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Abstract

Fruit and vegetable intake in young children in England is low compared with national recommendations. Existing interventions to improve consumption levels have a limited but positive impact. The research reported in this thesis aimed to better understand the determinants of fruit and vegetable consumption in young children, and the way in which these determinants interact. This new information will help inform the development of more effective interventions.

A mixed methods approach was used to explore, and develop a model of, the determinants of fruit and vegetable provision and consumption in pre-school children. A phased approach to the research was used to develop and refine a model of determinants. At each stage, a integrative tool, the Theoretical Domains Framework (TDF), was used to better understand these determinants. The TDF consists of 12 domains which capture a collection of theoretical concepts that characterise barriers and facilitators to a particular behaviour; data was coded to the corresponding TDF domains and added to the model of determinants presented at the end of each phase.

Results indicated that the most influential determinants included: the role of grandparents, parental role modelling (*both social influences domain*), and parenting style and practices (*nature of the behaviours domain*). Less influential but nonetheless important determinants included: feedback from the child, support from others *(both social influences domain),* time, cost, and availability of fruits and vegetables (*all environmental context and resources domain)*.

It is recommended that interventions which aim to improve the fruit and vegetable intake of pre-school children, particularly the intervention techniques and modes of delivery used, are informed by the results of this thesis. This will allow for interventions that are theoretically driven and thus more likely to be effective. It is acknowledged that intervention development should take into account 'local' contextual factors and the complex interplay of determinants.

Characterising the determinants of fruit and vegetable consumption in pre-school children

Claire Louise O'Malley

This thesis is submitted for the degree of
Doctor of Philosophy

Department of Sport and Exercise Sciences
Durham University
October 2018

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Abbreviations

DALY: Disability Adjusted Life Years

DLW: Doubly Labelled Water

HSE: Health Survey for England

IHME: Institute for Health Metric and Evaluations

IMD: Indices of Multiple Deprivation

MRC: Medical Research Council

NICE: National Institute for Health and Care Excellence

PHE: Public Health England

RCT: Randomised Controlled Trial

SCT: Social Cognitive Theory

SEM: Socioecological Model

SES: Socioeconomic Status

SLOA: Super Lower Output Areas

SLT: Social Learning Theory

SSB: Sugar Sweetened Beverages

TDF: Theoretical Domains Framework

UK: United Kingdom

USA: United States of America

WCRF: World Cancer Research Fund

WHO: World Health Organisation

Declaration

Chapter 3 of this thesis (*A systematic review examining determinants of change in fruit and vegetable consumption in children 0-6 years)* was carried out as part of a suite of reviews headed by colleagues at Cambridge University. For the aforementioned review, the author screened approximately 14,000 records (titles and abstracts) and read 337 potentially relevant studies in full. All remaining tasks relating to this review were carried out entirely by the author of this thesis.

Statement of Copyright

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I would like to thank all my friends for their words of encouragement and understanding my refusal of invites in favour of a night of writing! To my very good friend and fellow PhD student, Sarah Smith. Thank you for listening to all my moans, helping me turn the air blue and keeping me going. Thank you also to my desk buddy Kate Byrnes, you are a little super star!

Lastly and most importantly to my grandparents, for your support and unconditional love, I couldn't have done this without you.

Publications and dissemination of research

Journal Articles

Published

Hesketh KR, **O'Malley C**, Mazarello Paes V, Moore H, Summerbell C, Ong KK, Griffin S, Lakshman R, van Sluijs EMF. Determinants of Change in Physical Activity in Children 0-6 years of age: A Systematic Review of Quantitative Literature. *Sports Medicine* (2017). doi: 10.1007/s40279-016-0656-0

Paes, VM, Hesketh, K, **O'Malley, C**, Moore, H, Summerbell, C, Griffin, S, van Sluijs, EMF, Ong, KK. and Lakshman, R. (2015) Determinants of sugar – sweetened beverage consumption in young children: a systematic review. *Obesity Reviews*, 16: 903 – 913.

Lakshman, R, Mazarello Paes, V., Hasketh, K, **O'Malley, C**., Moore, H, Ong, K, Griffin, S, van Sluijs, and Summerbell, C. Protocol for systematic reviews of determinants/correlates of obesity-related dietary and physical activity behaviors in young children (preschool 0 to 6 years): evidence mapping and syntheses. *Systematic Reviews* 2013, **2**:28.

In Preparation

O'Malley, C, Paes, VM, Hesketh, KM, Moore, HJ, Griffin, S, van Sluijs, EMF, Ong, KK, Lakshman, R and Summerbell, CD (2018) Determinants of fruit and vegetable consumption in young children: a systematic review of quantitative studies. (Nutrition Reviews) *In preparation*

O'Malley, C, Moore, HJ, Summerbell, CD, Heslehurst, N (2018) Barriers and facilitators to parental fruit and vegetable provision of pre-school aged children: a meta synthesis using the Theoretical Domains Framework. (Implementation Science) *In preparation*

Accepted Conference Abstracts

Postgraduate Research Conference, (Durham University, June 2017) Characterising the determinants of fruit and vegetable consumption in pre-school children. **O'Malley**, C. Heslehurst, N and Summerbell CD (oral)

European Congress on Obesity (ECO) (Portugal, May 2017) Exploring barriers and facilitators of fruit and vegetable consumption in pre-school children: a meta-synthesis using the Theoretical Domains Framework (TDF) **O'Malley, C**, Summerbell CD, Moore, HJ and Heslehurst, N (poster)

School for Public Health Research (SPHR) Annual Conference (London, March 2017) Characterising the determinants of fruit and vegetable consumption in pre-school children. **O'Malley, C**, Summerbell CD, Moore, HJ and Heslehurst, N (poster)

School for Public Health Research (SPHR) Annual Conference (Newcastle, March 2016) Systematic review on the determinants of fruit and vegetable consumption in young children (aged 0-6) **O'Malley C**, Mazarello Paes V, Hesketh K, Moore H.J, Ong K, van Sluijs E, Lakshman R, Summerbell C.D (poster)

The UK Congress on Obesity (UKCRC) (Nottingham, Sep 2016) Barriers and facilitators of fruit and vegetable consumption in young children: a meta-synthesis using the Theoretical Domains Framework (TDF) **O'Malley, C**, Summerbell CD, Moore, HJ and Heslehurst, N (poster)

Association for the Study of Obesity (ASO) (Sheffield, Nov 2015) ASO Symposia: Early life (0-6 years) Determinants of Fruit and Vegetable intake in Pre-school Children (0-6 years) **O'Malley C.L** and Summerbell C.D (oral)

Postgraduate Research Conference, (Durham University, June 2015) Characterising the determinants of fruit and vegetable consumption in pre-school children using a mixed methods approach **O'Malley, C**. Heslehurst, N and Summerbell CD (poster)

International Society of Behavioural Nutrition and Physical Activity (ISBNPA) (Edinburgh, June 2015) Results: Systematic Review on the determinants of Fruit and Vegetable consumption in young children (aged 0-6) **O'Malley C**, Mazarello Paes V, Hesketh K, Moore H.J, Ong K, van Sluijs E, Lakshman R, Summerbell C.D (poster)

European Congress on Obesity (ECO) (Prague, May 2015) Systematic review on the determinants of fruit and vegetable consumption in young children (aged 0-6) **O'Malley C**, Mazarello Paes V, Hesketh K, Moore H.J, Ong K, van Sluijs E, Lakshman R, Summerbell C.D (poster)

Wolfson Research Institute (WRI), Research Colloquium (Durham University: April 2016) Characterising fruit and vegetable consumption in young children. **C.O'Malley** (oral)

Thesis reflection

After a number of years working as a researcher and being asked on various occasions if I would like to do a PhD, I finally decided that this might be a good idea. I resisted for a long time due to a number of reasons including having a young family and caring for my grandparents which resulted in a lack of time, having other work commitments and importantly, the fear of ending up like some of the wacky academics (of which there are many) whom I felt I had very little in common with.

My PhD was an NIHR School for Public Health Research funded studentship which I originally started full time. I think I initially underestimated the extra time and dedication required to carry out a PhD, assuming that it would sit quite nicely and run alongside other work I was involved with, which at times it did but in many instances, it didn't. Towards the end of my first year I increased my working hours and decided that studying on a part-time basis would be prove more beneficial for my work-life balance.

The first phase of my PhD involved carrying out a systematic review of determinants of fruit and vegetable consumption in young children. This review formed part of a suite of reviews looking at a number of determinants of energy balance related behaviours including physical activity, sedentary behaviour and sugar sweetened beverage consumption that were being carried out in collaboration with colleagues from Cambridge University. I enjoyed working with academics from other institutions and learning from their experiences to build upon my own. This wasn't always a straightforward process and at times required patience and further discussion to resolve differences in opinion, which I feel I handled quite well.

I used the Socioecological Model theory during the data synthesis phase of the quantitative review to aid with the understanding and mapping of determinants. This model was selected as one of the senior members of wider review team had used it previously with success and it had also been used in many other studies to understand behaviour. However, I was sceptical as to whether this would provide the best theoretical basis for my PhD. After reviewing the behaviour change literature I could see there were opportunities to use

alternative methods which could potentially capture more behavioural determinants and also provide better depth of understanding which would result in a much more comprehensive theory informed approach. I chose to use the Theoretical Domains Framework (TDF) as this framework incorporated 33 behavioural theories which gave me extra reassurance that the likelihood of capturing all aspects of the important behaviours was extremely high as opposed to using a method underpinned by only one theory. I was also drawn towards using the TDF due to its versatility, which had been demonstrated in other studies and the fact that it was developed with non-psychologists in mind.

Using the TDF throughout my thesis proved challenging, as this was a framework with which I was unfamiliar with before I started the PhD. However, for me this was also the most rewarding and interesting aspect of my PhD studies. I thoroughly enjoyed learning how to apply the TDF and putting it into practice in my work. Adapting the TDF for use in data synthesis for the mixed methods review was a lengthy, but in my view, worthwhile procedure for the depth of understanding and interaction of determinants it generated. Operationalising the coding manual proved tricky at times but with guidance from Nicola (one of my supervisors) and a behavioural scientist (Falko Sniehotta) from Newcastle University it was manageable and a process, which I ultimately enjoyed. As a non-psychologist, using the TDF has provided me with a better understanding of behaviour and this I feel has made me a better researcher.

Having carried out numerous interviews working on projects previously, I felt comfortable approaching schools and speaking with parents for my research. I also believed I was able to empathise with this population, being a parent myself and having encountered many of the situations experienced by parents. For example, I understood how it felt to become frustrated when children refused to eat certain fruits and vegetables and how difficult it was to encourage them to try new foods. I also believed that this made participants feel relaxed in my presence. In the initial stages of some interviews I felt that some parents thought I was there to pass judgement on their parenting skills in relation to types of food they provided their child. They were sometimes reserved or seemed to hold back sharing information in relation to energy dense and/or fast

food provision or would emphasise that they did not do this on a frequent basis. However, after being reassured that I was not there to pass judgement and there were no right or wrong answers to the questions, they appeared more at ease. In an ideal world, if I had had additional time and increased resources, I would have carried out interviews in more schools to allow for comparisons to be made and increase the generalisability of the findings.

Looking back at my initial thoughts and reservations about me carrying out a PhD, I am not, I don't think, any closer to becoming one of those wacky academics I mentioned at the beginning of my journey. However I do feel that I now share a common goal with other academics of striving to improve population health through research, and feel more of an equal when having academic discussions. This PhD has enabled me to find common ground with fellow academics and not only draw upon their expertise to better my own, but to feel more confident in offering my opinion when discussing research problems. I have also learned that academics from prestigious institutions do not always have the best solutions to real world problems and that sometimes stepping away from your comfort zone and embracing novel methods is the way forward.

1. Chapter 1: General introduction and literature review

The primary aim of this introductory chapter is to provide an overview of fruit and vegetable consumption both worldwide and in the UK and how this might be influenced by factors such as socioeconomic status and gender. Data pertaining to both adults and children will be presented. Maintenance of good health and how fruit and vegetable consumption may contribute towards a healthy diet will be discussed followed by health consequences of a poor diet and an insufficient intake. Evidence surrounding the importance of early intervention and understanding the most important determinants of fruit and vegetable consumption in young children will be considered. The case for intervening at an early age will also be presented along with challenges associated with measuring fruit and vegetable consumption in child populations. An introduction to behaviour change approaches and commonly used examples will be provided. Furthermore, developing behaviour change interventions and challenges associated with this will be discussed.

1.1 Definition of fruits and vegetables

There is currently no universal definition and agreement on the constituents of fruits and vegetables. Classification differs between countries as does general dietary guidance. For example, potatoes are generally described as tubers which, botanically form part of the vegetable family and are accepted as such in various countries such as Australia (The National Health and Medical Research Council, 2013). However in the UK potatoes are nutritionally classed as a starchy food and do not contribute towards the 5-a-day recommendations (Public Health England, 2016). Diversity in cultural customs and norms between countries and individuals are also thought to play a role in determining classifications (Thompson et al., 2011).The World Health Organisation's (WHO) International Agency for Research on Cancer states that a 'fruit' is typically referred to as a fleshy seed-associated structure of a plant that is sweet or sour, and edible in a raw state and that a vegetable is an edible plant part, including stalks, tubers, leaves, flowers and fruits and generally consumed raw or cooked (International Agency for Research on Cancer (IARC), 2003).

For the purpose of this thesis the definition of fruit and vegetables is: any edible plant foods excluding cereal grains, seeds, nuts, tea leaves, coffee beans, herbs and spices. This includes fruit juice, baked beans and other pulses, dried fruit, and fruit and vegetables which are frozen, canned, or used as a main ingredient in recipes or composite foods. This definition excludes potatoes and is in line with that agreed in the UK (Williams, 1995).

1.2 Guidelines for fruit and vegetable consumption.

1.2.1 International guidelines for adults

The World Health Organisation (WHO) recommend that a minimum daily intake of 400 g of fruit and vegetables (excluding potatoes) should be consumed for the prevention of chronic diseases (World Health Organization, 2018). Many European countries, including France, Germany and Spain have adopted a 5-a-day fruit and vegetable campaign or public health message. The Australian dietary guidance published in 2013 recommend at least two portions of fruit (150 g) and 5 portions of vegetables (75 g) daily, the equivalent of 8.5 UK portions . Similarly New Zealand guidleines recommend five servings a day which contain at least three vegetable servings and two of fruit (Ministry of Health, 2015). However the USA have now dismissed similar guidance and for favour of endorsing the ‘Fruit and Veggies – More Matters’ campaign, which involves varied consumption depending upon the caloric needs of the individual (Produce for Better Health Foundation, 2015).

1.2.2 International guidelines for children

There are currently no set guidelines for children relating to minimal daily amounts of fruits and vegetables and different countries advocate the consumption of differing amounts. For example, Greek guidelines recommend at least 500 g of vegetables per day, whereas Turkey suggest between 600-700 g of fresh fruits and vegetables per day (World Health Organization, 2003). In Austria it is recommended that 250 g of both fruits and vegetables are consumed daily, whereas in Sweden 400 g is deemed to be ample (Yngve et al., 2005).

1.2.3 UK Guidelines for children

The UK government recommend that 5 portions of fruit and vegetables per day are consumed for both adults and children (Department of Health and Social

Care, 2013). A portion size for adults is defined as 80 g, yet there is no specific amount given for children but states that it should vary with age, body size and levels of physical activity. As a rough guide, one portion is an amount that should fit into the palm of a hand (Public Health England, 2016). The Children's Food Trust recommend that a child portion should be half that of an adult (40 g) and incrementally increase as the child reaches adolescence, when it should equate to that of an adult (80 g) (Children's Food Trust, 2012). It is generally advised to increase intake with age until adulthood is reached or at lifepoints when requirements change such as pregnancy and old age.

1.2.4 Challenges of measuring fruit and vegetable consumption in children

Measuring food intake and in particular fruit and vegetable consumption plays an important role in assessing dietary status and quality (The Health and Social Care Information Centre, 2013, Lissner, 2002). It is also fundamental in understanding the relationship between diet and disease and designing interventions that hope to improve diet and subsequently, health (Kirkpatrick et al., 2018). Obtaining dietary intake for children has been noted as a somewhat arduous task (Livingstone et al., 2004, Collins et al., 2009, Magarey et al., 2011). Difficulties with measuring fruit and vegetable intake in children is more apparent in children than adults, due to their changeable cognitive stage and ability. In children of 8 years and younger, this is markedly challenging as this is a time when children are unaware of and incapable of accurately identifying the food, and the amount, they are consuming (Livingstone and Robson, 2000). Therefore, parents and carers play a pivotal role in reporting dietary intake in children.

There is no consensus relating to the best method for measuring fruit and vegetable consumption in children (Tugault-Lafleur et al., 2017). In population studies and those involving a large number of participants, it is common practice to use subjective methods of measurement such as the Food Frequency Questionnaire (FFQ) and diet diaries (Shim et al., 2014). However, these types of methods rely heavily on parental accuracy of reporting and are highly susceptible to social desirability bias as demonstrated in in a number of

studies that have employed such dietary assessment measures (Christian et al., 2015, Ervin and J Soutter E, 2015, Hebert et al., 2008).

Social desirability bias occurs when an individual answers questions in a way that is seen to be favourable to others. It is based on the premise that the answers provided are reflective of culturally acceptable and positive ideologies which are not always true or reflective of the person or situation in question (Van de Mortel, 2008). For example, parents do not want to appear inadequate and incapable of providing healthy nutritious meals and will therefore over report the amount of fruits and vegetables their child has consumed. This means that consumption may be even lower than is actually reported. There is also a high chance of reporting bias occurring when food is eaten outside of the home environment. Children of a young age are often in the care of others, whether that be family or paid care during the day when parents are at work. During these times parents ability to report intake with accuracy has been shown to diminish and is also influenced by other factors such as memory and the burdensome nature of the method used (Foster and Bradley, 2018, Baranowski and Simons-Morton, 1991). Although there is a higher likelihood of bias occurring using parent report methods, there is also evidence to indicate that, when in their own home environment, and when both parents provide a measure, they are more likely to do so with greater accuracy (Wallace et al., 2018, Baranowski and Simons-Morton, 1991).

The doubly labelled water (DLW) method, considered to be the gold standard bio marker of habitual energy intake has been used as a comparator for dietary assessment methods (Westerterp, 2017, Burrows et al., 2010). The DLW is an accurate yet invasive and labour intensive measure in comparison to FFQ's and other methods of dietary assessment. This makes it extremely impractical and expensive for use in large population studies but crucial in aiding understanding of limitations and capability of other dietary assessment methods (Burrows et al., 2010). Likewise, less intensive and alternative methods such as the 24-hour recall and weighted food methods have also been deemed accurate in some studies (Vilela et al., 2019, Shim et al., 2014, Schroder et al., 2001), however, as with FFQ's, they are heavily reliant on memory and accuracy of reporting and therefore subject to bias (Foster and Bradley, 2018).

A systematic review assessing the validity of dietary assessment methods for children found that the 24-hour multiple pass recall conducted over at least a 3-day period that includes weekdays and weekend days and uses parents as proxy reporters is the most accurate method to estimate total energy intake in children aged 4 to 11 years, compared to total energy expenditure measured by DLW (Burrows et al., 2010). In contrast to this another review concluded that FFQ's were the best method with which to capture intake in children aged 9 months to 11 years (Olukotun and Seal, 2015). However there are many factors that need to be considered prior to choosing an appropriate method, these include, age, cognitive ability, respondent burden, validity and reliability and research objectives (Magarey et al., 2011). These factors vary from study to study and what may be appropriate for one study may not be for another. The primary objective in obtaining an accurate measurement of child fruit and vegetable intake is to select a method that is most suitable for the study design and population in addition to one that has maximum validity and reliability (Collins et al., 2009).

There are a number of dietary assessment tools which are designed to capture dietary intake and fruit and vegetable consumption in children, however many are targeted towards older children with a higher cognitive ability (Foster and Adamson, 2014). There are other short assessment methods that have been deemed useful for quick and easy assessment, yet are still susceptible to validity and reliability bias with further detailed assessments recommended (Golley et al., 2017).

Given the expanse of dietary assessment methods available and numerous factors to consider when deciding which would be fit for purpose, there is a need for further guidance. The National Institute for Health Research and Medical Research Council have developed the Diet, Anthropometry and Physical Activity Measurement Toolkit. The diet element of this toolkit is freely available to researchers and public health practitioners as a guide to help chose an appropriate assessment method. It does not advocate the use of an individual method or instrument, but does provide further information on appropriateness of a variety of methods, depending upon the context in which

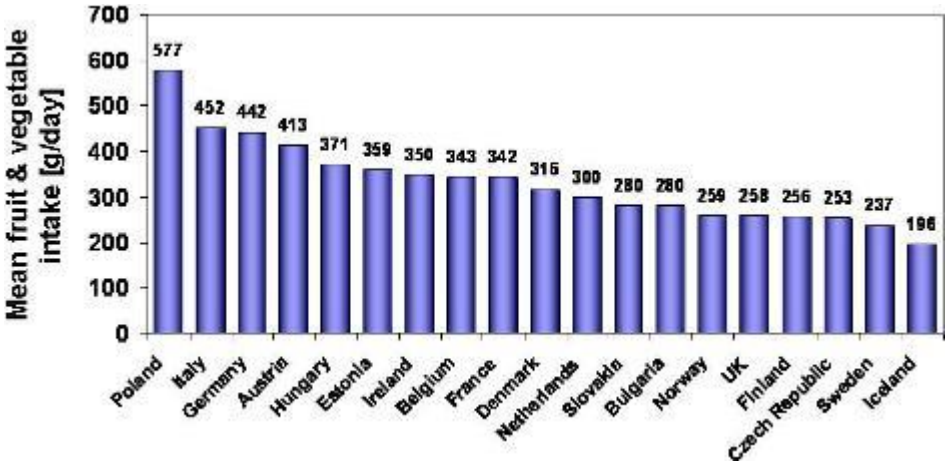
the dietary information is needed. A recent review of dietary assessment tools suggested using this tool in order to collecting the highest quality dietary data possible (Dao et al., 2019).

1.3 Prevalence of meeting recommendations

1.3.1 Adults

In 2008, European data suggested that in the UK adults were consuming on average, 258 g of fruits and vegetables per day, which when compared to other countries is relatively low, as depicted in Fig 1. Only adults in Poland, Germany, Italy and Austria were meeting recommendations of 400 g or more per day (European Food Safety Authority, 2008). The WHO estimates that over 50% of European countries are not meeting their national recommended daily targets and in one third of these countries levels drop to less than 300 mg per day (World Health Organization, 2006)

Figure 1: Mean fruit and vegetable consumption across Europe



Source: (European Food Safety Authority, 2008)

Results from the UK 2014 Health Survey for England show that between the years of 2001 and 2006, the proportion of men and women meeting recommendations increased to approximately 28% and 32% respectively. However since 2006 levels have decreased, ranging between 24-25% for men and between 27-29% for women. Adults between the ages of 19 to 64 were consuming an average of 4.1 portions per day and those that were 65 years or older consumed a slightly higher 4.6 portions (Department of Health and Social Care, 2014).

1.3.2 Children

Despite the beneficial effects of a diet high in fruit and vegetables, evidence suggests that children are not meeting recommendations (Wolfenden et al., 2012). Gender trends in the UK appear to mirror those in both international and European countries, with girls having a higher consumption than that of boys (Bere et al., 2008, Vereecken et al., 2015). However, in some countries survey data revealed that this trend was apparent for vegetable consumption only (Lynch et al., 2014). The 2014 Health Survey for England (HSE) indicated that on average girls were consuming 3.1 portions and boys 2.8 portions per day, with less than 20% of children meeting the recommended 5 portions per day (Department of Health and Social Care, 2014). Consumption levels appeared to be increasing in 2005; however, since 2010 levels have again dropped. Similar patterns have also been identified in other countries including Canada, USA and Greece (Attorp et al., 2014, Lorson et al., 2009, Manios et al., 2009).

1.4 SES markers and their effect on fruit and vegetable consumption

There is an abundance of evidence which demonstrates that socio-economic status plays an important role in the diet of adults (Darmon and Drewnowski, 2008, Jack et al., 2013, Maguire and Monsivais, 2015, Shahar et al., 2005). However, limited evidence exists which supports this relationship for children (Attorp et al., 2014). It may be said that such inequalities are transferable from adults to children, given that children generally live at home with a parent or guardian. In many cases this has been shown to be true, yet in some cases the scale of impact has shown to be much smaller than that which exists in adults (De Bourdeaudhuij et al., 2008, Giskes et al., 2002, Temple et al., 2006). However, findings from a review in children and adolescents which included 46 studies and examined the influence of socioeconomic position and consumption, presented an association between low SES status and a low or less frequent intake of fruit and vegetables (Rasmussen et al., 2006). However three studies in this review observed the highest or most frequent intake of fruits and vegetables amongst those groups of lower SES. Reflecting on findings, authors concluded that these contradictions were due to methodological bias, namely the use of multiple measurement techniques to define and report SES and recruitment of non-representative samples, giving rise to selection bias (Rasmussen et al., 2006).

1.4.1 Household income

Evidence suggests that those living in greatest poverty consume fewer fruits and vegetables than those living in the least (Giskes et al., 2002, Hosseinpoor et al., 2012, Laaksonen et al., 2003). The behavioral risk factor surveillance survey carried out in the USA in 2009 indicated that 21.3% of adults living in greatest poverty were consuming vegetables at least three times per day compared to 30.7% of those living in the least (Grimm et al., 2012). Similar patterns were also reported for fruit intake (Grimm et al., 2012). In the UK, adults from households that had lower incomes were shown to be less likely to meet fruit and vegetable recommendedations than those with higher incomes (NHS Digital, 2014). Average portions of friut and vegetables consumed per day declined with income, with 4.1 portions being consumed in the highest income quintile and 3 portions in the lowest (Department of Health and Social Care, 2014). A similar inverse association emerged for children with the highest reported average being 3.7 portions for those falling into the highest quintile (Department of Health and Social Care, 2014). Family income was deemed the most influential determinant in a review of children and adolescents which found positive associations in seven out of 14 papers reviewed (Rasmussen et al., 2006).

