieving the target behaviour and therefore two food guide models were also presented to parents (artefacts three and four) which has also been used in previous research to stimulate discussions on portion sizes (Spence et al., 2013). Table 17 below presents each artefact that was piloted with parents and where they were sourced from.

**Table 17: Artefacts presented to participants in study two**

Number	Artefact	Source	Appendix
1	Photographic age appropriate portion size recommendations	Public Health Warwickshire dieticians (sent via email to investigator)	3A
2	Handy diagram – portion sizes guide	Leeds Community Healthcare NHS Trust, (2012) (PDF sourced online)	3B
3	The eatwell plate	Public Health England, (2013) (Image sourced from website)	4C
4	The Food Pyramid	SafeFood (Image sourced from website)	4D

The artefacts were laid out on the table in front of participants so they were able to examine each one more closely. The participants were then asked to give their thoughts on each of the artefacts.

#### **7.2.5 Focus group questions**

The aim of study two was to receive feedback on the overall concept of the app and specific app features which, in turn, provided insights into the acceptability of certain behaviour change and gamification techniques. Focus groups also provided the opportunity to explore certain elements of usability and user experience, regarded as important for increasing the likelihood of user engagement (Section 2.7.1). Although there is no precise model that encompasses all the possible usability and user experience elements to explore with participants, Preece et al., (2002) model provided a good overview of usability and user experience goals to explore with parents as they gave feedback on the app (Section 6.1.4, Figure 23). Hence, questions drew on this model, which also ensured continuity from study one where the model was applied to help make decisions on which user preferences to take forward. The questions for study two (Appendix 3F) explored the following topic areas with parents as shown in Table 18 below.

**Table 18: Schedule of topics for study two**

	Topic
1	Overall impressions of the app
2	Overall helpfulness of the app and app features
3	Whether it is perceived as fun and enjoyable
4	Satisfying (any features that are liked or not liked)
5	Whether it is entertaining (mainly referred to content in the quiz feature)
6	Whether certain features were motivating or not (e.g. virtual gifts)

### **7.3 Analysis of focus groups**

The data was analysed using Braun and Clarke's (2006) principles for conducting a thematic analysis in psychology (Figure 10, Section 3.5). The first stage in analysis involved transcribing the data verbatim to allow for analysis and to gain familiarity of the data. Thoughts that emerged during the transcription process were also recorded in a Microsoft word document. The transcripts were then uploaded to NVivo 10 to lend itself more easily to the second stage which comprised of coding the segments of data for their basic meaning. The third stage involved inductive coding where themes emerged from the data (Appendix 4A). The fourth stage involved reviewing and refining the themes and required re-reading all of the coded extracts for each theme to ensure that they accurately represented and built a coherent picture of each theme. The fifth stage involved the final refinement of themes and names of themes. Preece's et al., (2002) model was then applied to the themes and sub-themes that has emerged to help provide information at a glance on positive and negative usability and user-experience aspects of participants' feedback (Table 19, Section 7.5).

## **7.4 Results**

With regards to smartphone ownership, 75% of participants reported owning a Smartphone (53% Android, 27% iPhone, 13% Blackberry, 7% Windows). Hence, for the parents recruited from the weight management programmes, across both studies; 69% reported owning a smartphone.

### **7.4.1 Thematic analysis report**

The focus groups received participants' feedback on the interactive mock-ups, along with a range of artefacts (Focus group three). Ideas for improvements were discussed around the following themes of: App features, Gamification, and Positioning of the app.

### **7.4.2 App Features**

#### **7.4.2.1 Food substitutes/healthy alternatives**

One parent in the first focus group felt that it would be useful to have an area in the app that provided information on healthier alternatives to certain unhealthy foods.

This was also a preference that was reported in study one (Section 5.6.1) but was rejected because it was not deemed relevant enough to the target behaviour.

However, the decision was made to include this in the intervention as this is something that parents continued to request across study one and study two focus groups, and hence this desired feature may increase parents' interest and attention in using the app in the first place. In addition, it was also recognised that replacing high energy density foods with lower energy density foods will support portion control. Therefore, the interactive mock-up was amended for the third focus group where parents responded positively to this app feature.

### Extract 1

*One thing I quite like is the swap, for one particular food you can swap for a better option (Parent, FG9).*

**Implications for mHealth component:** This feature was accepted as it had been requested by parents in both studies. However, this did not come within the budget and hence is recommended for the next stage of development.

#### 7.4.2.2 Portion measuring tool

With regards to options to help measure food portions, findings from study one revealed that parents felt that it would be useful to have some kind of visual reference that they could refer to (Section 5.6.5). Therefore, in the second focus group in study two, a range of options were explored with parents on whether hands or objects would be a good visual cue for them to use to measure portions. One parent felt that hand portions would be a better visual cue compared to an object.

### Extract 2

*You know you said you wasn't sure whether to use a hand or an object, I think a hand is better as it is always there, rather than saying it's going to be like a tennis ball (Parent, FG2).*

A similar finding has been reported in a sample with the general population, dieticians and consumers who preferred using hand measures (e.g. using the palm of the hand to measure meat), over household objects (e.g. cups, spoons, deck of cards) for children aged five and above (Flynn et al., 2012). In addition, a recent qualitative study reported that some parents used their hands to measure appropriate child portions and found this to be quick and simple method (Blake et al., 2015).



A review of online resources for measuring portions using hands revealed that dieticians from Leeds community healthcare NHS Trust had developed a guide for using hands to measure portions. Therefore, a decision was made to use hands as a visual cue to measure portions. More importantly, hand portions have the benefit of highlighting the important message that children's portions should be smaller than adult portions symbolised by using children's hands to measure child portions, and adult's hands to measure adult portions.

As a result of the aforesaid finding, the third focus group piloted the visual of using hand portions measures (Artefact two), developed by dieticians from Leeds NHS Trust (Table 17, Section 7.2.4.1). This measure elicited positive feedback from parents with regards to usability (e.g. easy to learn) and user experience (e.g. helpful).

### **Extract 3**

*I think the bit with the hands and the portion sizes, I think that's really really good as it's so difficult to know what a portion size is and very easy to use*

*It's a very good idea about portions as I never think about portions. The thing about hands is they grow as you get older and that's very clever. So a four year old hand and a 12 year old hand for a 12 year old (points to artefact ii) (Parents, FG 3).*

With regards to the local dietician's food portion measures (Artefact one), most of the parents found this confusing, although one parent found it useful to have a more exact measure for age appropriate portions sizes.

#### **Extract 4**

*I would find that confusing...(holds up artefact i) but if you would to say as portion and you hold it in your hand (holds artefact ii), you've got 2 small apples which you can hold in your hand and that makes one portion (Parent, FG3).*

**Implications for mHealth component:** Feedback from parents on their preferences for hand portions over other resources, along with consultations with the app company (who claimed that hand portions would be more engaging for parents due to their simplicity), led to the decision to use hand portions as a visual cue in the app for measuring adult and child portion sizes.

#### **7.4.2.3 Goal setting section**

One parent in the second focus group was concerned as to how the goal setting section would work with the diet they were on.

#### **Extract 6**

*I have my own diet so what happens when a mum has her own specific diet? (Parent, FG2).*

In addition, another parent in the last focus group felt it was unnecessary for parents to have their own goals and rewards for completion of goals because their only goal should be to help their children.

#### **Extract 7**

*And the parents I don't think will necessarily need a goal, their goals will be to help their children achieve their goals (Parent, FG3).*

However, other parents in the same group felt that it was important for the parents to be carrying out dietary goals along with their children and to be a role model for their children.

### Extract 8

*So it's about the family and they are all doing it together. It might be younger siblings and the older ones would be helping the younger one's to achieve the challenge. So I guess the focus of it is the whole family are approaching this as a challenge and they are going to work as a team to achieve it.*

*Parents need to provide a justification for why they can't have more food..and children may turn around to parents and say..you do it too (Parents, FG3).*

In contrast, one parent felt that the availability of nutritional information in the app was more important than setting goals.

### Extract 9

*It's more about information and feedback rather than rewarding through the goals and I think that will work more for the parents like that. And access to really good information about diet which I think as a parent, we struggle with most. Just with the conversation we have had in the last half an hour, I have learnt more about diet (inaudible) which is very good (laughs)..and I don't think I am unusual in this (Parent, FG3).*

However, there is now general consensus amongst practitioners and researchers in the field of behaviour change that information alone is not enough to change behaviour given other important complex influences on behaviour (Britt et al., 2004; Michie, Atkins, et al., 2008). However, setting attainable goals is a practical technique associated with positive outcomes in child and family weight management interventions (Baranowski et al., 2003; Golley et al., 2011; Hendrie et al., 2012) and hence this behaviour change technique was selected in step seven (Section 6.5).

**Implications for mHealth component:** The decision was made to keep the goal

setting section and allow parents and children to set out food portion goals together.

#### **7.4.2.4 The eatwell plate**

The eatwell plate was first identified by Change4life advisors in study one (Section 5.5.2.1) as a tool that they used with families to help them understand the balance of food groups. Therefore, the eatwell plate (Artefact three) was used as an artefact to gain feedback from parents on. Indeed, parents felt that the eatwell plate was difficult to understand and initially thought that they had to provide all the food groups in one single meal. However, the eatwell plate aims to give parents an idea of the portions of food groups they should be eating over the course of one day and/or one week, rather than in a single meal.

#### **Extract 10**

*I think it's quite hard to think of a practical way to use it because you got the food high in fat there, biscuits and all of that, you wouldn't normally eat that with a meal. That becomes a snack (Parent, FG3).*

Nevertheless, one parent felt the eatwell plate was a useful visual aid to show the proportions that should be eaten for each food group.

#### **Extract 11**

*Where you have two-thirds of meat (points at eatwell plate) that is much easier to work with (Parent, FG3).*

One parent highlighted the importance of moderating portions from each food group throughout the course of a day, rather than having too many of the same food group in one meal setting.

## Extract 12

*I don't know if you are going to incorporate that issue in your app but it..healthy eating is not just about what you eat and at what time, it's the actual combinations. So for example, for me being above 40 is healthy to have 3 carbohydrates and bla blab la. If I have all 3 carbs in one meal, I am done for and if you just have salad and fruit on another meal without any protein or carbohydrate it's no good as I am going to feel hungry in an hour. And so I don't know if you were trying (Parent, FG3).*

**Implications for mHealth component:** Based upon parents' difficulty in understanding how the eatwell plate should be used, it was decided to adapt the eatwell plate and make it clearer that these food group ratios applied to one day as well as providing the number of portions that can be eaten from each food group (as per the food pyramid, Artefact 4).

### 7.4.2.5 The Balance Wheel

Based upon the feedback on the eatwell plate, the interactive mock-up was refined (Appendix 3G) to include a feature referred to as the 'Balance Wheel' (Figure 33). This feature provided information on the maximum number of food portions within each food group. This was then piloted with parents in the third focus group to gain feedback on their impressions of the tool.



**Figure 33: Interactive mock-up of The Balance Wheel tool**

Overall, parents viewed the ‘The Balance Wheel’ tool and the concept of balancing food groups very positively and felt that this was better than counting calories.

### **Extract 13**

*I do like the idea as the alternative, which I am surprised you haven't mentioned it, is calorie counting and I don't know about that..not the way forward (Parent, FG3).*

Furthermore, parents described the balance wheel as a useful tool to increase parents' knowledge of the balance of foods as well as helping them to communicate the nutritional ratios of food groups to their children.

### **Extract 14**

*(inaudible) There is some on-going dialogue with parent and child of what they can eat e.g. Do you really need to eat that, why don't you have this..etc. Whereas I haven't got the knowledge myself apart from the*

*obvious things whereas if this (The balance of food portions and hand portions) increases the knowledge for able parents and the child (Parents, FG3).*

One parent particularly liked having information on the number of portions recommended for each food group per day.

#### **Extract 15**

*Well I think that is much better. It's almost like the 'eatwell day' or some graphic of that so it's a circle of the days intake in these different areas. I was looking at this and this was all news to me and one of first things I wanted to ask you was where can I get information on how many portions you should eat a day and what's the balance of them. So I would be absolutely, using this (Parent, FG3).*

**Implications for mHealth component:** The balance wheel was accepted and taken forward for development.

#### **7.4.3 Gamification**

Parents were asked about their thoughts on competing with other families in a healthy eating challenge. The overall consensus was that parents preferred not to compete with other families which is also a preference found in study one (section 5.6.7). However, one parent suggested that this could be an option in the app so that parents could choose.

#### **Extract 16**

*P1: Not too sure about that one as my son has a real complex about his weight so I think it would be tough on him to see other people and might get 'oh well they are doing better than me', do you know what I mean? It's like a confidence thing*

*P4: Unless it's an option you can do?*

*P3: Yeah..everyone's got different opinions (Parents, FG2).*

The Quiz feature was viewed positively by parents and something that motivated parents to want to use the app and improve their knowledge. The researcher asked for their thoughts on the content of the questions and parents felt that entertainment questions were not necessary.

#### **Extract 17**

*I would find it interesting enough just with food questions (Parent, FG3).*

With regards to incentives and rewards, one parent also felt that the game part of the app could reward children for their healthy eating by giving a reward such as a gold star.

#### **Extract 18**

*One point, kids in the lower band that you've got. They are probably more keen to go..if food's got a star in it, telling them that it's good or something like that, they probably will go for it. For example, in my son's school what they do at lunch time, they open the box and see what food they've got. So if they have something like a yoghurt, they say..so..so..between..and if they get some fruit they say a thumbs up and what motivates them to take fruit is 'I want something that gives me a thumbs up'. Even small things like stars will motivate them (Parent, FG3).*

Lastly, parents were happy to share their phone with their children for them to use the app as this is something that they habitually do.

#### **Extract 19**

*Yeah as it's something you have to do as a family then you got it work it as a family, if you're going to download the app, then you have to be*



*prepared to hand it over to the child, well (Child's name) is always playing with my phone, he's terrible, so for games I have downloaded for him. I think if you can trust your child or if he's too young then he will need supervision (Parent, FG2).*

**Implications for mHealth component:** At this stage it was decided to retain the family eating challenge aspect of the app within the family. The Quiz was kept, although questions relating to entertainment were taken out as parents preferred to focus on increasing their knowledge around healthy eating, which in this case, related to portion control.

#### **7.4.4 App Positioning**

Parents in the final focus group were encourage to feedback on the logo and name of the app (Appendix 3E). This was viewed positively by parents in relation to it not being positioned as a weight management app.

#### **Extract 20**

*P1: I think that's much better then..I was concerned , cause the way this was positioned was a family's fat challenge..so at least it's much more talking about healthy eating, because I think it's a real issues with the child..I mean my child is overweight and how do you actually deal with that, without saying to him – you're fat, you know, what you going to do about it? So positioning it much more in terms of health, which I think is good.*

*P2: I like the idea that it's about healthy eating, you know, not weight control, I like the name as well (Parents, FG3).*

However, one parent thought the name was slightly 'wordy' and felt that the logo and name were not 'cool' enough for children to want to engage with.

## Extract 21

*The trouble is with that, is there is quite a difference between the age of 5 and 12 and I'm thinking for a 12 year old, anything that involves your parents or mentions your parents and your mum isn't going to go down very well so it depends on what you call it with what age group you are. With 12 year olds its peer relationships and certain 'coolness', doesn't usually involve your mum and your dad and this notion of the family (Parent, FG3).*

**Implications:** To keep the positioning of the app as a family healthy eating app and to amend the logo and name to something that children will engage more with.

## 7.5 Summary of findings

Parental feedback on the interactive mock-ups provided valuable insight into parents' impressions, ideas and acceptability of the proposed app features. Decisions had already been made using the decision criteria applied to user preferences in study one (Section 6.1), with regards to criteria i, iii, iii, and v. Therefore, this stage in development focused exclusively on applying criteria iv: Alignment with usability and user experience goals (e.g. whether the app features were perceived as fun, helpful, motivating, aesthetically pleasing) with regards to parents' feedback on interactive mock-ups. Table 19 presents summaries the main findings from study two into three sections under the following themes: App features, Gamification and App positioning. Preece et al.'s (2002) model of usability and user-experience goals was then applied to help give an overview of whether the feedback was positive or negative with regards to components in the model such as 'satisfying' and 'easy to learn' as shown in Table 19 below. The table helped to facilitate further discussions with the app company to ensure this feedback was fully integrated into the technical development of the prototype app.

**Table 19: Summary of results from study two**

Theme	Sub-theme	Usability and user-experience rating*	Example quote
<b>App features</b>	Portion guide (suggestion of cues)	U: easy to remember how to use (+), easy to learn (+), UX: satisfying (+), helpful (+)	I think the bit with the hands and the portion sizes, I think that's really really good as it's so difficult to know what a portion size is and very easy to use (FG2)
	Food substitutes/healthy alternatives (s)	UX: helpful (+), satisfying (+)	One thing I quite like is the swap, for one particular food you can swap for a better option (FG2)
	Goal setting section (not developed for 1&2)	U: effective to use (+&-), UX: rewarding (+), emotionally fulfilling (+), helpful (+&-)	So it's about the family and they are all doing it together. It might be younger siblings and the older ones would be helping the younger one's to achieve the challenge. So I guess the focus of it is the whole family are approaching this as a challenge and they are going to work as a team to achieve it. (FG3)
	The Balance Wheel	U: effective to use, (+), have good utility (+), UX: emotionally fulfilling (+), helpful (+), satisfying (+)	Well I think that is much better. It's almost like the 'eatwell day' or some graphic of that so it's a circle of the day's intake in these different areas. I was looking at this and this was all news to me and one of first things I wanted to ask you was where can I get information on how many portions you should eat a day and what's the balance of them. So I would be absolutely , using this (FG3)

	The eatwell plate	U: easy to learn (-), confusing	I think it's quite hard to think of a practical way to use it because you got the food high in fat there, biscuits and all of that, you wouldn't normally eat that with a meal. That becomes a snack. (FG3)
<b>Gamification</b>	Competition against other families	U: safe to use (-), UX: motivating (-)	Not too sure about that one as my son has a real complex about his weight so I think it would be tough on him to see other people and might get 'oh well they are doing better than me', do you know what I mean? It's like a confidence thing (FG2)
	Badges (suggested)	UX: motivating (+), fun (+), entertaining (+)	If food's got a star in it, telling them that it's good or something like that, they probably will go for it (FG3)
	The quiz	UX: motivating (+), entertaining (+)	I would find it interesting enough just with food questions (FG3)
<b>App positioning</b>	Healthy eating app	UX: Emotionally fulfilling (+), satisfying (+)	I like the idea that it's about healthy eating, you know, not weight control, I like the name as well (FG3)
	Name	UX: emotionally fulfilling (-), rewarding (-), fun (-), motivating (-)	With 12 year olds its peer relationships and certain 'coolness', doesn't usually involve your mum and your dad and this notion of the family (FG3)
	Logo	UX: aesthetically pleasing (-), motivating (-), satisfying (-)	I find it boring. I really don't like it. It's not very appealing (FG3)

\*Adapted from Preece et al., (2002) model of Usability and User-experience goals

### **7.5.1 Discussion**

The aim of study two was to pilot the proposed app features and content with parents. This helped to gain feedback on the interactive mock-ups. However, the first two focus groups were not able to draw as much data as the last focus group which may reflect the different participant groups. The first two focus groups used parents already signed up to local weight management programmes, while the last focus group comprised volunteers from the university so they may have been more confident in voicing their opinions. Childhood overweight and obesity is a highly sensitive issue for parents and therefore some parents are hesitant to give their views on this subject matter. Thus, this ‘volunteer effect’ may explain why parents in this group behaved differently to the parents recruited from the weight management programme (the target group) (Boslaugh & McNutt, 2008).

According to Ginsburg (2011), focus groups are not commonly used for UCD sessions for a number of reasons. Firstly, there is the danger that participants will be influenced by other members in the group and secondly, what participants say they do may not be the same as what participants actually do. This is why it will be important to test the prototype app with parents and children as discussed in Section 10.1.5. Nevertheless, focus groups have the benefit of allowing creativity and new ideas to develop from group discussions (Ginsburg, 2011).

With regards to using the interactive mock-ups, the first focus group had difficulties moderating participants because there were two groups of parents working through the mock-ups on an iPad and a laptop and only one researcher. In addition, some of the parents found it challenging to navigate through the interactive mock-ups and had difficulty understanding how to operate the interactive mock-ups. For this

reason, a projector was used for the second and third focus groups, allowing the researcher to take parents through the user journey more easily.

## 7.6 Dietary steering board

Based upon feedback from parents, a measuring tool based on hand portions was chosen to support parents with measuring age appropriate portion sizes. Therefore, the dietician's leaflet on portion guide recommendations was not taken forward for use in the app. However, dieticians still provided important input and feedback on the artwork for the dietary content of the app presented next.

### 7.6.1 Artwork generation & review

Based upon piloting the artefacts with parents in study two, adaptations were made to existing portion recommendations (e.g. the eatwell plate) (Appendix 4B) which helped to develop The Balance Wheel (Figure 34) and The Hand Portion Guide (Figure 35). These were two key features designed support parents in providing their families with appropriate portion sizes.



**Figure 34: The Balance Wheel Artwork**

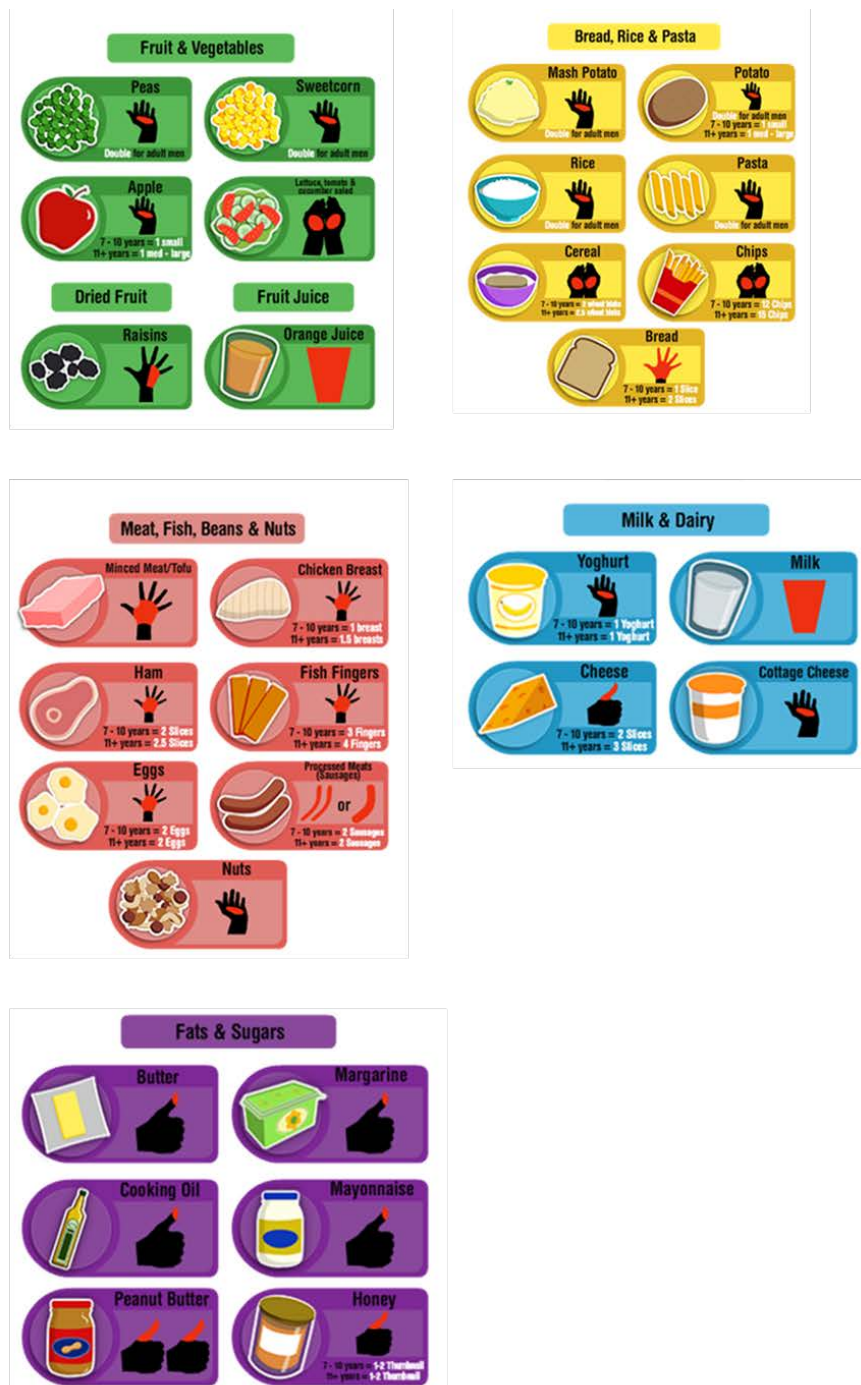


Figure 35: Hand Portions Guide Artwork

Both artworks were sent to the dietary steering board. These comments were collated and logged onto the app company's project tracking system for amends to be made (Appendix 4C). In addition, the dietary steering board also provided feedback on the nutritional content in the Quiz (Appendix 4D) and Tips on portion control (Appendix 4E).

## **7.7 Refinement of app features and generation of content**

This process involved refining: app features (based upon feedback during the preceeding steps from parents and experts); generating content; and technical development of the prototype app. The intervention mapping table was completed at this step where both user preferences and final app features were mapped to relevant theoretical components.

### **7.7.1 Overview of app 'Health Heroes'**

The app was named 'Health Heroes' after focus group discussions revealed that 'family health challenge' may not be appealing enough for children to engage with. The logo was created to represent a female hero character where a symbol of the Balance Wheel is shown on her costume (Figure 36). This accounted for the finding that mothers may be more likely to use the app considering in most cases, they are children's primary caregivers.

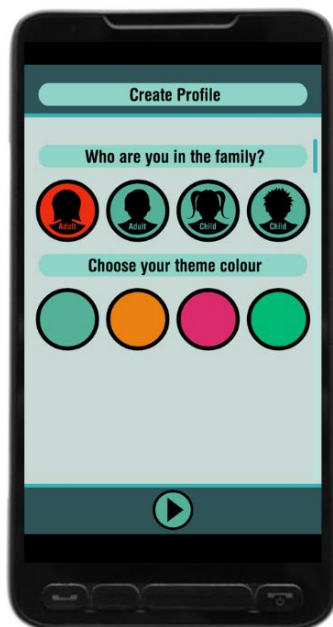




**Figure 36: Health Heroes logo**

### **7.7.2 Create profile**

Once parents have downloaded the app onto their smartphone and set up user profiles for family members (Figure 37), they must agree to help their children reduce their food portions before they can begin the challenge (Figure 38).



**Figure 37: Create Profile**



**Figure 38: Commitment to help family**

### 7.7.3 Log food

All users are then instructed to log their food using the camera function (Figure 38), indicating the food group, number of portions, and the type of meal e.g. breakfast or snack (Figure 39).