1.4.2 Deprivation

Foods deemed to be healthy such as fruits and vegetables have been found to be less abundant in areas of social disadvantage (Pessoa et al., 2015). A number of large scale, cross sectional studies found strong associations between deprivation and consumption of fruits and vegetables (Hawkesworth et al., 2017, Shohaimi et al., 2004). In the UK, the Health Survey for England revealed that consumption declined with declining Indices of multiple deprivation (IMD) scores. IMD scores are the official measure of relative deprivation for small areas (known as super lower output areas (SLOA)) or neighbourhoods in England (Department for Communities and Local Government, 2010). Only 22% of adults living in the in the least deprived quintile were meeting recommendations, compared to 29% living in the highest (Department of Health and Social Care, 2014). As with household income the trend in consumption was similar for children, with those children in the least deprived quintiles consuming an average of 3.2 portions of

fruit and vegetables compared with those in the most deprived who were consuming less than 3 portions (Department of Health and Social Care, 2014).

1.5 The role of fruits and vegetables in disease prevention and health

Consumed in sufficient amounts, fruits and vegetables play an important role in the maintenance of a healthy diet (Alissa and Ferns, 2017). Fruits and vegetables have a high vitamin, mineral and fibre content which help protect against a number of cardiovascular diseases, promote immunity and cell growth and encourage good digestive health (Kushi et al., 2012). In addition to their disease fighting properties fruits and vegetables are essential in supporting a healthy body weight as they are generally low in fat, sugar and salt (Slavin and Lloyd, 2012).

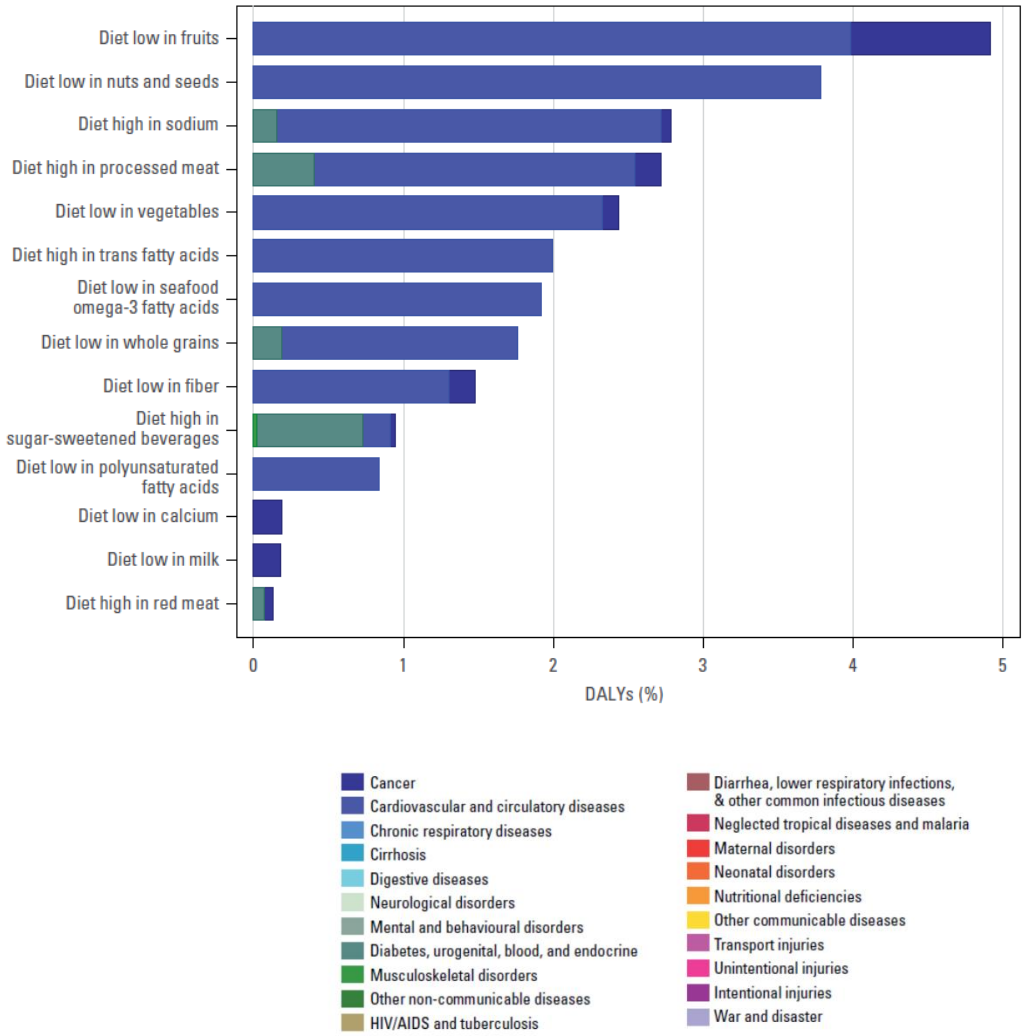
Fruits and vegetables contain naturally occurring sugars as opposed to “free” or “added” sugars (both monosaccharides and disaccharides). These are defined as being added to foods by the manufacturer, cook, or consumer, plus sugars naturally present in honey, syrups, and fruit juices (World Health Organization, 2015). Globally, food labelling often refers to “total” sugars which are comprised of naturally occurring, free and added sugars, regardless of source (Mela and Woolner, 2018).

Low fruit and vegetable consumption is commonly linked with increased mortality and morbidity, leading to a rise in non-communicable diseases such as heart disease, stroke and cancer and associated health complications (Nguyen et al., 2016). In 2013 the WHO estimated that inadequate intake was responsible for approximately 5.2 million deaths worldwide (World Health Organization, 2013). Having a reduced consumption was also rated as being amongst one of the top 10 risk factors for premature death. Secondary analysis of Health Survey for England data carried out in 2014 found a clear inverse association between fruit and vegetable consumption and risk of all cause, cancer and cardiovascular mortality (Oyebode et al., 2014).

It has been reported that approximately 16 million disability adjusted life years (DALYs, a measure of the potential life lost due to premature mortality and the years of productive life lost due to disability) and 1.7 million deaths worldwide are attributable to low fruit and vegetable consumption (World Health Organization,

2013). In the USA, the Institute for Metrics and Evaluation reported that in 2010 dietary risks factors were the primary cause of morbidity, being responsible for a higher health loss that that of smoking, high blood pressure and high blood sugar (Global Health Data Exchange, 2010). Attributable dietary risk factors included consuming less than 3 portions of fruit (11 oz) and 4 portions of vegetables (14 oz) per day (Global Health Data Exchange, 2010). Figure 2 shows that diets low in fruits and vegetables were recorded as the leading cause of premature death and disability compared to other dietary risk factors such as those high in sodium, processed meat and low in fibre (Global Health Data Exchange, 2010).

Figure 2: Percent of Disability-Adjusted Life Years (DALYs) attributable to the 14 dietary risk factors in men and women of all ages, in the USA, 2010



Note: The size of each colored portion of the bars represents the number of DALYs from a particular cause attributable to a given risk factor. DALYs from each risk factor should not be added together.

Source: (Global Health Data Exchange, 2010)

1.6 Low fruit and vegetable intake and chronic disease

The relationship between fruit and vegetable intake and chronic disease has been well documented (Miller et al., 2017, Wang et al., 2014). Links have been commonly reported with cardiovascular diseases, various cancers and obesity (Farvid et al., 2018, Russo et al., 2018, Yu et al., 2018, Zhan et al., 2017). Examples of evidence supporting these links will now be presented.

1.6.1 Cardiovascular diseases

1.6.1.1 Coronary heart disease

The protective effect of fruits and vegetables on coronary heart disease has been reported in a number of epidemiological studies (Nikolic et al., 2008, Yu et al., 2014). A recent review observed non-linear associations for both fruits and vegetables, with optimal reductions in risk seen at the lower levels of intake. There was a 21% reduction in relative risk up to 750 – 800 g per day for fruits and a 30% reduction in relative risk up to 550 – 600 g per day for vegetables (Aune et al., 2017). Although the amounts required to initiate positive effects remain ambiguous, a meta-analysis of 13 cohorts involving approximately 270,000 participants found that individuals consuming five or more serves per day compared to those consuming less than three serves per day had an increased reduction of 17% more in disease risk (He et al., 2006).

Similarly, another review including 469,551 participants reported average reductions in coronary heart disease mortality of 4% for fruits and vegetables combined, 4% for vegetables alone and 5% fruits alone (Wang et al., 2014). On a global scale, heart disease is said to be responsible for 7.6 million deaths worldwide, of which 1.8 million are due to low fruit and vegetable consumption (World Health Organization, 2013). It has also been reported that increasing fruit and vegetable consumption by one daily serve would reduce the risk of coronary heart disease by an average of 10% (Lock et al., 2005). A more recent Cochrane review concluded that although evidence suggests that an increase in fruit and vegetable consumption would have beneficial effects, studies were mixed with some advising consumption of at least five per day, whereas other suggested that this should be at least eight or nine portions (Hartley et al., 2013).

1.6.1.2 Stroke

A diet rich in fruits and vegetables is believed to have a protective effect against incidence of stroke (He et al., 2006). A meta-analyses of pooled prospective cohort studies involving over 760,000 participants showed that the risk of stroke decreased by 32% and 11% for every 200 g per day increment in fruits and vegetables respectively (Hu et al., 2014). Furthermore, an earlier review analysing nine cohorts of over 255,000 participants showed that those participants who were consuming three to five servings of fruits and vegetables per day and those consuming more than five servings per day (compared to those having less than three a day) had a relative risk of stroke of 0.89 and 0.74 respectively (Hu et al., 2014). According to the WHO, increasing an individual's fruit and vegetable consumption to more than 600 g per day could potentially reduce the incidence of ischemic stroke by 19% worldwide and on a European scale between 10 – 15% (World Health Organization, 2004).

1.6.2 Cancer

There is an abundance of evidence available which investigates the link between fruit and vegetable consumption and cancer (Farvid et al., 2018, Löf et al., 2011, Oyebode et al., 2014, Wang et al., 2014). However, establishing the impact of effectiveness can prove difficult, primarily due to confounding factors such as alcohol, smoking and other dietary factors (Aune et al., 2017, Key, 2011). In addition to this, many studies have been proven to be methodologically flawed with exaggerated outcomes (Leenders et al., 2015). A report produced by the World Cancer Research Fund (WCRF) in collaboration with the American Institute originally published in 1997 and updated in 2007 'Food, Nutrition and the Prevention of Cancer: a global perspective' has been widely drawn upon (World Cancer Research Fund, 2007). The report reviews evidence in relation to fruit and vegetable consumption and the effect on various cancers in a systematic and transparent way. This was performed in discussion with experts in the field, classifying research into categories such as 'convincing' and 'limited' based upon factors such as methodological quality and sample size. Strength of associations were based upon meta-analyses and cancers such as oesophagus, lung, stomach and mouth were deemed to be 'probable', whereas associations for colorectal, liver and pancreas were highlighted as being 'limited – suggestive' (World Cancer Research Fund, 2007). The cost of fruit and vegetable attributable

cancers is estimated to be 42 million worldwide (World Health Organization, 2013).

1.6.3 Weight management and obesity

There is little substantive evidence which supports a direct relationship between weight and fruit and vegetable consumption. The majority of studies report on fruit and vegetables as a secondary effect in studies whose primary outcome relates to other chronic diseases (some of which have already been discussed) such as heart disease and cancer. However there are a number of studies that document an inverse relationship between fruit and vegetable intake and weight management (Bertoia et al., 2015, Heo et al., 2011, Schwingshackl et al., 2015). A review of 17 cohort studies including over 563,000 adults concluded that a higher consumption of fruits was associated with reduction in waist circumference of -0.04 cm/year (Schwingshackl et al., 2015). Conversely, other reviews have found no or very little association between intake and weight and summarise evidence as being poor due to small sample size amongst studies as well as being methodologically weak which make inferences difficult to make (Ledoux et al., 2011, Mytton et al., 2014). Associations are often thought to be unclear, and it has been stated that diet alone cannot be held entirely responsible for weight loss (Kaiser et al., 2014). An increase in fruit and vegetable consumption, coupled with a reduction in overall energy intake and an increase in physical activity has been shown to provide the largest reduction in weight (Champagne et al., 2011).

1.6.4 Childhood obesity

Globally it has been estimated that in excess of 41 million children under the age of five years are either overweight or obese (World Health Organization, 2017). However, there is evidence which indicates that a plateau effect is emerging in some high income countries yet this has risen in the east, south and Southeast Asia (Abarca-Gómez et al., 2017). Although this evidence is seemingly promising there appears to be no indication of a reversal effect with regard to the obesity epidemic and levels remain high enough to pose significant threats on population health (Abarca-Gómez et al., 2017, Lobstein et al., 2015, Wabitsch et al., 2014). In the UK, approximately a quarter of reception aged children (4-5 years) are overweight on school entry, with this percentage having risen from 9.3% in 2015/16 to 9.6% in 2016/17 (Public Health England, 2018b). Furthermore

longitudinal evidence from the UK suggests that children are now three times more likely to become overweight than forty years ago and are highly likely to become overweight or obese adults (Johnson et al., 2015b).

As with adults, holistic approaches to weight loss are also seen to be successful in the treatment of childhood overweight and obesity (Mead et al., 2017). However, in younger age groups evidence is minimal with a recent systematic review including only 7 studies, from which no firm conclusions could be drawn due to poor quality of the research (Colquitt et al., 2016).

1.7 Why young children are an important target for promoting fruit and vegetable consumption.

Early childhood is an important time in life when healthy habits are formed and dietary-related behavioural risk factors develop (Savage et al., 2007). The early years environment, whether at home, pre-school or other forms of day care provide a platform for intervention to be delivered to promote and embed healthy behaviours. Therefore this crucial 'window of time' within a child's life becomes an ideal point at which to intervene. However evidence on interventions aimed at increasing fruit and vegetable consumption in this age group is somewhat sparse in comparison to adults and older children (Colquitt et al., 2016). In order to develop interventions which are successful, it becomes important to understand the factors which surround energy balance related behaviours in children.

1.8 Considering the determinants of fruit and vegetable consumption in young children

There are a number of reviews that aim to assess evidence in relation to the determinants associated with fruit and vegetable consumption in children (Blanchette and Brug, 2005, Cook et al., 2014, Di Noia and Byrd-Bredbenner, 2014, Ong et al., 2016, Rasmussen et al., 2006). However much of this evidence relates to children of school age or higher, with reviews and studies, particularly those of a longitudinal design, in pre-school children being sparse (Hodder et al., 2018). The majority of evidence reported for younger children is cross-sectional and there have been associations reported for various determinants which include; age, gender, food preference, neophobia and parental factors such as maternal age, SES, ethnicity, feeding practices, provision and modelling of fruit

and vegetable behaviours (Mittmann, 2014, Blissett, 2011, Pearson et al., 2009, Rasmussen et al., 2006, Campbell and Crawford, 2001). Determinants are discussed in greater detail below.

1.8.1 Age

Data relating to fruit and vegetable consumption and age is relatively inconclusive. However there is evidence to suggest that intake generally decreases with age and a number of studies conclude that the decline in consumption occurs before the age of 7 years (Albani et al., 2018, Kim et al., 2014). A review which included 98 studies, of which 22 reported associations with age, found that ten of these studies found an inverse association, whilst nine papers showed that there was no association evident (Rasmussen et al., 2006). Similar results have been shown in a cohort study carried out in 2009 which concluded that more then half the children aged 2-5 years (from a cohort of over 6,000) were meeting recommended daily guidelines for fruit in comparison to only 26% of 6-11 year olds (Lorson et al., 2009). A similar pattern was seen for vegetable consumption with 22% of 2-5 year olds meeting guidelines, yet for 6-11 year olds it was approximately 16% (Lorson et al., 2009).

In contrast, another review found that age was not associated with fruit and vegetable consumption in 11 of the 15 included studies (Di Noia and Byrd-Bredbenner, 2014). However, these results must be interpreted with caution as much of this evidence pertains to studies that were carried out in the USA where free fruit and vegetable schemes exist for young children. These schemes generally stop when the child reaches school age (approximately 6 years) and this could potentially be considered a potential confounding factor associated with a decline in consumption (Kim et al., 2014). In the review which found no association with age (Di Noia and Byrd-Bredbenner, 2014), it was also stated that results were aggregated for those studies examining one or more determinant, for example fruit, fruit juice and vegetables. Combining results in this way may lead to inaccurate reporting of results and aggregation error is believed to occur frequently in health related research (Kaplan et al., 2014).

There were a range of methodological flaws within studies which were often noted as limitations and could also potentially effect results, leading to multiple incidences of study bias including the use of; small sample sizes, non-representative samples, cross sectional designs, lack of theoretical underpinning, reliance on self-report measures and unreliable measurement tools (Di Noia and Byrd-Bredbenner, 2014, Kim et al., 2014, Rasmussen et al., 2006).

1.8.2 Gender

Similar to age, evidence in relation to gender is questionable. The review by Rasmussen et al. (2006) reviewed 49 studies asessing gender differences in fruit and vegetable consumption (Rasmussen et al., 2006). Twenty-seven of these studies concluded that girls were more likely to consume a higher or more frequent intake of fruit and/or vegetables than boys. Only four studies observed a higher intake in boys and 18 did not see any gender difference. However, differences apperared to differ depending upon region. Only one third of included studies carried out in the USA found a difference in intake among boys and girls, whereas 14 of the 17 (over 80%) European studies identified a gender difference (Rasmussen et al., 2006). Therefore country of origin may be responsible or attributed to any associated changes rather than gender. Conversely, in another review, no association between gender and consumption was found in 11 out of 13 studies which were all carried out in the USA (Di Noia and Byrd-Bredbenner, 2014). However, there have been a number of European studies that have reported a higher consumption in girls than boys, yet this has only been observed in children of school age and higher (Bere et al., 2008, Currie et al., 2008).

1.8.3 Food preference and neophobia

There is evidence that food preference is initiated before a child is born. In utero transmission of flavours from mother to child are thought to play a role in food preference as does the introduction of milk and eventually, solid food (Mennella and Bobowski, 2016). It has been established that humans have an innate predisposition for sweet and salty tastes and an aversion to bitter or sour tastes (Davison and Birch, 2001, Wardle and Cooke, 2008); however, the extent to which individuals accept these tastes is thought to differ depending upon genetic variability (Drewnowski, 2001). Food preference develops from a combination of

both genetic and learned behaviour and has been shown to track through into adolescence and adulthood (Finnane et al., 2017). The review by Rasmussen et al*.* (2006), included 11 papers which assessed the influence of food preference on fruit and vegetable consumption and a positive association was found in all of these studies (Rasmussen et al., 2006). Given that likes and dislikes are somewhat modifiable, repeated exposure has the potential to reinforce acceptance and subsequently preference for specific foods (Appleton et al., 2018, Mela, 2006, Mennella and Bobowski, 2016, Cooke et al., 2006). A recent review supports the idea of repeated exposure in increasing child fruit and vegetable consumption and advocates that both caregivers and practitioners should expose young children to a variety of healthy foods from a very early age, including the prenatal period, early milk-feeding and the introduction to complementary foods, which have all been shown to have the potential to assist with acceptance (Anzman-Frasca et al., 2018).

The development of neophobic tendencies have been well documented as having an influence on fruit and vegetable consumption and are decsribed as an avoidance or reluctance to taste unfamiliar foods (Birch and Fisher, 1998, Cooke et al., 2006, Kral, 2018). Neophobia is believed to develop around the ages of 20-24 months which coincides with cognitive growth when children attempt to categorise foods and make decisions on whether theyA are safe to consume (Harris, 2008). This developmental stage leads children to choose foods with which they are familiar (Wardle et al., 2003). This initial rejection of an unfamiliar food causes parents distress and can result in them limiting, or even omitting, the rejected food from the diet altogether. However, studies have shown that a child needs to be exposed to a food around 10 – 15 times before it is accepted (Birch et al., 1987, Birch et al., 1990). Neophobia is usually associated with a lower consumption of fruit and vegetables (Cooke et al., 2006) and an increase in exposure to high fat, high sugar foods (Liem and Mennella, 2002). An increase in sugary foods then leads to an increase in preference for them (Liem and de Graaf, 2004). Studies have also shown that if a child is able to choose freely from a large variety of food, they will choose those that are of little nutritional value (energy dense foods), if they have previously been exposed to these as opposed to healthier alternatives (Birch, 1992, Klesges et al., 1991, Marty et al., 2018). Encouraging parents and caregivers to increase exposure to fruit and vegetables

has been shown to improve consumption and reduce neophobia (Howard et al., 2012, Wardle et al., 2003).

1.8.4 Parental fruit and vegetable consumption

Positive associations between parental and child consumption are apparent in the literature (Pearson et al., 2009, Wyse et al., 2011). A review found that eight out of nine studies observed a positive association and that this association increased further in those homes where fruit and vegetables were freely available (Rasmussen et al., 2006). However, in another review, only maternal, and not paternal, consumption was consistently associated with child consumption (Di Noia and Byrd-Bredbenner, 2014). The majority of evidence is stated as being drawn is from studies in older children and adolescents and it's transferibility to younger populations is therefore questionable (Blanchette and Brug, 2005, Wyse et al., 2011). Moreover, it becomes difficult to make true assumptions in relation to these findings as the variation in data collection tools used and self-report methods may have introduced bias. Parental food preference has also been shown to impact upon decisions made on whether or not to provide fruit and vegetables to their children (Cooke et al., 2003a, Mittmann, 2014). The Framingham study which was carried out in 1992 revealed that parental eating habits and preferences had a direct influence on their pre-school child's diet (Oliveria et al., 1992).

1.8.5 Provision (availability and accessibility)

1.8.5.1 Parental provision

Having fruit and vegetables on offer and freely available in the home has been shown to be associated with an increase in child consumption in a number of reviews (Di Noia and Byrd-Bredbenner, 2014, Krølner et al., 2011, Rasmussen et al., 2006). In a large cross sectional survey including over 1,300 children results showed that children whose parents offered them fruit and vegetables daily and who took fruit and vegetables to school ate significantly more than those children who did not (Mittmann, 2014). This was mirrored in another survey of 396 children aged 3-5 years. Multiple regression analysis found positive associations between child fruit and vegetable consumption, availability ($p=0.006$) and accessibility ($p<0.012$) and also the number of occasions per day that parents provided their child with fruits and vegetables ($p=0.006$) (Wyse et al.,

2011). Rasmussen et al (2006) identified three studies that found positive associations between availability and consumption; however, one of these papers identified an association for girls only (Rasmussen et al., 2006). An earlier review in children over 6 years of age observed similar positive correlations after assessing evidence in four studies (Blanchette and Brug, 2005). There is also evidence to show that availability and accessibility interact with a number of other determinants of consumption such as exposure. For example, when fruits and vegetables are not on offer or accessible then exposure is compromised, which in turn can lead to a low preference for those fruits and vegetables that are offered less frequently (Fisher and Birch, 1999, van der Horst et al., 2007). In addition to this, setting has been shown to have an impact on consumption. For example the review by Rasmussen et al (2006) did not find any association with consumption and fruits and vegetables offered within the school setting, only within the home environment (Rasmussen et al., 2006).

1.8.5.2 Provision from others

Young children are cared for by a number of people who are not their parents including grandparents, friends and other family members. These carers can all potentially have impact upon the amount of fruits and vegetables that children consume yet there is very little evidence in this area. However, recent qualitative evidence has explored parental views on the impact which others have on their child's consumption, with results indicating that grandparents have a tendency to provide unhealthy foods as opposed to fruits and vegetables (Nepper and Chai, 2017).

1.8.6 Modelling

1.8.6.1 Parental Modelling

There is a large body of evidence which suggests that there is a strong association between parental role modelling and child fruit and vegetable consumption (Anzman-Frasca et al., 2018, Di Noia and Byrd-Bredbenner, 2014, Hodder et al., 2018, Mittmann, 2014). Young children who observe their parents consuming healthy foods such as fruits and vegetables are more likely to mimic and adopt such behaviours themselves (De Bourdeaudhuij et al., 2008, Reinaerts et al., 2007). However, in some studies evidence is stronger for mothers and more significant for girls rather than boys (Kristjansdottir et al., 2006). Reasoning

for this may be that there is limited research available to assess modelling impact in fathers at this early age. It is somewhat likely that mothers spend more time with their children in infancy than fathers as it is predominantly the mother who takes leave from work to raise children. Hence mother/child populations and their behaviours have been easier to study because they are more accessible than fathers. In addition to this it is suggested that the impact reported in girls is higher than boys as mothers potentially spend more time with daughters than they do with sons (Baker, 2016). Yet, there are some studies which failed to find any association between parental role modelling and child fruit and vegetable consumption (Matheson et al., 2006) and others which suggest that various measurement methods amongst studies such as parental and child reporting could be responsible for outcomes rather than direct effect (Bauer et al., 2011, Palfreyman et al., 2014). Despite this, parental modelling remains an important determinant which has proven to be targetted with success in intervention delivery to increase fruit and vegetable consumption in this age group (Holley et al., 2017).

1.8.6.2 Peer Modelling

There is limited evidence in this age group to support peer modelling of fruit and vegetable behaviour. However, experimental studies show that children are much more likely to eat fruits and/or vegetables if they observe their peers doing the same (Birch et al., 1990, Cooke et al., 2006). Although peers can be used as positive role models, there are also reports of strong associations for negative behaviour. If a child observes another rejecting fruits and vegetables then this has been shown to overide any positive modelling that may have previously taken place (Greenhalgh et al., 2009).

1.8.7 Feeding practices and styles

Parental feeding practices are behaviours which parents adopt that may be used to control how much, what, when and where a child eats (Ventura and Birch, 2008). A recent Cochrane systematic review found evidence that interventions that focus on improving feeding practices are successful in increasing fruit and vegetable consumption in children under the age of 5 years (Hodder et al., 2018). However, this evidence was deemed to be of low quality and that effect size was small with long term follow-up needed. Parents are often under the assumption

that if they restrict certain foods (for example, those high in sugar and fat) and do not allow their child access to them then this will prevent consumption and increase their preference for more healthy alternatives. However, evidence suggests that children are much more likely to desire a particular food if they are forbidden to eat it and they will be less likely to regulate intake of unhealthy alternatives in later life (Benton, 2004). Feeding styles which appear to have a positive response on encouraging consumption of fruits and vegetables are those which are described as authoritative. An authoritative feeding style is characterised by one which exhibits clear rules, yet provides explanation and warmth to the child and has shown to provide significant results in terms of increasing fruit and vegetable consumption in comparison to a more forceful/authoritarian style (Hughes et al., 2016, Rodgers et al., 2013). Cross-sectional evidence supports these findings and also advocates the use of structured mealtime practices such as eating as a family, allowing a child to serve themselves fruits and vegetables at mealtimes and eating at consistent times (Finnane et al., 2017, Wyse et al., 2011).