Figure 39: Take a picture of the food

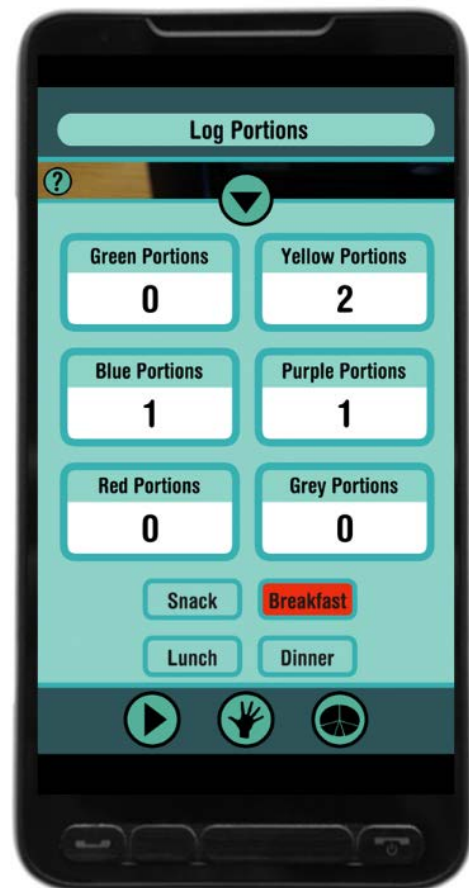


Figure 40: Log food portions

Users are prompted to use both the Balance Wheel (Figure 41) and the Portion Guide (Figure 42) tools to help them log food and measure the size of the portions. So for example, if they had a large portion of cereal, they would log this as two portions instead of one.



**Figure 41: Balance Wheel**



**Figure 42: Portion Guide**

#### 7.7.4 Quiz

Users also receive a daily quiz question (Figure 43) in relation to portion sizes and the content and balance of food groups. Users are awarded points for correct answers (Figure 44).

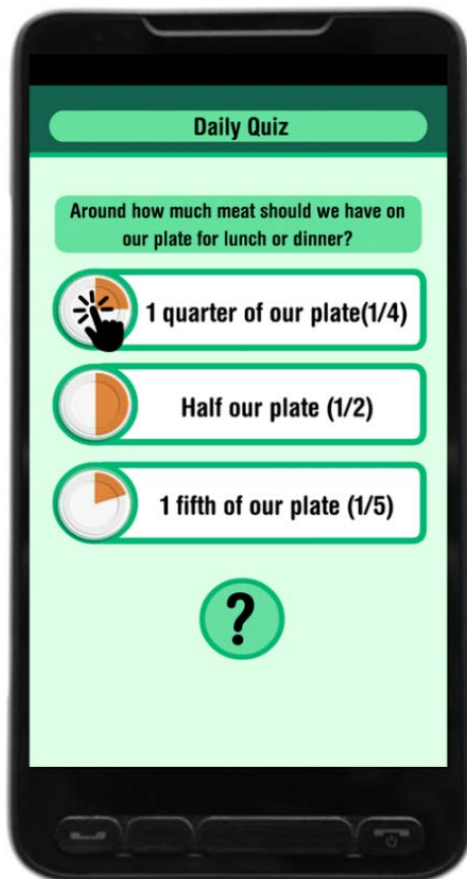


Figure 43: Daily Quiz



Figure 44: Points for Daily Quiz

### 7.7.5 Feedback on behaviour and goal setting

Once users have logged their food for one week, they will receive a visual report of their food portion intake (Figure 45), where any imbalance will be highlighted in red. Users are then instructed to select one of the highlighted areas to set a goal in for the coming week. They are also given the opportunity to set more specific goals in one of the highlighted food groups e.g. purple group, chocolate bars (Figure 46).



Figure 45: Food portions report

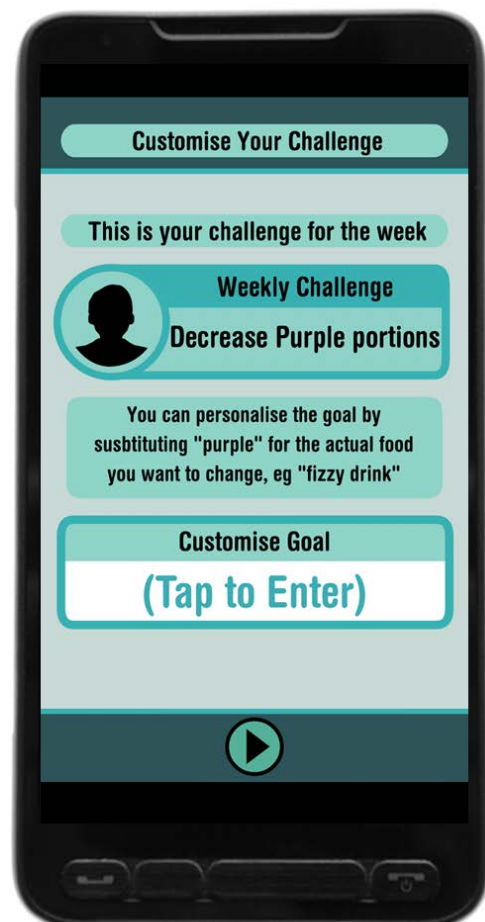


Figure 46: Goal setting tool

### 7.7.6 Family messaging centre

Users can also compose messages to send to other family members (e.g. partners), requesting help towards providing appropriate portion sizes for the family as shown in Figure 47 below. Users can choose between pre-defined messages in relation to portion sizes or they can create their own message. The message recipient will receive a pop-up of the message next time they open the app and will receive points for agreeing to help the message sender. Therefore, users will receive points for answering quiz questions, logging their food and helping other family members.



**Figure 47: Family messaging centre**



### 7.7.7 Homescreen

Feedback on users' progress towards their weekly goal, will be shown visually on the home screen in progress bars (Figure 48) and users will receive feedback on whether they completed their weekly portion goal or not (Figure 49).



Figure 48: Home screen



Figure 49: Goal completion feedback

### 7.7.8 Persuasive messages

Parents will receive daily notifications to log their food as well as persuasive messages and tips around reducing portion sizes (Figure 50). Parents are also signposted to other helpful websites and apps on healthy eating as well as local family dietician services and group weight management programmes (Figure 51).



Figure 50: Tips

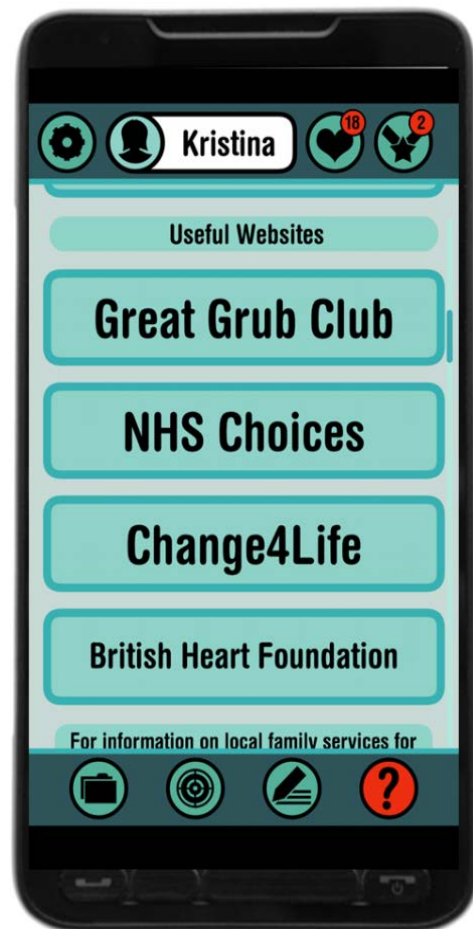


Figure 51: Links to useful websites and local services



### **7.7.9 The final Intervention Mapping Table**

Table 20 shows the results for the final Intervention Mapping Table where each theoretical, user-centred and app feature have been linked together across the three stages of development.

**Table 20: Final intervention mapping table**

Stage 1 (Steps 1-4)			Stage 2 (Steps 5-8)			Stage 3 (Steps 9-10)
COM-B	TDF	Sub-themes	User preference	IFs	BCTs *	App features
Psychological Capability	<b>Knowledge, Memory, attention and decision making processes</b>	Parents lack knowledge and have a difficulty in making decisions on appropriate portion sizes	Time saving and convenience (quick and simple), visual aids	Education, Training,	(2) Provide information on appropriate portion sizes (information provision), (3) Instruction on how to perform the behaviour, (15) Feedback on the behaviour, (21) Demonstration of the behaviour	Portion guide tool, The Balance Wheel, tips via notifications and in app messages, progress bars, Quiz
	<b>Knowledge, Memory, attention and decision making processes</b>	Parents lack knowledge on the balance of food groups	Time saving and convenience (quick and simple), visual aids, communication (tools they can use together)	Education, Training	(2) Provide information on portion guidelines for food groups (information provision), (3) Instruction on how to perform the behaviour, (15) Feedback on the behaviour	The Balance wheel, tips via notifications and in app messages, food reports, Quiz

	<b>Skills (Cognitive)</b>	Parents' difficulty in measuring in food portions	Time saving and convenience (quick and simple), visual aids, communication (tools they can use together)	Training	(3) Instruction on how to perform the behaviour, (19) Behavioural practice, (21) Demonstration of the behaviour	Portion guide tool, tips, Quiz
	<b>Skills (interpersonal)</b>	Parents' difficulty in Communicating with their children and partners around eating and weight issues	Communication (tools they can use together), gamification	Enablement	(13) Adding objects to the environment	The app itself is designed to foster communication by being a tool for the family to use together
	<b>Behavioural Regulation</b>	Parent's regulation of their own and their children's portion sizes	Minimal data input, quick and simple, tools to use together, visual aids, gamification-challenge for the	Training, Enablement, Modelling	(17) Goal setting of behaviour, (11) Self-monitoring of behaviour, (14) Identification of self as a role model (parental modelling) (21) Demonstration of the behaviour (15) Feedback	Food logging section, goal setting section, Persuasive messages via notifications and in app messages

			whole family to compete in		on the behaviour behaviour, (18) Non-specific reward	
		Parents' eating and shopping habits	Minimal data input, quick and simple, tools to use together, visual aids, gamification-challenge for the whole family to compete in	Training, Enablement, Modelling	(17) Goal setting of behaviour, (11) Self-monitoring of behaviour, (14) Identification of self as a role model (parental modelling) (21) Demonstration of the (15) Feedback on the behaviour behaviour, (18) Non-specific reward	Food logging section, goal setting section, Persuasive messages via notifications and in app messages
<b>Reflective Motivation</b>	<b>Intentions</b>	Parents' intentions to make changes to their children's dietary behaviours	Gamification (A challenge for the family to compete in)	Persuasion	(1) Commitment	Parents must agree to help their children achieve the target behavior before they begin the challenge
	<b>Social identity</b>	Role of the Mother	Communication (tools they can use together), gamification	Persuasion, Modelling	(14) Identification of self as a role model, (10) Verbal (text) persuasion about capability	Persuasive messages via within app text notifications

	<b>Beliefs about capabilities</b>	Parents have a lack of confidence in their ability to make changes to their children's dietary behaviours and weight	Time saving and convenience (quick and simple), visual aids, communication (tools they can use together)	Persuasion, Training	(11) Self-monitoring of the behaviour, (17) Goal setting of the behaviour, (15) Feedback on the behaviour, (14) Identification as a role model, (3) instruction on how to perform the behaviour	Persuasive messages via within app text notifications, Achievements, Progress bars, Quiz,
	<b>Beliefs about consequences</b>	Parents' beliefs of the health risks of childhood and adulthood overweight	N/A	Education, persuasion,	(4) Information about health consequences, (6) Information about social and environmental consequences	Persuasive messages via within app text notifications
		Parents' belief that they do not need to change children's eating behaviour if they do more exercise	N/A	Education, persuasion	(4) Information about health consequences	Persuasive messages via within app text notifications

		Parents' belief that if they overcook, they will overfeed their families	N/A	Training	(3) Instruction on how to perform the behaviour,	Tips via within app text notifications
		Parents' belief that portion sizes take too long to measure portion sizes	Time saving and convenience (quick and simple),	Education, persuasion, Training	(3) Instruction on how to perform the behaviour, (19) Behavioural practice, (10) Verbal (text) persuasion about capability	Portion guide tool, Persuasive messages via within app text notifications
<b>Automatic Motivation</b>	<b>Reinforcement</b>	Parents' dietary habits	Time saving and convenience (quick and simple),	Training	(3) Instruction on how to perform the behaviour, (19) Behavioural practice (22) Habit formation, (23) Habit reversal	Portion guide tool, food logging,
	<b>Emotion</b>	Parents' guilt of restricting food & Parents' fear of child becoming anxious about weight/eating disorders	Gamification ( a challenge the whole family can compete in)	Persuasion	(8) Information about emotional consequences, (7) Anticipated regret	Persuasive messages via within app text notifications

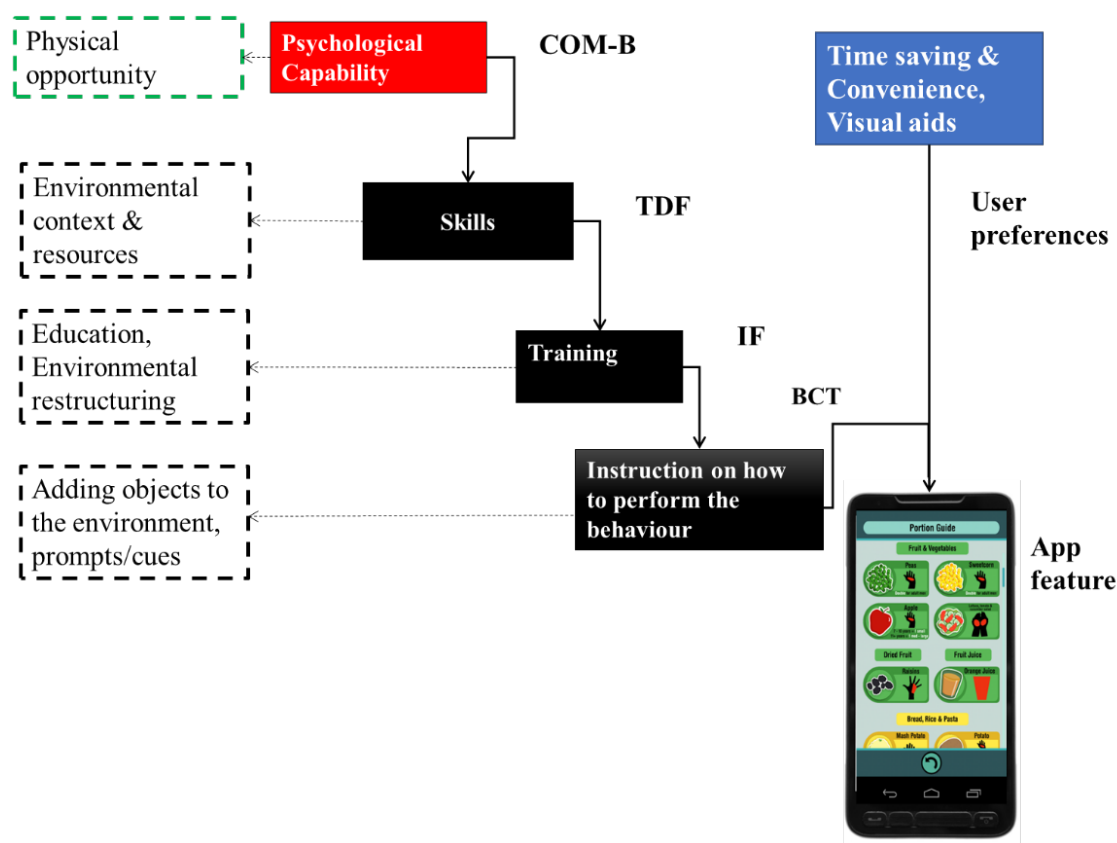
<b>Physical opportunity</b>	<b>Environmental context and resources</b>	Parents' resources for measuring portion sizes	Time saving and convenience (quick and simple), visual aids,	Environmental restructuring	(13) Adding objects to the environment, (9) Prompts/cues	The App (is an object added to the environment) Resources section - for measuring food portions
<b>Social opportunity</b>	<b>Social influences</b>	Grandparents	Communication (tools they can use together), gamification	Enablement	(20) Social support (unspecified), (18) Non-specific reward	The app provides a challenge which the whole family can compete in. Users can send requests via within app messages to other family members to help achieve their goals. The family member receives points
	<b>Social influences</b>	Partners	Communication (tools they can use together), gamification	Enablement	(20) Social support (unspecified), (18) Non-specific reward	

						for agreeing to help.
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\*BCT Numbers correspond to their numbers in the intervention flow chart (Figure 25, section 6.5.5)



Figure 52 below, gives a visual example of how the theoretical components were combined with the user-centred components to produce a single app feature using an example of the proposed portion guide tool.



**Figure 52: Theoretical components and user-centred components used to develop the portion guide**

Figure 52 shows in more detail the mapping process for a single app feature. It became apparent that app features also represented other BCTs that were not originally part of the sequential mapping process which has been documented by other researchers in the field (Mohr, Schueller, Montague et al., 2014). Thus, the intervention development process, although described sequentially, involves cycling back and forth through stages to refine the theoretical content.

#### **7.7.10 Generation of text**

Text was used as a mode of delivery for several BCTs in the intervention in the form of two app features: within app text notifications (delivering tips and persuasive messages) and an interactive quiz as shown in Table 20. Considerations need to be afforded to not only the theoretical determinants, intervention functions and behaviour change techniques but also how these are delivered (e.g. text, video, audio) and how health messages are framed. The generation of text for the notifications required a review of the empirical evidence to guide the process of message framing which refers to whether health messages describe the benefits of carrying out a behaviour (gain-frame) or the consequences of not carrying out the behaviour (loss-frame). A meta-analytic review on health message framing effects revealed that gain-framed messages were more effective for preventative health behaviours (Gallagher & Updegraff, 2012) and therefore this framing was used to guide the messages, notifications (Table 21) and quiz (Table 22) in the app where applicable. In addition, one a recent study also found that parents considered gain-framed messages as more engaging than loss-gained messages (Jarvis, Gainforth, & Latimer-Cheung, 2014). Therefore, gain framing was used to guide the health messaged delivered in the app.

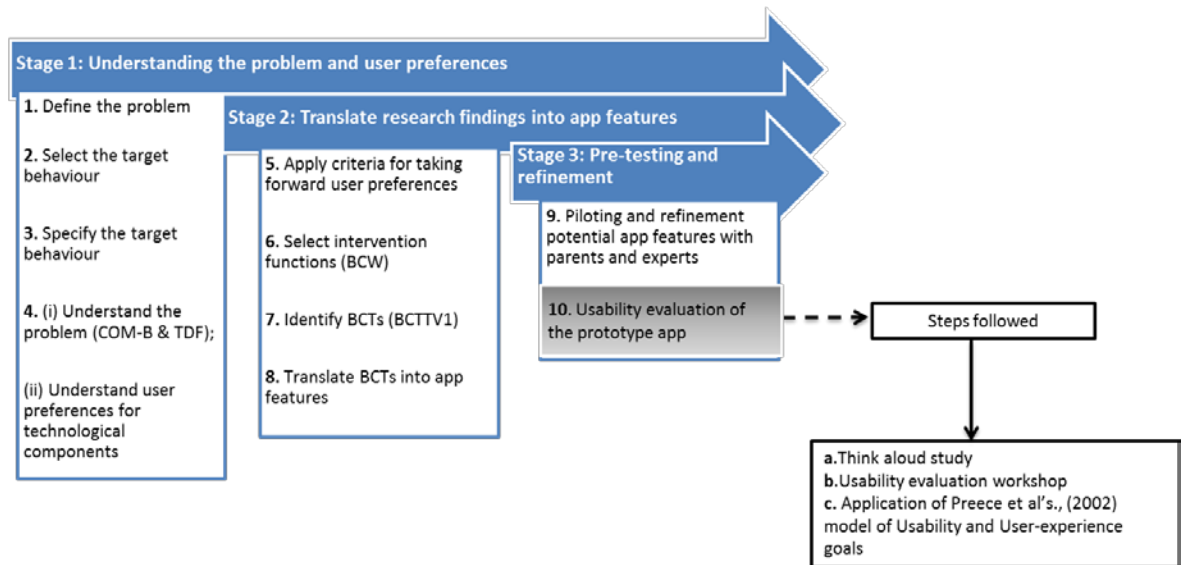
**Table 21: Excerpt of content for messages and notifications**

COM-B	TDF	BCTs	Example of content
Capability	Skills	Instruction on how to perform the behaviour	Try a smaller plate and bowl for your children's meals to help serve up smaller portions of food.
	Knowledge	Instruction on how to perform the behaviour	Eating a variety of foods from each food group will help you and your family eat a balanced and nutritious diet
Motivation	Beliefs about consequences	Information about social consequences	Well done! By helping your child to maintain a healthy weight you will reduce your child's risk of being teased at school because of their weight
	Social Identity	Identification of self as a role model	Eating healthily will set a good example for your children and help them to eat healthily too
	Behavioural regulation	Self-monitoring of behaviour	By helping your child to log their food every day, you will be more aware of what they are eating
	Emotion/beliefs about consequences	Information about emotional consequences, Instruction on how to perform the behaviour	Sometimes you can feel guilty when you restrict your child from eating something they want. By not having unhealthy snacks in the house, your child is less likely to want them.

**Table 22: Excerpt of content for the Quiz**

COM-B	TDF	BCTs	Example of content
Capability	Knowledge	Information provision	Why is it good to drink plenty of water?
	Skills	Instruction on how to perform the behaviour, Behavioural rehearsal	Select the best slow energy burners to eat for breakfast that will help us feel fuller for longer
Motivation	Beliefs about consequences	Information about social consequences	Helping your child to maintain a healthy weight will reduce your child's risk of which one of the following?

## Chapter 8 Usability evaluation of the prototype app



**Figure 53: Step 10 - Usability evaluation**

### 8.1 Introduction

The methodology for designing a healthy eating app has extensively involved a User Centred Design (UCD) approach throughout the development cycle. This approach advocates the importance of gathering users' needs, desires and limitations at each stage in the design process (Ginsburg, 2011). Step 10 in development process involved evaluating the usability of the prototype app. Usability refers to 'the extent to which a system can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use' (De Vreede, Fruhling & Chakrapani, 2005:1). Perceived usability of a system is an important influence on user engagement (Brien & Toms, 2010).

Systems considered to have greater usability are both easy to use and easy to learn. Usability focuses on a range of factors such as navigability (e.g. the ease with which users can navigate around an app), presentation of information, functionality, readability of text, and speed of output data. Research suggests that good levels of usability leads to positive user attitudes, increased use, and increased user efficiency of a system (De Vreede, Fruhling & Chakrapani, 2005).

This stage involved two studies (a think aloud study and a usability workshop with parents) with a common objective: to identify any usability issues that participants have with the prototype app.

#### **8.1.1.1 Think aloud study**

The field of cognitive engineering aims to understand the underlying principles behind human's interactions with systems and the design of interfaces that can support these interactions (Jaspers, Steen, Bos, & Geenen, 2004). There are a variety of formal (e.g. software inspections by trained inspectors), automatic (e.g. web-based fault analysers), empirical (e.g. usability surveys) or informal (e.g. cognitive walkthroughs) evaluation methods that can be used (Huart, Kolski, & Sagar, 2004; Yen & Bakken, 2009). The app has already undergone a formal usability inspection by testers at the app company before its release to the university. Therefore, the next stage consisted of utilising an informal inspection method known as the 'think-aloud' method, which permits a 'good compromise between cost and implementation time on the one hand, and the results they make it possible to obtain on the other'(Yen & Bakken, 2009:714).

The 'think aloud' approach was first introduced within the field of usability by Lewis, (1982), at IBM. The method was further developed based on the techniques

of protocol analysis (Ericsson & Simon, 1984), within the field of cognitive psychology. According to Ericsson & Simon (1993), verbal reports of cognitive processes are either drawn from information stored in short term memory (STM) or long term memory (LTM). In the case of a think aloud study, participants are required to access information from STM while information is attended to. The authors also maintain that tasks are not disrupted by these verbal reports. Therefore, it may be argued that in many cases, the think aloud method is a ‘unique source of information on cognitive processes’ and provides data on the constant processes of thought during task completion. In this regard, it may be seen as a direct method for gaining real insight into how humans problem solve (Jaspers, Steen, Bos & Geenen, 2004:783) and is extensively used and respected by usability experts (Nørgaard & Hornbæk, 2006).

The think-aloud (TA) protocol is one of the main tools employed by usability experts when conducting usability evaluations (Olmsted-Hawala, Murphy, Hawala, & Ashenfelter, 2010). This method of inspection involves individual assessments and cognitive walkthroughs where participants are asked to ‘think aloud’ as they complete a number of tasks (Mack & Nielsen, 1993). Such a process allows the researcher to use this information to identify any problem areas within the application being tested and formulate ideas for enhancements (Olmsted-Hawala et al., 2010).

#### **8.1.1.2 Usability workshop**

Usability workshops are used to evaluate specific usability aspects, where each workshop will have its own schedule and goals (De Vreede et al., 2005). This workshop-based method allows an interactive user-centred approach for eHealth

design projects using methods such as storyboards, design mock-ups and scenarios (Sutcliffe et al., 2010).

For the current study, a workshop was used to present the content of the prototype app to parents who had previously taken part in the weight management programmes and who represented the target audience for the app. It also allowed the opportunity to determine parental acceptability of the overall concept of the app and messaging content.

### **8.1.2 Overview of usability evaluation study**

The usability evaluation study focused on testing the prototype app using two cycles of evaluation. The think aloud study aimed to test the functionality (i.e. whether participants can carry out tasks for which it is designed?) and usability (i.e. how easy is it to use?) of the prototype app (Rogers et al., 2011). This was to ensure that any obvious issues (e.g. bugs or design flaws) could be amended before testing with parents.

The usability workshop allowed a continuation of the UCD approach adopted throughout the intervention development process. The workshop had the following specific goals to determine:

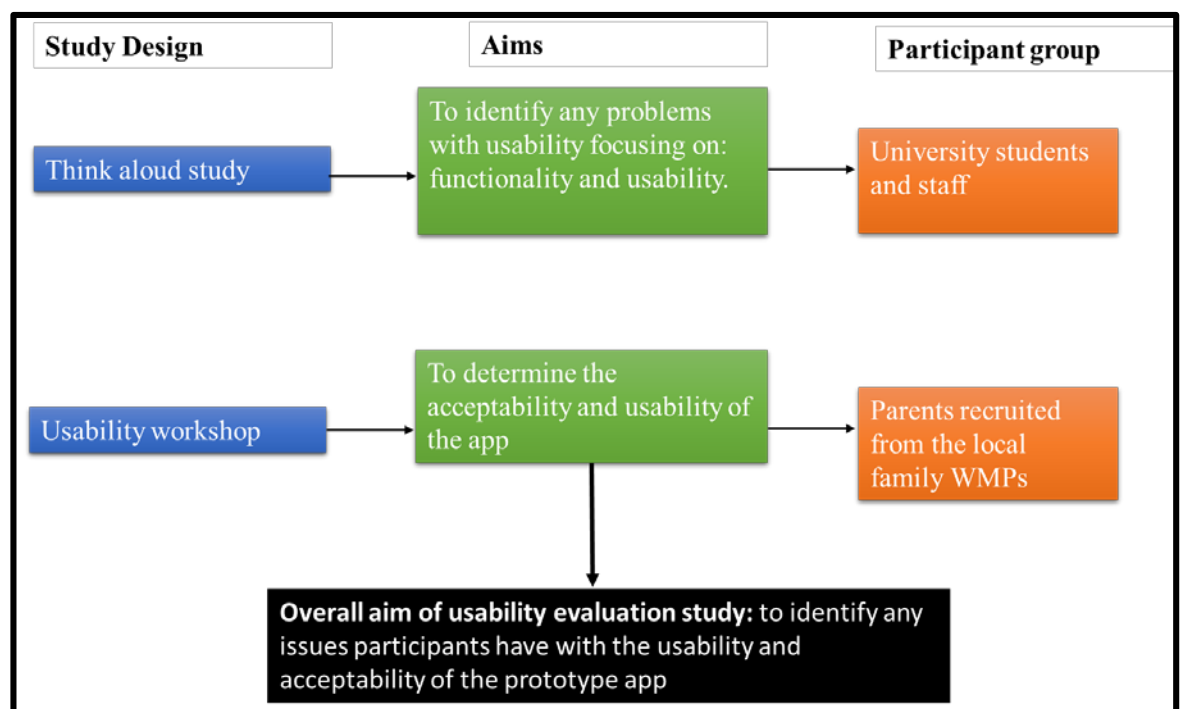
- The acceptability of the overall concept of the app (i.e. do parents want to use this app? do they like the concept of the app?).
- The usability of the portion measuring tools in the app (i.e. are they easy to understand and learn?).
- The legibility and acceptability of health messaging content (i.e. is the language used appropriate? Does any cause offence?).