Encouraging children to eat fruits and vegetables can prove difficult and often parents report using food as a reward to persuade their child to eat. However, at times the foods that they reward the child with are high in sugar and fat. This includes foods which are deemed to be a ‘treat’ such as ice cream and sweets which are sometimes held back by parents as a means of punishment if children do not eat the fruit and vegetables they are provided with. There is evidence that this type of parental behaviour is confusing to a young child and more often than not, undermines the establishment of healthy eating behaviours (Hendrie et al., 2017, Lively et al., 2017, O'Connell et al., 2012).

1.9 Tackling low fruit and vegetable consumption through behaviour change

There are a number of measures in place which aim to increase population fruit and vegetable consumption. These include improving food and agricultural systems, price incentivisation, reducing the costs of fruits and vegetables, encouraging gardening and agricultural programmes and implementation of behaviour change interventions to increase intake (Rakotoniaina, 2018). There are a number of behaviour change interventions, particularly in children which

aim to increase fruit and vegetable consumption. The effectiveness of such interventions are variable, depending upon a number of other determinants which may also effect intake. These factors may be non-modifiable such as age and sex, whereas others are modifiable such as diet and are targeted in interventions. Several systematic reviews have been carried out to evaluate the effectiveness of behaviour change interventions aimed at increasing fruit and vegetable intake in children (Knowlden and Sharma, 2012, Nekitsing et al., 2018, Wolfenden et al., 2012). However, evidence is limited, particularly for younger children. Although more studies are beginning to emerge, many are reported as being methodologically weak with small sample sizes making data inferences somewhat ambiguous (Hodder et al., 2018).

1.9.1 An introduction to behaviour change theory and commonly used approaches in public health

Theories aimed at changing behaviour are used as a means to explore and understand why behaviours change. Within public health they are often used to inform the design and delivery of interventions, and those that are deemed most successful are those which are underpinned by theory (Abraham et al., 2009, Cerin et al., 2009). Guidance exists which describes how health behaviour change interventions can be effectively embedded within research and practice (National Institute for Health and Care Excellence, 2014a). Therefore understanding behaviours and the context in which they occur is paramount to successful intervention design and delivery. Alone, behavioural theories cannot directly change behaviour but can inform researchers, policy makers and implementers who are wanting to instigate change about the factors to consider in doing so.

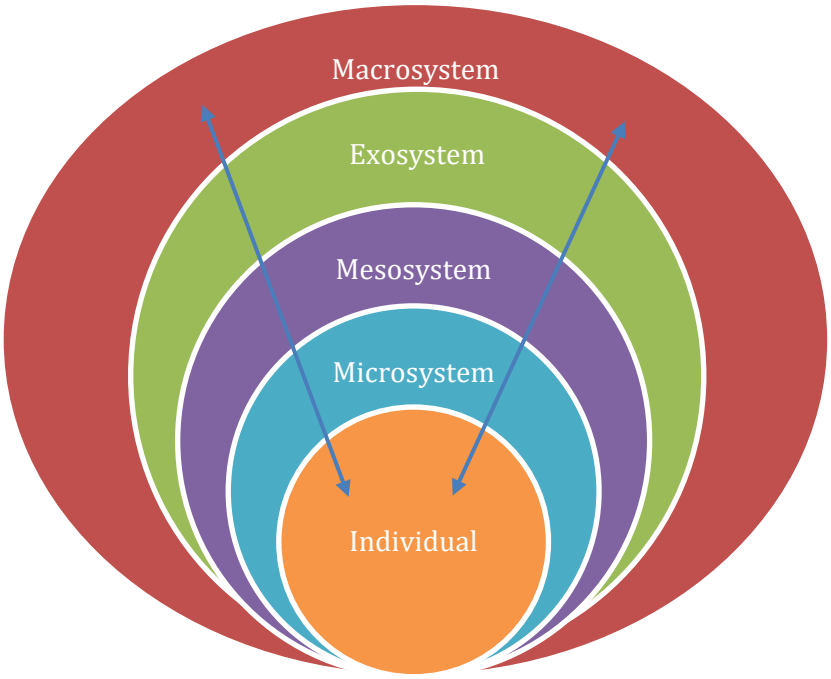
For the purpose of understanding health related behaviours and in particular, the barriers and facilitators to these behaviours, there are a number of models, underpinned by theory, that have been developed. These models allow researchers and practitioners to establish reasoning for particular public health problems and more importantly assist in the development of interventions to address these problems (Public Health England, 2018a). Therefore knowing what factors and in what circumstances specific behaviours occur, can be key to successful implementation.

There are a number of theories that have been used for underpinning health behaviour interventions and initiatives including; the socio ecological model (SEM) (Hirsch et al., 2016, Odum et al., 2016, Quick et al., 2017), the social cognitive theory (Annesi and Mareno, 2017, McCabe et al., 2015, Stacey et al., 2015), the health belief model (Jones et al., 2015, Tavassoli et al., 2017), and the theory of reasoned action (McDermott et al., 2015, Sheppard et al., 1988). Reviews which have assessed the characteristics of successful interventions aimed to improve eating behaviours of pre-school aged children found that models frequently used, and most likely to be effective in this age group, included; the SEM and the social cognitive theory (SCT) or social learning theory (SLT) (Hodder et al., 2018, Matwiejczyk et al., 2018, Nixon et al., 2012). These models will now be discussed in greater detail.

1.9.1.1 The Socio-ecological Model (SEM)

The SEM was first introduced as a conceptual model for understanding human development by psychologist Urie Bronfenbrenner in the 1970s and over a decade later, formalised as a theory (Bronfenbrenner, 1977, Bronfenbrenner, 1989). The initial theory was characterised by a series of nesting circles representing various systems with which an individual interacts with (Figure 3).

Figure 3: Illustration of the socio-ecological model



Adapted from (Bronfenbrenner, 1989)

According to Bronfenbrenner the microsystem which is the closest to the individual, represents interactions that are considered the strongest and having the most influence over the individual. This could include close family members, siblings or partners. The mesosystem refers to those connections which are not immediate but which the individual come into direct contact with such as work environments, schools, neighbourhood groups etc. The exosystem is said to attribute both positive and negative influences on the individual but does not directly interact with them. For example this may include community groups and organisations. Finally, the macrosystem includes any additional outside influences on the individual, for example any cultural or religious norms and values (Bronfenbrenner, 1989).

The model has since been further developed and is used frequently to understand health behaviour in a variety contexts (Marlier et al., 2015, Martin-Biggers et al., 2018, Pearson et al., 2017, Ssewanyana et al., 2018). Application of the model to guide interventions and policy development to increase fruit and vegetable consumption has proven to be an area of research interest (Graziose and Ang, 2018, Odum et al., 2016, Richard et al., 2011). The updated and adapted version of the model for health related purposes is comprised of the

following: individual, interpersonal, community, organizational, and policy/enabling environment (Figure 4). The most effective interventions are said to be those which are all encompassing and use a combination of actions which are targeted at all levels of the model (Wold and Mittelmark, 2018).

Figure 4: Adapted socio-ecological model for health

Adapted from (Jepeal et al., 2014)

The SEM is an approach which accepts that considering individual level behaviours is not sufficient to understand public health issues which can be extremely complex. It provides a holistic approach to capturing behavioural influences at a variety of levels. In considering interaction of these influences on behaviour, facilitates understanding and the ability to gauge impact on health outcomes (Robinson, 2008).

As stated previously, there are various adaptations of the model for use within a variety of settings and the levels of influence, depending upon the context in which it is used may be described differently. Levels of influence for application within a public health context (as outlined by (United Nations Childrens Emergency Fund (UNICEF), 2017)) are described and examples in terms of fruit and vegetable promotion provided for each:

1. Individual: An individual's various traits and identities make up this level of the Social Ecological Model. These characteristics have the capacity to influence how a person behaves. Age, gender, education level, and economic status are some examples. These factors are important to consider when constructing public health strategies, as characteristics such as socio economic status are linked to an individual's ability to access fruits and vegetables.

2. Interpersonal: Key players at an interpersonal stage may include relatives, friends and all those people that they have formed a close social relationship or network with. Interventions involving family members to promote healthy eating or discourage unhealthy eating in the individual would draw on findings from this level of influence.

3. Community: This level of the model focuses on the networks between organisations and institutions that make up the greater community. These associations include businesses and functions of the "built environment," such as food establishments that may or may not promote consumption of fruit and vegetables. It is important to understand the community level to determine where health behaviours originate.

4. Organisational: Organisations play a pivotal role in the development of behaviours as they can sometimes impose rules and regulations. For example a school may promote the consumption healthy foods by only allowing fruit to be eaten during break times rather than unhealthy alternatives.

5. Public policy: Policies and laws that are instigated at local, national and global levels are the influences that have the furthest reach within the SEM. These policies are important as they have the potential to impact at a population level. For example, the UK government's levy on soft drinks to reduce sugar and address child obesity levels. Taxation on unhealthy food and drink makes healthier alternatives (fruits and vegetables) more affordable.

The SEM provides a useful framework for achieving a better understanding of the multiple factors including barriers and facilitators that may potentially impact on dietary behaviours (Robinson, 2008). However there are implications for its use. The SEM is predominantly used at an individual and intrapersonal level and therefore ambiguity surrounds its application at a wider environmental level (Golden and Earp, 2012). Additionally, the model helps highlight what factors contribute to changes in behaviour, but it does not indicate to what extent these factors are having an impact. Application within community programmes and larger populations has proven to be costly and labour intensive in terms of maintaining close coordination between groups and individuals at varying levels of influence (Wold and Mittelmark, 2018). It also does not allow for explanation and description of interactions between multilevel components, which could result in incorrect assumptions being made (Diez Roux, 2004). This also makes it somewhat difficult to prioritise which issues to address and may result in ineffective intervention development.

1.9.1.2 The Social Cognitive Theory or Social Learning Theory

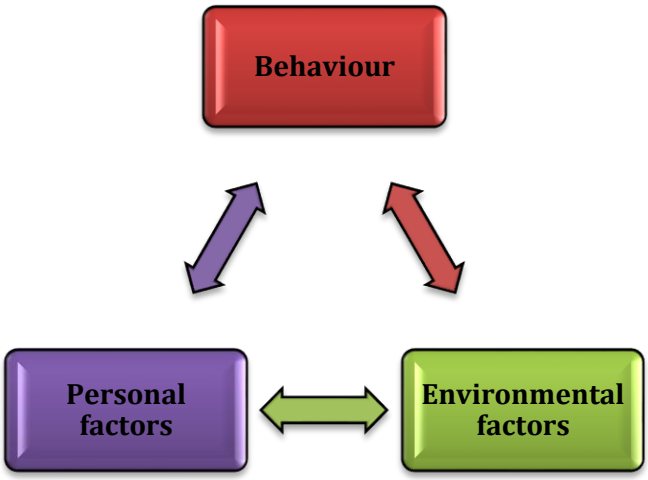
The Social Cognitive Theory (SCT) was first presented as the Social Learning Theory (SLT) in the 1960s by Albert Bandura (Bandura and Walters, 1963). Over two decades later it was further developed into the SCT which depicts the influence of an individual's experiences and environmental factors on behaviour (Bandura, 1986).This theory considers multilevel interactions and suggests that if you provide opportunity for social support through encouraging expectation, drawing upon self-efficacy and using observational learning and reinforcement that positive behaviour change can occur (Glanz, 2001, Nabi and Prestin, 2017). The primary purpose of the SCT is to explain why people engage in certain behaviours and to understand how people can regulate their behaviour through control and reinforcement in order to achieve goal-directed behaviour that can be maintained in the longer term (Bandura, 1998).

One issue which has arisen from behavioural intervention research is the lack of evidence to demonstrate long term effectiveness, in both the fields of treatment and prevention (Colquitt et al., 2016, Waters et al., 2011). The SCT, unlike some other models and theories, reflects on the maintenance of behaviour which is a key consideration when designing behaviour change interventions

(Kwasnicka et al., 2016). Maintenance is an important factor to consider as once positive changes have been made there is a need to sustain them.

The core concepts of this theory are explained by Bandura through a schematization of triadic reciprocal causation (Bandura, 1994). The schema shows how people acquire and maintain behaviour and how it is influenced by; the environment, personal characteristics and personal experience. Figure 5 represents this schema and highlights how the relationship between each is mutual.

Figure 5: Schematic representation of the social cognitive theory



Adapted from (Bandura, 1994)

The SCT is built on six assumptions, sometimes referred to as ‘constructs’. The first five stem from the original SLT and they are; reciprocal determinism, behavioural capability, observational learning, reinforcements and expectations. The sixth, self-efficacy was included at a later date following progression of the SCT. In thinking how these constructs might apply to an intervention aimed at increasing fruit and vegetable consumption (via caregiver provision of fruit and vegetables), a description for each is provided, along with a supporting example (Table 1).

Table 1: Description of SCT constructs and supporting examples

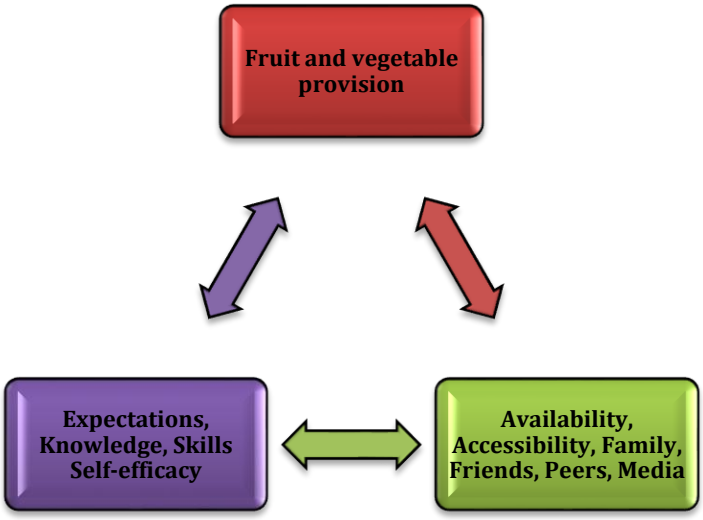
Construct	Description and example
Reciprocal determinism	This is the central concept of SCT (as depicted in the schema). This refers to the dynamic and reciprocal interaction of person (individual with a set of learned experiences), environment (external social context), and behaviour (responses to stimuli to achieve goals). This could refer to the interaction between a caregiver and their environment which may potentially result in provision of healthier food (i.e. fruit and vegetables).
Behavioural capability	This refers to a person's ability to perform a behaviour through essential knowledge and skills. In order to successfully perform a behaviour, a person must know what to do and how to do it. This may refer to the caregiver having the knowledge and skills that are necessary to prepare and provide fruits and vegetables for their child.
Observational Learning	This suggests that people can observe a behaviour asserted by others, and then mimic the behaviour themselves. This is often referred to as "behaviour modelling" Caregivers could watch a video or attend a class to show them how to prepare fruits and vegetables. They would then carry out this behaviour themselves, in turn increasing provision to children.
Reinforcements	This refers to the likelihood of a person continuing or discontinuing a particular behaviour. Reinforcements can be positive or negative. This may relate to the caregivers response to providing fruits and vegetables. For example a child may refuse to eat the fruit the caregiver has provided. This could result in the caregiver either refraining from serving that particular fruit again or motivate them to try serving it again, in hope that the child will eventually accept it.
Expectations	This refers to the anticipated consequences of a person's behaviour. It works on the premise that people anticipate the consequences of their actions before engaging in the behaviour. Expectations usually originate from previous experience and focus on the value that is placed on the outcome.

	The caregiver may have beliefs about the likely outcomes of providing fruits and vegetables to their child. i.e. It will lead to positive health outcomes for the child.
Self-efficacy	This refers to the level of a person's confidence in his or her ability to successfully perform a behaviour. It is influenced by a person's capabilities and environmental factors. This may relate to a caregivers ability to provide fruits and vegetables to their child.

Adapted from (Berlin et al., 2013)

In applying this within the context of fruit and vegetable provision, the schema may then be adapted and presented as depicted in Figure 6.

Figure 6: Application of the social cognitive theory to fruit and vegetable provision



Adapted from (Gaines and Turner, 2009)

Limitations of the SCT

There are several limitations of the SCT which should be considered when using this theory in public health. The theory itself does not determine how much impact each of the factors (within the schema) has on the behaviour. Difficulties then arise when determining which behavioural element may be best

targeted in order to achieve the best results (Carillo, 2010). There is also an assumption that if the environment is altered it will automatically result in a change to the individual, which in reality may or may not occur. As the theory also relies on the concept of learning it tends to dismiss those factors which occur due to an individual's biological make-up which may also influence a change in behaviour (LaMorte, 2018). Moreover, it has also been suggested that this theory does not consider emotion and its impact, therein missing important contributory factors to behaviour (LaMorte, 2018). Finally, as with other theories, applicability of all the constructs of SCT to one public health problem may be difficult especially in developing focused public health programs (Godin et al., 2008).

Given that behaviour takes place within different social environments it is not only necessary to consider individual factors but also other wider social influences. In addition to this any attempts to change behaviour must also account for these extrinsic factors to maximise chance of intervention success (Kwasnicka et al., 2016). Therefore selecting a behaviour change approach can prove tricky as some focus primarily on individual factors, which although are essential cannot account for all changes that occur. For example, interventions to improve dietary behaviours may focus on individual behavioural characteristics of those who would like to improve their eating habits but exclude thought for any extrinsic factors such as the influence of the food environment, other social influences and existing policy. However, this leads to the omission of factors that may be pivotal in driving the behaviour in question.

There is evidence which indicates that the effectiveness of a theory-based intervention may increase with the number of theories incorporated (Bluethmann et al., 2017). Considering the complexities in capturing all associated factors with a particular behaviour, it becomes necessary to contemplate other, more encompassing approaches. The theoretical domains framework is an approach which aims provide further scope to understand behaviour given that it has been designed to capture a multitude of behavioural theories. It was also designed with public health professionals in mind as a versatile and comprehensive tool that can be easily applied in practice (Michie et al., 2005).

1.9.2 A framework approach to behaviour change: The Theoretical Domains Framework (TDF)

The TDF was initially developed for implementation research to identify influences on health professionals behaviour related to implementation of evidence based recommendations (Michie et al., 2005). The framework is intended for use by non-psychologists to ensure theoretical grounding and inclusivity of behavioural determinants and to simplify the use of theory, in turn increasing accessibility (Francis et al., 2012).

The TDF was developed by a group of health psychology theorists, health service researchers and health psychologists and involved the synthesis of 33 theories of behaviour and behaviour change clustered into 12 domains (Michie et al., 2005). These domains capture a collection of theoretical concepts which characterise barriers and facilitators of behaviour and include: 1. Knowledge, 2. Skills, 3. Social/professional role and identity, 4, Beliefs about capabilities, 5. Beliefs about consequences, 6. Motivation and goals, 7. Memory, attention and decision processes, 8. Environmental context and resources, 9. Social influences, 10. Emotion, 11. Behavioural regulation and 12. Nature of the behaviours.

Further validation work by an independent group of behavioural experts resulted in a 14 domain version (Cane et al., 2012). This restructuring of domains retains 8 domains similar to the original versions and involves the splitting of others to create new domains. Domains include: 1. Knowledge, 2. Skills, 3. Social/professional role and identity, 4, Beliefs about capabilities, 5. Optimism, 6. Beliefs about consequences, 7. Reinforcement, 8. Intentions, 9. Goals, 10. Memory, attention and decision processes, 11. Environmental context and resources, 12. Social influences, 13. Emotion, and 14. Behavioural regulation. Both versions of the TDF are used in research and practice, depending upon specific use and preference (Atkins et al., 2017).

The TDF has been used extensively and has proven to be adaptable within studies whereby targeting and changing of behaviours are central to study design (Honigh-de Vlaming et al., 2013, Nicholson et al., 2014b, Taylor et al., 2013). This has included studies identifying influences on behaviour, exploration

of barriers and facilitators to implementing behaviour, systematic intervention design, process evaluation and guidance on identifying behaviour change techniques for intervention development (Atkins et al., 2017). It has also been used to inform data collection tools such as questionnaires and interview schedules to ensure that they are context specific and gather evidence that is likely to be highly applicable to intervention development (Debono et al., 2017, Seward et al., 2017).

The TDF was therefore selected as a framework for use within this research based on the following 1. It can be easily applied by non-psychologists who do not need to have specific knowledge in relation to behaviour change theory and is therefore suitable for all public health professionals to ensure they adopt a theory informed approach as recommended by bodies such as NICE and PHE, in light of evidence that suggests interventions grounded in theory are more likely to be effective; 2. It captures 33 behavioural theories and is therefore all encompassing and provides an element of certainty that all components of behaviour have been considered. 3. It is versatile with evidence to support its use within a wide range of contexts in health research. It has proven to be successful and can be used for both primary data collection and secondary analysis as demonstrated in the literature. Given that the framework incorporates a wide range of theories, allows for evaluation of more behavioural determinants that one theory alone cannot capture. This provides scope for more directed intervention development whilst considering all possible factors which may influence behaviour.

1.9.3 Challenges of using behaviour change theory to increase fruit and vegetable consumption in children

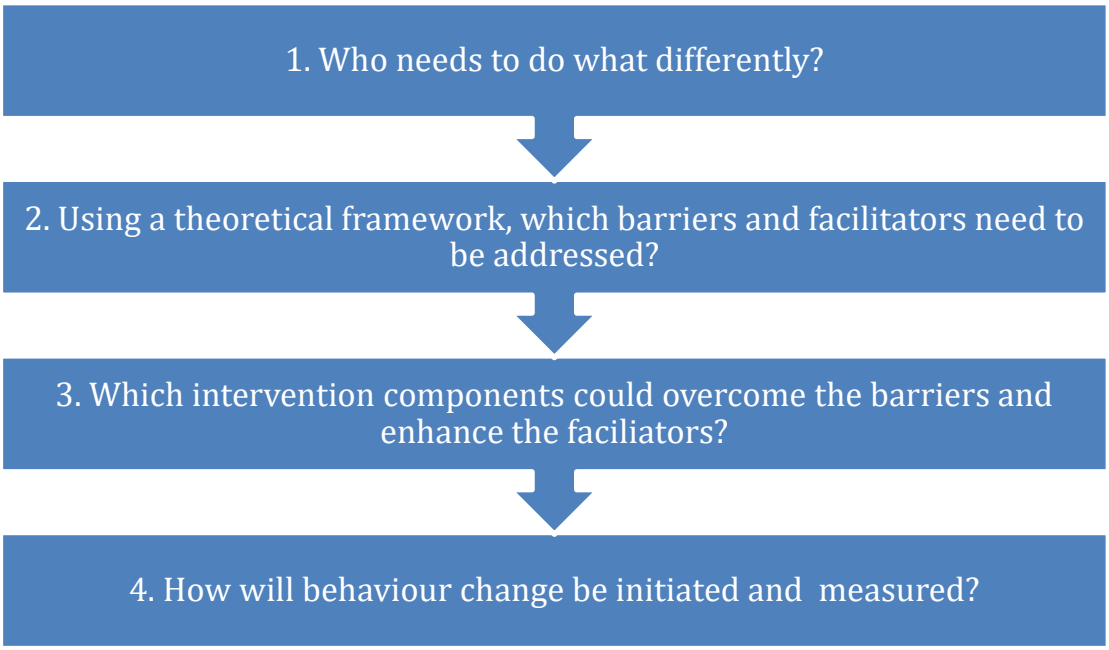
Changing one aspect of behaviour has been shown to have little effect on overall fruit and vegetable consumption in children (Bourke et al., 2014). Public health interventions focused on changing dietary habits to improve child health have a higher likelihood of being successful if they are holistic in nature (Laverack, 2017). There are a plethora of determinants surrounding children's lifestyles and for younger children making changes becomes increasingly difficult as this depends mainly, if not entirely, on the choices made by their parents and/or caregivers. Evidence suggests that addressing a number of determinants and aspects of

behaviour in order to increase consumption appears to work best (Hass and Hartmann, 2018). However, knowing what specific modes and mechanisms of behaviour to address in order to make such changes can prove difficult. It is often tempting to target specific behaviour mechanisms in the hope that this will prove successful, yet establishing exactly what needs to be changed and how do this takes time but been shown to be more effective and efficient in a number of behaviour change interventions (Michie et al., 2018). Therefore, the means and planning stages of behaviour change intervention development are extremely important.

1.9.4 Developing theory based behaviour change interventions using a systematic approach

The MRC framework and NICE guidance on the development of interventions draws upon evidence which suggests that interventions grounded in theory should be considered above others (Craig et al., 2013, National Institute for Health and Care Excellence, 2014b). There are a multitude of behaviour change theories and frameworks which currently exist which can prove daunting, particularly to those tasked with developing interventions that have very little or no psychological experience (Michie et al., 2011). French et al. (2012) developed a four step method which aims to facilitate intervention development and draws upon previous guidance (French et al., 2012). This process is represented in Figure 7.

Figure 7: Model development approach



Adapted from French et al (2012)

Utilising a systematic approach, such as that outlined by French et al (2012) allows for the identification of the target behaviour(s) that needs to change and helps expose both barriers and facilitators which may potentially initiate a change. This process adds to the existing evidence base, allows us to select and tailor an intervention whilst strengthening the likelihood of its success (Craig et al., 2013). Using a theoretical framework aids understanding of both barriers and facilitators surrounding a particular behaviour and directs how the particular mechanisms of an intervention might work.

The research in this thesis aimed to draw upon evidence surrounding the determinants of fruit and vegetable consumption in young children by exploring both barriers and facilitators to consumption (focusing on step one and two of this approach). The discussion chapter focuses on steps three and four, assessing intervention components and their likelihood of success in addressing the barriers and facilitators identified. Finally, consideration will be given to how intervention components might be best implemented, measured and operationalised in practice.

1.10 Aim and objectives of this research

The stated aim and objectives for this thesis are outlined below:

Aim: To develop the evidence base to inform a theory based behavioural intervention to increase fruit and vegetable consumption in young children.

Objectives:

1. To systematically review evidence on the determinants of fruit and vegetable intake in young children.

2. To explore the barriers and facilitators to fruit and vegetable consumption in young children.

3. To consider caregiver views and perceptions of barriers and facilitators of fruit and vegetable provision.

4. To develop a conceptual model of evidence-based determinants of fruit and vegetable consumption in young children to inform theory-based intervention development.