- The appeal of the design elements (i.e. do parents like the way it looks and feels? Is it stimulating?).

Ensuring that the tone of messages were acceptable to parents was regarded as particularly important with respect to the highly sensitive area of childhood weight management and the importance of engaging mothers (See Section 5.5.4.5 on Social Identity). In addition, previous research has highlighted parents' negative reactions to other public health initiatives such as the letters from the NCMP (Boddy, 2011). The workshop also aimed to increase parents' interest for becoming testers of the prototype app.

Figure 54 below presents the overall aims of the usability evaluation study.



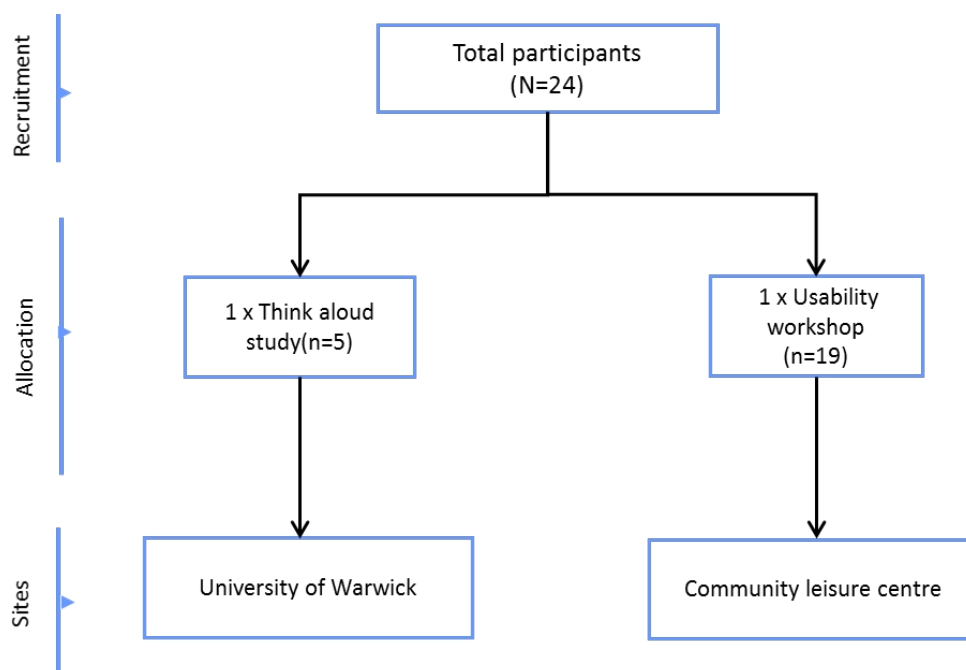
**Figure 54: Usability Evaluation aims**

## 8.2 Methods

### 8.3 Recruitment

The think aloud study involved an opportunity sample of PhD students and university staff, recruited from the university. Participants were recruited face to face in the department.

The usability workshop recruited a purposive sample of parents with the help of a family weight management programme manager. The programme manager sent out a mailshot to parents who had previously taken part in the family weight management programme from two months to one year ago.



**Figure 55: Recruitment flow chart for study three**

Figure 55 details the recruitment flow chart for the usability evaluation study where five participants took part in the ‘think aloud study’ comprised of both males ( $n = 2$ ) and females ( $n = 3$ ). Participants varied in their competency of using apps from

novice to the experienced. Participants ranged between the ages of 20-54 years old, consisting of three students and two university staff.

The workshop recruited 19 parents who had previously taken part in the family weight management programme and consisted mainly of mothers ( $n = 18$ ).

### **8.3.1 Ethical considerations**

For both usability evaluations, participants were welcomed and given an outline of the project and were reassured that it was not them being tested, but the app.

Participants were also informed that they were free to withdraw at any time during the session. The data collected (i.e. notes taken during both sessions) was transferred to the app company's password protected tracking system.

### **8.3.2 Settings**

The think aloud study took place in a controlled setting to check for any obvious flaws that could be amended before further usability evaluation took place with parents, allowing for faster iterations to the app. Participants carried out usability testing in a hired room at the university which allowed control over environmental and social influences that could impact on their performance.

The usability workshop with parents took place at a community centre in Rugby.

The family weight management programme provided local families taking part with healthy snacks and beverages.

### **8.3.3 Materials**

For the think aloud study an android smartphone (Samsung S3), 'Tasks Scenarios' paper document (Section 8.3.4.1.1; Table 24) and pen were used for the researcher to record notes. The usability workshop encompassed a computer, projector screen,

PowerPoint presentation (Appendix 5A), iPad and contact address forms (Appendix 5C).

### **8.3.4 Procedures**

#### **8.3.4.1 Think aloud study**

Five participants independently conducted tasks on an android smartphone device. Each participant was seated alone in the room behind a desk and given an introduction to the usability study. The introduction notified participants that they were helping to test the usability of a healthy eating app to check for elements such as whether it was easy to use, intuitive and functioned well. Participants were provided with a TA protocol and informed that they had twelve tasks to complete and if they could not complete one task, to move onto the next. Participants were instructed to verbalise their thoughts as they move through each task, without planning what they are going to say. They were asked to speak clearly and informed that they will be asked to share their thoughts if they are silent for any long period of time.

The researcher was seated in the room at the other side of the desk so participants' actions on the device could be observed. It was important to make participants feel at ease so they could perform routinely. Therefore, the researcher did not interrupt or comment when participants were making mistakes or having difficulty with the task, in line with usability evaluation guidelines (see Rogers et al., 2011). In addition, Ericsson and Simon's (1984) verbal protocol was followed where the researcher was required to remain silent during the session. Only short probes such as 'what are you thinking?' and 'keep talking' were used to keep the participant verbalising their

thoughts. This the authors propose, is to ensure that participants' verbalisations are not permeated by long term memory.

The researcher collected data through making annotations on the task scenarios document (see Table 23), where notes were taken of participants' verbalisations of their thoughts as they moved through each task. Once participants had finished working through all the tasks, they were thanked for their time and directed out of the room. After all five usability studies had been conducted, all the researcher's notes were collated and transferred onto the app company's online tracking system for modifications to be made to the prototype app (Appendix 5B).

#### 8.3.4.1.1 Task scenarios

Table 23 shows a list of 12 task scenarios developed for users to execute during usability testing.

**Table 23: Task Scenarios**

<b><u>Tasks</u></b>
<b>Please take as long as you need and 'think out loud' as you attempt to complete each task below. If you are unable to complete a task then please move to the next one.</b>
<b>Task 1</b>
Set up your profile (You can enter false or real details here)
<b>Task 2</b>
Agree to the terms and conditions
<b>Task 3 (DEMO starts)</b>
Please let the app take you through the demo and practice logging food ( <b>Enter: Snack: chocolate bar</b> ), and practice answering a quiz question
<b>Task 4</b>
Edit your profile (change some information in your profile)

**Task 5**

Find out which level you are in for your achievements

**Task 6**

Turn off the menu sounds

**Task 7**

Find out what you and your child have gained points in so far

**Task 8**

Find local weight management services

**Task 9**

Go to the portion guide

**Task 10**

Set up your child's profile (You can enter false or real details here)

***Quickly go through demo – log child's food (Enter: dinner, hamburger and chips)***

**Task 11**

Send a message from your profile to your child's profile

**Task 12**

Approve progress for your child

**8.3.4.2 Usability Workshop**

Parents were seated in a room with desks forming a U-shape around a projector screen. While parents took part in the workshop, children accompanying them were directed to the sports hall to take part in various sport activities facilitated by the weight management programme staff.

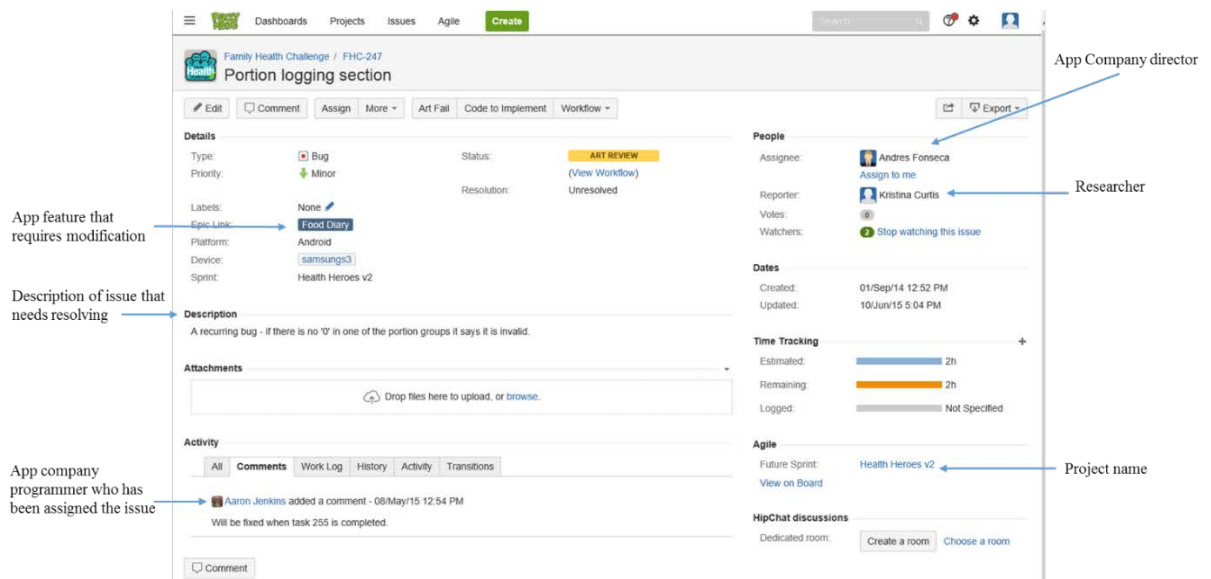
The usability workshop was facilitated by one researcher and also had a family weight management programme manager present for writing notes on parents'

comments on the app. The first five minutes of the session involved an introduction to the project and an overview of the aim of the workshop:

*For the last few years, parents and experts have been helping to develop a family healthy eating app aimed at helping parents to balance their families' portion sizes. We now have a prototype app that I would like to take you through today using screen shots shown on this projector screen. I would like to hear your comments on the overall idea of the app and the look and feel of it. I would also like to gain your feedback on messages that appear in the app, particularly whether they are easy for you to understand and whether any make you feel uncomfortable or offended. Please feel free to ask me questions at any time during the presentation and you are welcome to leave the workshop at any time if you wish to do so.*

For the remaining 40 minutes, the facilitator took participants through a PowerPoint presentation of screenshots of the prototype app (Appendix 5A) and the persuasive messaging content to check that the language used was clear and inoffensive towards parents. Parents' suggestions for improvements to the persuasive messaging text were amended in real time during the presentation with parents dictating the language they preferred for certain messages. Other comments relating to the concept, artwork and app features were recorded on an iPad in note form. In addition, the family weight management programme manager also made handwritten notes of parents' feedback as they were taken through the app. The workshop concluded with respect to reiterating and revising the workshop aims. In addition, parents were requested to provide their contact details if they were interested in becoming testers when the next iteration of the app is ready.

The data collected from the think aloud study and usability workshop were logged and stored electronically on the app company's password protected tracking system. These files were then used to communicate with developers and designers on the changes that needed to be made in order to improve the usability of the app. An example of logging a comment on the tracking system is shown in Figure 56 below.



**Figure 56: Screenshot of tracking system**

## 8.4 Results of think aloud study

Participants completed 12 simple tasks (Table 23) that are required to use the app in the first week of the intervention which ranged from setting up their profiles, to logging their food. The main findings from the study showed that participants were able to interact with the app but that this was not optimal. All the comments were logged onto the tracking system so developers could access them and provide an indication of their development time and begin work on different modules (See Appendix 5B). The usability issues that were raised are described under the following sections below.



#### **8.4.1 End User Licence Agreement (EULA)**

Users are required to agree to the terms and conditions set out in the End User Licence Agreement (EULA) before they can begin using the app. Several of the testers commented that the 'EULA' title is confusing. It was suggested by one tester that instead it could have what other apps show: 'Terms and Conditions'. In addition, one tester thought the EULA was confirmation of setting up their profile and mistook it as a confirmation message.

#### **8.4.2 Welcome page**

Once users have downloaded the app, upon first time use they will receive a welcome message as follows:

**“Welcome to the Health Heroes app!**

**This app will help you to recognise problem areas in your child’s diet and help you to set small practical goals to improve on these areas.**

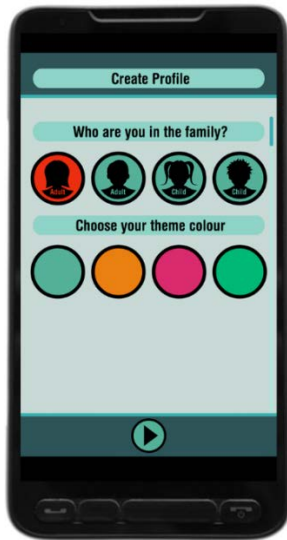
**It’s simple..**

**Small steps lead to big changes!!”**

Users commented on the font size and content on the welcome page. One user suggested amending the text to include problem areas in 'yours and your children's diet', instead of 'your child’s diet'. This comment suggested that the app needs to make clear that it is for parents to use with their children. In addition, one of the testers stated that the font was too small on the welcome page, which made it difficult to read.

### 8.4.3 User profiles

Users are taken straight to the profile page where they can set up their profiles (Figure 57). They are asked to provide a health heroes name (users can use their real name or a false name here), their gender and their age.



**Figure 57: Create Profile**

There were several issues highlighted by users with regards to this task. Firstly, it was pointed out that during the set up, when users enter 'Male', they receive a message that it is 'invalid' and in order to overcome this problem, users have to make sure it is all in lower case. This could pose problems as most phones automatically insert a capital letter at the start of a new word. One idea for an enhancement to this usability problem is to make the data input quicker and provide a drop down box where you can simply select 'Male' or 'Female'.

Another problem that was highlighted by several users was that there is no confirmation when a user has successfully set up a profile. Users wanted reassurance that they had performed the task correctly before moving onto the next task.

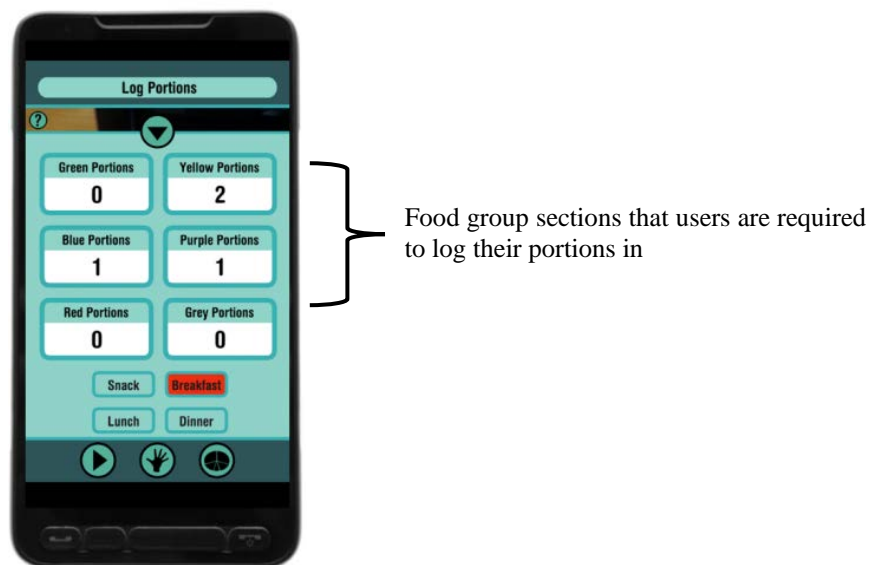
Task 4, pertaining to the task of editing user's profiles (see Table 23), was also observed as taking a long time to achieve. Several participants commented that it was not clear enough as to which icon represented the user profile. Furthermore, the existing icon for the user profile was not recognised as a button that could be tapped. This further demonstrated the complexity of the multi-touch nature of the app, highlighting the need to make buttons more obvious.

Ideas for enhancement included inserting a confirmation message or symbol such as a tick to validate that users have successfully set up their profiles. Improving the multi-touch feature of the app is discussed in section 8.4.6.

#### **8.4.4 Portion logging section**

The portion logging section is aimed at helping parents to monitor their own and their children's food portions. Parents also receive notifications to remind them to log food. Therefore, this section relates to three BCTs: Prompts/Cues, Self-monitoring of the behaviours and Monitoring behaviour by others without feedback.

Users are instructed to take pictures of their food and indicate which food group the food belongs to and how many portions they have had as shown in Figure 58.



**Figure 58: Portion Logging**

Two other tools that support parental self-monitoring behaviour are the Balance Wheel and Portion Guide. Users are instructed to review these tools to help them select the food group and portion size. So for example, if a user has eaten a large portion of cereal, these should be entered as two (or more) portions as per the portion size guide. The tools also relate to several BCTs including *Information provision*, *Instruction on how to perform the behaviour*, *Adding objects to the environment*, *Behavioural practice/rehearsal* and *Demonstration of the behaviour* (to children) shown in the Intervention Mapping Table (Section 7.6.9; Table 20).

There were a number of technical errors that were experienced by users when they were instructed to log food. Firstly, users had to enter a '0' value into the food group sections that were not in use, otherwise an 'invalid' error message is shown. Secondly, the screen froze for one of the testers after they had taken a picture. These errors were recognised by the researcher as 'recurring bugs'.

With regards to the process of taking pictures, it was noted by several users that parents are not always going to be able to take pictures of their children's food such as when they are at school. Therefore, there needs to be an option for logging food without having to take pictures of food.

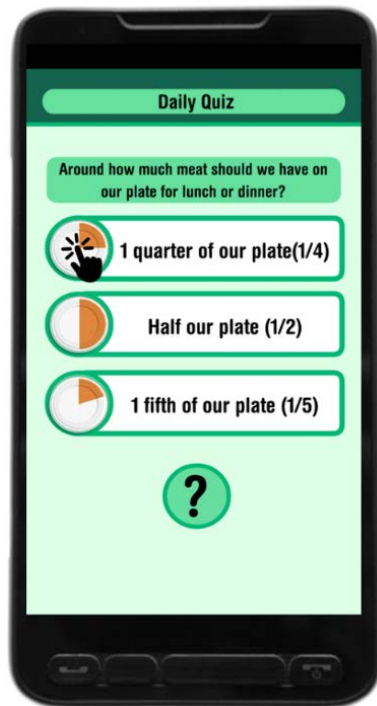
Currently, the portion logging section is all one colour which was chosen when the user set up their profile and customised the colour of the background. However, one user commented that it would be easier if the sections for logging portions corresponded to the colour of the food groups they represented. They felt this would save time in having to look the colours up on The Balance Wheel.

#### **8.4.5 Tutorials**

There was frustration with all testers with regards to the tutorial. Currently, when a parent sets up their profile and commence using the app, a tutorial takes them through all the tools in the app. However, the same tutorial is shown when they start using the app as another user (e.g. partner or child). This process was reported as too time consuming by all testers. One option for an enhancement to this usability issue would be to request that there is an option to 'skip demo'.

One tester reported that the order for the portion logging tutorial was confusing. They suggested it would be better if the balance wheel demonstration appears before the portion guide. This would then introduce users to the food groups before moving onto their appropriate portions.

Lastly, the quiz demonstration appeared to confuse participants. Currently there is animation that shows a hand dragging the correct answer to the question mark as shown in the Figure 59 below.



**Figure 59: Quiz demo**

Despite the demonstration of how to use the quiz, users failed to grasp the correct gesture to use (i.e. dragging the answer). Instead users tapped on the button they thought was the correct answer. As we may expect, users' previous experience of using apps are effecting their expectations, as most apps have buttons that are designed to be tapped, not dragged. Therefore, to make the app more intuitive and in line with users' expectations of buttons, an enhancement to this functionality would be to make these buttons the same as existing apps, as discussed further in section 8.4.6.

#### **8.4.6 Multi-Touch Display**

Multi-touch displays allow users to interact with mobile devices using their fingers. Interactions are executed through the use of gestures (specific finger movements) enacted on the user interface (Ginsburg, 2011). The app is built in a game engine to

allow for more animation such as dragging icons in the quiz section and the portion logging section sliding up after a picture is taken. However, this is not how most apps function and testers were generally unsure whether to tap or drag buttons. For example, several testers tried to tap buttons on the homepage, expecting to be taken to that section. However, there are currently no buttons on the homepage. In addition, buttons that were tappable such as menu buttons, often required users to tap them several times before they functioned, which suggests that the hit areas on the touchscreen are too small for some people's fingers and require expanding.

Testers also had difficulty using the quiz feature and it was observed that it was not intuitive enough for users to recognise which gesture they had to use (drag instead of tap buttons). One idea for enhancements here is to have all buttons functioning in the same way and as existing apps where buttons are tapped. In addition, any buttons appearing on the homepage should take the user through to that section when they are tapped.

#### **8.4.7 Navigability (Ask CG)**

Navigability refers to the extent to which users can explore and access any area of an information space (Fitzpatrick, 1970; Sundar, Bellur, & Jia, 2012). It is important that the structure of the app is not too complex or this could lead to users having difficulty using the app and feeling overwhelmed. Therefore, the think aloud study helped to test the navigation model and identify specific problems.

The main assets that limited the navigability of the app were the menu buttons. Several participants noted that the icons on the buttons did not match their actions. For example, the file icon button does not represent the home screen which it links to and therefore is not intuitive. Furthermore, testers made several attempts at trying to

log food as they were not sure where this section in the app appeared. One participant suggested having a separate button for logging food. It was also noted by several testers that they could not use the back button on the handset which made it difficult to return to previous sections and leave the section they were in.

## **8.5 Results from usability workshop with parents**

### **8.5.1 Parental acceptability of the overall concept of the app**

Parents responded positively to the screenshots of the app shown on the projector screen. There was agreement among parents that the app would be a ‘fun’ tool for families to use together which further validated the acceptability of the concept of the app. Parents expressed enjoyment and satisfaction regarding the visual appearance of the interface design which they also felt would attract their children to using the app. There was consensus among parents that a key attraction was the highly visual nature of the app, along with its focus on portion control.

### **8.5.2 Parental feedback on The Balance Wheel tool**

The Balance Wheel is a tool based on the eatwell plate that helps to convey the recommended ratios of food groups people should aim to achieve in their diets over a period of one day or one week. The Balance Wheel has six food groups: fruits and vegetables (green group), dairy (blue group), protein (red group), starchy foods (yellow group), Fats and sugars: oils and butter (light purple) and other (e.g. crisps, chocolate) (dark purple). The Balance Wheel also specifies the maximum number of portions within each food group that can be consumed each day, and has a section for recommended intake of non-sugary drinks e.g. water, skimmed milk.





**Figure 60: The Balance Wheel**

Parents agreed that The Balance Wheel (Figure 60) was a helpful tool in understanding the balance of food groups. There was broad consensus regarding the usefulness of having information on the maximum number of portions recommended in each food group per day. However, several parents agreed that the two food groups that come under ‘Fats and Sugars’ needed to be more differentiated in colour or there was danger in misinterpreting this as ‘21’ portions. This is a concern that was already identified by the researcher and will be modified in the next iterations of the app after this stage in usability evaluation.

### 8.5.3 Parental feedback on the Quiz tool

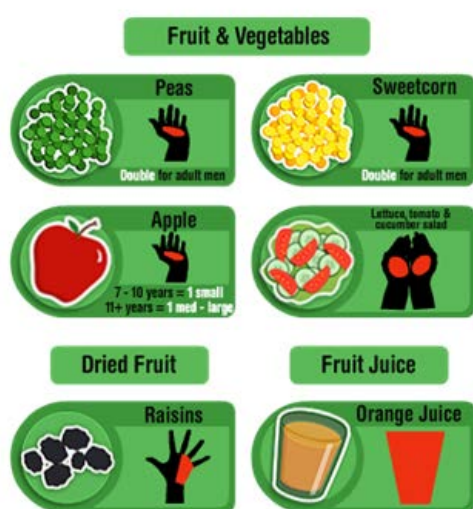
Users are given a new quiz question every day around portions sizes and the nutritional content of foods, which they receive points for answering correctly.

Feedback was positive among parents where it was agreed that it was a fun tool to engage the whole family in and that this would entice parents to keep using the app.

They also agreed that receiving points and badges for correct answers would be fun for children.

#### 8.5.4 Parental feedback on Portion Guide

The Portion Guide aims to show families the size of portions using different areas of the hand as shown in the example below.



**Figure 61: Green food group**

Parents' expressed divergent views with regards to the usability of the hand portion measuring tool (Figure 61). Some parents felt it was too confusing as it was not well-defined enough with regards to what the depth of food in the hand should be. It was therefore suggested by some parents that the images could provide examples of what the actual food looked like in the hand e.g. a hand holding mash potato in it. However, other parents felt that the hand portion measuring tool was simple enough to use and agreed it would be easy to implement in the home environment with their children.

One idea for an enhancement to the tool would be to provide an information icon on some of the pictures of food which once tapped, provided pictures of the food in a hand.

### **8.5.5 The name and logo of the app**

The logo is a female hero character aimed at appealing to the majority of the primary caregivers: mothers. However, a male hero character will also be available for fathers using the app. The logo (Figure 62) appears as the icon for the app on the phone and shows as a larger image when the user opens the app. The Balance Wheel is on the front on the costume to help convey the importance of keeping a balanced diet.



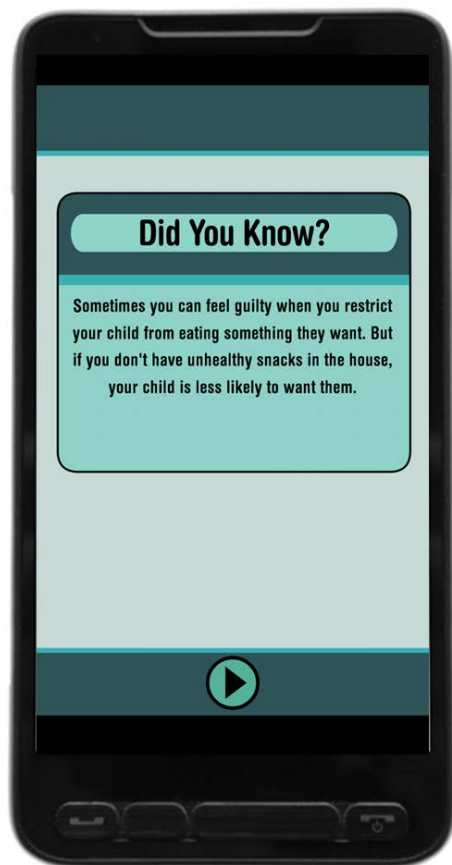
**Figure 62: Health Heroes Logo**

Overall the name and logo was liked by mothers in the workshop as they felt they could relate to a female superhero character. There was agreement among parents that they would be also appeal to children and increase the app's 'fun factor'.

Therefore, the logo can be seen as an improvement from the one presented in the interactive mock-ups (see Appendix 3E). However, one parent felt that the pointing finger could be mistaken for a gun. In addition, some parents felt that it would be fun to have superhero characters representing children when they were using the app. Therefore, these comments were taken forward with the app company so that they could amend the design.

#### **8.5.6 Parental feedback on health messaging content**

Parents receive persuasive messages and tips as ‘in app messages’ and notifications on the mobile device. An example of an in app message is shown below in Figure 63.



**Figure 63 Example of persuasive message**

Parents were presented with all the messages that appear intermittently in the running version of the app (62 messages) to check for their readability and acceptability (see Appendix 5A).

Parents responded positively to the tone of the messages and felt that they were motivating. There were only a few suggestions regarding the clarity of some of the messages. These were therefore amended in real time on the PowerPoint presentation, using parents own language. Table 24 below gives an example of this where the amended text is highlighted in red.

**Table 24: Parental suggestions for changes to copy**

Eating healthily will set a good example for your children and help them to eat healthily too
By cutting down on the amount of food we prepare and serve, we <b>save</b> money and waste less food!
<b>Just by cutting down on the amount of fizzy drinks you allow your child can make a BIG difference because they contain a lot of sugar</b>
<b>Reducing the size</b> of food portions can help you and your family to manage their weight
Healthy eating is not just about WHAT you eat but also HOW MUCH you eat
If you don't want to waste food, why not freeze it and use it for another meal?
Using a smaller plate for children will help you serve up smaller portions of food
Keep going! Small changes can make a BIG difference! Don't give up!
Eating a variety of foods from each food group will help you and your family eat a balanced and nutritious diet

Parents were also asked to share their thoughts on how many messages were appropriate to receive over the duration of a week. There was agreement among parents that it would be acceptable to receive around one or two messages per week. There was general consensus that parents did not want to be bombarded with too many messages which they felt could become annoying and intrusive.

### **8.5.7 Increasing parental interest in becoming testers**

At the end of the workshop, parents were given the opportunity to provide their contact details if they were interested in testing the prototype app. Encouragingly, all the participants signed up to becoming a tester which perhaps reflects their positive impressions of the app.

In contrast to study one and two, the majority of parents taking part in the workshops reported having IOS operating systems (e.g. iPhone). Therefore, in order to test on these parents, it will be necessary to deploy the app into IOS.

## **8.6 Discussion and Summary of findings**

Users' comments drawn from the think aloud study and usability workshop can now be integrated into app development for further iterations to the app. The usability evaluation study resulted in recommendations for amends to the functional and usability aspects of the app, along with the content and artwork relating to user experience principles. The workshop also helped to inform the local parent community about the healthy eating app, allowing them to sign up as testers.

The main findings from the think aloud study suggested that overall users could interact with the app but this could be further optimized through improvements to navigability, touch screen functionality and through simplifying the portion logging and tutorials sections. Furthermore, recurring bugs were identified in relation to the user profiles and portion logging tools.

The underlying principles of good design rely on information that is appropriately organised and visually well presented. A common factor for all users is therefore how quick and easy it is to navigate around this information (Stroulia et al., 2013).

The think aloud study revealed that users had some difficulties navigating around the

app with regards to returning to previous sections and finding the log food and profile sections. This undermines one of Jakob Neilson's principle of interaction design where it is important that users feel in control of their interactions such as being able to go back and exit (Neilson & Mack, 1994). It will therefore be important to enhance the navigation based on these findings, particularly as empirical findings suggest that the degree with which users engage with the content of a system is dependent upon their self-efficacy towards navigability of the user interface (Sundar et al., 2012).

Users also highlighted that it would be important to have the colour of the food groups in the food logging section, larger fonts for the text on the home screen and more intuitive icons for logging food and editing profiles. This is congruent with recent research reporting that users value the layout when it is intuitive and enables effortless data input (Mendiola, Kalnicki, & Lindenauer, 2015).

Workshops are considered as a 'well-established' method for involving users in participatory design (Sutcliffe et al., 2010). The main findings from the usability workshop related to parents' overall impressions of the app. The app was received positively by parents and all parents registered their interest in becoming testers of the prototype app. In particular, there was agreement among parents regarding their pleasure in the aesthetic qualities of the app. Aesthetics refers to the visual appearance of the user interface (O'Brien & Toms, 2008). Indeed, aesthetics are important for optimising parental engagement with the app where it has been suggested that positive aesthetic experiences enhance intrinsic motivation, focused attention, curiosity, interest and pleasure in using a system (Jennings, 2000).

Parents were in agreement regarding a number of positive emotions that the app evoked including their perceived fun, enjoyment and satisfaction with the concept of the app and its visual appearance. According to O'Brien & Toms, (2008), the emotional thread of users' interactions relate to users' affective experiences and help to sustain their engagement and use with an application. However, there was one negative emotional critique from a parent regarding the logo. Although the majority of parents liked the logo, one parent perceived the pointing hand as a gun. Furthermore, there was concurrence among parents that the hand measuring tool needed to be clearer and that it would help to provide real examples of the foods in the hand.

The messages were received positively by parents and important feedback was given with regards to the frequency of messages that aligns with other research in childhood weight management mobile interventions (Turner et al., 2015).



Preece et al.'s (2002) model of usability and user-experience goals was applied again to help give an overview of whether the feedback was positive or negative regarding usability and user experience in Table 25 below.

**Table 25: An overview of usability and user-experience ratings for prototype app**

Study	App feature/Content	Usability and user-experience rating*
<b>Think Aloud</b>	EULA	Efficient to use (-)
	Welcome page	Helpful (-)
	User Profile	Efficient to use (-), Satisfying (-)
	Logging food	Efficient to use (-),
	Tutorials	Efficient to use (-), Easy to learn (-),
	Multi-touch display	Easy to learn (-), Satisfying (-)
	Navigability	Efficient to use (-), Easy to learn (-)
<b>Workshop</b>	Overall impressions	Fun (+), Entertaining (+), Enjoyable (+), Aesthetically pleasing, Motivating (+)
	Impressions of the Balance Wheel	Helpful (+), Safe to use (-)
	Impressions of the quiz	Fun (+), Rewarding (+), Entertaining (+), Motivating (+)
	The hand portion tool	Easy to learn (-) (+)
	The Health Heroes logo	Fun (+), Aesthetically pleasing (-)
	Tips and persuasive messaging content	Satisfying (+), Motivating (+)

\*Adapted from Preece et al., (2002) model of Usability and User-experience go

### **8.6.1 Limitations**

The think aloud study may be seen as biased because testing took place in a laboratory controlled setting. However, to date, most childhood weight management mobile interventions have been tested in laboratory settings (Turner et al., 2015), so that environmental influences can be controlled for. This is problematic as it will be difficult to ascertain how users interact with the app within the context of a real world-setting where there are many distractions that may limit their capability and motivation to use the app. Further testing in a natural environment will therefore be necessary to overcome this limitation (See Section 10.1.5).

Studies were not audio or video recorded. However, the aim of the studies were to identify specific usability issues to allow for fast iterative development of the app rather than conducting a detailed analysis of the experience and meaning of the app. In this regard, detailed transcripts of the ‘think aloud’ sessions and usability workshop was not necessary at this stage in the development cycle. In addition, with regards to the usability workshop with parents recruited from the family weight management programme, handwritten notes are less intrusive in contrast to the use of a camera or audio recorder (Ginsburg, 2011).

As with focus groups, participants in the workshop may have influenced other participants in the group. Furthermore, the workshop also relies on what parents say they like and not what they will actually do when they have the app on their phones (Ginsburg, 2011). According to O’Malley et al. (2014), ‘usability’ refers to the extent to which an app can be used by the target population where specified tasks are completed and rated on their technical functionality and user satisfaction. Therefore, it will be important to conduct think aloud studies with parents and which also involve children (Section 10.1.2).

### **8.6.2 Conclusion**

Usability evaluation has helped to uncover a number of usability issues that will be addressed in the next iteration of the app. Usability evaluation is an ongoing process involving a continual cycle of testing and improvement. The proposed next stages in usability testing will be discussed in Section 10.1.2.

## **Chapter 9 Discussion**

### **9.1 Overall summary of thesis aims**

Smartphones possess a range of attributes that have the potential to support mHealth apps in helping consumers start or reinforce one or more health behaviours and/or reduce risk behaviours. However, the development of the majority of these apps available to consumers, appears to have occurred in isolation of theory and evidence, resting mainly on developers' intuitions (Mohr et al., 2014). Despite evidence suggesting theory and evidence-based digital interventions may be more efficacious for changing behaviour (Webb et al., 2010a; Ritterband & Tate, 2009; Fjeldsoe et al., 2012), researchers, practitioners and developers, are struggling to meet the twin demands of developing theory informed evidence-based mHealth interventions that also engage users. Drawing on extant evidence, and new empirical data, this thesis documents some of the first research addressing these challenges. The thesis achieved its overall aim of systematically incorporating theory, evidence and user-centred principles to inform the development of a mHealth app. The healthy eating app was aimed at complementing local family weight management services commissioned by Public Health Warwickshire, in the UK. Hence, at the time of writing, to the author's knowledge this is the first mHealth intervention of its kind that has applied a systematic method drawing on the BCW framework and user-centred data, in the development of a family healthy eating app targeting parents to support childhood weight management. In the process, several contributions to knowledge were made.

## **9.2 Contributions to knowledge**

### **9.2.1 A new model for mHealth design**

There are two main contributions to mHealth design. First, to address the dearth in theory driven and evidence based mHealth design, this thesis is the first to implement the BCW to the design of a mHealth app within the context of childhood weight management and portion control. Second, evidence suggests that many mHealth apps are developed without sufficient attention to factors that will maximize the likelihood that they will be effective and engaging. With this in mind, this thesis carried out an iterative process, drawing on user-centred data, and mapped these onto theoretical components and app features. Accordingly, this is the first detailed exemplar of how to combine methodologies from the behavioural science and design fields in this way. Balancing these sets of empirical findings involved the development and application of a novel decision criteria (Section 6.1) and the mapping of multiple theoretical, design and technological components for intervention development. Therefore, the thesis provides knowledge on how to translate both theoretical and user-centred findings into behaviour change techniques operationalised as tangible app features (Objective iii). In doing so, it provides a step-by-step guide to the intervention development process. It is considered good practice to document this process to maximize transparency and uptake for other intervention designers wishing to utilise and build upon this research (Bartholomew et al., 2011; Eysenbach, 2011; Michie, et al., 2011b; Riley et al., 2011).

Other studies that have developed methodologies for addressing the paucity of theory driven design in persuasive technologies include Orji & Mandryk, (2014), who extensively drew on the HBM (Rosenstock, 1974) to identify the influence of

determinants of eating behaviours in individualistic and collectivist cultures. As with the current study, they propose a ‘data-driven and culturally relevant design’ methodology (2014:208) involving the mapping of empirical findings (e.g. the theoretical determinants) to behaviour change techniques (using previous work conducted by Michie et al., 2008). However, unlike this thesis, they have not gone beyond the theoretical underpinnings of the app and further mapped these to user preferences (to help refine BCTs and make them culturally relevant to the target population) and system design (e.g. app features). Other models include the Behavioral Intervention Technology (BIT) model, which attempts to integrate conceptual and technological components of electronic health (eHealth) and mHealth interventions (Mohr, Schueller, Montague, Burns & Rashidi, 2014). Principally, it offers a method for targeting distal clinical aims (e.g. weight reduction) and translating behaviour change strategies into app features. In contrast, the current methodology starts with a theory led behavioural diagnosis of the target behaviour using the COM-B model, before moving onto the possible solutions. This allows an in-depth understanding of the target behaviour and the system of behaviours surrounding it (Section 5.8, Figure 21), a critical phase to accomplish before designing an intervention to address the target behaviour. Brendryen et al. (2013) also developed a theory driven, evidence based intervention drawing on an intervention mapping approach. Similar to the current methodology, they considered theoretical, empirical and practical elements when translating methods into practical strategies and intervention components. However, they do not take account of design elements relating to user preferences, usability and user-experience. The authors recommend using an intervention mapping approach because it offers a structured and multi-theory approach to ensure a ‘problem driven focus’ necessary for building

interventions (Brendryen et al., 2013:11). However, the authors note that this approach is not ideal for theory building. One of the advantages of using the BCW is that it is underpinned by a single theory which allows researchers to build a conceptual model of the problem, as well as building an intervention to address it.

The methodology in this thesis also builds on current mHealth intervention development and approaches because it uses a new dynamic model of behaviour change. It has been argued that current health behaviour change theories and models are largely static and linear in nature and consequently are a 'poor fit with the intra-individual dynamics of future mobile technology interventions' (Riley et al., 2011:66). Furthermore, none of the models described above integrate UCD elements, a crucial step that ensured the social validity of the app amongst the target population (Curtis, Lahiri, & Brown, 2015). The UCD approach involved an iterative approach that progressively refined the intervention to ensure that the proposed mHealth app was suitable and engaging for parents to use with their children within the current context of childhood weight management. Engagement with a health behaviour change intervention is a prerequisite to their adoption and effectiveness, and this a notable challenge for digital interventions which are often characterised by high attrition rates (Yardley et al., 2015). An important attribute of engagement is interest and as such a UCD approach also helped to ensure that parents were interested in the intervention. Initiating interest in an intervention is a vital first step to its uptake and use (Crutzen & Ruiter, 2015).

Implementation of a UCD approach also led to the use of gamification to help increase the use of the intervention and change behaviour (Zichermann & Cunningham, 2011). Gamification refers to the application of game elements to non-game contexts to help improve the user experience and engagement, without making

the intervention a full game (Vette, Tabak, Weering et al., 2015). It can also be argued that ‘meaningful gamification’ was facilitated by the use of a UCD approach where data was drawn on users’ needs, background and interest. This helped to ensure that the game elements employed were more in line with users’ own goals in healthy eating (Nicholson, 2012). For example, parents in the first focus group suggested that receiving points for achieving healthy eating activities would add a fun element to the intervention. This was then taken further in the second stage of the development process where BCTs were translated into app features, some of which were gamified. For example, providing instruction on how to perform the target behaviour was operationalised into a quiz where families can learn through discovery and receive points for correct answers. Following a systematic process linking theoretical domains, BCTs and app features also allowed the study to be the first to apply gamification techniques relating to all three COM-B conditions (Section 6.6.3). In contrast, so far, research indicates that gamification has mainly been applied to motivation. For example, Lister et al. (2014), conducted a regression analysis on 13 key health behaviour change constructs (e.g. self-efficacy, peer pressure, social support) grouped together in the COM-B model. Results revealed a significant positive correlation with the motivation component of the model ( $P < .001$ ) but not the capability and opportunity components. The authors concluded from this that gamification is therefore mainly used to motivate users’ behaviour but represents a missed opportunity in failing to target the other two components necessary for behaviour change to occur.



### **9.2.2 Understanding parental food portion behaviours within the context of childhood weight management (Study one)**

Since conducting study one (Section 5.1.2) between the periods of 2012-2013, the World Health Organization (WHO) has recognised that the development of healthy food portion sizes among families is deemed critical to childhood weight management (WHO Technical Staff, 2014). An examination of existing theoretical accounts of human behaviour highlighted the demand for a more inclusive approach that could account for broader influences on this target behaviour (Section 2.4.5). The data from study one helped to support this view wherein all COM-B domains, and their 12 associated TDF domains, were reflected as important in understanding parental food portion behaviours with their children. Therefore, exploratory research using the COM-B and TDF tools, allowed hypotheses to be generated (Francis et al., 2012) around the influences on parental food portion behaviours (See Figure 19, Section 5.8). In the process of understanding the target behaviour and population, the thesis also provides an outline of a methodology that can be repeated as necessary for other target behaviours and health issues.

To date, there has been a lack of understanding around parental influences on children's dietary behaviours within the context of the obesogenic environment (Skouteris et al., 2012). Consequently, how exactly to support parents in changing these behaviours has remained unclear (Golley et al., 2011). However, this thesis contributes to this knowledge through providing an in-depth analysis of parental dietary behaviours within the context of the obesogenic environment that favours large portion sizes.

The COM-B model and TDF has been newly applied to the issue of parental food portion behaviours with their children and helps to provide a more comprehensive understanding into this target behaviour. For example, so far efforts to explain the consumption of large portion sizes have focused mainly on the shape and size of dinnerware which provide visual cues that influence consumption beyond our conscious awareness and control in both adults and children (Robinson & Matheson, 2015; Wansink, Painter, & North, 2005; Wansink & van Ittersum, 2007); the availability of low cost large quantities of high energy dense foods (Colapinto et al., 2007, Golan & Crow, 2004, Ledikwe et al. 2005, Schwartz & Byrd-Bredbenner, 2006, Young & Nestle, 2003); and genetic and biological mechanisms underlying portion size effects such as the role of reward pathways and the heritability of eating behaviours (Fisher, Goran, Rowe & Hetherington, 2015). However, results in study one shows that both parents' emotional and automatic responding (e.g. parents' fear of being disliked by their children and portion measuring habits) and beliefs (e.g. the parental belief it takes too long to measure portion sizes) are important influences on their portion control behaviours. Consequently, interventions targeting portion control in children focusing purely on one aspect such as environmental strategies (e.g. Robinson & Matheson, 2015), may not be as effective as those that also account for emotional and reflective processes associated with parental dietary behaviours with their children.

An important limitation previously acknowledged with some of the prevailing theories of behaviour change in health psychology is their failure to account for the emotional factors that influence behaviour (Section 2.4.5). However, it was evident from focus group discussions that parents experience a range of emotions that potentially impact on their own eating habits and their management of their

children's eating habits. Despite this, there is a paucity of research investigating parents' emotional barriers to childhood weight management, where most of the research has focused instead on children's emotional barriers (see Puder & Munsch, 2010, Porter, Bean, Gerke, & Stern, 2010, Gundersen, Mahatmya, Garasky, & Lohman, 2011). While the current findings support existing evidence on emotional influences relating to parents' fear of eating disorders (Hart et al., 2003; Statham et al., 2011; Grimmett et al., 2008; Gillison et al., 2013) and guilt of restricting food (Steinsbekk et al., 2011), they also add a number of new insights including parents' fear of being disliked by their children (Section 5.5.4.2; Extract 60) and parents' negative reactions to the Change4life media campaign (Section 5.5.4.6; Extract 92) which supports the UCD approach used in this thesis and testing health messages on the target population (Section 8.5.6). Furthermore, while parents' denial of their child's overweightness has been cited in the literature (Gerards et al., 2012), a theoretical analysis of focus group discussions helped to delve deeper into this emotion and suggested several potential contributory factors that may give rise to parental denial including; parents' own overweight status (which parents may not wish to address); parents' view that their children's weight gain is inevitable because it persists in the family and; parents' own experiences of unsuccessfully losing weight which appeared to lower their confidence in being able to help their children. In this regard, we can see why it may be easier for parents to blame external factors for their children's weight gain (Gerards et al., 2012). Indeed, a more thorough understanding of parents' emotional barriers provides further opportunities for resolving them.

It is also important to consider that previous theoretical accounts such as the TPB and HBM, fail to take account of the full environmental influences on behaviour

(opportunity) that include not only the environmental context and resources but also the social environment. For example, the current research highlighted that parents limited time to make changes to their dietary habits with their children and their tight fiscal situation resulted in food economics and acquiring more food for less money. However, social influences involving grandparents and partners' provision of larger portions to children, also interact with these aforementioned environmental influences and have a synergetic effect on parental management of their children's portion sizes. Therefore, drawing on a more holistic approach to guide the research and analysis of the target behaviour allowed identification of further determinants, thus enabling more extensive ways of targeting this behaviour for change as demonstrated in the Intervention Mapping Table (Table 20, Section 7.7.9).

Other conceptual models that have integrated different theoretical approaches still fail to offer a comprehensive picture of the problem. For example, Golan and Weizman (2001), combine a behavioural, social learning, and family systems approach in their conceptual model where parents are also viewed as the agents of change. Whilst their approach does address the home environment and the importance of restructuring it to support healthier habits, it relies heavily on changing parental cognitions and increasing parenting skills without consideration of parental emotional barriers and dietary habits and how these should be overcome. In addition, similar to other approaches exploring and underpinning childhood weight management interventions (e.g. Brown et al., 2014), their model targets a number of dietary habits and physical activity behaviours simultaneously and therefore lacks the detailed specificity gained from targeting one main behaviour identified as the most important within a system of behaviours relevant to the health problem.

However, their model does highlight the importance of addressing the broader family context such as parenting skills which is discussed further in Section 10.1.1.

Brown et al., (2014) have also explored the issue of childhood weight management and provide a qualitative account that supports some of the theoretical domains findings in the current research such as parental knowledge, emotion, beliefs about capabilities and environmental resources. However, their data is drawn from a non-UK population and focuses on the barriers to weight management as opposed to the context of parents' portion behaviours. In addition, they conducted atheoretical research limiting their ability to postulate interactions between theoretical domains. In contrast, arguably the current data can be better understood within the COM-B model's proposition that parental capability and opportunity can influence parental motivation to carry out portion control behaviours. For example, parental skills in measuring portion sizes (psychological capability) appeared to influence their confidence in their ability to carry out this behaviour (reflective motivation), and parents' resources for measuring portion sizes such as plates (physical opportunity) appeared to influence their portion measuring habits (automatic motivation). Furthermore, the findings themselves also go beyond this overall relationship between COM-B domains and provide a premise for the interactions between TDF domains within the COM-B domain of Motivation. For example, both automatic processes (e.g. parental portion measuring habits, parental fear of eating disorders) and reflective processes (e.g. the parental belief that measuring portions is time consuming), appeared to influence parental intentions to make changes to their dietary behaviours with their children. However, previous attempts at explaining influences on parental intentions within this context have focused mainly on

reflective processes and not on automatic processes (e.g. Andrews et al., 2010; Rhee, De Logo, Arscott-Mills et al., 2005).

The data further suggested that factors relating to parental opportunity can influence their capability. For example, resources in parents' environment (e.g. plates) appeared to influence their abilities and skills in measuring portion sizes. These hypotheses can now be tested using quantitative methods that will help to confirm the presence of theoretical domains and their interactions with between and within COM-B domains.

### **9.2.3 Contributions to parental preferences for app features (study one, two and three)**

Understanding users' preferences for which features are valued in health apps represents an under researched area (Mendiola et al., 2015). However, in recent years, the notion of UCD has grown in momentum (McCurdie et al., 2012) and a growing number of studies have reported user preferences for health promotion apps (see Hilliard et al., 2014; King et al., 2012; Rabin & Bock, 2011; Ramanathan et al., 2013). However, there is a dearth of research investigating parental preferences for healthy eating app features within the context of childhood weight management. Parents represent in most cases the 'digital immigrants' and will have different learning styles and needs from their 'digital native' children. For this reason, it is important to make sure that parents are engaged in a digital intervention because ultimately, they always preserve their 'accent' in the past and are in the process of adapting to a new way of socialising and learning with digital technology (Prensky, 2001). Therefore, adopting a UCD approach for mHealth development was a vital component in ensuring interfaces are user-friendly and relevant to the target population (Buller et al., 2013).

In line with recommendations that health apps need to consider user barriers in order to increase their reach (Krebs & Duncan, 2015), the UCD approach applied in this thesis yielded granular information on the relevance, preference and acceptability of app features among parents. Firstly, it identified parental preference for: specific app features (e.g. recipes for household items); tools that were convenient and quick to use; visual aids of portion sizes; tools that facilitated communication; and gamified health. In addition, these findings provided insight into universal preferences including: minimal data entry and effort (Dennison et al., 2013); less burdensome methods for tracking food intake (Krebs & Duncan, 2015; Turner et al., 2015); visuals instead of text (Buller et al., 2013); and target population specified preferences including: information sharing and gamification where there has been mixed accounts in other target populations (Dennison et al., 2013; Hilliard et al., 2014; Spillers & Asimakopoulos, 2014; Turner et al., 2015).

A systematic review of prevention and treatment of childhood obesity using wireless technologies conducted by Turner et al., (2015), provides some insights into the user preferences of children and adolescents. However, only one study conducted by Sharifi et al., (2013), included focus groups with parents exploring their preferences for text messaging content. Interestingly, some of their results support the current intervention components selected from the mapping process used in this thesis. For example, parents in their sample requested the need for ‘action-orientated advice’ and specific strategies to achieve their goals which support the BCTs selected in the current intervention (Section 6.5). Furthermore, the current thesis findings relating to parental preference for recipes (Section 5.6.1) and acceptance of the quiz (Sections 7.3.3, 8.5.3) was also reported as favoured content among obese adolescents (Woolford et al., 2011). A recent qualitative study of parental perceptions and use of

portion control strategies provides some support for the finding that parents accepted and liked the idea of using hands to measure age appropriate portion sizes (Blake et al., 2015). The participants in their study also reported hand portions to be a quick a simple method to measure portions as reported in study two (Section 7.3.2.2).

Second, research on user experience strategies of mHealth apps remains limited (Spillers & Asimakopoulos, 2014) and therefore, Preece et al.'s, (2012) model of usability and user-experience goals was applied to parental feedback in all three studies. This helped to make decisions regarding which user preferences to take forward (see Section 6.1.4) and provided an overview of the positive and negative usability and user-experience elements of app features and content piloted with parents in study two and study three. Along with written accounts, this helped to provide a snapshot of parents' overall impressions and acceptability of the app, suggesting that parents had a positive user experience of the prototype app which included ratings such as fun, entertaining, aesthetically pleasing and motivating.

The think aloud study with staff and students at the university provided valuable insights into usability and technical issues which are important for the overall user experience (Spillers & Asimakopoulos, 2014). The findings were able to highlight barriers to usability and areas requiring optimisation such as the navigability of the app. In addition, the app's requirement of novel touch-screen gestures was observed as a barrier to usability. This supports previous research that participants prefer functions that align with their mental models and past experiences of a behaviour (Gartenberg et al., 2013). Therefore, it will be important to resolve these issues before testing with families as evidence suggests that people are more likely to adopt new technology if they perceived it to be practical and easy for them to operate (Porter & Donthu, 2006).