Throughout the thesis participants will be referred to as either professional caregivers (i.e. teachers) or parents (including parents and any other carers).

2. Chapter 2: Research design and methodological approach

A mixed methods approach was utilised for the purpose of this PhD thesis. This chapter will describe common philosophical approaches that are taken by researchers and provide examples of appropriateness of use, depending upon the type of research being conducted. My own philosophical stance will be stated, followed by a description of mixed methods research, possible designs, and advantages and disadvantages of use. Justification for using mixed methods for this research will be discussed, however the specific methods used for each phase will be described in detail within corresponding chapters. Particular problems such as data integration will be deliberated and a discussion of how such issues were overcome using model development will ensue. Finally, a visual representation of the design procedures employed throughout this PhD will be presented.

2.1 Philosophical considerations

Understanding the development of knowledge and the particular nature of such knowledge, provides grounding, and helps determine the direction that research may take. The way a researcher views the world and how they "see" the data will differ depending upon background and training. Such views, often referred to as paradigms help shape and explain why particular decisions are made with regard to research and these will help determine the subsequent approach, whether that be quantitative, qualitative or a mixture of both (mixed methods).

Cresswell and Poth (2017) describe such worldviews as the *"general philosophical orientation about the world and the nature of research that a researcher brings to a study"* (Creswell and Poth, 2017). There are a number of research philosophies that can be adopted, however three of the most common are; positivism, interpretivism and post-positivism. Each of these involves different assumptions about the world (ontology) and how we understand it. A researcher's position of understanding (epistemological stance) is a key driver in informing research decisions.

2.1.1 Positivism

A pure positivist researcher holds a belief that complete understanding can only be reached through traditional scientific experimentation and observation. Deductive reasoning, empirical evidence and hypothesis testing are key characteristics of this philosophical view. Such researchers see the world objectively and believe that our subjective experiences should be considered independently of the scientific evidence and that the researcher should remain emotionally detached and uninvolved (Johnson and Onwuegbuzie, 2004). Quantitative researchers who predominantly deal with large numeric data sets and surveys are likely to take this view.

2.1.2 Interpretivism

Interpretivists believe that in order to understand human action in a variety of settings individuals need to be observed in their natural setting. They believe that people's experiences and views are a reflection of their internal beliefs and are independent of any worldly, extraneous influences. They do not believe in objectivity due to the diversity of human experience and generate theory inductively through the identification of meaning (Denzin and Lincoln, 2017). Qualitative researchers such as those undertaking ethnographic and detailed observational studies often hold these views.

2.1.3 Post-positivism

Forming a post-positivistic view, a researcher shares the main assumptions as associated with that of a positivist, one that is grounded in objectivity. However they also believe that the subjective experiences which an individual's experience's help shape knowledge and our understanding of a particular phenomenon and that comprehension cannot be fully achieved without both. Post-positivism holds elements of cause and effect and embraces both logic and empiricism. Reductionism is key to this approach determined by a priori theories (Creswell and Poth, 2017). Researchers who utilise both quantitative and qualitative methods (mixed methods researchers) are generally of this view.

2.1.4 Philosophical stance

As a researcher, I hold a pragmatic post positivistic view of the world and believe that to successfully understand the complexities surrounding fruit and vegetable consumption in young children, both quantitative and qualitative strategies need to be employed to ensure that a 'complete' picture of evidence is captured. I believe that both quantitative and qualitative data is of value in different ways and both need to be addressed in order to achieve both the aims and objectives outlined in this thesis.

Identifying quantifiable associations between determinants and fruit and vegetable consumption is important to ascertain statistical trends and establish the current evidence base in order to verify which interventions are most beneficial. However, this does not provide an in-depth understanding of such determinants which qualitative inquiry can potentially achieve. For example, if we seek to further understand these determinants through first hand experiences (e.g. interviews), both barriers and/or facilitators to consumption can be explored. Gaining a more meaningful and comprehensive understanding of these determinants, allows for a more directive and specific approach when designing and implementing interventions aimed at increasing fruit and vegetable consumption in young children, and increases their likelihood of success. Therefore this thesis will follow a mixed methods design.

2.2 Mixed methods research

There are a plethora of research designs available to draw upon, depending upon appropriateness for answering the research question posed. However, mixed methods research has the advantage of utilising a number of techniques to investigate a complex research problem (Shorten and Smith, 2017). If carried out effectively mixed methods research has the potential to enhance the evidence base. The primary aim of using a mixed methods study design is to gain a comprehensive understanding of a research issue and involves the collecting, analysing and integration of both quantitative and qualitative research data (Creswell, 2005). In combining both methods it is hoped to achieve a thorough and robust depiction of a particular phenomenon of interest that cannot be fully achieved, should only one stand-alone method be used. In order to combine both quantitative and qualitative evidence within one study, the advantages and

disadvantages of using both quantitative and qualitative research methods need to be understood. Table 2 outlines these and allows for comparisons to be made between quantitative and qualitative research enquiry. Provided both methods are combined effectively, taking the positive aspects of each into account it is more likely to give rise to a successful analysis (Tashakkori, 1998).

Table 2: Quantitative versus qualitative research

Quantitative	
Advantages	**Disadvantages**
• Draws conclusions for large numbers of people • Analyses data efficiently • Investigates relationships within data • Examines probable causes and effects • Controls bias • Appeals to peoples preference for numbers	• Is impersonal • Does not record the words of participants • Provides limited understanding of the context of participants • Is largely researcher driven
Qualitative	
Advantages	**Disadvantages**
• Provides detailed perspectives of a few people • Captures the voices of participants • Allows participants' experiences to be understood in context • Is based on the views of participants, not the researcher • Appeals to people's enjoyment of stories	• Has limited generalisability • Provides only soft data (not hard data, such as numbers) • Studies few people • Is highly subjective • Minimises use of researchers' expertise due to reliance on participants

Source: (Creswell and Poth, 2017)

2.2.1 Challenges in mixed methods research

2.2.1.1 Philosophical differences

Given that both quantitative and qualitative methods differ in many ways, difficulties arise when combining the results of both. It has been argued that the diverse philosophical grounding of each design does not allow for them to be merged (Sale et al., 2002). However there are others who argue that both approaches can be combined as they share the same common goal, which is to understand the world in which we live and that this can be best understood by the 'union' of a series of phenomena (Feilzer, 2009). Many researchers believe multiple paradigms form the basis of mixed methods research and that utilising a combination of these creates a fuller, more comprehensive understanding of the research problem (Greene and Caracelli, 2003).

2.2.1.2 Data presentation and integration

The integrative strategy taken when combining both qualitative and quantitative data is an important consideration for mixed methods researchers. Presentation and analysis of findings can be dealt with separately and combined in a final comparison stage, whereby the quantitative and qualitative elements remain entirely distinct in analysis yet are compared and discussed together to draw conclusions and make inferences regarding the data. Quantitizing and qualititizing are other common methods employed whereby one type of data is transformed to another to create variables that may relate to themes or constructs which can then be combined. For example quantitative transformation may involve the numeric coding of interview data and be expressed in terms of how many respondents agreed or disagreed with a statement (Tariq and Woodman, 2013).

2.2.1.3 Sequence and design of mixed methods research

The sequence in which the data are collected and presented can vary from study to study; however, this is also determined by the research question. There are a number of ways in which this can be achieved and Creswell outlines the three main basic designs which are said to form the basis of all mixed methods studies (Creswell and Poth, 2017):

1. The *convergent design*, which involves the simultaneous collection of both quantitative and qualitative data followed by the analysis and

merging of results. Most commonly integration occurs during the interpretation phase when results are merged.

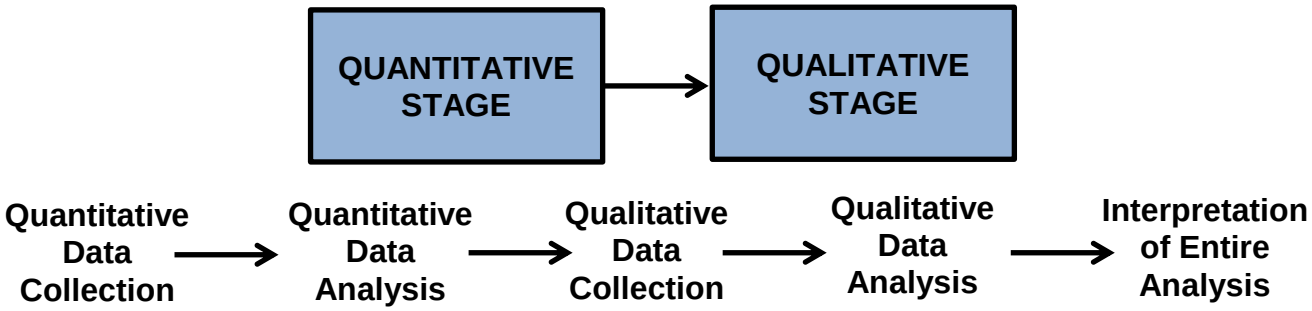
2. The *explanatory sequential design*, in which quantitative methods are used followed by qualitative to help explain and provide additional explanation of the results.
3. The *exploratory sequential design* in which qualitative data is explored first followed quantitative. The qualitative strand can sometimes be used to build upon theory or to identify variables that are tested in the quantitative follow-up.

The approach used in this thesis will be that of a sequential explanatory mixed methods design and will now be discussed further.

2.3 Sequential explanatory mixed methods

Creswell and colleagues have advocated the use of a post positivistic approach complementing a sequential mixed methods design (Creswell and Poth, 2017). Sequential explanatory mixed methods are commonly used by researchers and typically involve an initial quantitative phase followed by a qualitative data collection and analysis phase. Data is generally mixed using a connecting method whereby analysis of one type of data leads to another (Creswell, 2011). Graphical representation of the study design process is advocated to better understand the methods used and steps taken in the data collection, analysis and interpretation stages of mixed methods research. The study design process example shown in Figure 8 illustrates how the data collected and analysed in the quantitative phase provides an initial body of evidence that can be explored further and elaborated on in the qualitative phase.

Figure 8: Study design process



Adapted from (Creswell and Poth, 2017)

Although seemingly basic there are a number of methodological considerations that need to be taken in to account when utilising this type of design. Such considerations include; deciding on weighting given to both quantitative and qualitative phases, sequencing of data collection and analysis and process and timing of the integration of phases. Clarification of these points leads to design transparency and ultimately a more robust study (Ivankova et al., 2006).

2.4 Data integration using a model development approach

Model development and framework analysis will be employed throughout, providing an interconnecting tool with which to integrate and explain the relationship between data from all phases.

As the aim of this thesis is to understand the determinants of fruit and vegetable consumption a model development approach will combine both the quantitative and qualitative data. It will be used as an interconnecting tool with which to integrate, illustrate and understand both the quantitative and qualitative data generated in this thesis. Initially an *a-priori* conceptual model (in this case a model of determinants of fruit and vegetable consumption) will be presented at the end of this chapter. This model will be built upon throughout the progression of the thesis, drawing upon evidence generated in each chapter with the presentation of new determinants being progressively added. On summarising each chapter the determinants (including any barriers and facilitators to fruit and vegetable provision) identified will be added to the model and presented until a final model of determinants is achieved. This model will be developed using a “best fit” framework synthesis approach.

2.5 Framework synthesis approach

Framework analysis is a frequently used data interpretive analysis tool applied to primary qualitative research (Gale et al., 2013). Developed in 1980's by social policy researchers, it is referred to a matrix-based approach which allows for the categorisation and coding of data into pre-specified themes. Advantages are that the data can be explored in greater depth, a level of rigour and transparency is maintained and interconnecting and development stages are explicitly described throughout the analysis process. In addition, this method is believed to be the most appropriate in providing an holistic, descriptive overview of a phenomena taking a variety of subject related data into account (Smith and Firth, 2011). However there are limitations which must be considered such as the issue of subjectivity in the early stages and the inability to capture and synthesise highly heterogeneous data (Gale et al., 2013).

However by building on an initial framework approach a "best fit" framework provides a more systematic method resulting in the generation of a context specific conceptual model which aims to define and rationalise the decision making and health behaviours of patients and other groups (Carroll et al., 2013). This is a frequently used data analysis tool applied to primary qualitative research and adopted by non-qualitative researchers who wish to further understand a problem from a variety of perspectives (Booth and Carroll, 2015).

2.5.1 The Theoretical Domains Framework (TDF)

As previously outlined in the introduction (Chapter 1) the TDF is an integrative theoretical framework that has been applied across a wide range of populations to help further understand the determinants of behaviour change (Francis et al., 2009, Heslehurst et al., 2014, McDonald et al., 2015, Nicholson et al., 2014a). The framework was originally developed using a consensus approach by a group of health psychology theorists, health service researchers and health psychologists (Michie et al., 2005). The team of experts reviewed 33 existing psychological theories, comprising of 128 theoretical constructs which they then combined into one framework of 12 domains. These domains capture a collection of theoretical concepts that characterise barriers and facilitators of healthcare professional's behaviours (Michie et al., 2005). The domains include: 1. Knowledge, 2. Skills, 3. Social/professional role and identity, 4. Beliefs about

capabilities, 5. Beliefs about consequences, 6. Motivation and goals, 7. Memory, attention and decision processes, 8. Environmental context and resources, 9. Social influences, 10. Emotion, 11. Behavioural regulation, 12. Nature of the behaviours.

Further validation work in implementation science research and application of the TDF resulted in the development of a 14 domain version (Cane et al., 2012). Eight of the domains were similar to the original framework: 'Knowledge', 'Skills', 'Social/Professional Role and Identity', 'Memory, Attention and Decision Processes', 'Environmental Context and Resources', 'Social Influences', 'Emotion', and 'Behavioural Regulation'. However the domains 'Beliefs about Capabilities', 'Beliefs about Consequences', and 'Motivation and Goals' were preserved but were divided into six new clusters. The domain of 'Nature of the Behaviours' was removed because it was not believed to be fully represented.

The aim of using the TDF to synthesise this evidence-base is to utilise a theoretically informed framework to systematically identify determinants (namely barriers and facilitators) to behaviours in order to inform future behaviour change interventions. However, use of the TDF has evolved over time and it is now used in a number of ways such as; to identify important influences of behaviour, identify relevant theories, to map theory to behaviour change techniques and to guide intervention development. Recently, a guide was developed to facilitate implementation of the TDF, providing a number examples which demonstrate a variety of ways in which the TDF can be used whilst considering practical applications (Atkins et al., 2017). I used the TDF throughout my PhD as an *a-priori* framework as an interconnecting tool with which to integrate and explain the relationship between data from all phases of this mixed methods PhD, to inform the model development.

2.6 Sequential approach for this research

This PhD will follow a sequential explanatory mixed methods approach (as described earlier in this chapter), whereby the results from one phase will inform the next. An a-priori conceptual model will be presented, and each phase contributed to refining the model during the model development process. The

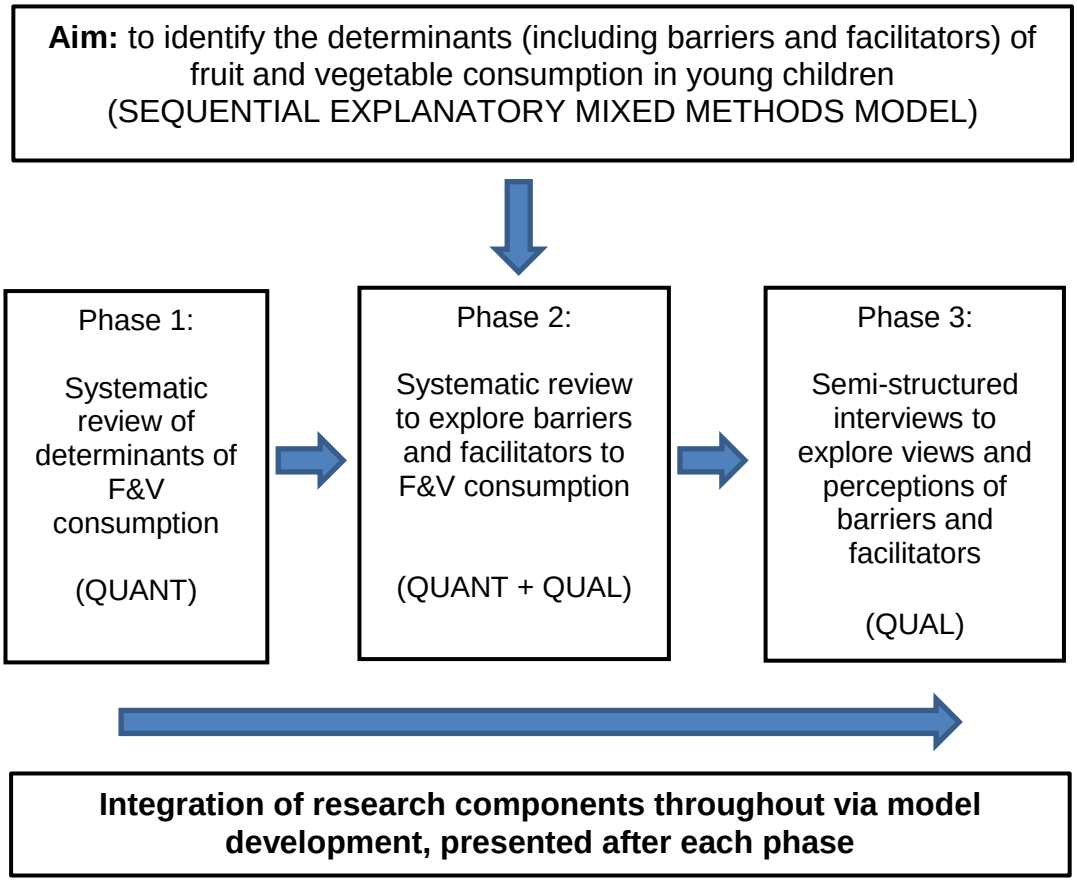
phases shown in Figure 9 are adapted from a study which adopted a similar process (Heslehurst et al., 2015). Phases will be carried out as follows:

Phase 1. A quantitative systematic review to assess the determinants of change in fruit and vegetable consumption in young children.
This review will assess both prospective cohort and intervention studies to quantitatively identify determinants of fruit and vegetable consumption in children.

Phase 2. A mixed methods systematic review to explore the barriers and facilitators of parents and professional caregiver's fruit and vegetable provision to young children.
This review will include both qualitative and quantitative survey studies to further explore determinants identified in Phase 1, and identify additional barriers and facilitators to fruit and vegetable provision among parents and professional caregivers.

Phase 3. Qualitative semi-structured interviews to explore parental views and perceptions of barriers and facilitators to fruit and vegetable provision in young children.
Semi-structured interviews will be carried out with caregivers of young children to corroborate evidence identified in phases 1 and 2 and help further understand barriers and facilitators to fruit and vegetable consumption in young children.

Figure 9: Diagrammatic representation of the sequential explanatory design procedures that will be followed throughout this thesis



Adapted from (Heslehurst et al., 2014)

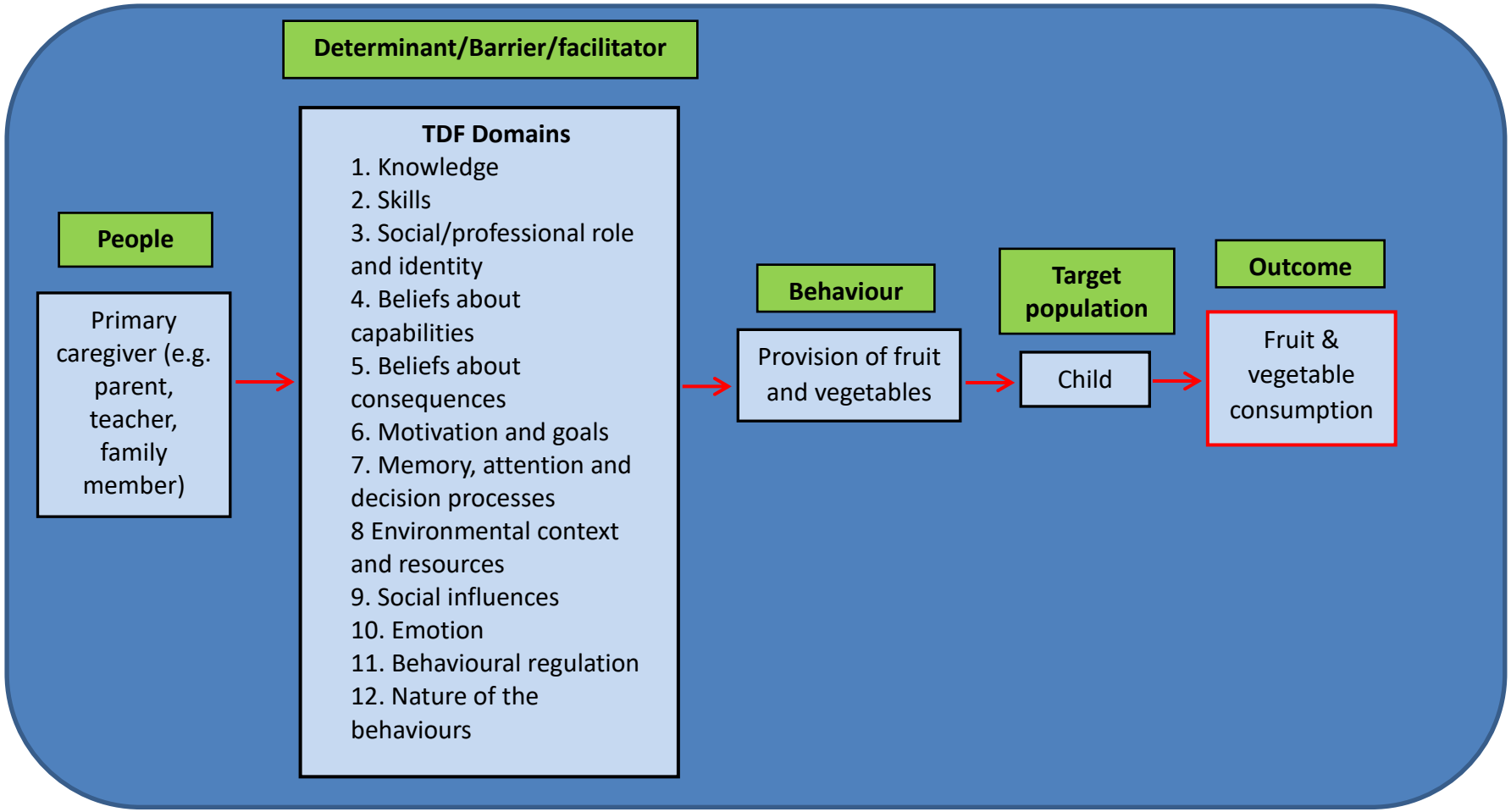
2.7 Weighting of components and value of evidence generated

Both quantitative and qualitative components of the systematic reviews and the interviews will add important elements of understanding to the research topic and as such will be weighted equally.

As highlighted in chapter 1, existing literature relating to the determinants of fruit and vegetable consumption in this age group is sparse. The initial quantitative systematic review (phase 1) aims to provide a general picture of the current evidence base. Phase 2 will build on this evidence, with the intention of extending the general picture by looking at both qualitative and survey evidence to explore barriers and facilitators which surround fruit and vegetable provision and ultimately child consumption. For the final phase (phase 3) a series of individual interviews with caregivers of young children will provide in-depth and rich information to validate findings from phases 1 and 2 and explore any gaps. Data

from all three phases will be combined using model development methods to provide a comprehensive overview of determinants (including barriers and facilitators) of fruit and vegetable consumption in young children. This information aims to help direct future intervention development by identifying which determinants can be targeted in order to increase fruit and vegetable consumption.

Figure 10: Presentation of a-priori model of determinants



2.8 Description of *a-priori* model of determinants

The a priori model presented depicts the first step in the model development process (as described in chapter 2). It is a diagrammatic representation of possible determinants (including barriers and facilitators) of caregivers (both parents and professional caregivers) behaviours and aims to show how these could potentially impact on fruit and vegetable consumption in young children. Data relating to determinants which arise from each component of this PhD (from the quantitative systematic review, mixed methods review and interviews) will be coded to the appropriate TDF domains using a pre-established and tested coding manual. These domains hope to reflect a collection of theoretical constructs that characterise the barriers and facilitators of caregiver behaviours in relation to fruit and vegetable provision to young children. The 12 domains with which the data will be coded to are: 1. Knowledge, 2. Skills, 3. Social/professional role and identity, 4. Beliefs about capabilities, 5. Beliefs about consequences, 6. Motivation and goals, 7. Memory, attention and decision processes, 8. Environmental context and resources, 9. Social influences, 10. Emotion, 11. Behavioural regulation and 12. Nature of the behaviours. The model also aims to help understand how these determinants may interact with one another. As the thesis progresses it hopes to provide an holistic picture of possible determinants that could be targeted in interventions to improve fruit and vegetable provision and ultimately child consumption. Using a systematic approach to understanding behaviours enables the current knowledge base to be strengthened whilst broadening the opportunities to support more detailed intervention development.

Chapter 3: A systematic review examining determinants of change in fruit and vegetable consumption in children 0-6 years.

3.1 Introduction

The following review is part of a suite of three reviews which have been conducted in collaboration with Cambridge University and The Centre for Translational Research in Public Health (FUSE). The aim of these reviews were to identify determinants of obesogenic behaviours in children 0-6 years. The three reviews were; 1. Determinants of Fruit and Vegetable intake (for which I took the lead), 2. Determinants of Physical Activity and Sedentary Behaviours (led by Dr Katheryn Hesketh (KH)) and 3. Sugar Sweetened Beverages and Other Dietary Related Behaviours (led by Veena Paes (VP)). The protocol for this review has been published in *BMC Systematic Reviews* (Lakshman et al., 2013).

The wider review team was comprised of the following; Carolyn Summerbell (CS), Helen Moore (HM), Raj Lakshman (RL), Esther van Sluijs (EvS), Simon Griffin (SG) and Ken Ong (KO). However, I led the fruit and vegetable review, screening approximately 14,000 records (titles and abstracts), reading 337 potentially relevant studies in full. In total, 14 intervention and 12 cohort studies were retrieved. I extracted, analysed and interpreted data for this review under the supervision of CS and HM.