#### **9.2.4 Contributions to implementation of the BCW**

A number of contributions to knowledge in this thesis relate to learning from the application of the relatively novel BCW framework for intervention development. First, there is a paucity of family-based interventions that modify processes in impeding healthy behaviours (Skelton et al., 2012) and which focus exclusively on one main dietary behaviour. Within this thesis the BCW approach was applied as a means of addressing this gap. The BCW recommends selecting the target behaviour before conducting empirical research with the target population. However, decisions regarding which target behaviour was having a significant impact on children's weight and was most acceptable for parents to elicit change in, could not be made without conducting research with parents first. To overcome this challenge, the first two focus groups with parents, along with consultations with experts, helped to select the target behaviour, which was then explored in subsequent focus groups. As a result, the process of deciding on the target behaviour led to new knowledge on the acceptability of changing this nutrition behaviour in comparison to other behaviours such as increasing fruit and vegetable intake (Section 4.2.2). Although parents were aware of associated health messages (e.g. five a day), early focus groups established they were reluctant to change this behaviour. This again highlights the importance of taking the environmental context of the public's mistrust and increasing resistance to certain health promotion messages into account when developing effective interventions (Orji & Mandryk, 2014).

Second, while the BCW recommends that intervention designers follow a particular sequence of steps, operationalising these steps through the research, led to a new sequence of steps. For example, the BCW guide offers eight sequential steps in health behaviour change intervention design. These are: (1) Define the problem; (2)

Select the target behaviour; (3) Specify the target behaviour; (4) Identify what needs to change; (5) Identify intervention functions; (6) Identify policy categories; (7) Identify BCTs and (8) Identify modes of delivery (Michie et al., 2014b). However, the current research necessitated conducting steps six and eight at the beginning of the intervention development process which reflects in part the collaborative partnership with the local health department (Section 1.5).

With regards to identifying policy categories (Step six in the BCW), the app can be categorised as ‘Service provision’ and ‘Communication/marketing’ where it will complement existing local family weight management services and communications. An intervention mapping approach was drawn upon, in the recognition that it is essential that public health stakeholders are on board from the start of the intervention development process. Public Health Warwickshire was an important stakeholder in this research and therefore it was important that the app aligned with their objectives to provide weight management services to families that were evidence and theory based.

With respect to selecting a mode of delivery (Step eight in the BCW), arguably, in the case of apps, they are more than just a delivery mode if we take account of smartphones’ highly personal nature (Klasnja & Pratt, 2012), where recent industry survey data reported that people look at their phones around 221 times a day (Tecmark, 2014). Consequently, focus groups explored topics around both theory and user-preferences for technology components, right from the start and all the way through, so that both components could be developed in unison. However, if the mode of delivery was decided at the end of the research conducted for a COM-B diagnosis, this may have required further research with parents to collect information

on user-centred components, which would increase the time in intervention development.

In addition, implementing the BCW for a mHealth intervention, required adding new steps (steps four (ii), five, eight, nine and ten: Figure 7, Section 3.2) to ensure that parents were involved in each stage of development in line with a UCD approach. These steps helped to understand certain parental preferences and interest in potential app features as well with parental views and acceptability regarding how BCTs had been translated into app features. These steps were essential in understanding how to engage parents in the intervention (Yardley et al., 2015). Furthermore, the BCW approach does not guide the operationalisation of BCTs with regards to health messages. For example, intervention designers need to take account of how theoretical constructs (e.g. Beliefs about consequences) that have been operationalised into BCTs (e.g. Information about health consequences) are presented in the app (e.g. positively framed or negatively framed in messages and notifications). Therefore, steps involved reviewing the evidence on message framing for the current population and context, creativity in translating these into app features and making sure these messages were acceptable to parents (Section 8.5.6).

### **9.3 Strengths of the research**

A major strength of this research was the involvement of multiple stakeholders in the mHealth app development process: the local authority, family weight management service commissioners, community programme managers (for recruitment of parents with overweight children and future implementation of the app); Change4life advisors, parents of overweight and healthy weight children (for ensuring social validity amongst the target population), paediatricians, dieticians, psychologists (for

the nutritional and psychological content), mobile app experts and software engineers (for the translation of research findings into app features and technical development of the app). In this regard, results can serve as a systematic framework for developers in terms of incorporating stakeholder-informed design elements in the development of health promotion apps. In particular, the involvement of parents throughout the entire intervention development process was key to helping to uncover psychological domains, necessary to reduce the evidence gap around parental barriers to portion regulation, as well as their desires and requirements for healthy eating app features.

A strength of using the TDF and COM-B theoretical tools is the strong evidence base of these approaches (Francis et al., 2012), supporting the study's ability to refine the exploratory approach and to map the results onto intervention components. Therefore, using the COM-B and TDF to frame and conceptualise the problem also allows the translation from theory to practice that has not been possible before with previous theoretical models of childhood weight management. Furthermore, the BCW framework uses a standardised language of theoretical constructs and behaviour change techniques which is essential for the replication and synthesis of research and evidence (Abraham & Michie, 2008). However, similar to other psychological models and health behaviour change intervention frameworks, the BCW stops short of serving as a guide when it comes to translating behaviour change techniques into specific intervention content. This task, which is dependent on the skills of the interventionist, is further complicated when strategies need to be specified for a medium like an app. In this regard, this thesis contributes by expanding the BCW framework and drawing on the disciplines of design, engineering and input from the commercial app industry, for the development of a

behaviour change intervention that is relevant for the mobile app eco-system. In some respects, once refined through further testing with parents, the intervention development process followed in this thesis, might be seen as a companion to implementing the BCW in the mHealth environment. In addition, despite the consensus for drawing on evidence, theory and formative research with the target population for mHealth development (Fjeldsoe et al. 2012; Pagoto & Bennett, 2013), few published studies to date have provided detailed information on how they achieve this (Fjeldsoe et al., 2012). Therefore, the thesis has led to a peer reviewed step by step exemplar for how evidence, theory and user-centred components can be incorporated into a mHealth app (see Curtis et al., 2015).

In addition, the UCD approach involved parental input from the beginning of the design process through to the prototyping with interactive mock-ups. By comparison, other mHealth development approaches have not made users central to the design process. For example, Carter et al. (2013) in the development of a weight management app known as 'My Meal Mate', collected feedback from a small number of participants ( $N = 12$ ) who were not the target population, at the software prototype stage, rather than gathering data on their needs and requirements at the start of the design process. Similar to other mHealth intervention design methods (e.g. see Whittaker et al., 2012, Cafazzo et al. 2012 and Fjeldsoe et al. 2012), the current study used an iterative design process, based upon sequential research with the target audience. In addition, the COM-B analysis and wider literature (Section 5.5.4.2) emphasised the need for CHWM interventions to be sensitive to parents' feelings and make sure they pilot certain materials e.g. letters, before they are released to the wider parent population. Therefore, a strength of the current study is

that the messages in the app were tested with a workshop of 19 parents, before releasing to the wider parent population (see Chapter 8).

Currently in the UK, there is a dearth of national guidance on recommended portion sizes. While the DOH 'eatwell plate' guides on the proportions of each food group, it fails to provide quantified amounts within each food group, as well as their size (e.g. recommended to have no more than 3 dairy portions, and the recommended size of these individual food items such as cheese) (Faulkner et al., 2012). A relative strength of the current intervention is that it adapts the eatwell plate and targets not only portion sizes but the frequency of portions consumed and the type of food consumed which follows a similar approach to McConahy et al. (2004). This led to two main tools in the app: the Portion Guide and the Balance Wheel. These tools together provide parents and children with information on appropriate portion sizes for each type of food (as per the five food groups in the eatwell plate) as well as the maximum daily number of portions within these food groups, which current national portion and serving size schemes do not provide guidance on (Faulkner et al., 2012). In addition, current national guidelines on portions do not provide information on age appropriate portion sizes (Faulkner et al., 2012), whereas the app recommends using child's hand to measure child portions and an adult's hands to measure adult portions. This helps parents to understand that children need smaller portions without having to provide an exact measure for which there is none. The existence of an intervention clearly targeting these behaviours for weight management, paves the way for further research that will identify whether changes in these behaviours, leads to changes in weight status amongst children.

## 9.4 Implications for public health practice

This thesis makes a key impact to practice with regards to how the BCW framework can be implemented for the development of a health promotion app for local public health services. During the research period of this thesis, new NICE behaviour change guidelines (NICE: guidelines PH49 Behaviour change: individual approaches, 2014), were released highlighting the importance of underpinning interventions with theory and evidence. Within this context, NICE provide examples of two tools specifically relating to the BCW framework that can be used to achieve these guidelines: the COM-B model and behaviour change technique taxonomy, hence providing further rationale for using this approach in the current thesis.

Furthermore, along with the BCW framework's impact on current NICE behaviour change guidance, the framework is also widely available to the public as a practical guide to intervention design: *The Behaviour Change Wheel: A Guide to Designing Interventions* within which the current research has been used as a case study (Michie et al., 2014b Box 1.13:83). However, although the authors aim for the BCW framework to be used to support public health commissioners, service providers and practitioners without behavioural change expertise, it could be argued that they need greater support in this process. Therefore, this thesis makes a contribution by providing a detailed exemplar of how to implement the BCW in practice, alongside integrating a UCD approach in an open access publication (see Curtis et al., 2015).

## 9.5 Limitations of the research

A number of limitations of the research need to be considered. First, the empirical research engaged a small purposive sample, with the majority of participants being females. Consequently, the identified views on the facilitators and barriers to

parental provision of a healthier diet for their children may be less representative of fathers and male caregivers. This is also a limitation of current school based approaches that have been criticised for their failure to target spouses (McLean et al., 2003). However, mothers engaged most on this issue as they are in most cases, the primary caregivers, as demonstrated in other research regarding childhood weight management (e.g. Bolling et al., 2009; Ogden, Reynolds & Smith, 2006; McConahy et al., 2004; Stewart, Chapple, Hughes, Poustie & Reilley, 2008). Therefore, as mothers are more involved with dietary activities with their children (Bish, Regis, & Gottesman, 2005), they may be most likely to use the app. In addition, the sample also comprised of mainly white British participants which again limits its relevance to ethnic minorities, where tools such as The Balance Wheel (Figure 39, Section 7.6.1) may not reflect the types of food that some ethnic minorities consume, a limitation of other current guidelines on portion sizes (Faulkner et al., 2012).

Second, only one target behaviour (i.e. portion sizes) and one setting (i.e. the home environment) were the focus of the current thesis. Arguably, because mHealth technology allows an intervention to be accessed from any location, allowing other dietary control behaviours (and other health behaviours) to be supported outside of the home environment, the intervention developed does not maximise the potential of its mode of delivery. However, it is also arguably the case that the target behaviour chosen could lead to families' consuming more fruit and vegetables as a positive spillover effect of reducing portion sizes. For example, the app includes tips on how to reduce portion sizes of main meals by increasing vegetable portions alongside the meal. Furthermore, the app reports on whether users are eating enough of the green food group which comprise fruit and vegetables (Figure 43, Section 7.6.5).



Third, the portion measure tool in the app does not provide information for multi-ingredient foods such as lasagne or sauces, and only provides the daily recommended number of high energy density foods but not their portion size, which is similar to existing guidance (Faulkner et al., 2012). In addition, some children may have large hands and some adults may have very small hands, nonetheless, using a hand as a guide, still may be a more appropriate visual cue than household objects such as plates. However, from a public health perspective, ongoing app development work provides the opportunity for further research in trialling these measures with parents, where it is anticipated that improvements on these limitations will be made. Furthermore, overall challenges arose with respect to selecting portion recommendations to provide families in the app, largely because there are no evidence based guidelines and consensus for age appropriate portion sizes. Therefore, it will be important to carry out further research not only on the implementation of the hand portion guide, but also on the evaluation of the app's guidance on portion sizes. Currently promotions of dietary guidelines are not accompanied by an evaluation of their effectiveness on eating behaviours and weight management (Brown & Timotijevic, 2011; Faulkner et al., 2012).

The empirical research used a qualitative study design, whereas quantitative surveys have typically been applied to research designs seeking the most appropriate targets for interventions to date (Birch & Ventura, 2009; Brown & Ogden, 2004). However, the BCW approach does not require this, partly because the COM-B model includes factors that go beyond the socio-cognitive spectrum (e.g. opportunity) and questionnaires can only measure perception of opportunity rather than objectively assess this. The qualitative approach followed, allowed the researcher to draw on richer reflections of barriers and facilitators to the target behaviour, and assesses the

contribution of the socio-cognitive and external factors influencing the target behaviour without assuming that a true reflection of relative contribution has been measured. In addition, the decision to use a qualitative design was made in part due to the exploratory nature of the study (Section 5.1.1). Furthermore, the qualitative research design allowed the simultaneous exploration of theoretical and user-centred components.

### **9.5.1 Limitations of the BCW framework**

There are also a number of limitations with the application of the BCW approach. Selecting which BCTs to use in the intervention represented a challenging process since the BCTT (v1) does not currently link individual BCTs to their theoretical determinants. Indeed, this appears to be a universal problem with health behaviour change theories and frameworks, where so far key frameworks are limited by their failure to link theoretical domains to the mechanisms of change (Michie & Johnston, 2012). Although more recently, Kok et al., (2015) have published the ‘Intervention Mapping (IM) taxonomy of behaviour change method which links behaviour change techniques back to their related theories and also defines their parameters for effective use. However, despite earlier work in mapping behaviour change techniques to behavioural determinants (Michie, et al., 2008), this has not been taken forward in the BCW framework where BCTs have only been mapped to intervention functions. Nevertheless, it should be acknowledged that Michie and Johnson (2012) are continuing to build upon preliminary work in this area (see Michie, Johnston, et al., 2008) which forms part of their on-going research. Hence, considerable time was spent at this step, where it was also necessary to review earlier work linking BCTs to behavioural determinants. For example, ‘information provision’ was included to account for some of the quiz questions, which has been mapped to increasing

knowledge (referred to as ‘provide general information’) in earlier work (Abraham & Michie, 2008).

Significant time was also spent reviewing extant childhood weight management (CHWM) interventions. Due to the relative infancy of the field of eHealth, evidence on CHWM was mainly drawn from non-digital interventions. Difficulties in selecting appropriate BCTs to use in the intervention arose as a result of poorly specified interventions, making it challenging to synthesise the information about effective techniques for supporting parents in childhood weight management. Interventions also used different outcome measures and targeted a mixture of nutrition behaviours which made it challenging to draw any firm conclusions. Childhood weight management interventions, similar to other behaviour change interventions, have provided limited knowledge on which precise mechanisms of action are at work and this often leads to ineffective techniques being overused and effective techniques underused (Susan Michie & Johnston, 2012).

A drawback with using the BCT taxonomy (v1), is that it cannot easily account for specific parenting strategies which may promote new behaviours in their children such as: having a positive tone of voice; warmth and affection; showing interest in children’s school life and other activities; involving children in shared decision making; being flexible with their children and listening and negotiating (Faith et al. 2012). In addition, the BCTT (v1) does not include techniques such as ‘Motivational interviewing’ which may be seen as a potentially effective technique to address childhood weight issues. It can help to draw out ‘intrinsic parental values’ and ‘resolve ambivalence to behaviour change’ (Bolling et al., 2009:172). Furthermore, the BCT taxonomy is comprised largely of individualistic techniques as opposed to those that can be readily applied at group or population level. However, according to

Michie (2015), the taxonomy is a work in progress and further literature and disciplines will help to expand it, where essentially, it is important that the scientific community work together on it so that a common language can be used in the reporting of BCTs in interventions.

Lastly, as noted by Orji & Mandryk, (2014), using a mapping process for intervention development, is always subject to interpretation. The process of selecting intervention functions (IFs) was challenging because many of the same BCTs belonged to different IFs. It has also been based on a small sample within the context of parental food portion behaviours and childhood weight management and therefore the results should be applied with caution to other health behaviours. Nevertheless, the underlying principles of mapping theoretical determinants to behavioural strategies, user preferences and app features is applicable to any health behaviour.

## **Chapter 10 Conclusions and Future work**

### **10.1 Conclusions**

There is interest from all sectors in employing mHealth interventions to improve clinical and public health practices and outcomes. At the same time, there is a growing interest from the general public with regards to using mHealth interventions to enable greater control over their health behaviours. Within the context of mHealth, we cannot ignore the reality that theoretical, user-centred and technological components are inexorably linked. Simultaneous consideration must therefore be afforded to them, following a systematic development process that draws on relevant theory, evidence and research with the target population.

This thesis has demonstrated how the BCW framework can serve as a systematic and comprehensive guide to ensure that a health promotion app is underpinned with relevant theory and evidence. Integrating this step-by-step approach with activities and methods from user-centred design and collaboration with the commercial app industry has also been clearly explicated. Therefore, the thesis impacts on the practice of developing theory and evidence based, user-centred mHealth apps. It provides a template and practical guide for researchers and app developers looking to apply similarly systematic and rigorous approaches to content development of mHealth interventions in the future. Furthermore, the thesis also provides a guide on how service users (i.e. parents signed up to family weight management programmes) can be involved in the co-creation of a public health intervention.

To date, there has been a paucity of research investigating the interacting factors influencing parents' portion control behaviours with their children. The thesis has contributed to knowledge around important determinants of parents' portion control

behaviours revealing that parents' internal processes such as their emotional responses, habits and beliefs, along with social influences from partners and grandparents, and environmental influences relating to items such as household objects, all interact and influence their portion size behaviours. This more comprehensive analysis provided new insight on the affective influences on parental portion behaviours such as parents' fear of being disliked by their children, their negative reactions to government weight management campaigns and potential reasons for their denial of their child's overweight status. Therefore, this deeper understanding of the problem permits more extensive ways of solving it and increases the intervention's potential for success in impacting on families' nutrition and weight outcomes. In addition, previous research has mainly involved non-UK based parents with children under five, who may or may not have been overweight. Hence, this thesis represents the first UK-based study using mainly parents on family weight management programmes underpinned by the TDF and COM-B theoretical frameworks and at the same time, advances our understanding of parents' key preferences for app features that are both specific universal in nature.

In sum, taking into consideration the impact on practice for developing a theory and evidence based, user-centred mHealth intervention and the contributions to knowledge around parental portion behaviours and app preferences, the thesis helps to bridge the gap left in the fields of both mHealth development and childhood weight management.

## **10.2 Future Directions**

### **10.2.1 Other avenues of research for childhood weight management**

A range of factors were identified in the focus groups as important for managing portion control behaviours. However, some of these were excluded from the Health Heroes app (Section 6.2), mainly, because they were seen as beyond the scope of a mHealth app specifically targeting parental behaviours within the home environment. Nevertheless, these influences on parental dietary behaviours provide opportunities for further research.

Within the context of childhood weight management (CHWM), arguably changing the food environment such as the availability of supermarket promotions and design of food packaging requires policy wide changes. However, the app could help to support parents' purchasing behaviour with the use of 'ecological momentary interventions' also known as 'just in time' interventions, which deliver relevant information for people at the right time in their natural environments (Heron & Smyth, 2010; Riley et al., 2011). So for example, further research could explore the use of the GPS function on the smartphone to prompt parents receiving a notification on their phone as they enter a supermarket, to inform them of the benefits of not buying low cost unhealthy food on promotion.

Change4life advisors also highlighted that parental stress and children's behavioural issues were also barriers to parents' ability to manage their children's diet. Indeed, one systematic review shows that the majority of family-based weight management programmes do not target general child behaviour management and family functioning and those that did address the broader family context, showed greater success in childhood weight management (Kitzmann & Beech, 2006). Therefore,

further research could explore combining strategies for changing health behaviours with parenting skills, stress reduction and overall family functioning. Arguably, interventions attempting to change parental dietary behaviours with their children need to be aware of the wider family context and functioning that may limit effectiveness if not addressed. Within the context of mHealth, there could be a section in the app that helps to address these aspects such as providing parents with stress management training, which has shown promise in reducing anxiety and improving coping skills in other populations (see Villani et al., 2011).

The small sample of fathers in the current study provides opportunities for further research with male caregivers to explore how their experiences, thoughts and behaviours influence children's dietary behaviours and what they can do to support both mothers and children. Likewise, research was carried out with mainly white British participants and further research with ethnic minorities to help tailor the app for the needs of a broader population is a useful direction for further work (e.g. with regards to language and cultural influences surrounding families' dietary behaviours).

### **10.2.2 Measuring parental and child engagement with the app**

Human behaviour is part of a system between our capabilities, motivation and the environment, where technology is in abundance; thereby making further testing essential in order to understand this human-technology system (Michie, 2015).

According to Spring (2015), behaviour change mechanisms work differently in a digital environment. Consequently, it is important that designers are aware of interactions occurring between the technology and the underlying principles of behaviour change where further testing with the target population can help to refine these interactions. Further research could also employ a valid user engagement



measure such as the multidimensional scale developed and evaluated by Brien and Toms (2010), to measure parents' and children's engagement with the mHealth technology. This could be used together with a 'descriptive research approach' where parents' and children's interactions with the app are observed to provide information on a number of engagement conditions such as their emotional and verbal expressions and sensory skills when using the app as conducted in previous research with children and apps (Noorhidawati et al., 2015:387).

### **10.2.3 Evaluation of the app on changing the target behaviour**

According to Ploderer et al. (2014), the current study can be seen as a 'research through design approach' where Change4Life advisors, parents, technology designers, dieticians and public health staff were involved in the initial design phase. Thus, the next phase in this approach, is to test it in a natural setting with parents and children to understand how they interact with the app. In line with the MRC guidance on evaluating complex interventions (Craig et al., 2008), this stage could involve modelling the process and outcomes of the app in changing families' portion sizes and weight. Following a similar method used by Willey and Walsh (2016), a quasi-experimental research study could be conducted, using a single arm pre and post-test assessment of portion sizes, BMI and theoretical hypotheses. Here the emphasis is on how the technology is integrated into users' routines rather than theorising how it should be used according to its design. For example, Ploderer et al. (2014) tested their smoking cessation app on a small sample of smokers attempting to quit and found that although participants had liked the idea of interactive games during initial interviews, they did not go on to use these distraction tools in practice when cravings occurred. The discordance between what people say and what people do, necessitates testing the prototype with the target audience and make adjustments

and improvements based upon both subjective (e.g. self-reports) and objective (e.g. data analytics) feedback.

Following this, a feasibility trial which tests protocol for a later full randomised control trial, will help to evaluate the effects of the Health Heroes app on changing families' portion sizes and weight outcomes. Non-intrusive data collection tested and refined throughout the trials, such as usage data of app features (and corresponding BCTs) and their correlation to behaviour change, will help to measure engagement with the intervention as proposed in other mHealth research (Brindal, Hendrie, & Freyne, 2016).

Ultimately, following a systematic and rigorous process in both the development and evaluation of the app, will undoubtedly help to advance the field of mHealth and behaviour change. As Sherry and Ratzan (2012) eloquently state 'the unanswered question remains not if, but rather how fast and how efficiently mHealth will realize its transformative potential' (2012:3).

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## Appendices

### Appendix 1:

#### Appendix 1A: Participant Information Sheet

A participant information sheet was produced for Change4life advisors, parents' recruited from the weight management programme and parents recruitment from the university. Below is an example of the one presented to parents recruited from the weight management programme.

4.02.13

**Project Title: To develop a Healthy Eating App to support parents in making changes to their children's diet.**

*The current project aims to develop a health app designed by parents that will provide tools to support parents in managing their children's weight through healthy eating.*

**INVITATION**

You are being asked to take part in a focus group to help design a healthy eating app to support healthy eating in families in Warwickshire. My name is Kristina Curtis and I am a PhD student at WMG under the supervision of James Hart and Katherine Brown. This research has received favourable opinion by the Biomedical Research Ethics Committee (BREC) of the University of Warwick.

**WHAT IS THE STUDY ABOUT?**

The study is trying to find out what features in an app will best support families in Warwickshire with regards to managing their weight and eating habits.

**WHY HAVE I BEEN INVITED?**

You have been invited to take part in the focus group because you are a parent who has agreed to take part in the Family fitness and Nutrition programme in your area.

**DO I HAVE TO TAKE PART?**

Taking part is entirely voluntary and you should read this information sheet about what it involves. If you agree to take part you will be asked to sign a consent form agreeing to your participation in the study but you may withdraw at any time.

**WHAT WILL HAPPEN**

In this study, you will be asked to complete an informed consent form (after reading this information sheet). You will be asked questions on certain features that may go in the App and shown other websites and Apps. The session will be recorded but your identity will be kept anonymised if we share any findings in the research process.

**TIME COMMITMENT**

1



The focus group will last for approximately 1 hour while you are taking part in the family fitness and Nutrition programme.

#### BENEFITS AND RISKS

No major benefits or risks are anticipated but you will have to give up your time.

#### COST, REIMBURSEMENT AND COMPENSATION

Your participation in this study is voluntary.

#### FOR FURTHER INFORMATION

I will be glad to answer your questions about this study at any time. You may contact me at

[K.e.curtis@warwick.ac.uk](mailto:K.e.curtis@warwick.ac.uk) or by calling me on 07916 142 132.

#### WHAT IF THERE IS A PROBLEM AND WHO SHOULD I CONTACT IF I WISH TO

If there is a problem with the research the University has in force a Public and Products Liability policy which provides cover for claims for "negligent harm" and the activities here are included within that coverage subject to the terms, conditions and exceptions of the policy.

Any complaint about the way you have been dealt with during the study or any possible harm you might have suffered will be addressed. Please address your complaint to the person below who is a senior university official entirely independent of the study:

Nicola Owen

Deputy Registrar

Deputy Registrar's Office University of Warwick Coventry

CV4 8UW

Email: [Nicola.Owen@warwick.ac.uk](mailto:Nicola.Owen@warwick.ac.uk)

Tel: 024 7652 2785

#### WILL MY TAKING PART IN THE STUDY BE KEPT CONFIDENTIAL?

Yes. All information which is collected about you during the course of the research will be kept strictly confidential, and any information will be kept within a locked filing cabinet in the office at the International Digital Laboratory.

You will only be asked to provide basic information (age, gender, if you are a healthcare professional) and your name will not be taken. During the study data will be stored within a locked filing cabinet and on university owned computers which require a user name and password by Kristina Curtis. This data will be accessed only by Kristina Curtis. After the study the data will be kept for 5 years until the PhD has been completed and passed after which it will be destroyed.

It will not be possible to identify you from any published material arising from the study as anonymity will be ensured as all participants will be given a participant identification number.

#### WHAT WILL HAPPEN IF I DON'T WANT TO CARRY ON WITH THIS RESEARCH?

You may decide to stop being a part of the research study at any time without explanation. You have the right to ask that any data you have supplied to that point be withdrawn/destroyed. You will still be given a voucher for your contribution.

You have the right to omit or refuse to answer or respond to any question that is asked of you and there will be no consequences of withdrawal or changing your mind part way through.

You have the right to have your questions about the study answered (unless answering these questions would interfere with the study's outcome). If you have any questions as a result of reading this information sheet, you should ask the researcher before the study begins.

#### WHAT WILL HAPPEN TO THE RESULTS OF THE RESEARCH STUDY?

The results of the study will help to develop a Healthy Eating App and the results will be written up and presented within academic papers and at conferences. The results will be used within the final PhD thesis. All data collected will be anonymous so no one can identify you as an individual.

#### WHO IS ORGANISING AND FUNDING THE RESEARCH?

The University of Warwick is the sponsor of the research.

#### WHO HAS REVIEWED THE STUDY?

All research is checked by a research ethics committee. This study has been reviewed and given favourable opinion by the University of Warwick's Biomedical Research Ethics Committee.

## Appendix 1B: Consent form

All participants were asked to complete the following consent form prior to taking part in the focus group.

INFORMED CONSENT FORM		
<b>Project Title: To develop a Healthy Eating App to support parents in making changes to their children's diet</b>		
By signing below, you are agreeing that: (please insert your initial into the boxes below)		
(1) you have read and understood the Participant Information Sheet,	<input type="checkbox"/>	
(2) questions about your participation in this study have been answered satisfactorily,		<input type="checkbox"/>
(3) you are aware of the potential risks (if any), and	<input type="checkbox"/>	
(4) you are taking part in this research study voluntarily (without coercion).		<input type="checkbox"/>
(5) you agree to the session being audio recorded	<input type="checkbox"/>	
(6) you are aware that you can withdraw from the study at any time without giving a reason and any information you have already submitted will be withdrawn.	<input type="checkbox"/>	
(7) you give permission for the information you give in the focus group to be stored on a password protected Warwick university computer.	<input type="checkbox"/>	
_____ Participant's Name (Printed)*	_____ Participant's signature*	_____ Date
_____ Name of person obtaining consent (Printed)	_____ Signature of person obtaining consent	_____ Date
<i>*Participants wishing to preserve some degree of anonymity may use their initials</i>		

## Appendix 1C: De-briefing sheet

The following de-briefing form was administered to all participants after the focus group had finished.

### Focus Group de-briefing sheet

Thank you very much for taking part in the focus group today. I hope that you have found the experience an enjoyable one!

The results of the focus group will be used to develop a healthy eating app to support families in eating a healthier diet. The results will also be used for my doctorate project and may be published in a relevant journal, talked about at conferences in the form of an oral presentation (where I speak about the results to an audience) or a poster presentation (where a printed poster is produced highlighting some of the key findings). However, please note that your individual identity will not be disclosed at any time. Your participation in this research is entirely anonymous (no one will ever be able to identify you in the study).

If you have any concerns about the topics raised in today's session please feel free to talk to me in private after the session or you can contact me later on ([k.e.curtis@warwick.ac.uk](mailto:k.e.curtis@warwick.ac.uk)). Please also let me know if you would like a copy of the findings which can be sent to you by email or post.

If you would like some more information and ideas on healthy eating to use with your family please visit the following websites:

<http://www.nhs.uk/Change4Life/Pages/change-for-life-families.aspx>

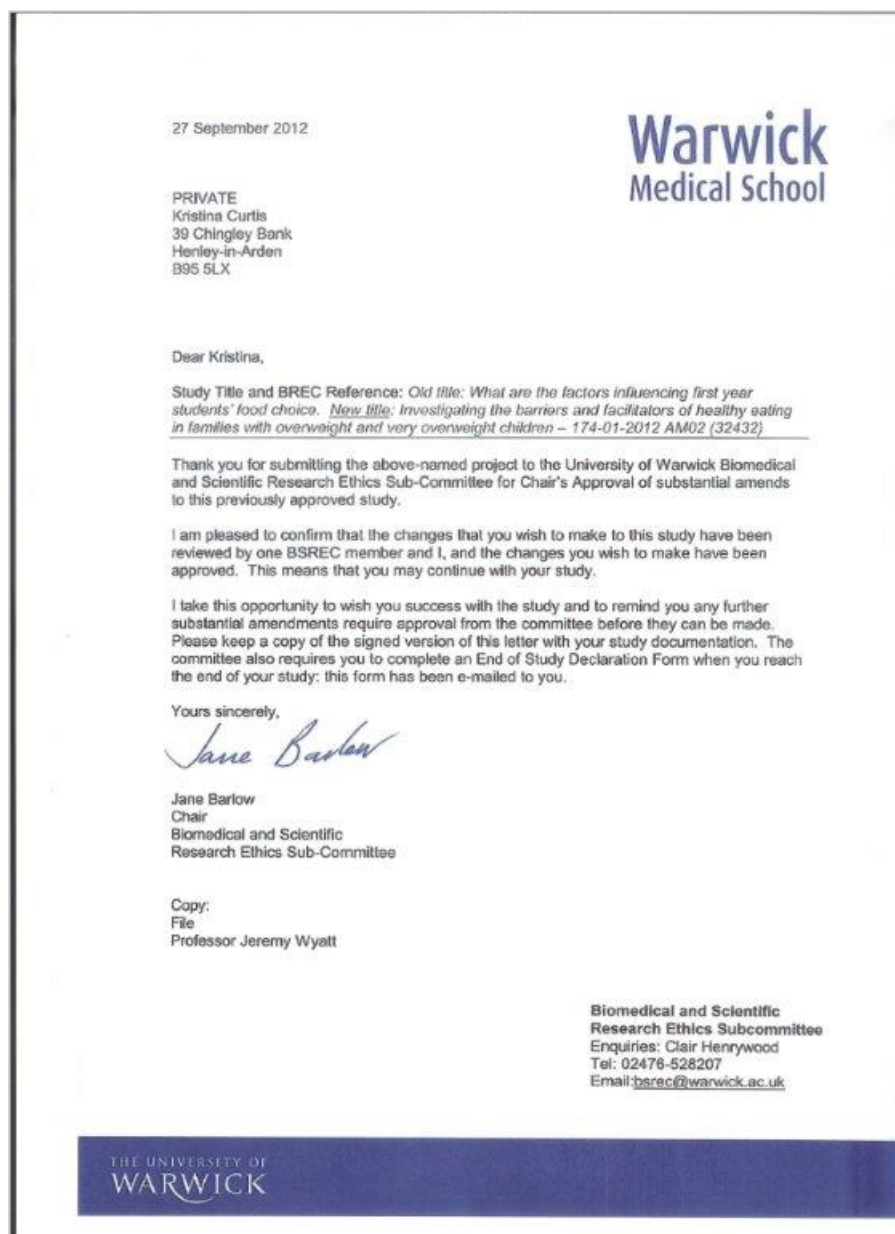
<http://www.schoolfoodtrust.org.uk/>

Many thanks,

Kristina

## Appendix 1D: Ethical approval

Approval was gained for the research from the Biomedical Research Ethics Sub-Committee:



## Appendix 1E: Schedule of questions for Change4life advisors

Parents were given the following schedule of questions:

1

### Focus group Schedule of questions

Introduction (5 minutes)

The purpose of this focus group is to explore your experiences and thoughts on making changes to your own and children's diet to help with weight management. Your views today will help with the design of a healthy eating App that will be able to support parents in making healthier food choices for their families.

**Does anybody have any questions before we start?**

#### **Anonymity of presentation of results**

- Introduce digital audio recorder
- Stress confidentiality
- Set ground rules

### **1 Knowledge**

#### **1.1 Recognition of child's weight status**

From your experiences of working with families, what are your thoughts on parents' perceptions of their child's weight status and their recognition of overweight?  
What may be some of the reasons that make this process difficult for the parents?  
(emotional factors such as guilt & denial, family norm, distrust in BMI)

### **2 Social Identity**

#### **2.1 The meal provider**

From your experiences, what are your thoughts on the mothers and fathers role in cooking meals for the family?

Social Identity



## 2.2 Parents' weight status

What are your thoughts on the weight status of the parents you see?

## 3 Social Influences

From your experiences, what are your thoughts on the social/peer pressure that parents perceive in regards to their child being overweight? (**or is it the norm?**)

What are your thoughts on the Grandparents and other relatives influence on children's eating habits?

## 4 Cognitive and interpersonal skills

### 4.1 Family communication

What are your thoughts on parents' ability to communicate with their family around issues of healthy eating and weight?

## 5 Behavioural Regulation

### 5.1 Parenting style

From the parents that you see, what are your thoughts on their parenting style? (e.g. permissive or authoritative)

## 6 Environmental context & resources

### 6.1 Family weight management programmes

From your experiences, what are your impressions on parents' attitudes to child/family weight management programmes?

## **7 Beliefs about capabilities**

### **7.1 Parents' beliefs**

What are your thoughts on parents' beliefs in their ability to change their children's eating habits?

## **8 Memory, Attention and decision processes**

### **8.1 Parents' health literacy**

What are your thoughts on parents' levels of general health literacy? (labels, websites)

## **9 Beliefs about consequences**

### **9.1 Parents' perceptions**

From your experiences, what are your thoughts on parents' perceptions of the risks of their child being overweight? What do you think are some of their main concerns? (high cholesterol, diabetes, stroke, joint problems, sleep disorders)

What are your thoughts on the parents' perceptions of the food environment (either within the home or outside of the home)?

From your experiences, what are the parents' perceptions of the time it takes to prepare healthier food?

## **10 Emotion**

### **10.1 Parents' emotional barriers**

What are your thoughts on parents' perceptions of the emotional barriers they are likely to feel when trying to change their children's eating habits? (e.g. guilt about setting limits on food intake and feeling badly for their child when he/she is not allowed to eat the same amount of sweets as other children)



## **11 Knowledge**

### **11.1 Parents' nutritional knowledge**

What are your thoughts on parents' knowledge of healthful and unhealthful food and beverages?

What about parents' knowledge around food portions?

## **12 Environmental Context and Resources & Physical Skills**

### **12.1 Environmental barriers to parents' making dietary changes**

From your experiences, what environmental and physical factors do you think affect parents' ability to carry out the lifestyle changes (**in regards to food**) necessary to manage their child's weight (e.g. **no time to cook, parents' cooking skills**)

## **13 Emotion**

### **13.1 Psychosocial stressors**

What are your thoughts on the psychosocial stressors that children you work with may be experiencing? (e.g. parental separation, bullying, familial stress).

How do you think psychosocial stress affects children in regards to their eating?

## **14 Intentions**

### **14.1 Parental motivation to change health behaviour**

From your experiences of working with parents, what are your thoughts on parents' motivation to change their own and their families eating habits?

How do you think we can increase their motivation to change their own their families eating habits?

## Appendix 1F: Schedule of questions for parents

Parents were given the following schedule of questions:

### Focus Group Schedule of Questions - Parents

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#### **Introduction (5 minutes)**

The purpose of this focus group is to explore your experiences and thoughts on making changes to your own and children's diet to help with weight management. Your views today will help with the design of a healthy eating App that will be able to support parents in making healthier food choices for their families.

Does anybody have any questions before we start?

#### **Anonymity of presentation of results**

- Introduce digital audio recorder
- Stress confidentiality
- Set ground rules

#### **Explain:**

***Less healthy food: High energy density foods – donuts, chocolate bars, cream, chips, cakes***

***Healthy food: Low energy density foods – vegetables, fruit, rice, lentils, semi-skimmed mil***

## **Topic Guide**

### **Knowledge**

- 1.1 From your experiences, what are your thoughts on parent's knowledge of appropriate portion sizes for children's meals and what children's daily food intake should be? (How do they judge what is enough/too much?)
- 1.2 What are your thoughts on parents' knowledge of healthful and unhealthful food and drinks? (Are you always aware of how much sugar/fat are in them?)

### **2 Behaviour regulation**

- 2.1 From your experiences, how easy it is for parents to be aware of how much food their children are eating on a daily basis (and parent's themselves)?
- 2.2 What kind of things could help parents keep track of what their children are eating? And themselves and other family members?

### **3 Cognitive & interpersonal skills (family communication)**

- 3.1 From your experiences as a parent, how difficult it is for parents to talk to their children as well as family members about making changes to their diet?

### **4 Beliefs about capabilities**

- 4.1 From your experiences, how confident do you think parents feel in being able to make changes to their children's eating habits & family (and their own).

### **5 Beliefs about consequences**

- 5.1 From your experiences, what are parents' main worries in terms of their child not eating enough fruit and vegetables (not getting enough nutrients, diabetes, heart disease), or do they not worry?
- 5.2 What are parents' main worries about the consequences of their child being overweight? (Bullying, being overweight in adulthood, diabetes, heart disease..)

## **6 Reinforcement**

- 6.1 What kind of things influences you most when you buy food at the supermarket? (promotions, marketing claims, location of food).

## **7 Emotion**

- 7.1 What are your thoughts on emotions that parents may feel for setting limits of the food their children eat? (guilt).
- 7.2 Are there any fears you have in talking to your children about over eating? (Fears of eating disorders)
- 7.3 What are your thoughts on whether parent's feeling stressed can make it difficult for them to cut back on giving unhealthy snacks? (Distracts them when you have had enough)

## **8 Social influences**

- 8.1 What are your thoughts on who in your environment make it difficult for you to make changes to your children's eating habits and your own? (Grandparents, partners, other parents, lunchboxes)
- 8.2 How do you think people in your social and home environment could be more supportive of eating more healthily?

## **9 Any other barriers**

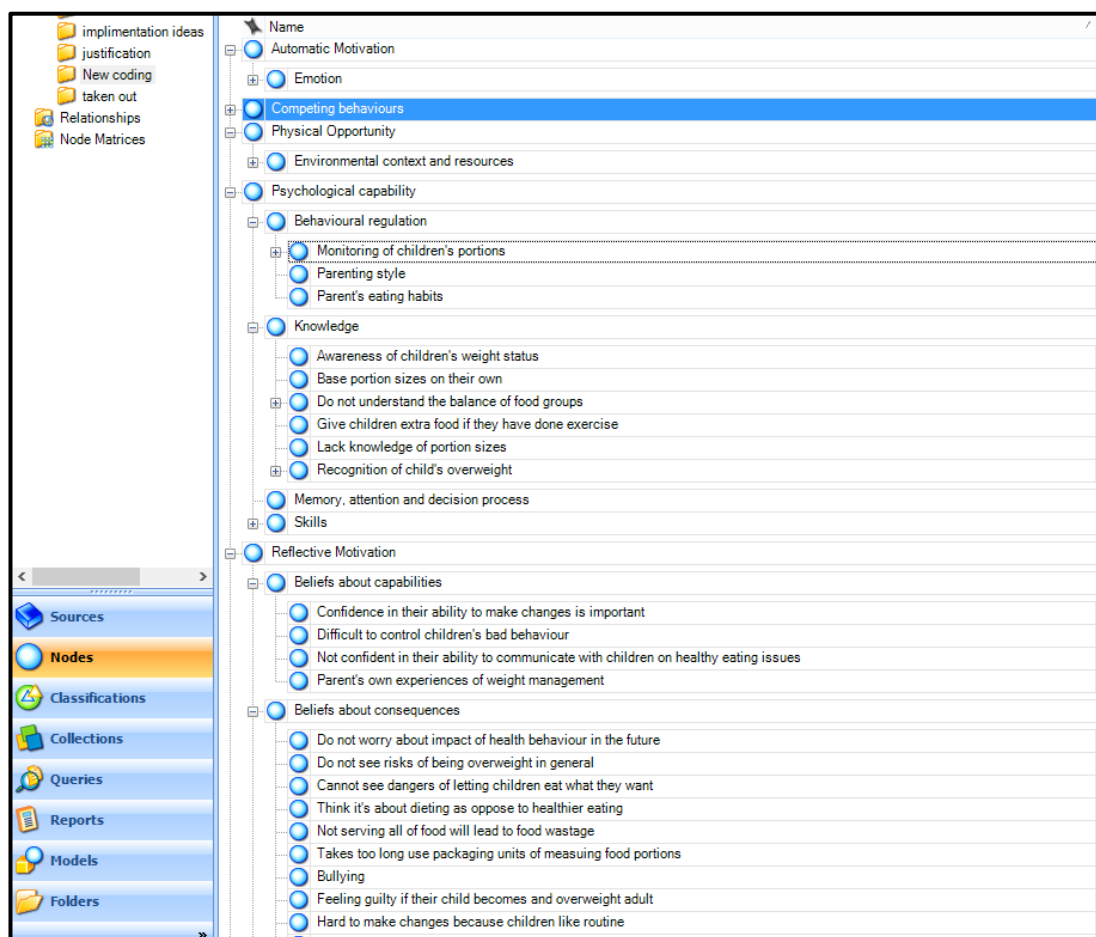
- 9.1 Are there any other barriers to making changes to your children and families eating habits that we haven't talked about?

## **10 Health Apps**

- 10.1 How many of you have a Smartphone or will be getting one soon?
- 10.2 What kind of apps (if any) do you use at the moment?
- 10.3 What are your thoughts on whether you would be interested in using an app to support healthy eating in the family?
- 10.4 What are your thoughts on what the main focus of the App should be to support parents?

## Appendix 1G: Coding framework used for thematic analysis

Below is a screen shot of the coding framework (using COM-B and TDF domains) used to conduct the thematic analysis in NVivo 10.



## Appendix 1H: Codes relating to the background of the project

The table below provides an excel output from NVIVO of the background codes relating to childhood weight management programmes that were excluded from the intervention mapping process.

Environmental Resources for weight management
Duration on weight management programmes puts parents off
Facilitators
Acts as a behavioural contract
Children have social support
If parents don't gel with other parents on weight management programmes they will drop out
Lack of resources for children in Year 6
Local schemes available for healthy eating
Parents prefer to send their children to WMPs but not attend themselves
Other Professionals & Approval from others & organisations
Dieticians give parent's a boost in motivation
Other Professionals contradict weight status of child
Parents' are embarrassed when Change4Life advisor sees their unhealthy food purchases
Parents have no help and advice on weight matters after 5
Parents may feel they are being targeted
Parents may not want any intervention if already involved with other interventions
Parent's view of organisation providing support can be a barrier
Some parents feel that Change4Life advisors speaking to their child is more meaningful for child

## Appendix 1I: Sub-themes excluded from app development

The screenshot below shows a snapshot of the codes that were excluded at this stage in the development process as they were not suitable for app development.

Excluded			
Name	Sources	References	
Automatic Motivation	0	0	
Emotion	0	0	
Recognition of child's overweight	0	0	
Clothe's sizes are getting bigger now	1	1	
Do not think their child is overweight	2	7	
Have no one to guide them on normal weight after the age of 5	1	1	
Knew their child was overweight	1	1	
Lack understanding of children's BMI measures	1	1	
More difficult to recognize if they are borderline	1	1	
Parents find it difficult to understand their child's weight in the letter	1	1	
Parents want to know what the ideal weight should be	2	2	
Parent's with nw children use the curve supplied when their child was a baby a	1	1	
Some parents are surprised at child's weight status and want support	1	1	
Suspected child was overweight	1	1	
The norm has gone up which makes it more difficult	1	1	
Use clothes sizes as a guide	1	1	
Stress	0	0	
Families are stressed	1	1	
If you do not have unhealthy food in the house then less risk of giving in when	1	2	
Parents may be stressed with other things so healthy eating is not a priority	2	2	
Reinforcement	0	0	
Children's behaviour	0	0	
Children's resistance to healthy food	1	2	
Controlling behaviour becomes more of a priority than healthy eating	1	1	
Difficult for parents to encourage changes without it becoming a battle	2	2	
Physical Opportunity	0	0	



## **Appendix 2**

### **Appendix 2A: Criteria applied to user-preferences for app features**

A decision criteria was developed to help with decisions on which user preferences should be taken forward to the next stage of development. The table below shows the full list of user preferences that were considered and the decision to accept, half accept or reject.

Themes	Codes	Group		
Themes	Codes	Group	Rejected/ Accepted	Reason
<b>App features: Increasing parents knowledge of recipes and healthier foods; parental monitoring of their children's weight and eating habits, goal setting,</b>	Recipe output of household ingredients	Parents (FG2-5)	Rejected	(i)Does not fit with target behaviour (ii)Already on the market in the form of a website iii) not within budget
	Apply the cooking part of the app to the whole family	Parents (FG2-5)	Half accepted	(iv)Aligned with recommended user experience goals (only half accepted because cooking replaced with portion control)
	Practical tips and planning meals	Parents (FG2-5), Change4Life advisors (FG1)	Half accepted	(ii) Practical tips for providing age appropriate portion sizes rather than meal planning as this is already on the market (Change4Life app)
	Involve children with planning meals	Parents (FG2-5),	Rejected	(i)Not in line with the target behaviour

	Every family is different so need different choices of goals	Change4Life advisors (FG1)	Accepted	(v) Supported by literature (see Section 3.3)
	Needs to be a balance between communicating seriousness of overweight and that small changes can make a difference	Change4Life advisors (FG1)	Accepted	(v) Context and theoretical justification
	Parents can make healthy food more available within the home	Change4Life advisors (FG1)	Accepted	(v) Fits with theoretical components of app and support from literature see Section 3.3 (environmental restructuring).

<b>Communication</b>	A way to help parents talk to their children about food without causing an argument	Parents (FG6)	Accepted	(v) Supported by theoretical findings (see Section 5.10.6). The App itself can function as communication tool between families.
<b>Time saving and convenience</b>	Needs to be minimal data input	Parents (FG2-6)	Accepted	(iv) Aligned with usability goals (efficient to use), (v) Parents perceived time constraints as an important barrier,
	Information on healthier alternatives	Parents (FG2-5)	Accepted	(i)Can be used to reduce portions of unhealthy food and replace with healthier food (iv) Aligned with user experience goals (helpful)
	Quick and simple	Parents (FG2-6)	Accepted	(iv) Aligned with usability goals (easy to learn, easy how to remember how to use)
<b>Visual aids (and monitoring)</b>	Visual aids or videos to demonstrate content in food may help	Change4Life advisors (FG1)	Accepted	(i)Fits in with target behaviour (e.g. high sugar content means you have to have small portions of it) ,(ii) Aligned with user experience goals

	Having an Eatwell plate that allows you to choose food style	Change4Life advisors (FG1)	Half accepted	(i) Fits with the target behaviour - Some form of the Eatwell plate should be included but for the purpose of portion sizes and food frequency instead of different culture foods and styles
	Useful to have a chart to show children's weight and the difference small changes can make	Parents (FG2-5), Change4Life advisors (FG1)	Rejected	(v) Do not want to position the app as a weight management app which may induce stigma in using the app.
	The Taste Rainbow	Change4Life advisors (FG1)	Half accepted	(iv) Aligned with user experience goals (aesthetically pleasing, fun). Colours will be used to represent food groups instead of vegetables.




	Fun visuals of food portions	Parents (FG2-5), Change4Life advisors (FG1)	Accepted	(i) Fits with target behaviour, (iv) Aligned with usability goals
Gamification	Would like games or tools they can use together	Parents (FG2-5)	Accepted	(iv) Aligned with recommended usability goals
	A challenge for the whole family to compete in	Parents (FG6)	Accepted	(iv) Aligned with user experience goals, (v) supported by theoretical findings and literature (see Section 3.3 and 5.10.7)
	A point system for healthy and unhealthy food you have had	Parents (FG6)	Accepted	(iv) Aligned with user experience goals

	Make it a competition and award stars for healthy eating	Parents (FG6)	Half accepted	(iv) Aligned with user experience goals The app can help families work together and allow virtual rewards in the form of levels and/or badges
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## **Appendix 2B: BCT-App Translation Table**





Popular weight loss and exercise apps were coded using the BCTT (v1) to help identify how BCTs in these apps had been translated into app features. This was then presented to the app company to help with their understanding of how BCTs appear in current health promotion apps.



BCTs	Definition (Behaviour Change Technique Taxonomy V1)	How can this be operationalised in an app?	Example app
<b>Goals and planning</b>			
<b>Goal Setting (behaviour)</b>  	Set or agree a goal defined in terms of the behaviour to be achieved	App sets max daily calories that can be consumed to reach target weight	MyFitnessPal
<b>Goal setting (outcome)</b>	Set or agree a goal defined in terms of a positive outcome of wanted behaviour	User can set target weight	MyFitnessPal,
<b>Action Planning</b>	Prompt detailed planning of performance of the behaviour (must include at least one of context, frequency, duration and intensity). Context may be environmental (physical or social) or internal (physical, emotional or cognitive) (includes	Users can set duration and frequency of exercise	MyFitnessPal
<b>Review behavioural goals</b> 	Review behaviour goal(s) jointly with the person and consider modifying goal(s) or behaviour change strategy in light of achievement. This may lead to re-setting the same goal, a small change in that goal or setting a new goal instead of (or in addition to)	Can indicate if tasks have been completed but doesn't allow you to adjust goals. Calendar shows completed tasks	30 day ab challenge




	the first, or no change		
<b>Discrepancy between the current behaviour and goal</b>	Draw attention to discrepancies between a person's current behaviour (in terms of the form, frequency, duration, or intensity of that behaviour) and the person's previously set outcome goals, behavioural goals or action plans (goes beyond self-monitoring of behaviour)	Can compare your behaviour to how many tasks you complete	30 day ab challenge
<b>Commitment</b> ■	Ask the person to affirm or reaffirm statements indicating commitment to change the behaviour	The app prompts the user to cut the ribbon and take up healthy lifestyle challenges	My Diet Coach
<b>Feedback and monitoring</b>			
<b>Monitoring of behaviour by others without feedback</b> ■	Observe or record behaviour with the person's knowledge as part of a behaviour change strategy Note: if monitoring is part of a data collection procedure rather than a strategy aimed at changing behaviour, do not code; if feedback given, code only	GPS	Runkeeper
<b>Feedback on behaviour</b> ■	Monitor and provide informative or evaluative feedback on performance of the behaviour (e.g. form, frequency, duration, intensity)	Informs user of how many colour (red, green, yellow) foods they have consumed and how many steps taken	Noom weight loss coach


		App tells you how many calories you have consumed each day and energy burned from exercise	MyFitnessPal
<b>Self-monitoring of behaviour</b> 	Establish a method for the person to monitor and record their behaviour(s) as part of a behaviour change strategy	User can track food consumption and exercise expenditure	MyFitnessPal
<b>Self-monitoring of outcome(s)</b>	Establish a method for the person to monitor and record the outcome(s) of their behaviour as part of a behaviour change strategy	Users can monitor weight	Calorie counter
<b>Feedback on outcome(s) of behaviour</b>	Monitor and provide feedback on the outcome of performance of the behaviour	Can review progress of weight loss on a chart	MyFitnessPal
<b>Social Support</b>			

<b>Social support (unspecified)</b>  	Advise on, arrange or provide social support (e.g. from friends, relatives, colleagues, 'buddies' or staff) or non-contingent praise or reward for	Access to online community (can post on each other's wall, send messages, review progress)	MyFitnessPal
<b>Social support (practical)</b>	Advise on, arrange, or provide practical help (e.g. from friends, relatives, colleagues, 'buddies' or staff) for performance of the behaviour	Mini-challenges and online forums	Noom weight loss coach
<b>Social support (emotional)</b>	Advise on, arrange, or provide emotional social support (e.g. from friends, relatives, colleagues, 'buddies' or staff) for performance of the behaviour	Access to topics that relate to the emotional side of weight loss and eating in the forum	Noom weight lose Coach
<b>Shaping Knowledge</b>			
<b>Instruction on how to perform the behaviour</b>  	Advise or agree on how to perform the behaviour (includes 'Skills training')	Tips section provide information on healthy eating	Noom weight loss coach






<b>Information about antecedents</b>	<p>Provide information about antecedents (e.g. social and environmental situations and events, emotions, cognitions) that reliably predict performance of the behaviour</p> <p>Advise to keep a record of snacking and of situations or events occurring prior to snacking</p>	Quick tips (e.g. you'll reach your fitness goal faster if you have a friend)	MyFitnessPal
<b>Natural Consequences</b>			
<b>Information about social and environmental consequences</b>	Provide information (e.g. written, verbal, visual) about social and environmental consequences of not performing the target behaviour	<i>The app can provide persuasive messages informing parents of the risks of bullying when children are overweight</i>	No examples
<b>Information about health consequences</b>	Provide information (e.g. written, verbal, visual) about health consequences of not performing the target behaviour	<i>Providing parents with information on the short terms and long term health consequences for childhood overweight</i>	No examples
<b>Anticipated regret</b>	Induce or raise awareness of expectations of future regret about performance of the unwanted behaviour	<i>The app can provide persuasive messages informing parents that the guilt they may feel now when restricting food will be even</i>	No examples