3.2 Background

Chapter 1 of this thesis describes the beneficial health effects of a diet abundant in fruit and vegetables. However despite such benefits, children within both the UK and worldwide are not meeting recommended consumption guidelines (Wolfenden et al., 2012, The Health and Social Care Information Centre, 2013). The importance of maintaining a diet high in fruits and vegetable is widely researched and developing healthy habits at an early age is now thought to play a key role in maintaining long term health and ultimately, longevity (Rekhy and McConchie, 2014). Evidence pertaining to interventions aimed at very young children is increasing, however at present, particularly those deemed to be of high quality, remain sparse (Wolfenden et al., 2012).

Instilling healthful behaviours in young children can prove challenging and more often than not is influenced by a multitude of contributing factors. In order to change/manipulate behaviour an initial understanding of the determinants effecting the behaviour in question need to be established (Craig et al., 2008). As described in chapter 1 a significant number of potential determinants/correlates to fruit and vegetable consumption in pre-school aged children have been explored, however the majority relate to cross sectional evidence, showing no temporal causality between the determinant and fruit and vegetable consumption.

The SEM has proved to be a useful framework in which to define and understand the determinants of a variety of behaviours, including fruit and vegetable consumption (Mehtala et al., 2014, Robinson, 2008, Townsend and Foster, 2013). Categorisation of determinants into a variety of domains, depending upon their level of influence (individual, interpersonal, environmental, wider community and policy) allows us to ascertain which setting to target. Future intervention development can therefore be more specific, with a higher likelihood of success.

At present there is limited evidence to support any causal predictors of change in fruit and vegetable behaviour amongst very young children, with the majority of studies reporting change in older and adolescent aged children (Rasmussen et al., 2006). This systematic review was therefore conducted to appraise the evidence surrounding determinants of change in young children's (aged 0-6 years) fruit and vegetable consumption.

3.2.1. Rationale for a systematic review

Policy decisions, particularly those which are health related should be informed using the best available evidence (Centre for Reviews and Dissemination, 2008). Due to the heterogeneity of studies and variable quality it becomes difficult to utilise findings. Some studies are methodologically flawed, biased, contain ambiguous results or are non-generalizable. It is important to assess each with rigour to ensure which are the most reliable and should be used to inform policy and practice.

A systematic review summarises the results of a number of studies to provide an overall understanding of the most current evidence. When results are combined

this gives a more reliable and accurate assessment of the effectiveness of an intervention or its specific components. In addition to evaluating evidence a systematic review can also highlight disparities and gaps in the evidence base, thereby directing future intervention development and research. To ensure that a review is being carried out in a robust and transparent manner, there are a number of organisations who have developed step by step guidance for reviewers to follow. With this in mind, the following review was carried out in accordance with the rigorous conduct and reporting of systematic reviews (Centre for Reviews and Dissemination, 2008).

The overall purpose of the review (in the context of this thesis) was to identify both prospective cohort and intervention evidence on determinants of fruit and vegetable consumption in young children. This evidence will then be built upon in phase 2 of the thesis.

3.3 Methods

3.3.1 Scoping phase

An initial scoping phase was conducted prior to performing the full search in order to maximise sensitivity and specificity. This allowed for refinement of the final search strategy and included; identifying key publications and contacting experts in the field. Subsequent searches were then run to ensure these important studies were captured.

A common search strategy was applied to all three reviews in order to target studies showing determinants of change in each of the target behaviours (fruit and vegetable consumption, SSB consumption, PA and other dietary-related behaviours). Search terms used were agreed by all members of the project team. Terms related to; population (young children), study design (observational, intervention and review studies), outcome (fruit and vegetable consumption, sugar sweetened beverage consumption, other diet-related outcomes and physical activity) and exclusion of clinical populations (i.e. cystic fibrosis, autism, asthma).

An electronic search was conducted, covering eight electronic databases (Medline, Embase (via Ovid), Cinhal, Psychinfo (via Ebsco), Web of Knowledge

(via Thomson Reuters), British Nursing Index (BNI), Applied Social Sciences Index and Abstracts (ASSIA) and Sociological Abstracts (via Proquest)). The associated search strategy can be seen in Appendix 1. No period or language restrictions were applied and studies were included up to and including December 2015. All identified articles were imported into an Endnote Database and de-duplicated in preparation for screening.

3.3.2 Study selection

A sample of papers (n=1000) were screened for inclusion by all primary reviewers (KH, VP and CO). One senior reviewer (CS) screened the same studies for inclusion and results were compared until ≤5% discrepancy was achieved (Bonell et al., 2011). A random sample (10%) of the remaining articles were double screened two senior reviewers (RL and EvS). Decisions regarding discrepancies were reached through reviewer discussions until agreement was reached. Specific details were extracted by each reviewer for those studies which, at screening, met the inclusion criteria (author, publication year, country, behaviour assessed and study design). This information was then collated by the relevant study lead and a full-text copy of studies ordered if required for further review.

3.3.3 Refinement of inclusion and exclusion criteria

Observational (non-intervention), longitudinal (prospective and retrospective) and intervention (randomised controlled trials (RCT's), and non-RCT'S) studies which quantified an association between a determinant AND fruit and vegetable consumption in children aged 0-6 years were included. Studies demonstrating non-temporal, cross-sectional associations were excluded. Inclusion and exclusion criteria specific to this review can be found in Table 3.

Table 3: Inclusion and exclusion study criteria for fruit and vegetable (F&V) review

Inclusion Criteria	Exclusion Criteria
• Intervention studies (RCT's and non-RCT's) targeting F&V consumption • Non-intervention/observational i.e. cohort studies that quantified the association between correlate/determinant and F&V consumption in obese or non-obese children • Studies that measured F&V consumption (i.e. weighed food measures, diet diaries, food records, 24-hour recalls, questionnaires) • Child age between 0-6 years at baseline • Studies including overweight and obese participants	• Non-human studies • Laboratory/Experimental-based (such as vitamin and preloading studies) • Cross-sectional studies • Studies on health outcomes for these behaviours (i.e. studies describing the association between dietary habits and obesity or cardiovascular risk factors) • Studies not reporting consumption data, quantitative studies that measured F&V behaviours but did not describe an association • Studies in clinical populations (e.g. malnutrition, disability, allergy, dental caries, asthma, cerebral palsy, cystic fibrosis, autism) • Studies specifically related to breast/ bottle-feeding and/or weaning of infants

Components of intervention studies were not considered as determinants as these simply define the effectiveness of an intervention which is not the aim of this review. In addition to this inferences cannot be made regarding intervention components and change in fruit and vegetable consumption if the intervention is comprised of multiple elements. Therefore intervention studies were only included if they provided a differential effects analysis and not just change for change in studies groups over time.

For the purpose of this review categorisation of studies according to design was performed by two reviewers (CO and CS). Studies were not counted twice and those involving any type of intervention which aimed to change behaviour in any way were classified as *intervention* studies. Studies involving no intervening factors, observing the behaviour of a population over time (including control group data) were classified as *prospective* studies.

3.3.4 Data Extraction

Full texts articles deemed eligible for inclusion were read by CO and double screened for inclusion by CS. Data was extracted using a standardised form and included the following information; author, year, country, study design, setting, population, baseline characteristics, intervention description and theoretical model used (for relevant study design), measure of fruit and vegetable consumption, potential determinant, analysis method, follow-up duration and classification of determinant (into one of five SEM model levels; intrapersonal (child), interpersonal (parent/caregiver), environmental, wider community and policy). A full list of information extracted can be found in Appendix 2.

3.3.5 Quality Assessment

Quality appraisal was performed by CO and double checked by CS for each of the included studies using adapted quality assessment criteria (Evidence for Policy and Practice Information and Co-ordinating Centre, 2010). Criteria as highlighted in Table 4 focused on assessing both internal and external validity of included studies. For intervention studies, seven items were scored focusing on internal validity (e.g. randomization procedure, objective measure of outcome, retention). For observational studies, seven items were scored focusing on both internal and external validity (e.g. representativeness of study population,

multivariate analysis carried out). Studies were classified as high, intermediate or low quality based on the number of quality criteria met: (High: ≥6; Medium; 4-5; Low; 1-3).

Table 4: Quality assessment criteria

For intervention studies (Score)	For observational (non-intervention) studies (Score)
Total quality assessment score (maximum of 7) was derived for fulfilment of following criteria: 1) Representative of general population (Yes: 1, No: 0) 2) Number of participants at baseline >100: 1, 50-100: 0, <50: low quality) 3) Retention (>70%: 1, <70%: 0) 4) Randomisation (Randomised: 1, non-randomised: 0) 5) Allocation concealment (Yes: 1, No: 0) 6) Blinding (Yes: 1, No: 0) 7) Objective outcome measure (Yes: 1, No: 0)	Total quality assessment score (maximum of 7) was derived for fulfilment of following criteria: 1) Representative of general population (Yes: 1, No: 0) 2) Number of participants at baseline (>100: 1, 50-100: 0, <50: low quality) 3) Retention (>70%: 1, <70%: 0) 4) Prospective study design (Yes: 1, No: 0) 5) Analysis of dataset from baseline (Yes: 1, No: 0) 6) Multivariate analysis (Yes: 1, No: 0) 7) Objective measure of outcome (Yes: 1, No: 0)*

Scoring system for studies: High Quality: >6; Medium 4-5; Low: 1-3 (Evidence for Policy and Practice Information and Co-ordinating Centre, 2010)

* Objective measures of fruit and vegetable consumption are, for the purpose of this review, defined as either weighed food measures, estimated food measures using food photography, or direct (and independent) observations.

3.3.6 Data Synthesis

Meta-analysis of data was deemed inappropriate due to substantial heterogeneity between studies. Therefore narrative synthesis was undertaken. As previously described the SEM model was used as an analysis tool on which determinants identified were mapped according to their corresponding category (i.e; intrapersonal, interpersonal, environmental, wider community and policy) with conceptually similar exposures being combined. Each extracted determinant was given a score based on the direction and strength of evidence of the association

(no association; (0), or a statistically significant association (+ / -) ($p<0.05$)) between the determinant and the change in fruit and vegetable consumption (see Table 5). Where four or more studies reported on a potential determinant, double signs were used to indicate greater confidence in the summary (++/--/00) as used in previous studies (Hinkley et al., 2008, Sallis et al., 2000).

Table 5: Classification of determinants by strength of evidence of association with change in fruit and vegetable consumption

Studies reporting association (%)	Summary	Explanation
0-33	0	No association
34-59	?	Indeterminate, inconclusive
60-100	+	Positive association
	-	Negative association

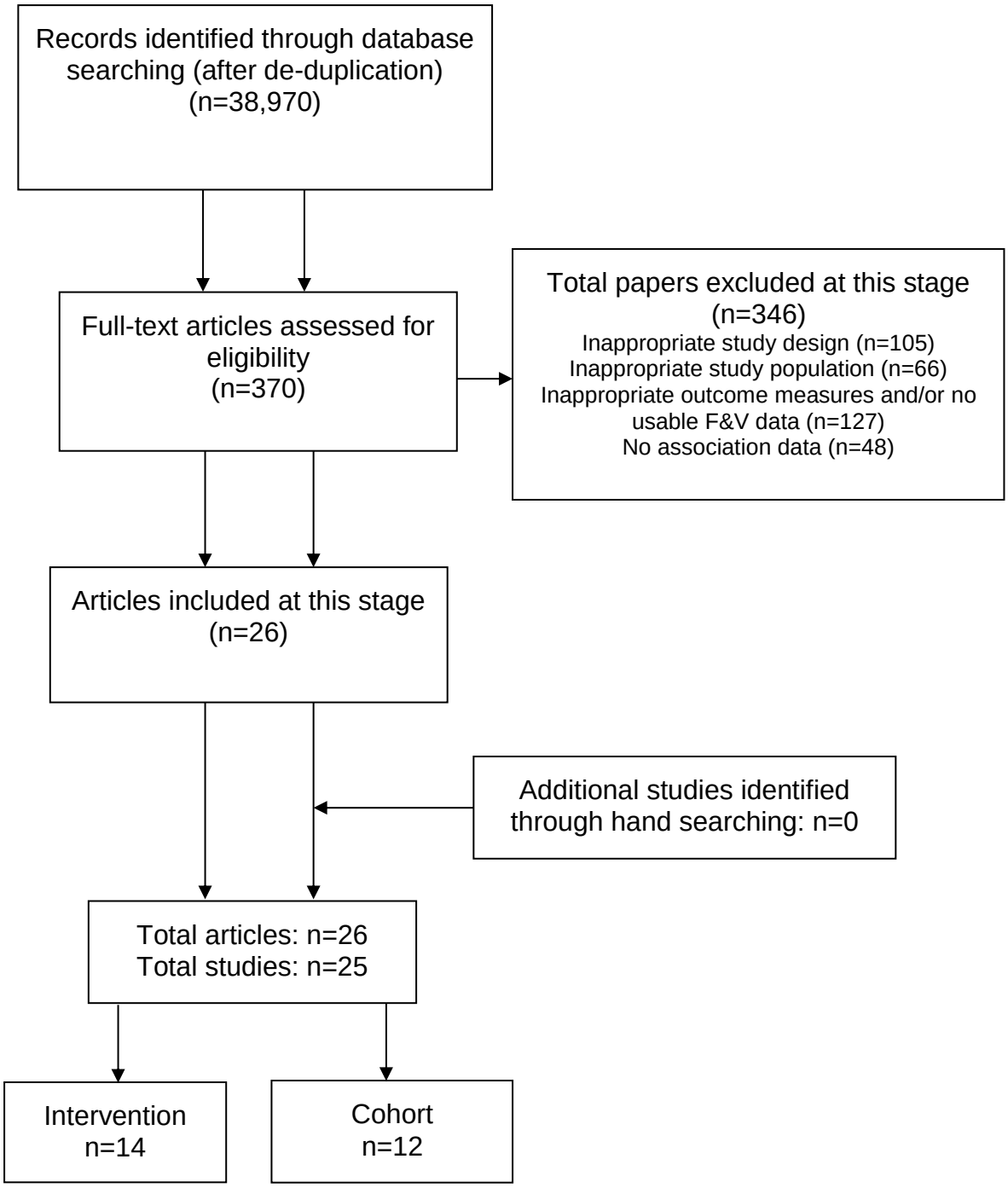
Adapted from (Hinkley et al., 2008)

N.B. Where four or more studies report on the potential determinant, summary is coded as 00, ??, - - or + +

3.4 Results

The electronic search yielded 38,970 records from which 370 full text articles were screened for eligibility. 26 papers were included in the systematic review reporting 25 studies, all identified by the electronic searches. No papers were identified through hand-searching. A summary flow chart of the literature identification is presented in Figure 11 as is commonly reported in systematic reviews for transparency purposes (Moher et al., 2009).

Figure 11: PRISMA flow of studies included in the review



3.4.1 Study Characteristics

Study characteristics for both prospective and intervention studies included in the review can be seen in Appendix 3 and 4 respectively.

Table 6: Prospective studies

Determinant ***(and, for dichotomous variables, reference group (ref); for continuous variable, direction)***	**Association[1] between determinant (at baseline) and change in fruit and vegetable (F&V) consumption over time** **–**	**0**	**+**	**N studies reporting a – or + association**	**Summary[2]**
INDIVIDUAL					
1. **Sex** (ref = girls)	(Talvia et al., 2005)	(Louzada da Costa et al., 2012, Valmorbida and Vitolo, 2014)		1/3	0
2. **Age** ↑		(Louzada da Costa et al., 2012)		0/1	0
3. **Number of siblings** ↑		(Valmorbida and Vitolo, 2014)		0/1	0
4. **Ethnicity** - British Pakistani (ref = White British)	(Sahota et al., 2015)[V]		(Sahota et al., 2015)[F]	1/1	-[V]/+[F]
5. **Child Temperament** - Externalising (hyperactive/aggressive) ↑	(Vollrath et al., 2012)			1/1	-
- Surgency (active/sociable) ↑			(Vollrath et al., 2012)	1/1	+
- Internalising(anxious/dependent) ↑		(Vollrath et al., 2012)		0/1	0
6. **Dietary patterns** -Fruit juice/soft drink consumption ↑	(Alexy et al., 1999)[F], (Vilela et al., 2014), (Valmorbida and Vitolo, 2014)[V]	(Valmorbida and Vitolo, 2014)[F]		3/3	-
-Salty snack consumption ↑	(Vilela et al., 2014)			1/1	-
-Sweet/confectionary consumption ↑	(Vilela et al., 2014)	(Valmorbida and Vitolo, 2014)		1/2	?
-Meat/Fish/Diary consumption ↑		(Vilela et al., 2014)		0/1	0
-F&V consumption (in infancy) ↑		(Valmorbida and Vitolo, 2014)[V]	(Grimm et al., 2014), (Valmorbida and Vitolo, 2014)[F]	2/2	+

Determinant ***(and, for dichotomous variables, reference group (ref); for continuous variable, direction)***	**Association[1] between determinant (at baseline) and change in fruit and vegetable (F&V) consumption over time** **–**	**0**	**+**	**N studies reporting a – or + association**	**Summary[2]**
-%commercially prepared, compared with homemade, complementary foods ↑	(Foterek et al., 2015)[V] (in infancy: boys and girls) (Foterek et al., 2015) (preschool and school: boys)	(Foterek et al., 2015)[F] (in infancy: boys and girls) (Foterek et al., 2015) (preschool and school: girls)		1/1	-
-Age of introduction of F&V ↑		(Grimm et al., 2014)		0/1	0
-Duration of exclusive BF ↑		(Valmorbida and Vitolo, 2014)		0/1	0
-Problematic eating behaviours in infancy (4 components, including fussiness and neophobia)↑	(Oliveira et al., 2015)			1/1	-
INTERPERSONAL					
7. **Parental education** -Maternal education ↑		(Valmorbida and Vitolo, 2014)		0/1	0
-Paternal education ↑			(Valmorbida and Vitolo, 2014)	1/1	+
8. **Parental occupation** -Maternal occupation		(Valmorbida and Vitolo, 2014)		0/1	0
-Paternal occupation		(Valmorbida and Vitolo, 2014)		0/1	0
9. **Family income** ↑	(Valmorbida and Vitolo, 2014)[F]	(Valmorbida and Vitolo, 2014) [V]		1/1	-[F]/0[V]

Determinant ***(and, for dichotomous variables, reference group (ref); for continuous variable, direction)***	**Association[1] between determinant (at baseline) and change in fruit and vegetable (F&V) consumption over time** **– 0 +**			**N studies reporting a – or + association**	**Summary[2]**
INTERPERSONAL					
10. **Maternal weight** ↑		(Valmorbida and Vitolo, 2014)		0/1	0
11. **Feeding practices** Maternal coercive/authoritarian ↑	(Alsharairi and Somerset, 2015) (Gregory et al., 2011)[F]	(Gregory et al., 2011)[V]		2/2	-[F]/0[V]
Paternal coercive/authoritarian ↑	Alsharairi (boys)	(Alsharairi and Somerset, 2015) (girls)		1/1	-
Maternal restriction ↑		(Gregory et al., 2011)		0/1	0
Paternal restriction ↑					
12. Maternal **role modelling** ↑		(Gregory et al., 2011)[F]	(Gregory et al., 2011)[V]	1/1	+[V]/0[F]

[1]An association (or no association) as reported in the primary paper of the cohort study between the determinant of interest and the change in fruit and/or vegetable intake over time; + or – associations which were reported with statistical significance are highlight against a background of light blue.
[2]Where **≤3 studies per determinant**: '0' represents 0-33% of findings support a + or - association; '?' represents 34-59%, and '+' or '-' represents 60-100%. Where **≥4 studies per determinant**: '00' represents 0-33% of findings support a + or - association; '??' represents 34-59%, and '++' or '--' represents 60-100%. [F]= fruit consumption only, [V] = vegetable consumption only

Table 7: Intervention studies

Determinant *(and, for dichotomous variables, reference group (ref); for continuous variable, direction)*	**Association[1] between determinant (at baseline) and change in fruit and vegetable (F&V) consumption over time** **–**	**0**	**+**	**N studies (of total) reporting a – or + association**	**Summary[2]**
INDIVIDUAL					
1. **Sex** (ref = girls)		(Bayer et al., 2009, De Bock et al., 2012),(De Coen et al., 2012), (Reinaerts et al., 2007)[F], (Witt and Dunn, 2012), (Nyberg et al., 2015)[F], (Natale et al., 2014)	(Reinaerts et al., 2007)[V], (Nyberg et al., 2015)[V]	2/7	00
2. **Age** ↑	(Klohe-Lehman et al., 2007)[F], (Whaley et al., 2010)[V]	(De Coen et al., 2012), (Klohe-Lehman et al., 2007)[V], (Leahy et al., 2008)[V], (Reinaerts et al., 2007)[V], (Natale et al., 2014)	(Reinaerts et al., 2007)[F],(Whaley et al., 2010)[F]	2/6	00
3. **Ethnicity** -Non-native Germans (ref = native Germans)		(De Bock et al., 2012)		0/1	0
- Non-native Dutch (ref = native Dutch)		(Reinaerts et al., 2007)[F]	(Reinaerts et al., 2007)[V]	1/1	0[F]/+[V]
Included Hispanic (Cubans), Other Hispanics, Non-Hispanic blacks (Haitians), Other non-Hispanic Blacks, Non-Hispanic whites, and Other.		(Natale et al., 2014)		0/1	0
4. **SES** ↑		(Witt and Dunn, 2012) (De Coen et al., 2012)		0/2	0
5. **Anthropometry** - Weight ↑	(Haire-Joshu et al., 2008)	(Leahy et al., 2008)[V]		1/2	-[F]/0 [V]
- Height ↑		(Leahy et al., 2008)[V]		0/1	0[V]
- BMI ↑		(Leahy et al., 2008)[V]		0/1	0[V]
6. **Dietary patterns** F&V intake ↑			(Natale et al., 2014)	1/1	+

Determinant ***(and, for dichotomous variables, reference group (ref); for continuous variable, direction)***	**Association[1] between determinant (at baseline) and change in F&V consumption over time** **–**	**0**	**+**	**N studies reporting a – or + association**	**Summary[2]**
INTERPERSONAL					
7. **Maternal age** ↑	(Klohe-Lehman et al., 2007)[V]	(Cameron et al., 2014)[F], (Klohe-Lehman et al., 2007)[F]	(Cameron et al., 2014)[V]	2/2	0
8. **Parental education** Maternal education ↑		(Cameron et al., 2014)[F], (De Bock et al., 2012), (Wolfenden et al., 2014)	(Bayer et al., 2009), (Cameron et al., 2014)[V]	2/4	??
Paternal education ↑		(Wolfenden et al., 2014)	(Bayer et al., 2009)	1/1	0
9. **Occupation**. Maternal never been in employment (ref=ever been employed)		(Klohe-Lehman et al., 2007)[V]	(Klohe-Lehman et al., 2007)[F]	1/1	+[F]/0[V]
10. **Family income** ↑		(Wolfenden et al., 2014)		0/1	0
11. **Parental weight** ↑		(Haire-Joshu et al., 2008)		0/1	0
12. **Feeding practices** Coercive/authoritarian ↑		(Leahy et al., 2008)[V] (O'Connell et al., 2012)[V]		0/1	0[V]
Restriction ↑		(O'Connell et al., 2012)[V]		0/1	0[V]
13. Peer **role modelling** ↑			(O'Connell et al., 2012)[V]	1/1	+[V]
ENVIRONMENTAL					
14. Teacher education/experience ↑		(Witt and Dunn, 2012)		0/1	0
15. Classroom size ↑		(Witt and Dunn, 2012)		0/1	0
16. Number of snack time opportunities (at childcare centre) ↑		(Witt and Dunn, 2012)		0/1	0

[1]An association (or no association) as reported in the primary paper of the cohort study between the determinant of interest and the change in fruit and/or vegetable intake over time; + or – associations which were reported with statistical significance are highlight against a background of light blue.
[2]Where **≤3 studies per determinant**: '0' represents 0-33% of findings support a + or - association; '?' represents 34-59%, and '+' or '-' represents 60-100%. Where **≥4 studies per determinant**: '00' represents 0-33% of findings support a + or - association; '??' represents 34-59%, and '++' or '--' represents 60-100%.[F]= fruit consumption only, [V] = vegetable consumption only

3.4.1.1 Prospective cohort studies (n=12)

Twelve studies were identified of which the majority were conducted in Europe (Alexy et al., 1999, Foterek et al., 2015, Oliveira et al., 2015, Sahota et al., 2015, Talvia et al., 2005, Vilela et al., 2014, Vollrath et al., 2012) two in Australia (Alsharairi and Somerset, 2015, Gregory et al., 2011), two in Brazil (Louzada da Costa et al., 2012, Valmorbida and Vitolo, 2014) and one in the USA (Grimm et al., 2014). Two of these studies were the longitudinal control group data from RCTs (Louzada da Costa et al., 2012, Talvia et al., 2005). Studies were published between 1999 and 2015. Sample sizes ranged from 78 to 12739, and children's age at baseline from birth to less than 7 years. Time from baseline (when determinant of interest was assessed) to outcome assessment (fruit and vegetable consumption) ranged from just a few weeks to 6 years.

3.4.1.2 Intervention studies (n=14)

Fourteen intervention studies were included; seven in the USA (Haire-Joshu et al., 2008, Klohe-Lehman et al., 2007, Leahy et al., 2008, Natale et al., 2014, O'Connell et al., 2012, Whaley et al., 2010, Witt and Dunn, 2012), two in Germany (Bayer et al., 2009, De Bock et al., 2012) and Australia (Cameron et al., 2014, Wolfenden et al., 2014), and one each in the Netherlands (Reinaerts et al., 2007), Belgium (De Coen et al., 2012), and Sweden (Nyberg et al., 2015). Studies were published between 2007 and 2014. Sample sizes ranged from 49 to 1340, and children's age at baseline from 3 months to 6 years. Intervention duration ranged from four weeks to two years, and follow-up from immediately after the intervention to two years.

Six of the intervention studies claimed to have been underpinned by theory; Social Learning Theory (SLT) or Social Cognitive Theory (SCT) (n=2) (Bayer et al., 2009, Klohe-Lehman et al., 2007), the Social Ecological Model (n=1) (De Coen et al., 2012), or a combination of theories (n=3) (De Bock et al., 2012, Haire-Joshu et al., 2008, Whaley et al., 2010), two of which used SLT or SCT alongside other theories or frameworks (De Bock et al., 2012, Haire-Joshu et al., 2008). Ten of the intervention studies were targetted at the child, parent, and/or preschool childcare setting (i.e. individual, interpersonal, environmental domains of the SEM); one study (Whaley et al., 2010) targetted parents only.