		<i>greater if their children are unable to maintain a healthy weight</i>	
<b>Information about emotional consequences</b>	Provide information (e.g. written, verbal, visual) about emotional consequences of not performing the target behaviour	<i>The app can provide persuasive messages informing parents that they will increase their children's confidence if they help them to maintain a healthy weight</i>	No examples
<b>Comparison of the behaviour</b>			
<b>Demonstration of the behaviour</b>	Provide an observable sample of the performance of the behaviour, directly in person or indirectly e.g. via film, pictures, for the person to aspire to or imitate (includes 'Modelling')	The app links to videos on YouTube demonstrating each exercise	30 day ab challenge
<b>Social comparison</b>	Draw attention to others' performance to allow comparison with the person's own performance Note: being in a group setting does not necessarily mean that social comparison is actually taking place	Users can view friends' progress and share their progress	MyFitnessPal
<b>Information about other's approval</b>	Provide information about what other people think about the behaviour. The information clarifies whether others will like, approve or disapprove of what the person is doing or will do	Users can see 'likes' of their progress that they share	MyFitnessPal

Associations			
<b>Prompts/cues</b> 	7.1 Prompts/cues Introduce or define environmental or social stimulus with the purpose of prompting or cueing the behaviour. The prompt or cue would normally occur at the time or place of performance	The app prompts users to log their food three times a day	My Fitness Pal
Repetition and substitution			
<b>Behavioural practice/rehearsal</b>  	Prompt practice or rehearsal of the performance of the behaviour one or more times in the context or a time when the performance may not be necessary, in order to increase habit and skill	App prompts you to carry out Ab exercises	30 day ab challenge
<b>Habit formation</b>	Prompt rehearsal and repetition of the behaviour in the same context repeatedly so that the context elicits the behaviour	App prompts you to carry out Ab exercises every day at a certain time	30 day ab challenge
Comparisons of outcomes			
<b>Credible source</b>	Present verbal or visual communication from a credible source in favour of or against the behaviour	Well known programme	Weight Watchers app

<b>Comparative imagining of future outcomes</b>	Prompt or advise the imagining and comparing of future outcomes of changed versus unchanged behaviour	Provides images and phrases of possible outcomes of losing weight (e.g. overweight person next to healthy weight person)	My Diet Coach
<b>Reward and Threat</b>			
<b>Non-specific reward</b> 	Non-specific reward Arrange delivery of a reward if and only if there has been effort and/or progress in performing the behaviour (includes 'Positive reinforcement')	Points awarded for making progress in healthy lifestyle challenges, learning new diet skills and contributing to 'My diet Coach community'	My Diet Coach
<b>Non-specific incentive</b>	Inform that a reward will be delivered if and only if there has been effort and/or progress in performing the behaviour (includes 'Positive reinforcement')	Once you earn points in making progress you can dress your avatar with more clothing options	My Diet Coach
<b>Regulation</b>			



<b>Conserving mental resources</b>	Advise on ways of minimising demands on mental resources to facilitate behaviour change	Provides food calories and food colour so can help to make food choices	Noom weight loss Coach
<b>Antecedents</b>			
<b>Restructuring the physical environment</b>  	Change, or advise to change the physical environment in order to facilitate performance of the target behaviour or create barriers to the unwanted behaviour	The app can offer tips such as: provide a bowl of salad or vegetables with the main meal to prevent you and your child from eating too big portions	No examples
<b>Adding objects to the environment</b> 	Add objects to the environment in order to facilitate performance of the behaviour	Calorie counter and barcode scanner features	MyFitnessPal
<b>Identity</b>			
<b>Identification of self as a role model</b>  	Inform that one's own behaviour may be an example to others	<i>The app can provide persuasive messages informing parents that if they eat healthily, they will be setting a good example for their children</i>	No examples
<b>Self-belief</b>			

<b>Verbal persuasion about capability</b> 	Tell the person that they can successfully perform the wanted behaviour, arguing against self-doubts and asserting that they will succeed	<i>The app can provide persuasive messages telling parents that they can reduce portion sizes easily when they use the portion guide tool</i>	No examples
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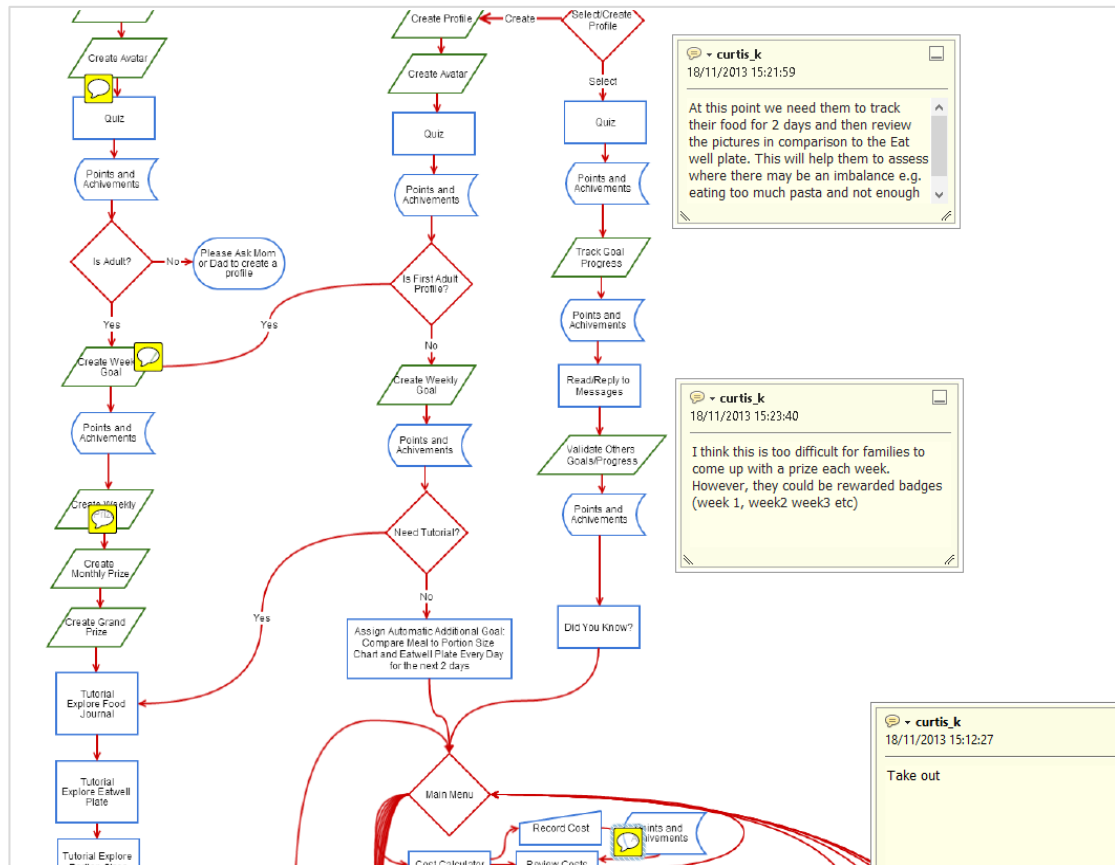
## Appendix 2C: BCTs – User preferences – App features table

BCTs identified as part of step 7 were then combined with relevant user preferences drawn from study one to help in the development of app features as shown in the table below.

BCT	User preferences themes & codes	App features
1. Commitment	Gamification (A challenge for the family to compete in)	Parents must agree to help their children achieve the target behavior before they begin the challenge
2. Information provision	Time saving and convenience (Quick and simple), visual aids, Communication (tools they can use together)	Balance Wheel, Portion guide tool, quiz
3. Instruction on how to perform the behaviour	Time saving and convenience (Quick and simple), visual aids, Communication (tools they can use together)	Balance Wheel, Portion guide tool,
4. Information about health consequences	Communication (tools they can use together), Gamification	Quiz
5. Information about the emotional consequences	N/A	Notifications/ in app messages
6. Information about social and environmental consequences	N/A	Notifications/ in app messages
7. Anticipated regret	N/A	Notifications/ in app messages
8. Information about emotional consequences	N/A	Notifications/ in app messages
9. Prompts/Cues	N/A	Notifications/ in app messages
10. Verbal persuasion about capability	N/A	Notifications/ in app messages
11. Self-monitoring of the behaviour	Time saving and convenience (minimal data input)	Food log
12. Monitoring of behaviour by others without feedback	Time saving and convenience (minimal data input)	Food log
13. Adding objects to the environment	Time saving and convenience, visual aids	Balance Wheel, Portion guide tool,
14. Identification of self as a role model	Communication (tools they can use together), Gamification	Notifications/ in app messages
15. Feedback on the behaviour	Time saving and convenience, visual aids,	Visual feedback of food groups to target in the following week
16. Goal setting (behaviour)	Time saving and convenience, visual aids,	Goal setting tool (general and specific)
17. Review behavioral goal	Time saving and convenience, visual aids,	Goal setting tool
18. Non-specific reward	Gamification	Points, awards, levels
19. Behavioural practice	Time saving and convenience (Quick and simple), visual aids, Communication (tools they can use together)	Balance Wheel, Portion guide tool,
20. Social support	Time saving and convenience (minimal data input)	In app messages can be sent to each other
21. Demonstration of the behaviour	N/A	

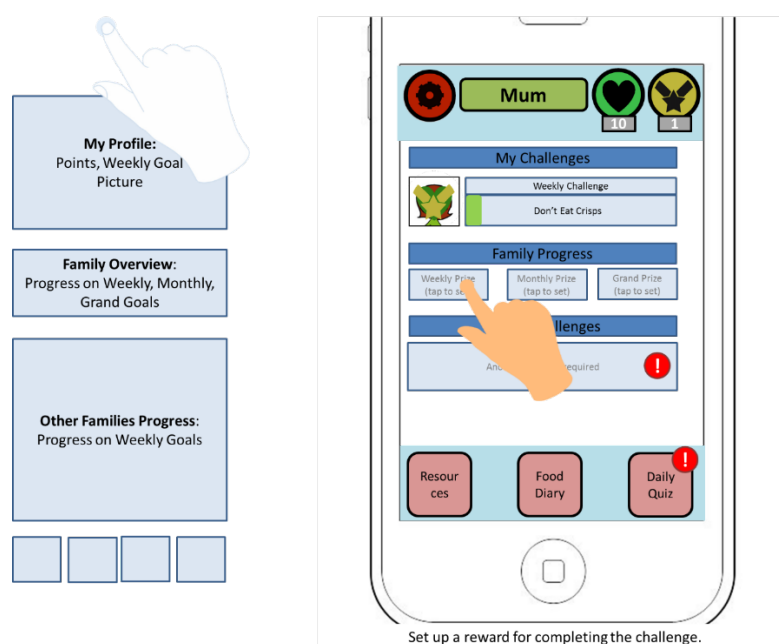
## Appendix 2D: Conceptual specification with investigator notes

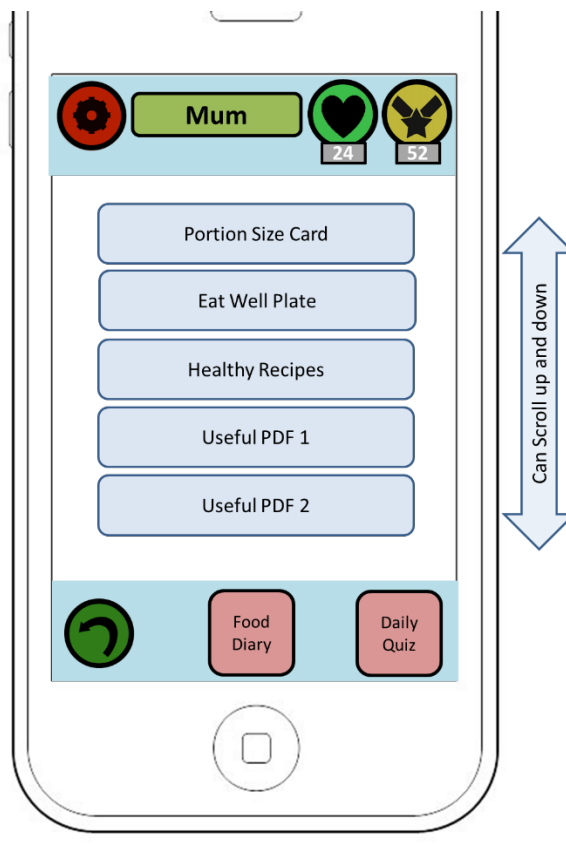
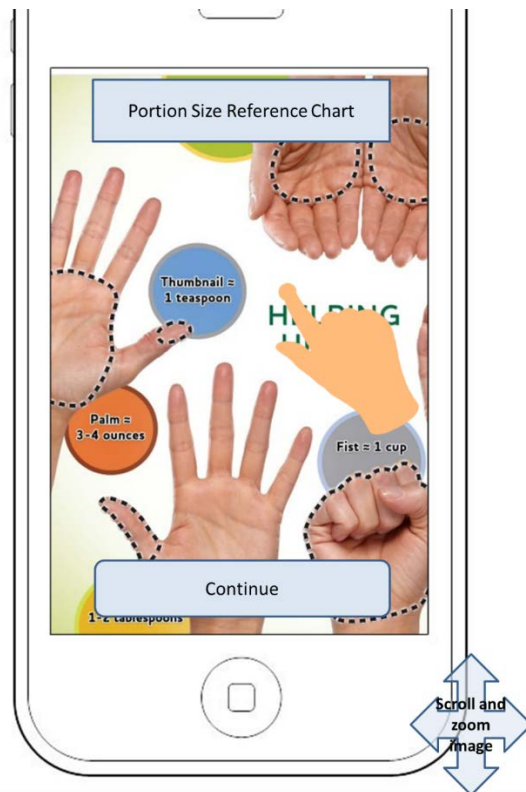
A conceptual specification detailing the game flow and app features was developed by the app company, to allow the thesis author to comment on changes required.



## Appendix 2E: Interactive mock-ups



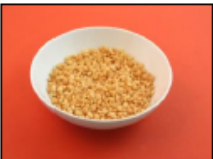

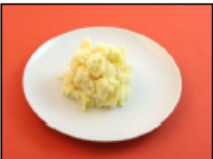

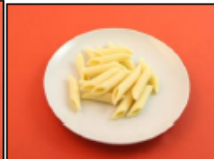


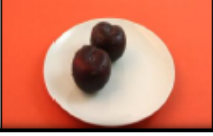

Several versions of interactive mock-ups (consisting of around 30 slides) were developed by the app company to help prototype proposed app features and content with parents. Examples of the slides are presented below.







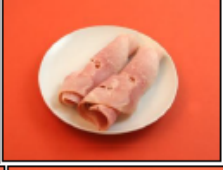








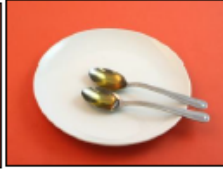




## Appendix 3:

### Appendix 3A: Portion recommendations provided by local dietitians

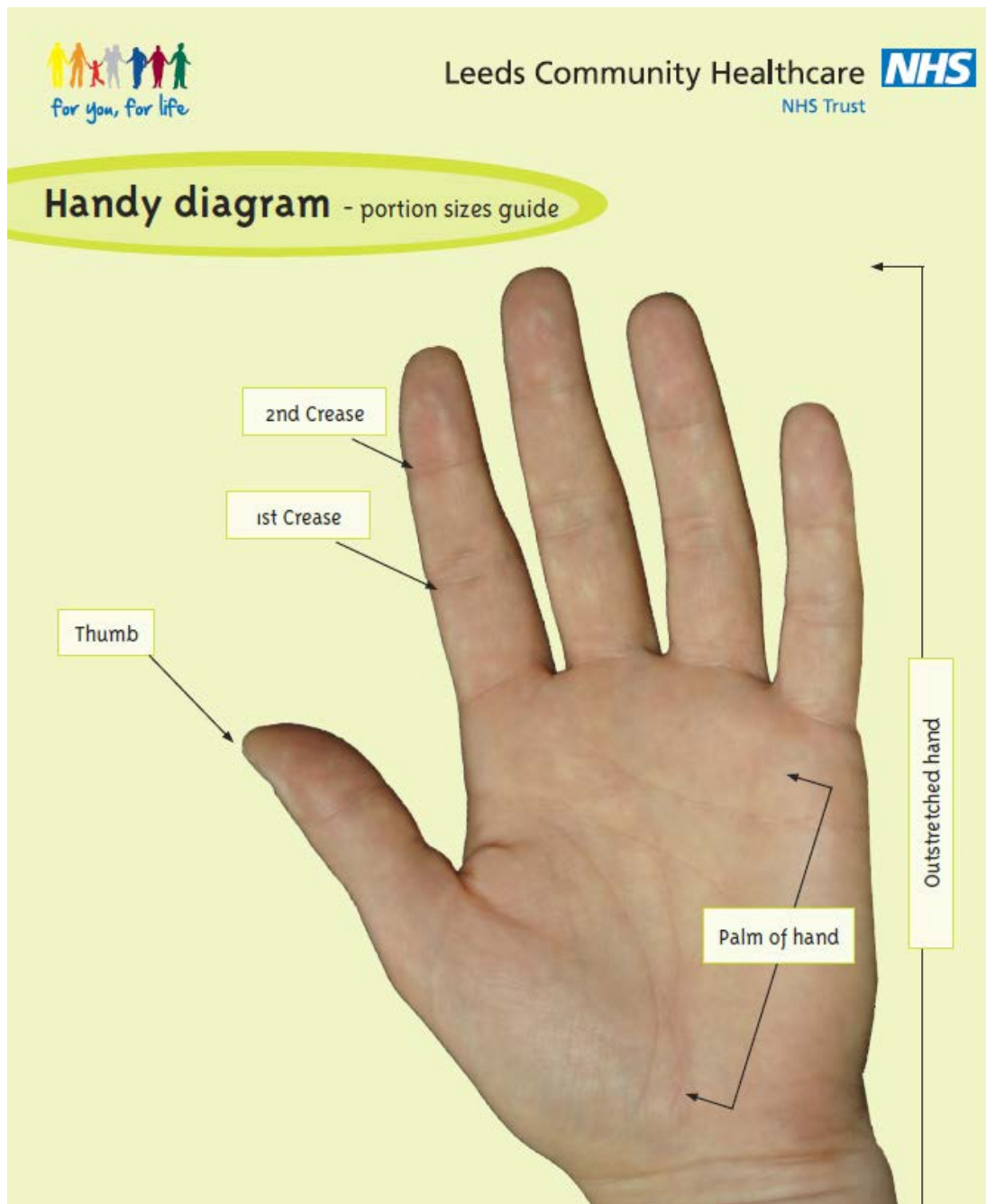
<div> <div>South Warwickshire </div> <div>NHS Foundation Trust</div> </div>		
Appendix 3: Age 7-10 years		
Expected meal pattern: 3 meals and 1-2 snacks or milky drinks. If you choose to include the foods below, suggested age-appropriate portion sizes are listed.		
Foods	Portions	Example Photos
Bread	<ul style="list-style-type: none"> <li>1 – 1 ½ slices (30-40g)</li> </ul>	
Breakfast cereal	<ul style="list-style-type: none"> <li>2 - 3 tablespoons cereal (20-30g)</li> <li>2 wheat biscuits</li> </ul>	 
Potato / rice / pasta	<ul style="list-style-type: none"> <li>3 tablespoons mashed potato(140g) / cooked rice (90g) / cooked pasta (65g)</li> <li>3 small potatoes</li> <li>12 chips (70g)</li> </ul>	    
Fruit	<ul style="list-style-type: none"> <li>1 medium / 2 small pieces (80-100g)</li> <li>2 ½ tsp raisins (20g)</li> <li>170ml fruit juice</li> </ul>	 

Vegetables	<ul style="list-style-type: none"> <li>1 ½ tablespoons (45g)</li> </ul>			
Milk and dairy foods	<ul style="list-style-type: none"> <li>190ml semi-skimmed or skimmed milk</li> <li>1 standard pot yoghurt (100g)</li> <li>20g cheese</li> </ul>			
Meat / fish / egg / pulses etc	<ul style="list-style-type: none"> <li>3 tablespoons minced meat (85g)</li> <li>1 chicken breast</li> <li>2 slices cooked meat</li> <li>3 fish fingers</li> <li>1 ½ sausages</li> <li>5 tablespoons baked beans (160g)</li> <li>1 ¼ tablespoon houmous</li> <li>140g fish or quorn pieces</li> <li>1 egg</li> </ul>			
				
				
Fats and Sugars	<ul style="list-style-type: none"> <li>1 teaspoon butter / margarine (12g)</li> <li>1 teaspoon oil (5g)</li> <li>2 teaspoons honey (20g)</li> </ul>			



### Appendix 3B: Hand portion image

The Handy diagram was piloted with parents in the final focus group in study two (artefact two), and adapted for the Portion Guide tool used in the app.



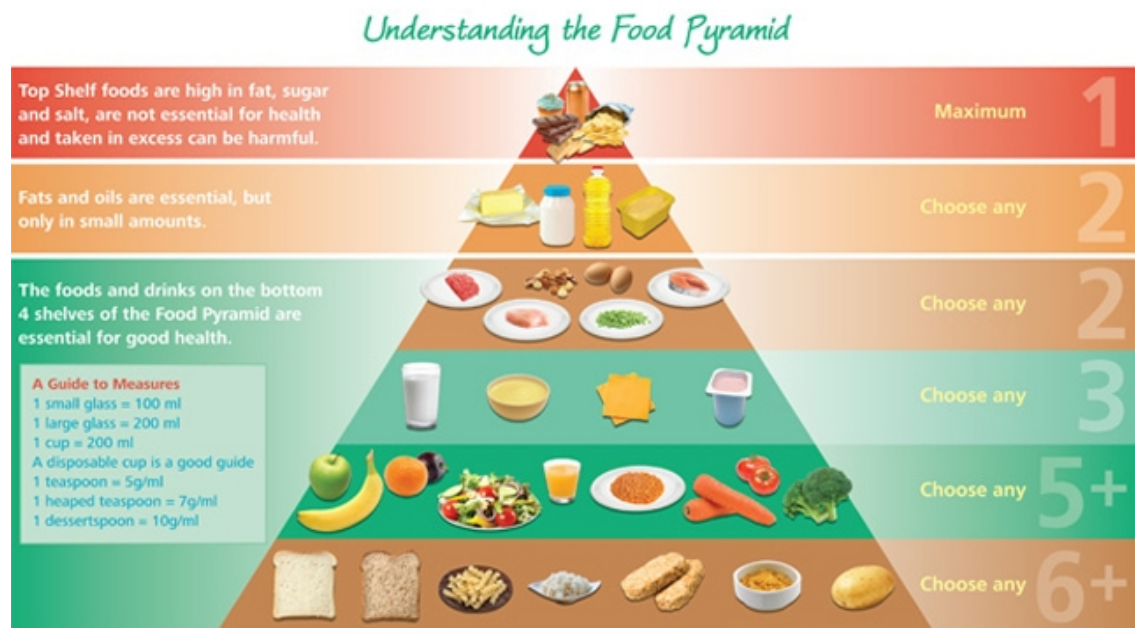
### Appendix 3C: The eatwell plate

The DOH eatwell plate was an artefact provided to participants in the final focus group in study two (artefact three), to gather feedback on their thoughts of using an infographic like this to help with understanding the relative proportions of food groups necessary for a well-balanced diet.



### Appendix 3D: The Food Pyramid

The Food Pyramid (sourced from *safefood*- food safety regulator in Northern Ireland) was another artefact shown to parents in the final focus group in study two (artefact 4), to gather their feedback on whether they liked this approach to guide them in getting the right balance of foods in their diets.



### **Appendix 3E: Logo & name of app**

The logo and name of the app was developed in time for the final focus group with parents in study two. Therefore, feedback for gathered from parents on the image presented below.



### **Appendix 3F: Topic schedule for study two**

The following schedule of questions were explored with participants in study two:

#### **Rapid feedback – interactive mock-ups and content**

##### **Overall impression**

1. What are your thoughts on how fun this app is to use for a family?
2. What are your thoughts on whether this app would be helpful and supportive for parents trying to reduce both the SIZE and frequency of portions of foods?
3. Which features would you find most enjoyable?
4. Are there any elements that are particularly entertaining?
5. What are your thoughts on whether you would find it motivating or not?  
  
Which features would motivate you most?

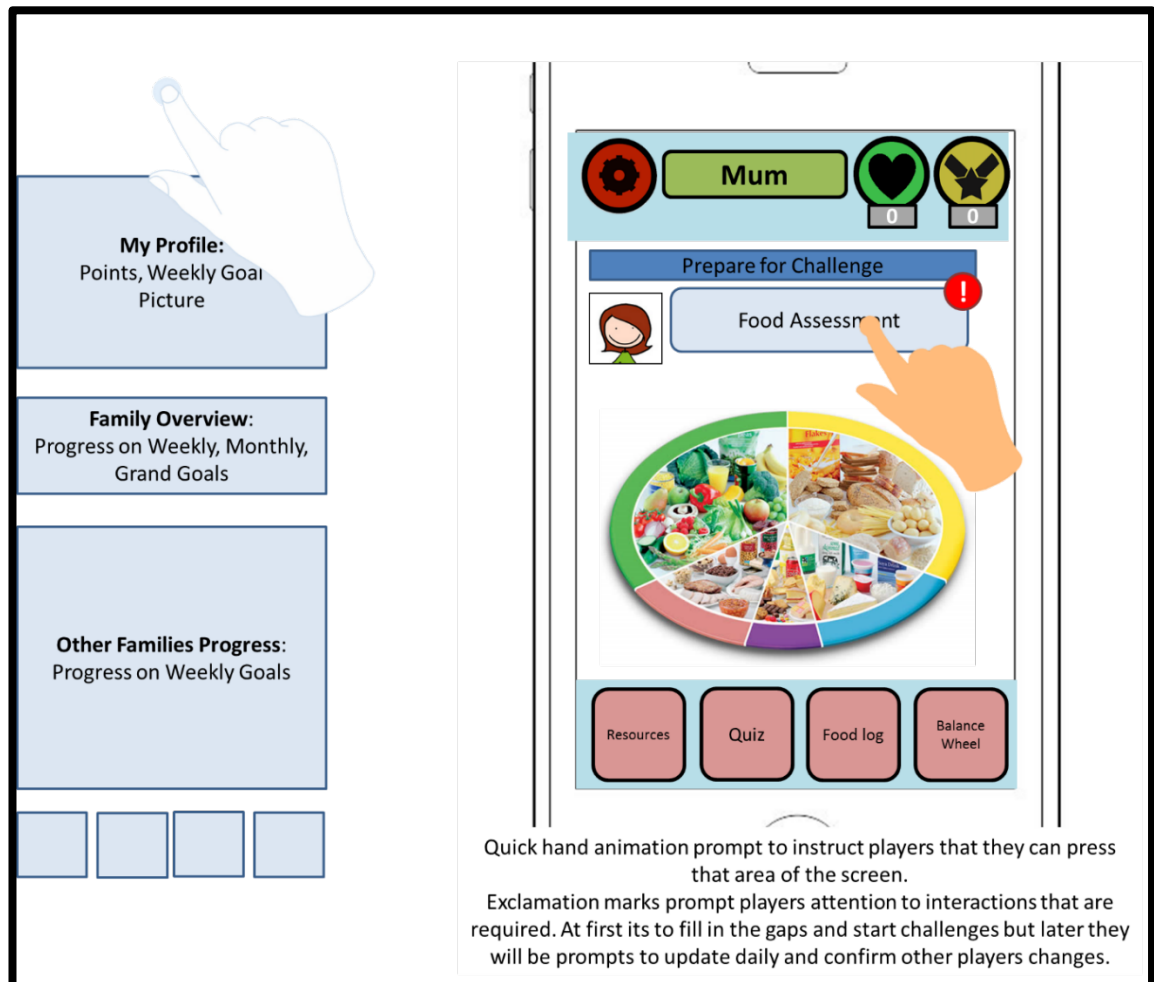
##### **Specific Content**

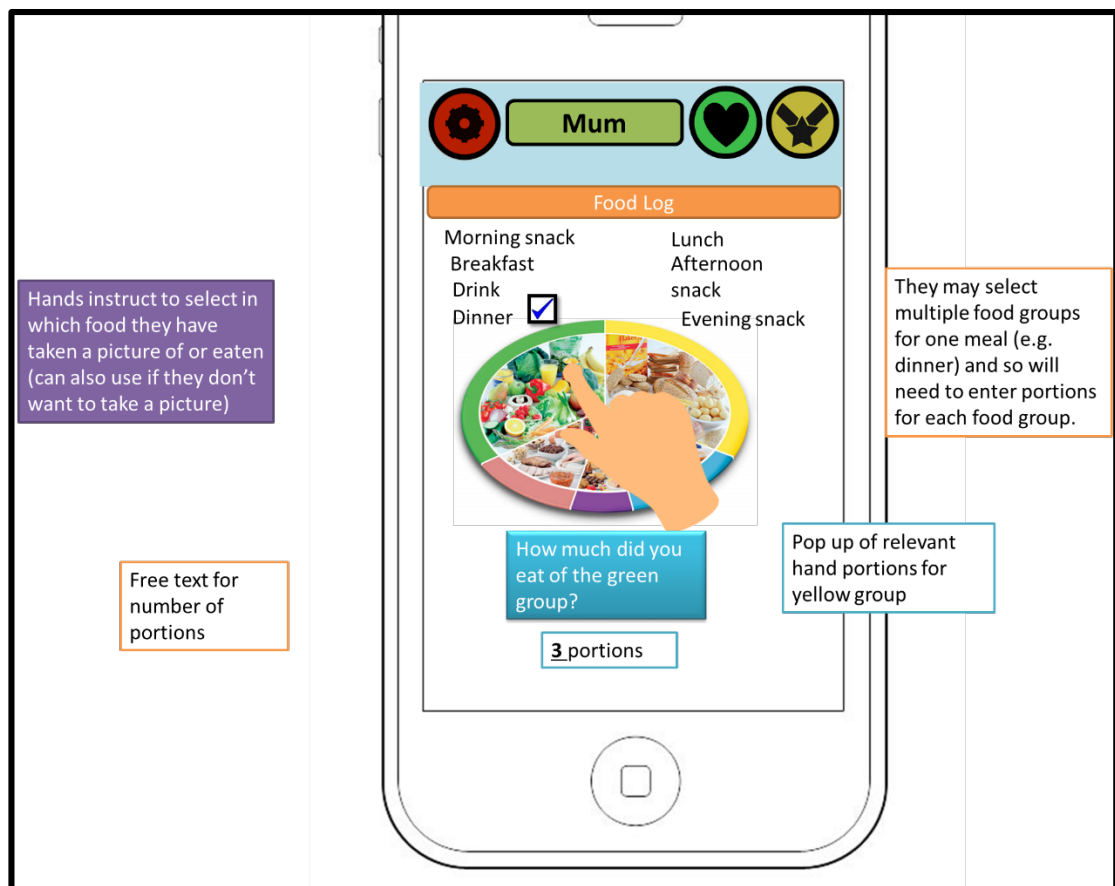
1. What are your thoughts on whether the app is easy to use as a whole?
2. What are your thoughts on how easy the food logging process is to use for families?
3. What are your thoughts on how easy the goal setting tool is to use in the app?
4. What are your thoughts on how catchy the name is? Is the app what you expect it to be? Any ideas on other names? LOGO?

5. What are your thoughts on representing portions in these pictures (show pics1)
6. What are your thoughts on the hand portions as a visual tool for parents?
7. What are your thoughts on the existing eatwell plate? Is it clear what it is for?
8. What are your thoughts on an adapted version of the plate and the new name?

### Appendix 3G: Interactive mock-up two

The thesis author made amends to the interactive mock-ups presented to the final focus group in study two to. Changes were made as a result of feedback from focus group one and two and discussions with the app company around design of the app.



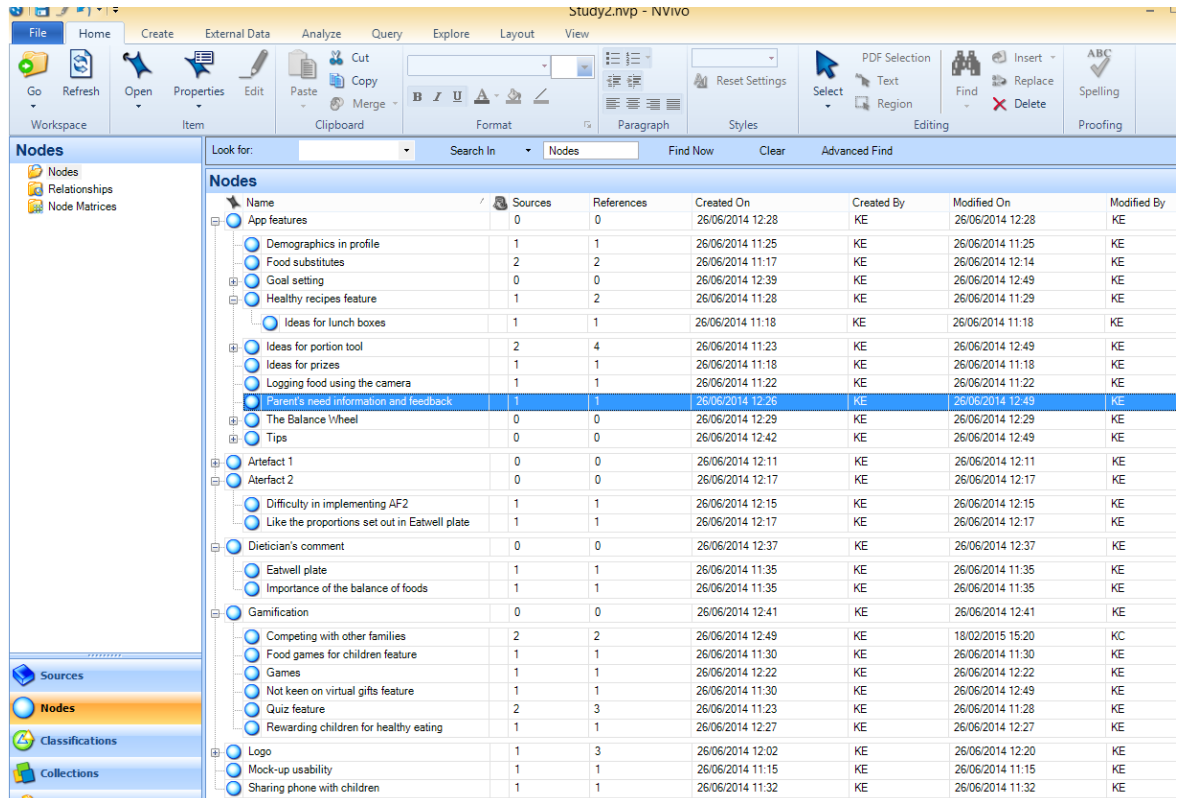




## Appendix 4

### Appendix 4A: Example of Coding in NVivo for study two

Below is a screenshot of the inductive coding carried out in NVivo 10 for study two:

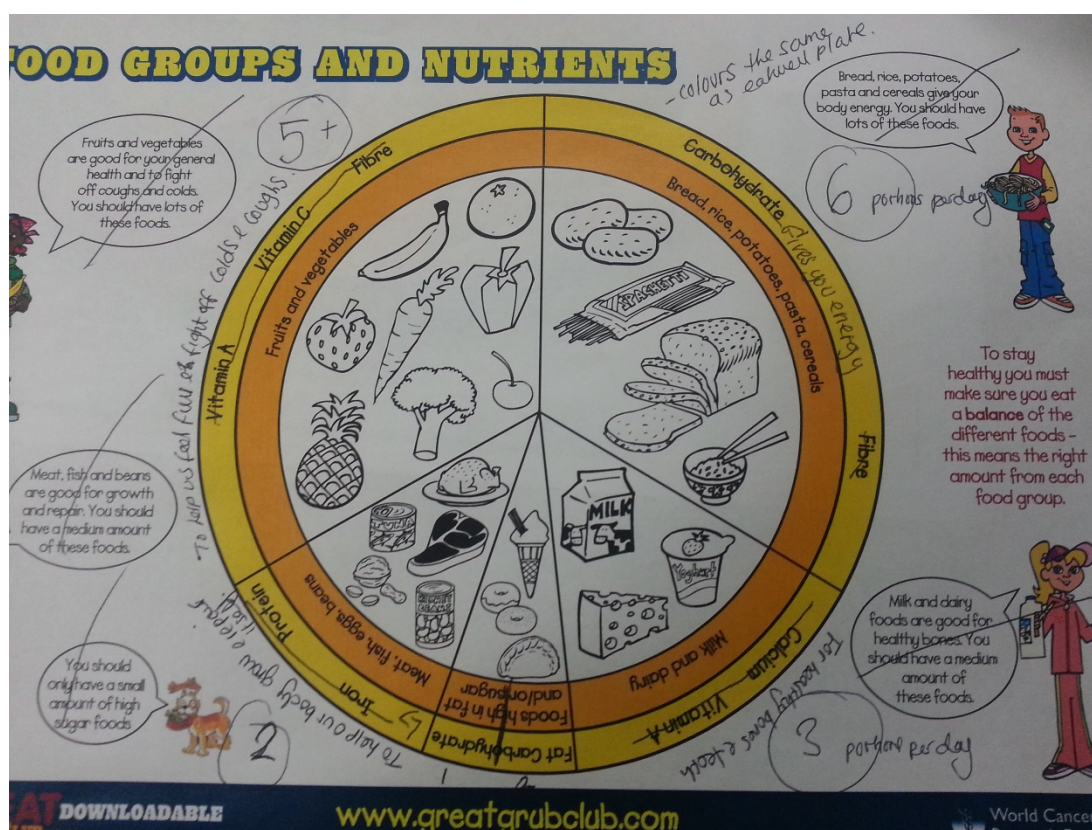


The screenshot displays the NVivo 10 software interface. The top menu bar includes File, Home, Create, External Data, Analyze, Query, Explore, Layout, and View. Below the menu is a ribbon with various tool icons. The main workspace is divided into two panes. The left pane, titled 'Nodes', shows a hierarchical tree of nodes. The right pane, also titled 'Nodes', displays a table of nodes with columns for Name, Sources, References, Created On, Created By, Modified On, and Modified By. The table lists various nodes such as 'App features', 'Demographics in profile', 'Food substitutes', 'Goal setting', 'Healthy recipes feature', 'Ideas for lunch boxes', 'Ideas for portion tool', 'Ideas for prizes', 'Logging food using the camera', 'Parent's need information and feedback', 'The Balance Wheel', 'Tips', 'Artefact 1', 'Artefact 2', 'Difficulty in implementing AF2', 'Like the proportions set out in Eatwell plate', 'Dietician's comment', 'Eatwell plate', 'Importance of the balance of foods', 'Gamification', 'Competing with other families', 'Food games for children feature', 'Games', 'Not keen on virtual gifts feature', 'Quiz feature', 'Rewarding children for healthy eating', 'Logo', 'Mock-up usability', and 'Sharing phone with children'. The 'Parent's need information and feedback' node is highlighted in blue.

Name	Sources	References	Created On	Created By	Modified On	Modified By
App features	0	0	26/06/2014 12:28	KE	26/06/2014 12:28	KE
Demographics in profile	1	1	26/06/2014 11:25	KE	26/06/2014 11:25	KE
Food substitutes	2	2	26/06/2014 11:17	KE	26/06/2014 12:14	KE
Goal setting	0	0	26/06/2014 12:39	KE	26/06/2014 12:49	KE
Healthy recipes feature	1	2	26/06/2014 11:28	KE	26/06/2014 11:29	KE
Ideas for lunch boxes	1	1	26/06/2014 11:18	KE	26/06/2014 11:18	KE
Ideas for portion tool	2	4	26/06/2014 11:23	KE	26/06/2014 12:49	KE
Ideas for prizes	1	1	26/06/2014 11:18	KE	26/06/2014 11:18	KE
Logging food using the camera	1	1	26/06/2014 11:22	KE	26/06/2014 11:22	KE
Parent's need information and feedback	1	1	26/06/2014 12:26	KE	26/06/2014 12:49	KE
The Balance Wheel	0	0	26/06/2014 12:29	KE	26/06/2014 12:29	KE
Tips	0	0	26/06/2014 12:42	KE	26/06/2014 12:49	KE
Artefact 1	0	0	26/06/2014 12:11	KE	26/06/2014 12:11	KE
Artefact 2	0	0	26/06/2014 12:17	KE	26/06/2014 12:17	KE
Difficulty in implementing AF2	1	1	26/06/2014 12:15	KE	26/06/2014 12:15	KE
Like the proportions set out in Eatwell plate	1	1	26/06/2014 12:17	KE	26/06/2014 12:17	KE
Dietician's comment	0	0	26/06/2014 12:37	KE	26/06/2014 12:37	KE
Eatwell plate	1	1	26/06/2014 11:35	KE	26/06/2014 11:35	KE
Importance of the balance of foods	1	1	26/06/2014 11:35	KE	26/06/2014 11:35	KE
Gamification	0	0	26/06/2014 12:41	KE	26/06/2014 12:41	KE
Competing with other families	2	2	26/06/2014 12:49	KE	18/02/2015 15:20	KC
Food games for children feature	1	1	26/06/2014 11:30	KE	26/06/2014 11:30	KE
Games	1	1	26/06/2014 12:22	KE	26/06/2014 12:22	KE
Not keen on virtual gifts feature	1	1	26/06/2014 11:30	KE	26/06/2014 12:49	KE
Quiz feature	2	3	26/06/2014 11:23	KE	26/06/2014 11:28	KE
Rewarding children for healthy eating	1	1	26/06/2014 12:27	KE	26/06/2014 12:27	KE
Logo	1	3	26/06/2014 12:02	KE	26/06/2014 12:20	KE
Mock-up usability	1	1	26/06/2014 11:15	KE	26/06/2014 11:15	KE
Sharing phone with children	1	1	26/06/2014 11:32	KE	26/06/2014 11:32	KE

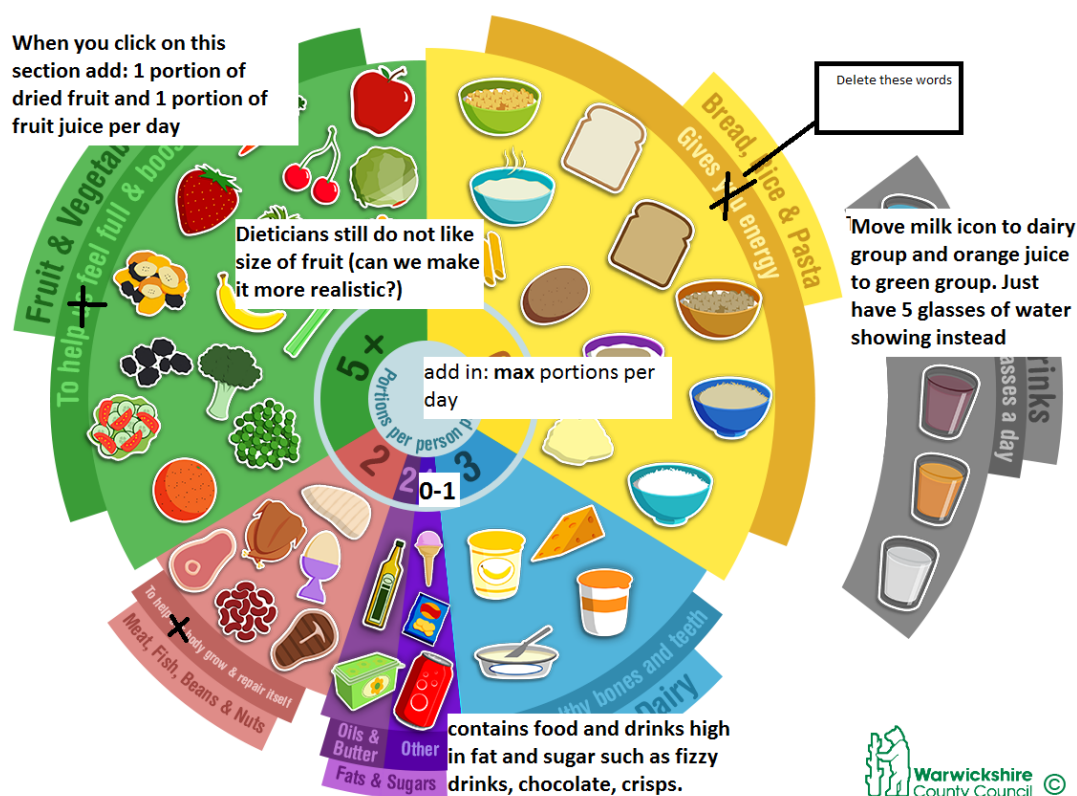
## Appendix 4B: Ideas for Balance wheel

Based upon parents' feedback on having an infographic similar to the eatwell plate the following two designs helped to direct the app company on how it should be adapted.



## Appendix 4C: Dietary steering board comments on nutrition artwork

Below is an example of one of one of the artworks that was produced by the app company known as 'The Balance Wheel'. This was then presented to the dietary steering board for comments. The thesis author then made a note of the feedback and send the following amends back to the app company:



## Appendix 4D: Dietary steering board comments on quiz content

The content for the quiz involved developing questions with multiple answers for parents and children to choose from. A dietician from the dietary steering board reviewed the content and made suggestions for amends as highlighted in red below.

Copy of quiz questions (for Warwickshire app) 10 14Rut

	A	B	C	D
26		<b>Correct answers</b>	<b>Incorrect answers</b>	
27	What can we do to help us not eat too much?	Eating more slowly	Eating fast Watching television while eating	
28				
29	Why is it good to drink plenty of water?	Water keeps us hydrated and energised.	Water makes us feel bloated	Not sure about the term energised
30			Water is not good for us	
31	Which food groups should we try to eat less of?	Chocolate bar (Purple food group)	Carrots (green food group)	Not sure about this question. The answers are foods, not food groups.
32			Wholemeal bread (yellow food group)	If the intake of starchy foods is high, they might need to reduce their intake of bread etc
33		Sweets (purple food group)	Celery (green food group)	
34		Butter (purple food group)	Apples (green food group)	

## Appendix 4E: Dietary steering board comments on portion control tips

The family lifestyle officer reviewed the content for portion control and made suggestions for other tips to include in the app (highlighted in blue).

### *Tips on how you can reduce portion sizes when you serve main meals*

1. Try a smaller plate and bowl for your children's meals to help serve up smaller portions of food.
2. Try to serve half of yours and your family's plates with vegetables, a quarter with protein and a quarter with carbohydrates to help you eat a balanced meal

3. Give your child a smaller portion to start with. They can always ask for a second helping.
4. Encourage your child to eat more slowly to allow time for them to notice when they are getting full. Leave some time before offering pudding.
5. Try to have mealtimes around the dining room table and not in front of the TV. This will help you and your family to notice signals of feeling full.
6. Encourage your child to share their snack, for example share their bag of crisps or their chocolate bar with their sibling
7. Portion your own and your families' plates when you are serving your food, half vegetables/salad, quarter protein, quarter carbohydrates
8. Measure the amount of oil you use when you are cooking by using a teaspoon rather than free pouring the oil into your pan
9. Be careful when giving your children ready-made meals. These foods are usually pre-packed as adult portions so your child will not need the full portion.
10. Encourage your children to eat different varieties of one food group so they get different vitamins and minerals e.g. instead of 5 pieces of bread encourage them to eat other types of carbohydrates such as cereal and potatoes
11. Serve salad or some cut up veg during a meal to help prevent you and your children from overeating
12. Try serving smaller portions of the main meal and provide side bowls of salad or raw vegetables for you and your family to fill up on
13. If you have children who are fussy eaters encourage them to eat at least a spoonful of everything from their plate

***Tips on how to reduce portion sizes between meals***

1. Encourage your child to drink enough water between meal times. This will help them to feel less hungry.
2. Allow up to 2-3 healthy snacks (e.g. fruit or wheat biscuits) a day
3. Instead of eating all the leftovers, why not keep it for tomorrow's meal?
4. Having a bowl of fruit and vegetables on show for your children, helps them to fill up on food from the green group, keeping them fuller for longer!
5. Make sure you drink enough and keep hydrated (6-8 glasses a day) so you do not mistake hunger for thirst. Aim to drink mostly water but other drinks can include, milk, diluted fruit juice and low sugar squash.

***Tips to help reduce portion sizes when you buy food***

1. Cut up fruit and hand them out to your children when you are cooking
2. Try to reduce the size of unhealthy snacks through the purchase of multipacks of snack-size chocolate bars and savoury snacks and try to limit their consumption to just one bar or bag per day. Multipacks normally contain smaller portions.

3. If food is on offer you may be able to freeze some of it and use it again for another meal. If it's vegetables, you can blanch them to keep the freshness locked in. Here's how: <http://www.thekitchn.com/how-to-blanch-vegetables-home-108570>

**Tips to help reduce portion sizes when you eat out**

1. Avoid supersizing food at fast food outlets to avoid eating too big portions
2. If the food portions of the food are too big share them with other family members or friends
3. [If you have more than one child on a trip to the cinema, divide the popcorn into smaller boxes from them to eat out of unless they are happy to share one box](#)

## Appendix 5

### Appendix 5A: Health Heroes review presentation

This PowerPoint presentation was presented to parents on a projector screen. The evaluator took parents through the concept of the app, including its content and the overall user journey, encouraging feedback. Example slides from the presentation are shown below.





## Tips and messages in the app

From around the age of 11 you can start serving adult portion sizes but remember to use the hands to guide you!

If you sometimes reward your child with food when they are good, replace this with a badge from the app or sticker they can wear

To help your children make healthier food choices, use the balance wheel to explain the effect each food group has on our bodies

Show your children the balance wheel to help them understand why we need a balance of foods in our diets

Make sure everyone in the family eats three regular meals a day to help them maintain a healthy weight

Fill half your family's plates with vegetables to help them feel full

If your child complains they do not have enough food on their plates, use the hand portion guide to explain they need less food than adults because they have smaller hands and so a smaller stomach

Sometimes you can feel guilty when you restrict your child from eating something they want. But if you don't have unhealthy snacks in the house, your child is less likely to want them.

Making changes together as a family will increase your chances of making long term changes to your eating habits

Try to avoid buying unhealthy snacks that are on promotion. By not having unhealthy snacks in the house, the easier it is to help your child cut down on them

Using words like 'chunky' or 'big boned' to describe children may mean they are overweight. By helping them to cut down on their portions of food, you will help them maintain a healthy weight

Try to measure food portions using yours and your children's hands before you start cooking so that you do not cook too much food

By helping your child to log their food every day, you will be more aware of what they are eating

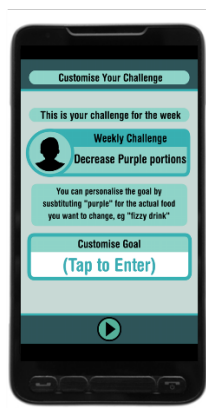
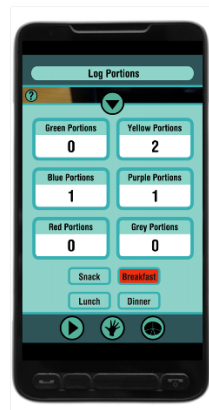
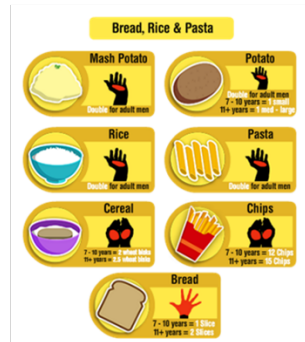


Monitor your family's food intake..



Understand the balance of foods..





## Appendix 5B: Snapshot of Task Tracking System

To ensure fast iterative development and monitoring of changes required, all comments from reviews, consultation with experts and usability testing was logged on the Task Tracking System. Below show examples of logged tasks.

<b>[FHC-258] <a href="#">Hand portion guide</a></b> Created: 06/Oct/14 Updated: 06/May/15			
Status:	To Do		
Project:	<a href="#">Family Health Challenge</a>		
Component/s:	None		
Affects Version/s:	None		
Fix Version/s:	None		
Type:	Improvement	Priority:	Normal
Reporter:	<a href="#">Kristina Curtis</a>	Assignee:	<a href="#">Danny Marsh</a>
Resolution:	Unresolved	Votes:	0
Labels:	None		
Remaining Estimate:	3 hours		
Time Spent:	Not Specified		
Original Estimate:	3 hours		
Epic Link:	<a href="#">Balance Wheel</a>		
Sprint:	Health Heroes v2		
<b>Description</b>			
Can you take out all text underneath pictures except for cereal pic. So take out all reference to male portions.			
Green group			
1. add 170ml for orange juice icon			
Yellow group - five examples of food(potato, pasta, rice cereal, bread)			
1. clenched food icon - for potato, pasta, rice			
2. cereal keep the same			
3. take out chips			
4. bread keep the same			
Pink group			
1. replace sausages with beans icon and use same icon as palm of hand			
2. replace fried egg with boiled egg			
Blue			

<b>[FHC-255] <a href="#">Food logging tool</a></b> Created: 06/Oct/14 Updated: 06/May/15			
Status:	To Do		
Project:	<a href="#">Family Health Challenge</a>		
Component/s:	None		
Affects Version/s:	None		
Fix Version/s:	None		
Type:	Improvement	Priority:	Minor
Reporter:	<a href="#">Kristina Curtis</a>	Assignee:	<a href="#">Andres Fonseca</a>
Resolution:	Unresolved	Votes:	0
Labels:	None		
Remaining Estimate:	1 hour		
Time Spent:	Not Specified		
Original Estimate:	1 hour		
Epic Link:	<a href="#">Food Diary</a>		
Sprint:	Health Heroes v2		
<b>Description</b>			
Can you take out the '0' values from the portion groups and leave this blank so users can enter entries?			

### **Appendix 5C: Registration form for user testing**

At the end of the usability workshop, parents were able to leave their contact details using the form below if they wanted to become testers for the app.

### **Healthy Eating App Registration Form**

**Name:** .....

**Children's Name and Age:** .....

**Contact Number:** .....

**Address:** .....

**Email Address** (access to the app will be sent via email): .....