3.4.1.3 All included studies

In total 23 of the 26 studies measured both fruit and vegetable consumption (Alsharairi and Somerset, 2015, Bayer et al., 2009, Cameron et al., 2014, De Bock et al., 2012, De Coen et al., 2012, Foterek et al., 2015, Gregory et al., 2011, Grimm et al., 2014, Haire-Joshu et al., 2008, Klohe-Lehman et al., 2007, Louzada da Costa et al., 2012, Natale et al., 2014, Nyberg et al., 2015, Oliveira et al., 2015, Reinaerts et al., 2007, Sahota et al., 2015, Talvia et al., 2005, Valmorbida and Vitolo, 2014, Vilela et al., 2014, Vollrath et al., 2012, Whaley et al., 2010, Witt and Dunn, 2012, Wolfenden et al., 2014), of which six (Cameron et al., 2014, Gregory et al., 2011, Klohe-Lehman et al., 2007, Reinaerts et al., 2007, Sahota et al., 2015, Wolfenden et al., 2014) reported fruit and vegatable outcome data separately. Two studies (Leahy et al., 2008, O'Connell et al., 2012) measured vegetable consumption only, and one study (Alexy et al., 1999) measured fruit consumption only. Three studies reported an objective measure of fruit and/or vegetable intake (Leahy et al., 2008, O'Connell et al., 2012, Wolfenden et al., 2014); objective measures in this context were defined as weighing food consumed and/or direct observational data recorded by the (independent) researcher. The remainder (n=15) reported subjective outcome measures ('self-reported' by proxy, usually the mother), and most of these studies used food frequency questionnaires to collect data. Four studies were rated as being of low methodological quality (Klohe-Lehman et al., 2007, Leahy et al., 2008, Reinaerts et al., 2007, Whaley et al., 2010), and the remaining studies were scored as intermediate. A total of 17 potential determinants were identified.

3.4.1.4 Individual determinants (n=7)

Nine intervention (Bayer et al., 2009, De Bock et al., 2012, De Coen et al., 2012, Haire-Joshu et al., 2008, Klohe-Lehman et al., 2007, Leahy et al., 2008, Reinaerts et al., 2007, Whaley et al., 2010, Witt and Dunn, 2012) and six cohort (Alexy et al., 1999, Louzada da Costa et al., 2012, Sahota et al., 2015, Talvia et al., 2005, Vilela et al., 2014, Vollrath et al., 2012) studies highlighted determinants within the individual domain. Only gender and age were identified in four or more studies, however associations concluded that between 0-33% of these studies supported an association with fruit and vegetable intake. Results therefore illustrated that gender and baseline age did not determine change in fruit and vegetable consumption over time.

One study (Sahota et al., 2015) identified ethnicity as a determinant of fruit and vegetable intake. Fruit consumption of British Pakistani children was more likely to increase, compared with White British children, over time. The opposite was true for vegetable consumption. One (Reinaerts et al., 2007) of two studies (De Bock et al., 2012, Reinaerts et al., 2007) comparing non-natives with native children found that vegetable consumption of non-native Dutch children was more likely to increase over time.

Only two studies (De Coen et al., 2012, Witt and Dunn, 2012) were identified that reported an indication of SES i.e. level of income, education, occupation, or any combination of these as a potential determinant; neither showed an association between SES and change in fruit and vegetable consumption.

Two of the studies included in this review provided data about body fatness as a potential determinant (Haire-Joshu et al., 2008, Leahy et al., 2008). In general, there was no association between body fatness and change in fruit and vegetable consumption, although one study (Haire-Joshu et al., 2008) did find that children of ideal weight were more likely to increase their fruit and vegetable consumption over time.

One study (Vollrath et al., 2012) provided information about child temperament as a potential determinant. Children who exhibited an externalising temperament (hyperactive/aggressive) were more likely to decrease their consumption of fruit and vegetables over time compared with children who did not exhibit this behaviour, and children who exhibited a surgency temperament (active/sociable) were more likely to increase their consumption of fruit and vegetables over time compared with children who did not exhibit this behaviour.

Two studies (Alexy et al., 1999, Vilela et al., 2014) found that children who had higher intakes of fruit juice, sugar sweetened beverages (SSB), confectionary, and/or salty snacks, were more likely to have lower intakes of fruit and vegetables over time.

3.4.1.5 Interpersonal determinants (n=7)

There was some evidence that children of older mothers who have lower intakes of vegetables over time (Klohe-Lehman et al., 2007), and children of mothers that are more educated have higher intakes of fruits and vegetables over time (Bayer et al., 2009, Cameron et al., 2014). There was also evidence that children of mothers who had never been employed (compared with those who had or were currently employed) have higher intakes of fruit over time (Klohe-Lehman et al., 2007). Only one study reported on parental weight as a determinant; parent weight was not a determinant of fruit and vegetable intake in their children (Valmorbida and Vitolo, 2014).

Interestingly two studies found that children of mothers who use authoritarian feeding practices are more likely to have lower fruit consumption over time (Gregory et al., 2011). Maternal role modelling and peer fruit and vegetable consumption were identified as predictors of higher intakes of vegetables in children over time (Gregory et al., 2011, O'Connell et al., 2012).

3.4.1.6 Environmental determinants

Only one study reported on environmental determinants (Witt and Dunn, 2012). However no associations were found for teacher experience, classroom size and timing of snack given within a childcare setting.

3.5 Discussion

In summary, the best available evidence (results from a minimum of two prospective cohort studies per determinant) identified in this systematic review suggests that the consumption of lower levels of fruit juice and SSB's, and higher levels of fruit and vegetables consumed in infancy are associated with a greater increase at approximately seven years of age. In addition, maternal coercive/authoritarian feeding practices are associated with a lower increase in fruit intake. Results from intervention studies, where available, supported these findings. In addition, two studies (one cohort and one intervention) identified role modelling as a determinant of greater increases in vegetable intake. Of note, for most determinants which were identified as part of this systematic review were identified in only one or two studies.

There was no consistent evidence that age or gender were determinants of changes in fruit and vegetable intake in young children. Also, the limited information identified around SES suggests that socioeconomic inequality is not a determinant of change for fruit and vegetable intake in young children. Athough there was no SES determinants of fruit and vegetable intake in young children in this review, such determinants have been identified in older children (Zarnowiecki et al., 2014). This may suggest that socioeconomic inequalities, at least as they relate to fruit and vegetable intake, may be less apparent in young children compared with older children and adults. However, individual studies included in this review suggested that ethnicity may be a determinant of fruit and vegetable intake. For example, in a study conducted in the UK (Sahota et al., 2015), British Pakistani children were more likely to eat more fruit, and less likely to eat more vegetables, compared with White British children.

There was no significant relationships identified between child or parental fatness and fruit and vegetable intake in the child over time. Of course, this is not to say that absolute values did not differ.

Modifiable interpersonal level determinants which may be associated with higher intakes of vegetables over time include parental role modelling and peer fruit and vegetable consumption. In addition, maternal coercive/authoritarian feeding practices may be associated with lower intakes of fruit over time. These findings support previous work which shows that exposure, particularly repeated exposure, to a variety of fruits and vegetables and their associated flavours, alongside watching others around you (role models and peers) enjoy eating these foods, is a determinant of young childrens fruit and vegetable consumption (Birch and Fisher, 1998, Wardle et al., 2003, Horne et al., 2004, Lowe et al., 2004).

There was one study identified (Witt and Dunn, 2012) that provided relevant information on potential determinants of the school or childcare environment; teacher education or experience, classroom size, and the timing of snack offered to the child at the childcare centre. However, none of these potential determinants were found to significantly increase or decrease fruit or vegetable intake in young children. There were no studies identified that provided relevant information on potential determinants of fruit and vegetable consumption at a policy level,

although it must be recognised that there are such examples of practice in the primary school setting (e.g. free provision of fruits and vegetables), and evaluations of these appear positive (Driessen et al., 2014).

The interpretation of the results of this review requires careful consideration, given the limitations identified below, and also the problem of correlation versus causation. Although this review has identified some determinants (or exposures) as being associated with subsequent change in fruit and vegetable intake, this does not prove that that they are causative. There is a certain degree of uncertainty inherent in the evidence reviewed, given that it is impossible to determine if there are uncontrolled variables.

3.6 Strengths and Limitations

The strengths of this review included its limitation of consideration of determinants to the best available source of information, in the form of prospective studies (rather than cross sectional or serial cross sectional studies). An additional strength was its inclusivity in terms of determinants identified, since no a priori list of determinants was included in the protocol. Also, the review was conducted with rigor and is reported in this paper according to PRISMA guidelines (Moher et al., 2009).

However, there are a number of important limitations of the work. First, the main reason for conducting a systematic review is to collate all empirical evidence that fits pre-specified eligibility criteria in order to answer a specific research question. It uses explicit, systematic methods that are selected with a view to minimizing bias, thus providing more reliable findings from which conclusions can be drawn and decisions made. Although methods used were sound, most determinants identified in this systematic review were assessed in only one or two studies. In effect, for these determinants, one can consider this work as a scoping review, where results from individual studies are being reported (rather than making a judgement about the the collective findings from a number of studies).

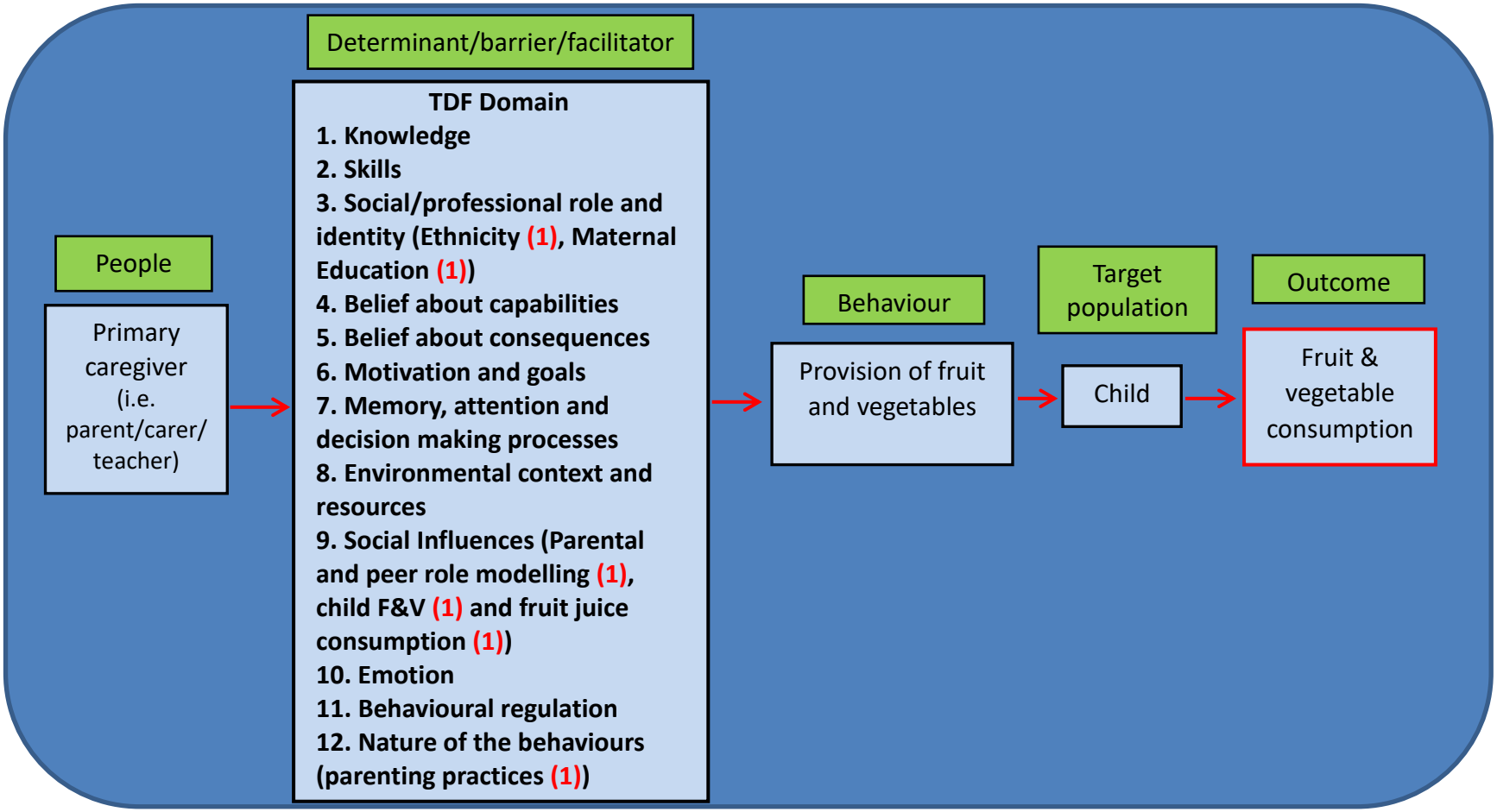
On observing the quality and variability of the dietary change data of the studies included in this review there appeared to be no trend in the level of impact of a determinant on change in fruit and vegetable intake over time by dietary assessment method. This too could potentially be a limititation. Furthermore, most of the dietary assessment methods used have not been validated in young children, for either their ability to reliably assess a valid dietary intake at one point in time, or change over time. However it is difficult to measure dietary intake in general, and particularly in young children, given that the food and drink they are offered does not always end up in their stomachs and digested. For this reason, it is perhaps understandable that many researchers have avoided trying to assess young children's dietary intake, particularly over time, and this issue is likely to be one of the reasons for the limited evidence base we identified in this review.

Finally, the studies identified varied in the age of the child at baseline, and duration of study. Although tracking of dietary behaviours has been shown to start in the early years, it is clear that the degree of tracking becomes greater with the age of the child (Craigie et al., 2011, Fletcher et al., 2017, Mikkilä et al., 2005, Ambrosini et al., 2014). However this systematic review did not attempt to control for this, and examined all included studies together by determinant,which again could be acknowledged as a limitation.

3.7 Conclusion

The quantitative evidence base on the determinants of fruit and vegetable consumption in young children is limited, but the best available evidence suggests that lower fruit juice and SSB intake, higher fruit and vegetable intake, non-authoritarian feeding practices, and positive role modelling are all consistently positively associated with increased fruit and/or vegetable intake in children before they reach seven years of age.

Figure 12: Presentation of refined model of determinants



(1) Determinant identified in systematic review

3.8. Description of refined model of determinants

The model presented on the previous page includes determinants identified as part of the quantitative systematic review which were discussed earlier in this chapter. It must be noted that the TDF was not originally used as a method of analysis for this review. As previously stated this review was part of a suite of reviews coordinated by Cambridge University to explore energy related behaviours and therefore adheres to the methods specified in the original protocol (Lakshman et al., 2013). However for the purpose of this thesis, results (determinants identified) have been mapped onto the corresponding TDF domains for consistency of methods, reporting and progression of the model.

In this chapter the following determinants were identified as having a possible impact on parental provision behaviours and child fruit and vegetable consumption: child fruit and vegetable intake, child fruit juice intake, ethnicity, maternal education, parental and peer role modelling. These determinants were coded to the corresponding TDF domain/s and added to the refined model of determinants (Figure 12).

There were limited determinants identified in this chapter. However, this review only included prospective (longitudinal) and intervention evidence. Therefore other (i.e. cross sectional and qualitative) evidence should also be explored in order to highlight any important additional determinants that may exist and to consider the relationship between these determinants to increase inclusivity. An attempt will be made to capture this data in chapter 4.

Chapter 4: Exploring barriers and facilitators of fruit and vegetable provision and consumption in pre-school children: a mixed methods meta-synthesis

4.1 Introduction

Parents and caregivers bestow much responsibility for shaping the way children behave from infancy, for example by modelling these very behaviours themselves (Anzman et al., 2010, Palfreyman et al., 2015) . Evidence generated in Chapter 3 suggests that intrapersonal factors (those involving parents and caregivers of children) are more likely to be influential in determining fruit and vegetable consumption in young children which is also supported by previous evidence in this area (Collins et al., 2014, Scaglioni et al., 2018). However, understanding how and why these determinants have such an impact needs to be investigated further. This mixed methods review aimed to identify both barriers and facilitators to fruit and vegetable provision by parents and professional caregivers, to understand the complexities of these behaviours and to further develop the model of determinants. The decision to include evidence on both parents and professional caregivers was made as both are responsible for caring for children and therefore there was a need to review survey and qualitative literature on determinants which was not explored in Chapter 3. It was hoped that evidence generated in this chapter would help provide an all-encompassing picture of determinants and inform subsequent phases of this research.

4.2 Research questions and objectives

What are the determinants of fruit and vegetable provision behaviours among professional caregivers and parents of children aged 0-6 years?

Objectives:

1. To identify existing qualitative and survey research exploring parents and professional caregivers perspectives of provision of fruits and vegetables to pre-school children.
2. To explore the theoretical determinants of professional caregivers and parents behaviours which influence pre-school children’s fruit and vegetable consumption.

3. To identify professional caregivers and parents behaviours that may act as barriers or facilitators to pre-school children's fruit and vegetable consumption.

4.3 Methods

4.3.1 Searching

An intensive search strategy was utilised for the purpose of this review, comprising of a three phase process inclusive from inception up until August 2016;

1. Eight electronic databases were searched with no language or period restrictions. These included: Medline, Embase, Cinhal, Psychinfo, Web of Knowledge, British Nursing Index (BNI), Applied Social Sciences Index and Abstracts (ASSIA) and Sociological Abstracts. (See search strategy, Appendix 5). Retrieved articles were imported to an EndNote database and de-duplicated.
2. A reference list search of all included papers and related reviews.
3. A Google Scholar search was carried out using key words (fruit and vegetable consumption, fruit and vegetable provision, pre-school children, caregivers, parents, views and perceptions, surveys, questionnaires) to include the first 100 hits.

Phases 2 and 3 were performed to capture any additional studies which were not identified in the database searches.

4.3.2 Screening

Title and abstract screening of all studies was performed by two researchers independently (CO and HM). Any discrepancies were discussed and a third reviewer (NH) consulted to resolve and disputes. Full papers were retrieved for all potentially eligible studies identified by title and abstract screening, and assessed for inclusion by two reviewers independently (CO and NH). Any descrepancies were discussed until a firm decision was agreed.

4.3.3 Inclusion/exclusion criteria

Studies were included if they applied a qualitative method (e.g. focus groups, interviews) or survey method (e.g. questionnaires) to investigate pre-school children's parents and/or professional caregivers perceptions of determinants of the provision of fruits and vegetables to the child/ren in their care. All non-peer reviewed, unpublished, or review studies, and those reported in any other language than English were excluded. Studies specifically focussing on children with existing health conditions (such as dental caries, asthma, cerebral palsy, cystic fibrosis etc.) were also excluded.

4.3.4 Data extraction and quality appraisal

A standardised data extraction template was developed. Details on the following were extracted; study context and design, participant characteristics, data collection, analysis methods and direct quotes/results (Appendix 6).

Quality appraisal of studies was performed using previously defined quality assessment criteria for qualitative and survey study design seperately (Evidence for Policy and Practice Information and Co-ordinating Centre, 2010). For qualitative studies criteria focused on assessing both internal and external validity of the studies including; whether the research question was clearly stated, approach appropriate for the research question, qualitative approach clearly justified, study context clearly described, role of the researcher clearly described, sampling methods clearly described, sampling strategy appropriate for research question, method of data collection clearly described, data collection method appropriate, method of analysis clearly described, analysis appropriate for the research question, and conclusions supported by sufficient evidence. Each study was assigned a score based on criteria met and categorised accordingly (High quality: $\geq$10; Medium: 9-6; Low: $\leq$5). For survey studies the following categories were given consideration; background and justification, appropriateness of; methods, sample selection, research tools, results, response rates, interpretation and discussion and ethics and disclosure. Studies were categorised as very good, good to very good, good or limited. If studies included both qualitative and survey data, they were given a score for each component.

Data extraction and quality assessment was performed independently by two researchers (CO and NH or HM). Results were compared and any discrepancies resolved through discussion between both researchers. A third reviewer (CS) was also available to resolve any disputes but was not needed.

4.3.5 Data analysis

Data was independently coded by two reviewers (CO and NH) using a framework synthesis approach which has been used succesfully in a previous review (Heslehurst et al., 2014). Using a framework provides a systematic yet flexible model for managing and mapping data and facilitates the coding process (Dixon-Woods, 2011). The decision was made to use the original 12 domain version of the framework rather than the updated 14-item version (Cane et al., 2012) due to the purpose which it was being used for, namely secondary analysis rather than primary data collection and issues relating to subjectivity when classifying results into domains.

The framework used for the purpose of this review is an adapted version of the the 12 domain TDF (Michie et al., 2005).

The TDF was used as an a priori framework for the initial data coding stage of the synthesis. A coding manual (Appendix 7) was developed to operationalise the TDF for the context of this specific review. Relevant data on parental and professional caregiver behaviours which are barriers to, or facilitators of, fruit and vegetable provision were coded to the relevant domain/s.

4.3.6 Development of coding manual

The process of developing the coding manual involved two researchers (CO and NH) independently coding data to the 12 TDF domains from a sample of six of the included studies, and comparing for consistency in coding the data to each domain. Where there was agreement that a specific concept represented a domain then this was incorporated into the coding manual. For example; if both researchers independently agreed that data on parental role modelling behaviours represented the domain “social influences”, then the concept of role modelling was added to the coding manual as an example of data for that domain. Examples of all concepts that may be included in the context of this study are

provided in the coding manual (Appendix 7). Any discrepancies about which domain the coded data represented were discussed between reviewers and the agreed concepts were incorporated into the coding manual.

There were circumstances where it was not clear which domain a concept belonged to, for example data relating to parents wanting to learn how to prepare fruit and vegetable recipes was inconsistently coded as “knowledge” or “skills”. In such cases, independent advice was sought from health psychologists with TDF expertise (Professor Falko Sniehotta and Dr James Newham, Newcastle University) to help refine working definitions and clarity within domains. The development of the coding manual was an iterative process of refinement and testing for consistency in coding between researchers. New data was coded until there was a high level of agreement between both reviewers of the type of data that represented the TDF domains in the context of this research question.

Once the final coding manual was agreed to be context specific, CO coded all of the data in all included studies (including those used for the development of the coding manual). Validation of these was performed by NH who assessed 20% of included studies and independently coded this data. The remaining studies were reviewed by NH for agreement of coded concepts in line with the coding manual. Disagreements with coding were discussed further and agreed. This coding comparison and agreement process allowed for the identification of any discrepancies whereby a health psychologist (Professor Falko Sniehotta) was consulted. This occurred on only one occasion relating to how to contextualise data relating to feedback from the child and how this then might influence the parental/caregiver’s decision making processes.

Data synthesis was undertaken using a three stage process as outlined by Heslehurst et al 2014 (Heslehurst et al., 2014);

1. Framework coding: All relevant data was coded to the TDF domains, including participant quotations, statistical results from the survey studies and any other data, in the results section of the included studies. Data not directly relevant to the determinants of parents or professional caregivers fruit and vegetable provision behaviours was not coded for the purpose of this review (Studies

reporting fruit and vegetables among other food provision behaviours (e.g. sugar sweetened snacks and drinks)

2. Frequency analysis: The cumulative frequency of coding for each domain across all included studies was identified to establish which domains were most frequently reported in the entire dataset. The number of included studies which reported data for each domain was also identified to establish frequency that the domains were present across studies. This stage was carried out to determine if a domain with a high cumulative frequency (i.e. total number of times coded) was skewed by high coding in a small number of studies, or whether it was a domain that was consistently reported across a large number of studies.

3. Thematic synthesis: A technique previously used was followed to carry out thematic synthesis of data within each domain (Thomas and Harden, 2008). Data was open-coded using a line-by-line coding technique, according to it's meaning and context. Descriptive themes were then developed, depending on similarities identified within the data. Interpretation of data into analytical themes followed. This allowed for data to be considered collectively, characterising relationships between themes and domains, and established whether or not these were barriers or facilitators to professional caregivers and parents fruit and vegetable provision behaviours.

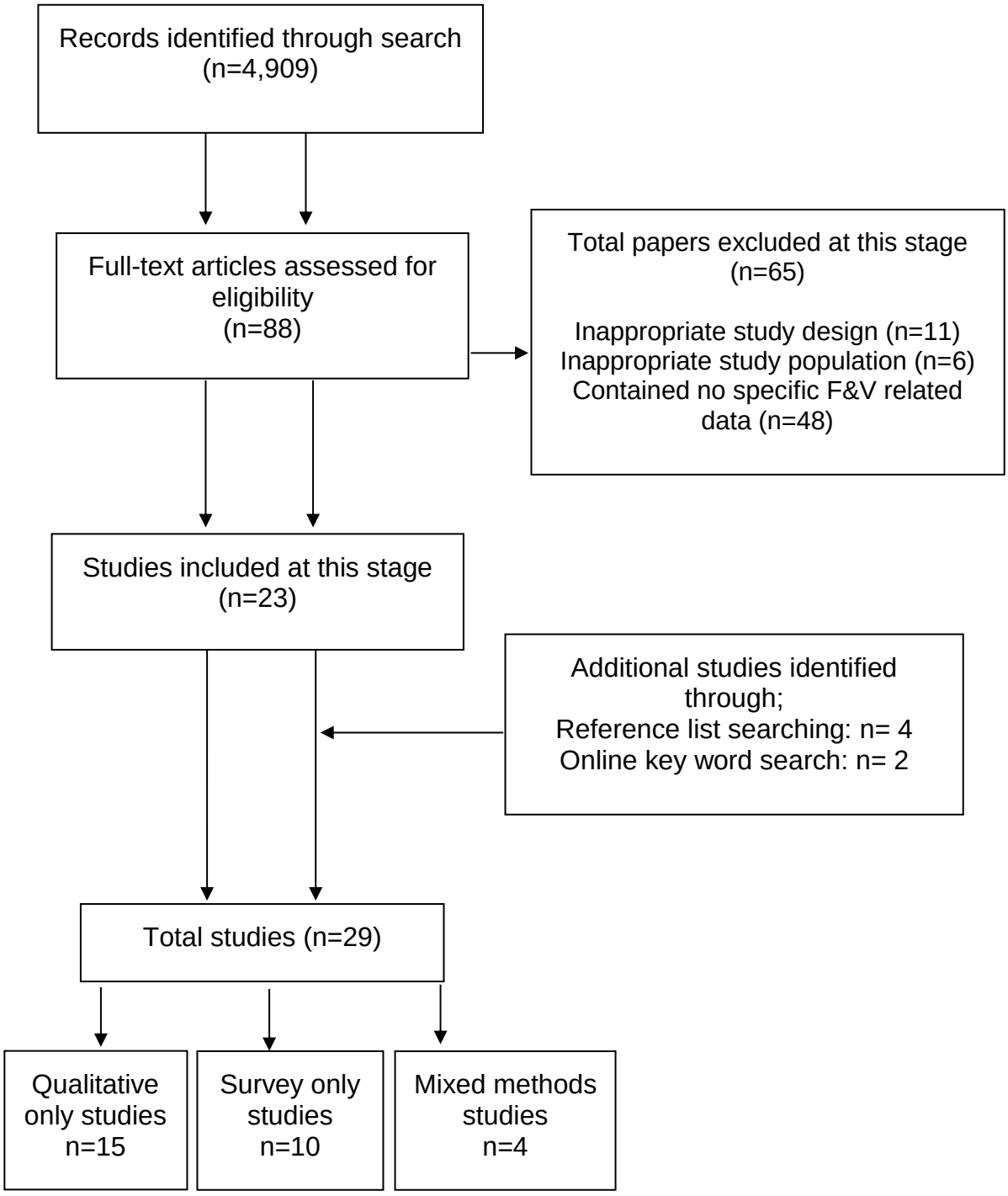
Results are reported according to corresponding TDF domains, and supported by verbatim quotations from the included studies.

4.4 Results

The database search, after de-duplication yielded 4,909 results (Figure 13: PRISMA flow diagram); 88 full text articles were assessed independently for inclusion. Of these, 65 were exluded for a number of reasons including; inappropriate study design (n=11), inappropriate study population (n=6) and inappropriate data (i.e. contains no fruit and vegetable specific data) (n=48). An additional six studies were identified through reference list (n=4) and online searching (n=2). Authors of included studies were contacted via email to request further information in relation to two studies of interest; however, none of the information was relevant for inclusion in this review and was therefore excluded.

Fifteen of the studies included qualitative data, ten studies reported survey data, and four were mixed methods design including both qualitative and survey components.

Figure 13: PRISMA flow of studies included in the review



4.4.1 Study characteristics and quality assessment

There were 29 studies retrieved in total (Bauer et al., 2012, Beltran et al., 2011, Carnell et al., 2011, Cooke et al., 2003b, Crombie et al., 2009, Fleischhacker et al., 2007, Hayter et al., 2015, Herman et al., 2012, Hildebrand and Shriver, 2010, Hingle et al., 2012, Horodynski et al., 2010, Johnson et al., 2015a, Mita et al., 2013, Nanney et al., 2007a, Norman et al., 2015, Omar et al., 2001, Pagnini et al., 2007, Papaioannou et al., 2013, Peters et al., 2014, Rodríguez-Oliveros et al., 2011, Shriver et al., 2010, Sinley and Albrecht, 2015, Sweetman et al., 2011, Vereecken et al., 2010, Wardle et al., 2005, White et al., 2011, Wyse et al., 2011, Nanney et al., 2007b, Sherry et al., 2004) of which 15 were qualitative only, 10 survey only and four were of mixed methods design. Characteristics for all included studies can be seen in Appendix 8. Seventeen studies originated from the United States, six from the UK, three from Australia and one each from Mexico, Sweden and Belgium. Studies spanned from 2001 to 2015 with the majority being published between 2011 and 2015 (n=17). Twenty seven studies included parental data, one professional caregiver (i.e. teacher) and one both. Eleven studies claimed to have been theory driven; yet in some, explanations for approaches seemed vague, simply stating use rather than application. However a number of studies provided good explanation of theories and application (Beltran et al., 2011, Fleischhacker et al., 2007, Shriver et al., 2010). Examples of theories used included; Transtheoretical Model of Behaviour Change, Information, Motivation and Behavioural Skills Model and Self Determinantion Theory.

All included data related to parents and professional caregivers of pre-school aged children between the ages of 2 and 5 years. For those studies containing qualitative data only (n=15), the majority were rated as high quality (n=11), three were considered intermediate and the remaining one low. Of the survey only studies (n=10), two were deemed to be good-very good, five were good and the remaining three were limited. Of the mixed methods studies (n=4), the qualitative components were rated as high (n=3) and intermediate (n=1), and the survey components as either good-very good (n=1) or good (n=3).

4.4.2 Coding frequency analysis

The total number of codes assigned to the dataset was 806 and the domains most frequently identified included ‘nature of the behaviours’ (coding frequency n=182), ‘social influences’ (coding frequency n=178), and ‘knowledge’ (coding frequency n=171). The least identified domain was ‘behavioural regulation’ (coding frequency n=2). Those domains which were present across the greatest number of studies were ‘social influences’ (n=25) and ‘nature of the behaviours’ (n=22). Although ‘knowledge’ had a high coding frequency, only half of the included studies were coded to this domain. In comparison, the ‘environmental context and resource’ domain was coded less frequently than knowledge (coding frequency n=92) but was more consistently represented across studies (n=15 studies). The coding frequency table (Table 8) indicates the number of times a domain is coded, how many barriers and/or facilitators were identified and the number of studies in which the domain in question appears. Coding for barriers was highest in ‘social influences’ and ‘environmental context and resources’, however both of these domains also presented a high frequency of facilitators. The ‘nature of behaviours’ and ‘knowledge’ domains reported the highest number of facilitators.

Table 8: Domain coding frequency table

Domain	Number of times	B	F	Number of Studies
Knowledge	171	33	138	14
Skills	18	16	2	6
Social/professional role & identity	23	2	21	9
Belief about capabilities	11	8	3	4
Beliefs about consequences	68	8	60	12
Motivation and goals	25	11	14	10
Memory, attention and decision making processes	22	13	9	7
Environmental context and resources	92	51	41	15
Social Influences	178	85	93	25
Emotion	14	10	4	6
Behavioural Regulation	2	0	2	2
Nature of the behaviours	182	39	143	22

B: Barriers; **F**: Facilitators

4.4.3 Thematic analysis

Results within each domain are discussed in greater detail below, including a summary overview of the key results for each domain, followed by a detailed description of the themes. Examples of coded results are presented in Appendix 9 whereby data is highlighted in terms of whether or not it is considered as either a barrier (red) or facilitator (green) to fruit and vegetable provision.

4.4.3.1 Domain 1. Behavioural Regulation

Summary: There was very little data coded to this domain, none relating to professional caregivers and only two studies (each coded once) involving parents. In these studies, pre-planning meals and repetition of behaviours, such as scheduling meals to include fruits and vegetables at the same time every day, were facilitators of fruit and vegetable provision.

> *Parents who were actively trying to serve more fruits and vegetables to their children and repeating this on a regular basis were more likely to continue to do so in the future. Consistency and pre-planning of meals appeared to facilitate provision. In addition to this repetition of such tasks improved parental self-efficacy to perform the behaviour* (linked with *belief about consequences* domain). (Papaioannou et al., 2013)

4.4.3.2 Domain 2. Belief about Capabilities

Summary: There was no data available for professional caregivers. For parental studies this domain was coded on 11 occasions with the majority being facilitators to provision (n=8). Parents who felt confident in their own abilities were more likely to provide fruits and vegetables.

There were three studies which highlighted a link between experience in preparing and handling of fruits and vegetables. Those parents who were confident in their own abilities and prepared fruits and vegetables on a regular basis were more likely to try new recipes and tasks, in turn facilitating provision.

4.4.3.2.1 Experience and confidence

Both barriers and facilitators within this theme were identified. There appeared to be a link with experience and confidence in relation to fruit and vegetable preparation and trying new methods and recipes (Hildebrand and Shriver, 2010, Shriver et al., 2010, Sinley and Albrecht, 2015). Those parents who were confident in their own abilities were more likely to try new recipes and tasks, whereas parents who were less inclined to try new things lacked confidence, which then had an impact on provision.

> *Self-efficacy for serving fruits and vegetables at home appeared to be high* (Hildebrand and Shriver, 2010)

> *Parents and guardians in the action/maintenance stages reported having higher self-efficacy to serve fruit and vegetables* (Shriver et al., 2010)

Parents who were less confident in their abilities reported preparing the same fruit and vegetable recipes on a regular basis and reported becoming bored with

the repetitive nature of the dishes. Some parents believed that it was easier for them to get their children to eat fruit as opposed to vegetables.

> *Focus group participants indicated that they often prepare the same meals repeatedly and "get into ruts" because they lack confidence to try new recipes and offer a variety of different fruits and vegetables to their family* (Sinley and Albrecht, 2015)

> *Parents/guardians also confirmed that their children consumed more fruit than vegetables and felt that it was much easier to make their children eat fruit than vegetables* (Shriver et al., 2010)

Parents shared mixed views on their abilities to meet recommendations. Again, parents who were highly confident felt they were more likely to achieve daily recommendations, whereas others who doubted their abilities admitted that they struggled to do so. Some parents expressed that they found it a challenge to provide up to three portions of fruits and vegetables per day and overall had limited success of meeting daily requirements.

> *Other important factors were stating that providing 2–3 portions of fruit daily was not easy…….* (Crombie et al., 2009)

4.4.3.3 Domain 3. Beliefs about consequences

Summary: One professional caregiver study and 11 parental studies were coded to this domain. The domain coding frequency was 68 of which eight were barriers and 60 facilitators to provision. Beliefs that children would achieve a state of "good health" and meeting recommendations were most frequently described consequences of consuming fruits and vegetables, and were important drivers for caregivers to provide. Parents often gave examples of the detrimental health consequences of a diet low or deficient in fruits and vegetables which also acted as a facilitator for provision. Caregivers believed that explaining both the positive and negative health outcomes to children would encourage them to eat more. Parents discussed the consequences of allowing children the freedom to choose their own foods. Views were mixed with some believing children would always choose unhealthy alternatives to fruits and vegetables and others thought the

responsibility would result in them making more healthy, independent food choices in the future.

4.4.3.3.1 General health

Both professional caregiver and parents believed that consumption of fruits and vegetables provided general health benefits to children and that these benefits were essential for lifelong health. Embedding fruit and vegetable behaviours at an early age was thought to play an important role in achieving and maintaining health later in life.

> *Overall, participants perceived that eating FV among pre-schoolers is linked to children's positive health outcomes* (Mita et al., 2013)

> *"I believe strongly that eating healthfully, including eating more vegetables is an important part of keeping my child healthy"* (Beltran et al., 2011)

> *Development of good eating habits…."I just want them to have good eating habits in the long run" (Discussing expectations of behaviour and health status associated with fruit and vegetable consumption)* (Hingle et al., 2012).

4.4.3.3.2 Specific health benefits

Professional caregivers spoke of how fruits and vegetables provided the body with much needed energy, whereas parents believed there was a link between improved social and cognitive development as well as physical benefits.

> *"…they are with me from 8.30 until 2.30 and they need some type of vegetables or fruits in their body to keep them going through the day"* (Mita et al., 2013)

> *"When you eat healthy food, certain types of vegetables they boost the, I guess endorphins in your brain are to think better versus the sluggish foods…so I guess it'll help you with the brain, you know"* (Beltran et al., 2011)

Consumption of fruits and vegetables and weight was mentioned in three studies, with a higher intake being linked to better weight management (Fleischhacker et al., 2007, Hingle et al., 2012, Rodríguez-Oliveros et al., 2011). Parents listed fruits and vegetables which they believed would benefit the child and help prevent obesity…*orange, banana, tangerine, apple, strawberry, watermelon* etc (Rodríguez-Oliveros et al., 2011). One parent stated their own weight status acted as a prompt to provide more fruits and vegetables for fear of their child experiencing the same issues in the future.

> *"After she got that big belly (I started to talk to the childcare providers about food). My kids starting to look like mom. And, I'm like, I don't want her to get so heavy, like me…."* (Fleischhacker et al., 2007)

4.4.3.3.3 Meeting recommendations for health

Consequences and importance of meeting recommended daily amounts or what parents deemed to be sufficient amounts of fruits and vegetables were discussed in a number of studies. If children were believed to be meeting guidelines, then parents thought that this would result in positive health benefits. Parents believed that if children did not consume "enough" fruits and vegetables, they would not be able to obtain vitamins and minerals in order to maintain health. Parents believed that if recommendations were not being met, this would result in nutrient deficiencies, leading to detrimental effects on health. In three studies parents listed and array of ailments associated with a low fruit and vegetable intake such as gastrointestinal problems, increased frequently of illness, development of nutrient deficiencies, increased behavioural problems, tendencies for junk foods, likelihood of becoming overweight, delayed development and lack of energy resulting in an inability to take part in physical activity (Beltran et al., 2011, Hingle et al., 2012, Johnson et al., 2015a).

> *"It's very important because I worry if she's getting enough iron and vitamins…."* (Hingle et al., 2012)

> *"I cook fruits and vegetables because they have nutrients"* (Shriver et al., 2010)

> *"The nutritious attribute of getting the vitamins and minerals and all of that from the vegetables and how it really aids into being a healthier person…"* (Beltran et al., 2011)

4.4.3.3.4 Parenting practices and health consequences

Parents and professional caregivers discussed the consequences of using different parenting practices and the impact this has on provision. Views were somewhat mixed with some believing if they were more lenient and allowed the child to make their own fruit and vegetable choices, this would lead to healthier independent choices in the future. However, others felt that using a more permissive parenting approach would result in their children not consuming any fruits and vegetables as they would always choose the more unhealthy alternatives and would often be drawn to other distractions (such as playing) if given the choice.

> *"…It'll help them be healthier on their own. Their decision making would be a lot better other than choosing the sugar or choosing the chips all the time"* (Beltran et al., 2011)

> *"Mothers reported that children would often say they were full so they could go play or avoid eating a food item they disliked"* (White et al., 2011)

Although there were mixed views relating to parenting practices, a number of parents and teachers were in agreeance that caregivers should be encouraging and that fruits and vegetables should be provided a number of times before it is successfully accepted by the child (repeated exposure – linked in with *nature of the behaviours* domain). Some also recognised that using force may not result in positive responses from the child.

> *"The older two won't eat Brussel sprouts but I normally just put a couple on there and eventually they will try them and like them. I think it's the learning isn't it?"* (Carnell et al., 2011)

The majority of professional caregivers recognised they should not force children to eat fruits and vegetables and also noted that children might not like eating them if they push them too hard (Mita et al., 2013)

Using health consequences as a means of encouraging children to eat more fruits and vegetables was used in both parent and professional caregiver studies.

> *"Oh, you're going to be so big and strong"* (Mita et al., 2013)
> *Teach the child that eating fruits and vegetables will make them strong and healthy* (Papaioannou et al., 2013)

However some parents spoke of the barriers faced, including the difficulties and frustration encountered when trying to get their child to eat fruit and vegetables. Some reported feeling unable to influence their child's behaviour (*linked up to belief about capabilities domain*) and felt that it would be pointless providing more fruits and vegetables as the child would dismiss it through dislike *(linking up to social influence domain)*. The consequence of this assumed dislike resulted in parents simply not providing any fruit and vegetables through fear of rejection (linking up to *nature of the behaviours* domain)

> *"Why cook vegetables if he does not eat it"* (Shriver et al., 2010)

> *"They don't really eat hardly anything, I can't find a way where I can just give it to her and make her enjoy the fruits and vegetables"* (Hayter et al., 2015)

4.4.3.4 Domain 4. Emotion

Summary: Data from six studies were coded to this domain. The coding frequency was 14, of which ten were barriers and four facilitators to fruit and vegetable provision. Negative emotional responses dominated. Teachers spoke of feelings experienced when children refused to eat fruit and vegetables such as frustration, whereas parent's displayed feelings of worry in relation to the maintenance of good health through adequate consumption.

4.4.3.4.1 Negative emotion

Negative emotional responses were experienced by both professional caregivers and parents in relation to providing fruit and vegetables to children in their care. Professional caregivers gave various negative emotional responses when asked about challenges surrounding the child's rejection of fruit and vegetables including words such as "sad", "frustrated", "upsetting" and "exhausted" (Mita et al., 2013). Emotional stress and frustration was also apparent in parents when discussing provision mechanisms such as cost and shopping situations (barriers as identified in the *environmental context and resources domain*).

> *"…..and you are spending all of your money getting where you need to go and it's* ***horrible****; because I have to tell those kids I don't have enough money for you to have vegetables at lunch."* (Sinley and Albrecht, 2015)

Parents described feeling overwhelmed in shopping situations with the pressures of restricting junk food and food choice. These feelings were intensified when shopping with children (linked with the *social influences* domain).

> *"Sometimes I will take 'em (referring to kids), I will pick one up you know what I mean, but I just get* ***overwhelmed****. It is just so much, like I can't debate on whether or not, you know, you try not to have so much junk food"* (Fleischhacker et al., 2007)

Concerns and worry in relation to child eating behaviours as a result of the effects others had on their child were highlighted (linked with the *social influences* domain). Data was identified on a number of occasions in two parental studies (Hingle et al., 2012, Norman et al., 2015).

> *''It's very important because I* ***worry*** *if she's getting enough iron and vitamins because sometimes when I take her to the doctor, he'd say it's just a little bit on the low side"* (Hingle et al., 2012)

> *Parents expressed* ***concerns*** *regarding food choices connected to fruits and vegetables… barriers included the child's or another family members dislike of vegetables* (Norman et al., 2015)

4.4.3.4.2 Positive emotion

Reporting of positive emotion was limited; however, in one study parents discussed feeling proud to act as role models to their children (linked to the *social influences* domain). In another, parents described the sensation of being pleasantly surprised at the fact their child ate meals containing vegetables (eaten in nursery) which they did not expect (linked to the *social influences* domain).

> *Across formative and evaluative groups, mothers reported that they realised and* ***relished*** *being role models for their children* (White et al., 2011)

> *"I noticed that [the child] came home and said that he had eaten skin coloured beans with ground beef. 'What, did you eat chili con carne?' 'Yes, it was really good', he said, and I would never have thought that!"* (Norman et al., 2015)

4.4.3.5 Domain 5. Environmental Context and Resources

Summary: Fifteen studies were coded to this domain, two professional caregiver and thirteen parental. The coding frequency was 92, of which 51 were barriers and 41 facilitators. Teachers spoke of children's rejection of fruits and vegetables (linked with *social influences* domain) and said they would be less accepting of them if they were spoilt, did not look aesthetically pleasing or they did not like the texture. Teachers believed that ensuring fruits and vegetables were readily accessible and reducing cost would improve provision. Fruits and vegetables were deemed to be expensive, with parents choosing not to provide them due to cost implications. Seasonality and wastage were also mentioned as barriers to provision. Resources were discussed frequently as having an impact on provision such as time, financial implications and transport. Parents also discussed consequences of different food environments and how this might impact on children's fruit and vegetable consumption and their ability to provide such as the supermarket, nursery or restaurant. Having the resources to grow their own, using frozen alternatives when preparing meals and simply having fruits and vegetables in the view of the child, within easy reach and in an accessible format were strategies that facilitated provision and/or consumption.

4.4.3.5.1 Professional caregivers

Teachers spoke of children's negative response to the appearance and texture of fruits and vegetables. They believed that if a child was unaccepting of the appearance and averse to the texture they would be unwilling to try/consume it.

> *The majority of teachers mentioned that children reject eating fruits and vegetables because of the texture (e.g. mushy) and appearance (e.g. black spots on bananas)* (Mita et al., 2013)

Professional caregivers recognised that accessibility and affordability were key barriers to provision and suggested ways of overcoming these problems such as encouraging caregivers to grow and use their own produce. Stakeholders described how having the opportunity to take part in such programs had been successful in improving consumption and had a positive impact in other areas such as improving knowledge and fitness.

> *"….Community stakeholders suggested that these programs have been effective at addressing numerous aspects related to fruit and vegetable intake, "They were learning the value of hard work and exercise with gardening…and what's good to eat and how to eat it"* (Sinley and Albrecht, 2015)

4.4.3.5.2 Parents

4.4.3.5.2.1 Home food environment

Parents spoke frequently of the importance of availability and accessibility of in the home. They believed that their own ability to provide could potentially have an impact on child consumption. Some claimed to have fruits and vegetables on view so that children could easily access it should they wish.

> *Participants claimed to provide healthy food in the home (fruit, vegetables and healthy snacks) for children to independently access* (Peters et al., 2014)

> *To place fruits and vegetables where your child can easily reach them….To make sure that fruit and vegetables are available around the*

> *house (listed methods used to enhance availability)* (Papaioannou et al., 2013)

Having fruits and vegetables in a format that is easy to consume for the child by pre-preparing it (i.e. chopped/peeled) facilitated consumption. If fruits and vegetables were readily available then they were more likely to be consumed.

However although such practices were seen to increase the possibility of consumption, many did not follow these. Some parents did provide variety however failed to prepare the fruits and vegetables hence reducing accessibility. Suggesting that, by simply having the fruits and vegetables present and in abundance is not enough to guarantee consumption.

> *Multiple regression analysis indicated that a higher fruit and vegetable consumption was significantly associated with having fruit and vegetables stored in a ready to eat format…..While, on average, households had almost 22 different types of fruit and vegetables available in the house, fewer than half of those households (39%) kept both fruit and vegetables in a ready-to-eat accessible format* (Wyse et al., 2011)

4.4.3.5.2.2 Out of home

Parents described how other environments had an effect on provision and consumption. They spoke of difficulties faced when supermarket shopping such as overcrowded shops, long queues and a lack of variety.

> *…Parents were most likely to agree that there was very little variety of fruits and vegetables where they buy their groceries* (Bauer et al., 2012)

> *"The supermarket is sometime really overcrowded….I don't like long lines"* (Fleischhacker et al., 2007)

For some parents they described eating out as being a problem, stating the fruit and vegetable options were limited. However others felt that options were good but admitted that when they ate out, they did not want to consider eating fruit and

vegetables and some simply did not want to spend money on purchasing them (linked with *memory, attention and decision making processes* domain).

> *Some parents/guardians thought that it was difficult to eat in restaurants. However the majority of parents/guardians did not want to think about fruits and vegetables when eating out* (Shriver et al., 2010)

> *Many discussed how grocery shopping (such as fruits and vegetables) is money and they do not like to spend money on food* (Fleischhacker et al., 2007)

4.4.3.5.2.3 Nursery and school environment

Some parents of reception-aged children believed that the school environment did not provide their children with any fruits and vegetables and if they did, parents often thought that this was not enough. Others felt that schools did not know (*linked with knowledge domain*) what constitutes healthy food and stated that they tended to serve less healthful options.

Parents felt the school environment had a negative influence, particularly school canteen options:

> *"but what they (schools) class as healthy is not…and you can't get a single piece of fruit in the canteen"* (Peters et al., 2014)

> "*They (nursery school) do give them snacks at school, like fruits and vegetables, but it's not as often. They should really give them more"* (Sinley and Albrecht, 2015)

In other studies, parents felt that their children would be more inclined to eat foods in the nursery environment that they wouldn't usually eat at home, therefore encouraging fruit and vegetable consumption (*linked with social influences domain*).

> *[my daughter] is eating a lot more vegetables now since she's started school dinners because she's seeing other children around her eating*

them and she's slightly better at school because they've got all their friends. And they're all [eating], aren't they? (Hayter et al., 2015)

4.4.3.5.2.4 Affordability

Cost of fruits and vegetables was seen as a barrier to provision in seven of the studies (Fleischhacker et al., 2007, Hayter et al., 2015, Hildebrand and Shriver, 2010, Hingle et al., 2012, Omar et al., 2001, Shriver et al., 2010, Sinley and Albrecht, 2015). Many parents believed that eating healthily would cost them more. Supermarkets were commented on as being places where fruits and vegetables were generally overpriced.

Many parents had a perception that healthy food was too costly…."having fresh fruits and vegetables on a daily basis is expensive" (Hayter et al., 2015)

The results from the survey revealed that the intentions to serve more fruits and vegetables were significantly impeded by the negative aspects…including costs (Shriver et al., 2010)

Caregivers communicated that affordability limits them in their purchases of fruits, vegetables, and healthful foods in general (Sinley and Albrecht, 2015)

Seasonality played a role in cost implications with parents noting that fruit and vegetables that were not in season were particularly expensive, making them more unobtainable due to the increase in cost.

"One of my big concerns is sometimes, like right now the vegetables and fruits are in season, yeah, they're cheap but once you get in winter months the stuff that's cheap now goes skyrocketing in price and sometimes money's thin" (Omar et al., 2001)

However, there were examples where parents believed that fruit and vegetables were inexpensive, but these parents had access to local (and often cheaper) markets as opposed to having to shop in larger supermarkets.

> *Some parents thought that fruits and vegetables were among the cheaper foods to buy…"The guys [market stall holders] that sell the fruit for a pound…they're great"* (Hayter et al., 2015)

The temporal nature of affordability was discussed with some parents describing how they were unable to purchase fresh fruit and vegetables at the end of the month due to limited funds.

> *"Because we get paid monthly, so the week before payday were really skint and it's like running the freezer and the cupboards down…."* (Hayter et al., 2015)

4.4.3.5.2.5 Other resources (time, practical resources and transport)

In addition to cost implications parents in several studies expressed that they did not have enough time to shop and/or prepare fruits and vegetables. Others expressed a need for more practical resources such as recipe ideas to improve knowledge, practical skills and ultimately provision. Many parents felt they needed tips, recipe ideas and easy to access procedural instructions on how to prepare fruit and vegetables and include them in meals.

> *"….they needed tips on how to offer fruits and vegetables and how to combine them with other food their child liked. Nearly all parents were interested in learning tasty and easy recipes*" (Shriver et al., 2010)

> *"Like, it's a hand in hand thing. If I want to cook healthy meals for my family but I don't have the resources"* (Sinley and Albrecht, 2015)

> *The results of the FV survey revealed that the intentions of parents/guardians' in lower stages of change to serve more FV were significantly impeded by the negative aspects of making FV available, including the cost of FV, the amount of* ***time*** *necessary for preparing FV and the number of trips to the store necessary to purchase FV…* (Shriver et al., 2010)

> *Requests for nutrition education classes included…new recipes…*(Hildebrand and Shriver, 2010)

> *Nearly all parents were interested in learning tasty and easy recipes…*(Shriver et al., 2010)

Transportation and associated costs were also highlighted as a barrier to provision. Some parents spoke of having to depend on others to take them shopping if they did not own a car and/or were unable to drive, and others felt that the costs of transport prevented them from having money to spend on purchasing fruit and vegetables.

> *"I need the food so I got to get someone to take me" (many relied on family, neighbours, a taxi-like service, or public transport to get to and from the grocery store)* (Fleischhacker et al., 2007)

> *"And a lot of the time you have no transportation to get to the store….and all you are spending all of your money getting to where you need to go and it's horrible; because I have to tell those kids I don't have enough money for you to have vegetables at lunch"* (Sinley and Albrecht, 2015)

4.4.3.5.2.6 Food wastage, shelf-life and spoilage

Food being spoilt and wastage was mentioned in numerous studies with some reporting that food from supermarkets was not always fresh at the point of purchase. Cost was also linked to wastage and parents spoke of spending money on various items which tended to have a short shelf-life.

> *…they (parents) were more likely to report that where they buy groceries the fruit and vegetables were in poor condition* (Bauer et al., 2012)

> *Sometimes stuff is not fresh there (discussing supermarket shopping)* (Fleischhacker et al., 2007)

> *"Not only can it be costly to purchase it (fruit and vegetables)…but then if it's not used within a short amount of time then it gets thrown out"* (Hingle et al., 2012)

Parents reported that if the fruit and vegetable produce did not look at their freshest then they would be less likely to purchase them and children would refuse to eat them (*linked with social influences domain*).

Parents also had fears that if a food was spoilt and/or not prepared in the right manner it could potentially be harmful to the child. This in turn prevented parents from purchasing certain items, if they deemed them to be at a higher risk of spoilage.

> *Caregivers communicated concerns regarding best practices to keep their food from becoming harmful to their families…."Some vegetables are worse (for spoiling) than others" (referring to Tomatoes and spinach)* (Sinley and Albrecht, 2015)

> *Several parents mentioned the possibility of increased pesticide with increased vegetable consumption if food was not washed and peeled.* (Hingle et al., 2012)

4.4.3.5.2.7 Coping strategies

Despite the aforementioned barriers, there were various strategies that parents used to combat these, hence facilitating provision. Making the best use of available resources, reducing costs and limiting food waste were discussed. Parents mentioned cooking with canned or frozen vegetables and others used food coupons as a means of reducing shopping costs.

> *…they (parents) frequently purchased canned or frozen because of the extended shelf-life, convenience and expense* (Hildebrand and Shriver, 2010)

> *"That's handy for stuff like shepherd's pie, I just chuck in those mixed veg and that's fine" (discussing frozen vegetables)* (Hayter et al., 2015)

> *"The Sunday paper is my best friend"…some, but not most, parents used coupons when out shopping* (Fleischhacker et al., 2007)

Growing and eating home grown fruits and vegetables (*linked with nature of the behaviours domain*) was also deemed to be cost effective. In addition to this studies observed that children were more likely to eat and enjoy fruit and vegetables if they had grown it themselves.

> *Children from families who consumed home-grown fruits and vegetables more frequently preferred more fruits and vegetables* (Nanney et al., 2007a)

> *Caregivers discussed gardening programs as an option to defer the costs of fruits and vegetables* (Sinley and Albrecht, 2015)

4.4.3.6 Domain 6. Knowledge

Summary: There were fifteen studies coded to this domain, two professional caregiver and 13 parental. The coding frequency for this domain was 171 of which 33 were barriers and 138 facilitators. Both professional caregivers and parents demonstrated a good understanding of fruits and vegetables and their effects on general health. However they lacked knowledge surrounding nutritional guidance, wanted to know what effects specific nutrients had on bodily functions and expressed a need for more educational resources to facilitate their learning. Professional caregivers spoke frequently of wanting to increase fruit and vegetable knowledge with the aim of improving the health of the children in their care and felt that knowledge was a key component to increasing consumption. Parents were keen to increase procedural knowledge in relation to preparing fruits and vegetables and were open to using a variety of resources to do so. They also discussed wanting to learn alongside their children which they felt would be mutually beneficial. Their understanding of fruits and vegetables, their origin and uses were mixed and although at times parents spoke confidently of their knowledge this was not always correct.

4.4.3.6.1 Professional caregivers

Teachers spoke of involving children in the learning process and how education played a central role in helping them understand why they should eat fruit and vegetables. They also recognised that education was equally as important for themselves and parents in order to increase consumption among young children.

> *"children are with me 8.30 until 2.30 and they need some type of vegetables or fruits in their body to keep them going through the day"* (Mita et al., 2013)

> *Teachers reported that they used fruit and vegetable-related information (e.g. where and apple comes from) to get pre-schoolers to eat fruit and vegetables during mealtimes* (Mita et al., 2013)

> *(Participants expressing what they believe to be important when increasing consumption/provision of fruits and vegetables) "It's the knowledge and desire to cook healthy food for your family…I really feel it's education, that's the main thing…I think it's education all the way through. Teach them (parents) how to go to the grocery store. Teach them how to make a list"* (Sinley and Albrecht, 2015)

Professional caregivers sometimes thought that they lacked knowledge and spoke frequently of their desire to learn more.

> *The majority of teachers, however, emphasized their lack of knowledge…One teacher said, "How the fruits and vegetables can be good for their body health, I want to learn more about that."* (Mita et al., 2013)

> *Participants communicated a need and a desire to increase knowledge regarding fruits and vegetables* (Sinley and Albrecht, 2015)

4.4.3.6.2 Parents

4.4.3.6.2.1 Conceptualisation of fruits and vegetables

Parents confidently named fruits and vegetables and specified their origin (e.g. the ground, from root, trees etc.) however this information was not always accurate. They were also able to give examples of various fruits and vegetables, the majority of which were identified correctly. They also understood that a selection could be combined to make a dish and what type of meal time this would be appropriate for i.e. breakfast, snack etc. However some parents felt that fruit should only be given once a main meal had been eaten (linked with *nature of the behaviours*).

> *"Usually if they eat everything, then they will get the fruit. I would consider it more of a dessert."* (Johnson et al., 2015a)

4.4.3.6.2.2 What makes fruits and vegetables 'healthy'?

Parents described that fruits and vegetables were healthier alternatives to other foods and that those that were "natural" were healthier than those that were processed.

> *"Fruits and vegetables are healthier than a bag of chips"* (Shriver et al., 2010)

> *"Some fruits have a lot of sugar, like the canned fruit"* (Fleischhacker et al., 2007)

In other studies various cooking methods and storage were thought to alter the nutritional properties of fruits and vegetables, with many parents believing that fresh were always healthier than frozen or tinned alternatives.

> *"use the least amount of cooking oil possible"* (Parent discussing healthful cooking practices) (Rodríguez-Oliveros et al., 2011)

> *In general, parents understood general health benefits provided by fruits and vegetables, although they believed fresh produce was healthier* (Hildebrand and Shriver, 2010)

> *Nearly all parents believed that fresh fruits and vegetables are best and that frozen and canned vegetables contain a lower amount of nutrients* (Shriver et al., 2010)

4.4.3.6.2.3 Knowledge and recommendations

Parents felt they would have to increase their child's intake of fruit and vegetables to meet recommendations. However knowledge surrounding recommended daily amounts was mixed. In three studies (Crombie et al., 2009, Fleischhacker et al., 2007, Nanney et al., 2007b) parents believed that eating between three and five portions each day was sufficient enough in order to maintain health; however some felt this amount was not achievable. In addition to the qualitative evidence, the survey analysis as reported by Crombie et al (2008) reported that children were likely to have a poor diets if mothers though that the recommendations were less than five pieces of fruits and vegetables per day (OR=3.05, 95% CI 1.35, 6.92).

> *Most parents believed children should eat fruit and vegetables three times a day for good health* (Nanney et al., 2007b)

> *"…something you need three to five a day, don't eat that either"* (mother of child) (Fleischhacker, 2007)

4.4.3.6.2.4 Knowledge relating to why parents provide fruits and vegetables

(linking up with *motivation and goals* domain. i.e. having knowledge acts as a motivator to provision)

4.4.3.6.2.4.1 General health benefits

Parents made various statements in relation to the general health benefits of fruit and vegetables which were all positive. The majority of parents believed that they were good for children, aided development, provided the body with nutrients and formed the basis of a healthy diet and lifestyle.

> *Fruits and vegetables are nutritious, good for you, help you grow…* (Fleischhacker et al., 2007)

> *The level of mother's general knowledge about the benefits of a healthy diet was very high.* (Crombie et al., 2009)

4.4.3.6.2.4.2 Fruit and vegetable properties

In a number of studies, parents frequently discussed the properties of fruit and vegetables and gave this as the reason for providing their child with them in order to improve health. Parents deemed them to be high in both vitamins and minerals, low in sugar and rich in antioxidants.

> *"I serve fruits and vegetables to my kids because I want to give them healthy food…I cook fruit and vegetables because they are healthy and have nutrients"* (Shriver et al., 2010)

Although parents knew that they were beneficial for the body some parents had incorrect knowledge of specific nutrients and their associated health benefits.

> (Talking about vegetables and what they do for the body*)…"they have something with acids, fluoride acid…..fruits are high in proteins"* (Fleischhacker et al., 2007)

> *"The more vegetables a child intake is best for them than like the more starchy; like that is going to break down and not be good to run. She needs to run."* (Johnson et al., 2015a)

Parents also spoke of specific fruits and vegetables and the effect these had on the body. Again such beliefs acted as a facilitator to provision even if the knowledge behind them was incorrect.

> *"Pears give you iron….carrots make your teeth strong and your eyesight"* (Fleischhacker et al., 2007)

4.4.3.6.2.4.3 Health outcomes and deficiencies

Parents discussed various health outcomes and consequences as a reason for wanting to provide their child/children with fruit and vegetables (linked to *beliefs*

about consequences domain). Parents believed that having a diet rich in fruit and vegetables would help prevent disease such as obesity and cancer, have a positive effects on specific bodily functions and social health. They also discussed how obtaining the 'right' amount of nutrients would prevent deficiencies and associated diseases.

> *"Fruits and vegetables help maintain a stable weight"* (Shriver et al., 2010)

> *Fruits and vegetables give you regular, good bowel function, keep skin healthy, help eyesight…gives you energy, makes the body feel great…gives you self-esteem…fights infection..* (Fleischhacker et al., 2007)

> *"More fruit and vegetables could help prevent cancer"* (Crombie, 2008)

> *Like some fruits and vegetables help like to reduce the risk of cancers and stuff like that.* (Sinley and Albrecht, 2015)

4.4.3.6.2.5 Awareness of knowledge

On occasion parents recognised they lacked general fruit and vegetable knowledge and expressed a desire to know more about their properties and function. A lack of procedural knowledge when preparing fruit and vegetables was also evident. Parents felt they would benefit from additional resources/lessons to enhance understanding and improve their cookery skills (linked with the *environmental context and resources* and *skills* domain) and some believed that children should be involved in this learning process.

> *Caregivers requested information regarding specific health benefits of fruits and vegetables….as one focus group participant stated "I don't even know what all of the vegetables are so something (resource) to tell me this is what it is good for"* (Sinley and Albrecht, 2015)

> *Several parents/guardians expressed a lack of knowledge about how to cook vegetables for their children……Nearly all parents were interested in*

> *learning tasty and easy recipes that would be appealing to their children, particularly for vegetables.* (Shriver et al., 2010)

> *Requests for nutrition education classes included cooking with children….*(Hildebrand and Shriver, 2010)

Some parents shared their experiences of how using resources and involving children has the potential to increase knowledge and help facilitate provision.

> *"Just recently I've planted a veggie patch with the kids and trying to read more books about getting them involved in planting and the watering and the whole growing cycle so they could have a bit more of a connection with what will come into their mouths this summer, you know as the salad bowl comes to the table"* (Peters et al., 2014)

4.4.3.7 Domain 7. Memory, Attention and Decision Making Processes

Summary: Data from seven parental studies were coded to this domain. The coding frequency was 22, with 13 barriers and nine facilitators to the provision of fruits and vegetables. There was no data for this domain from professional caregivers. Parents reported providing children with fruits and vegetables as opposed to unhealthier alternatives based on the belief that this would support the child's health and development (linked with *knowledge* domain). Choices to provide were often influenced by children's preference (both actual and perceived) and parental habit. Some parents spoke of their decision not to think about provision when engaged in other activities.

4.4.3.7.1 Alternative food offerings and decisions to provide

Data relating to parents decisions to provide fruit and vegetables, or not was mixed. Although some parents provided unhealthy options, others made the decision to provide fruit and vegetables as healthier substitutes.

> *Parents choose to use fruits and vegetables for snacks instead of cookies and chips.* (Papaioannou et al., 2013)

> *Countering, or replacing a less healthful behaviour with a healthful one was also a commonly used behavioural strategy.* (Hildebrand and Shriver, 2010)

In addition to this some parents consciously chose to use their free time to prepare fruit and vegetables which facilitated the likelihood of provision.

> *If you've got five minutes while someone's having….a sleep or something like that, you can pre-cut the vegetables for later on that evening and things like that*… (Hayter et al., 2015)

However others found making fruit and vegetables accessible to their child difficult when engaged in other tasks such as shopping. Parents did not want to think about food options and often felt rushed into making a decision which meant they forgot to do the "healthy" behaviour, i.e. provide fruits and/or vegetables.

> *….when I'm in a rush I feel overwhelmed (to choose)….Sometimes I will take em (referring to kids), I will pick one up you know what I mean, but I just get overwhelmed. It is just so much, like I can't debate on whether or not, you know, you try not to have so much junk food* (Fleischhacker et al., 2007)

4.4.3.7.2 Decisions influenced by child preference (linked with *social influences* domain)

The majority of studies coded to this domain discussed how decisions made by parents to provide fruit and vegetables were influenced strongly by child preference. If parents believed that the child/ren preferred a particular type of food then they would be more likely to serve it. Parents expressed difficulties in attempting to increase their child's fruit and vegetable consumption due to their reluctance to eat and/or try them. Some chose not to introduce new foods containing unfamiliar fruits and vegetables through fear of the child's rejection of the food. However, there were parents who felt that repeated exposure could play a positive role in increasing provision (linked with *nature of the behaviours* domain).

> *To ensure that their children would eat what was offered, many mothers made "known favourites or asked their children what they wanted to eat".* (White et al., 2011)

> *Lack of children's preferences for fruits and vegetables, especially vegetables, emerged as a negative aspect of serving them to children.* (Shriver et al., 2010)

> *Mothers identified with the idea that "new foods take time" and liked an emphasis on having "patience" with their children during the process.* (White et al., 2011)

However, one study also reported that a lack of parental attention to cues from the child influenced their provision behaviours.

> *Inadequate child-parent interplay also appeared as a barrier, where parents failed to recognise the child's preference for vegetables.* (Norman et al., 2015)

4.4.3.8 Domain 8. Motivation and Goals

Summary: There were 10 studies coded to this domain, two professional caregiver and eight parental. The coding frequency was 25, of which 11 were barriers and 14 facilitators to provision. The primary motivator for both professional caregivers and parents to provide fruit and vegetables was the belief that it would have a positive impact on the child's health (linked with *beliefs about consequences* and *knowledge* domains). However barriers noted differed between the two. Teachers often thought parents may not be providing fruit and vegetables in the home environment, making them more compelled to provide during nursery/school hours. Parents spoke frequently of other competing factors which hampered their ability and intention to provide including time, cost and hectic lifestyles (linked in with *environmental context and resources* domain).

4.4.3.8.1 Health motivators

Teachers discussed wanting to have a positive impact on child health by providing healthy foods, they felt that some children may not be provided with

fruit and vegetables at home and this belief acted as a motivator for them to provide and encourage consumption in school.

> *As positive motivators, the majority of professional caregivers mentioned that they wanted to expose pre-schoolers to healthy food at school…..they also mentioned that they wanted to help their students develop healthy eating habits for a child's development and growth, because their students may not be exposed to healthy food at home* (Mita et al., 2013)

Health related motivators were also common amongst parents.

> *"I serve FV to my kids because I want to give them healthy food. FV are the most important food of the day"* (Shriver et al., 2010)

Having an adequate fruit and vegetable consumption and meeting recommendations were considered important motivators for parents. If parents considered consumption to be adequate then this would provide children with the nutrients they needed for growth and development. Some parents also indicated that their child/children were not meeting recommendations and this also acted as a motivator for them wanting to provide more.

> *Several parents wished to increase their child's vegetable consumptions* (Norman et al., 2015)

> *All parents stated it was "important" or "very important" that their child ate at least three servings of fruits and vegetables per day…..However most stated that their child did not meet guidelines* (Hingle et al., 2012)

4.4.3.8.2 Competing priorities

In attempting to meet guidelines and increase provision, parents noted a number of competing factors which interfered with or lowered the intention of them performing the behaviour. For example; time constraints, busy lifestyles, cost and child behaviour were all identified as barriers influencing the intention to provide (link with *environmental context and resources* domain).

> *Most mothers reported having busy, sometimes hectic schedules. For some, this busy schedule extended to the evening meal, which they described as "quick" or "rushed."* (White et al., 2011)

> *It is difficult to find time to cook in the evening* (Bauer et al., 2012)

> *The results of the FV survey revealed that the intentions of parents/guardians' in lower stages of change to serve more FV were significantly impeded by the negative aspects of making FV available, including the cost of FV, the amount of time necessary for preparing FV, and the number of trips to the store necessary to purchase FV.* (Shriver et al., 2010)

Child behaviour, in particular neophobia was discussed as having a detrimental impact on provision (linked in with *social influences* domain). Parents felt frustrated and that it would be pointless providing fruit and vegetables through fear of them being repeatedly rejected.

> *Reasons for not meeting guidelines were often framed as "being a struggle" or "losing battle" with children. As one mother put it, "well, it's important. I would like for her to but I just know that it's a losing battle"* (Hingle et al., 2012)

4.4.3.9 Domain 9. Nature of the Behaviours

Summary: Data from 22 studies were coded to this domain, 20 parental and two professional caregiver. The coding frequency was 182, of which 143 were facilitators and 39 barriers. Professional caregivers actively used encouragement as a means of coaxing children to consume more fruit and vegetables. They believed that educating children in their care was important and that that education in the home environment was not always sufficient. Parents discussed frequency of provision and gave examples of meals and snacks they provided that contained fruit and vegetables. They also spoke of using a variety of convenience foods and preparation methods to save time when cooking (linked with *environmental context and resources* domain). As with professional caregivers parents used encouragement as a means of increasing consumption,

however unlike teachers some parents felt a need to educate their children on the possible detrimental effects that a diet deficient in fruit and vegetables may have on health. A number of studies found that authoritarian parenting practices were related to a decrease in consumption, whereas those with a semi-authoritarian style (e.g. restriction of snacks yet non-forceful in nature) are likely to have a more positive impact on the child resulting in an increase in consumption. Parental strategies to facilitate consumption included; playing games, providing rewards, involving children in food preparation, disguising fruit and vegetables in other foods and altering its flavour to make it more appealing to the child. Practising traditional mealtime behaviours such as sitting together as a family, eating at regular times and not watching media all appeared to facilitate provision.

4.4.3.9.1 Professional caregivers

Professional caregivers discussed various strategies they used in order to increase consumption of fruit and vegetables. Teachers felt that educating children was an important mechanism to increasing provision and consumption (linked with *knowledge* domain). They actively encouraged children by informing them of the health benefits using age appropriate language. However they also felt that that if they applied to much pressure on a young child it could have detrimental consequences.

> *"Fruits and vegetables are good for you…..oh you are going to be so big and strong"* (Mita et al., 2013)

> *"I really feel its education, that's the main thing…I think it's education all the way through"* (Sinley and Albrecht, 2015)

> *"I'm trying to encourage them. I don't want to run them away either, you know, I feel like there is a fine line…if you push too hard depending on the child they may not be accepting of that"* (Mita et al., 2013)

Teachers also discussed their thoughts on challenges to provision, stating they found it difficult introducing children to new foods and naming parents and family

(linked with *social influences* domain) as one of the main barriers to children not consuming enough fruit and vegetables.

> *"Challenges are sometimes parents…they won't eat with their children at home, their families won't eat fruits and vegetables…it's something new that's being introduced to them, so trying to get them to at least try it, that's a major challenge"* (Mita et al., 2013)

4.4.3.9.2 Parents

Parents frequently gave examples of when they would serve fruits and vegetables, for example as snacks or with other foods to form part of a meal. They also spoke of serving fruit and vegetables as alternatives to other less healthy options.

> *"A lot of times she'll ask for something sweet like "Can I have a biscuit?" and I'll say no, but you can have a yoghurt or an apple or a banana"* (Carnell et al., 2011)

Frequency of provision was variable among studies with some claiming to provide more than three portions per day, however there was no evidence to suggest that recommendations (of five portions per day) were being met in any of the studies. Mothers often doubted their ability to provide more than three portions per day (linked in with *beliefs about capabilities* domain).

> *Parents provided their children with fruits and vegetables more than three times a day.* (Wyse et al., 2011)

> *Mother's views on the provision of fruits was that they were not likely to provide 2-3 portions of fruit daily.* (Crombie et al., 2009)

4.4.3.9.2.1 Promoting health, education and encouragement

As with professional caregivers, parents encouraged children to consume fruits due to overall health benefits (linked up with *motivation and goals* domain). Parents spoke of using mealtimes to promote consumption through education, discussing both health benefits and consequences of a bad diet.

> *"I serve fruits and vegetables to my kids because I want to give them healthy food….Fruits and vegetables are the most important food of the day and I cook them because they are healthy and have nutrients"* (Shriver et al., 2010)

> *…to tell your child what will happen to them if they eat too many bad foods (to encourage them to eat fruits and vegetables)* (Papaioannou et al., 2013)

4.4.3.9.2.2 Convenience foods and preparation methods

Parents discussed providing ready meals instead of those prepared using fresh fruit and vegetables. An increase in ready meal provision was related to a decrease in fruit and vegetables. Conversely if fresh ingredients were used, consumption increased. Parents also spoke of using practical preparation solutions to overcome barriers, such as using frozen vegetables in dishes as opposed to fresh, saving time and facilitating consumption (linked with *environmental context and resources* domain).

> *Multiple linear regression analysis revealed liking for vegetables was negatively predicted by use of pre prepared dishes for the child's main meal…there were persistent negative associations with using ready-made sauces for the child's main meal (p=0.05).* (Sweetman et al., 2011)

Parents also spoke of using familiar fruit and vegetables through habit and lack of food preparation skills (linked with *skills* domain) instead of trying those they were less acquainted with.

> *"Parents stated that they did not know how to cook them and that their variety of fruits and vegetables was limited"* (Hildebrand and Shriver, 2010)

4.4.3.9.2.3 Parenting styles

Parenting practices and their effect on child fruit and vegetable consumption were discussed in a number of studies. Authoritarian and permissive parenting practices appeared to be related to a lower consumption compared to a more

semi-authoritarian approach which was linked to an increase in consumption. Not allowing children to decide when they are full, insisting they sit at the table, preventing them from taking part in other activities if they do not eat their fruit and vegetables and making them feel guilty for not doing so did not increase consumption more than those parents using a more negotiating parenting style. Forceful parenting practices were also linked to the child developing a dislike of fruit and vegetables.

> *More parental control was associated with less frequency of children's fruit and vegetable consumption and neophobia* (Wardle et al., 2005)

> *A significantly lower consumption of vegetables was found in children with parents that used more parent-centred (authoritarian) practices* (Vereecken et al., 2010)

However those children, who had parents that restricted snacking in between meals, were introduced to fruit and vegetables at an early age and offered them without being forced were more likely to have a higher intake.

> *Simple regression analysis found statistically significant positive associations (p <0.003) between children's fruit and vegetable consumption and only allowing children to eat at set meal times* (Wyse et al., 2011)

> *The earlier the age that the children had been introduced to fruit, the greater the child's current intake* (Cooke et al., 2003b)

4.4.3.9.2.4 Strategies to facilitate consumption

Parents used various strategies to facilitate fruit and vegetable consumption. Several mothers mentioned playing food games with children to encourage consumption and others admitted to increasing the amount of food served in hope that the child would eat more.

> *Mothers described their efforts at length, including deliberately increasing the amount of food put on children's plates and playing games…*(Pagnini et al., 2007)

> *Some parents used high levels of practical methods (e.g. played a game to get children to eat fruit and vegetables)* (Papaioannou et al., 2013)

Disguising fruit and vegetables, altering their taste and presenting them in an aesthetically pleasing way so as to appear more appealing and palatable to children were other methods parents used to facilitate consumption. Parents believed that if they did not do this then the child would simply refuse to eat the food (linked with *social influences* domain).

> *"Like we made peas and carrots and we had to put like a little bit of brown sugar in it otherwise they wouldn't even try it"* (Sinley and Albrecht, 2015)

> *Disguising food so children don't really know when they are eating vegetables (because they wouldn't otherwise eat them.)* (Peters et al., 2014)

> *"I made the food into pictures on her plate. She ate well and was persuaded to sample one or two new things" (discussing food presentation to increase consumption.)* (Carnell et al., 2011)

4.4.3.9.2.5 Child involvement

Involving children in various stages of food preparation, educating them and providing them with responsibility appeared to facilitate consumption. Parents described how they allowed their children to serve themselves at mealtimes and used practical methods such as gardening and cooking to inspire, teach and encourage them to eat more fruits and vegetables.

> *"We have plates there and then put you know like salad and fish or whatever in the middle and then they it themselves onto their own plate so sort of then yeah, doing it themselves so they sort of choose how much they eat"* (Peters et al., 2014)

> *Having children participate in cooking (listed by parents when asked of ways to encourage consumption and preference for fruits and vegetables)* (Pagnini et al., 2007)

Parents described how they would add fruit to recipes and let their children help. This allowed the child to take part in an activity they enjoy whilst hopefully increasing consumption.

> *"She likes making little cakes and jellies and things and she'd made some jelly frogs and we put some cubes of pineapple into that and cake and things so it wasn't just pure jelly"* (Carnell et al., 2011)

In contrast, mothers in one study admitted that they did not allow their child to be involved in any food preparation. Reasons given were time, safety (linked with *environmental context and resources* domain) and child ability.

> *"Many mothers reported that they did not involve their children in food preparation activities. They doubted their children's abilities to help prepare food and expressed concerns about the safety and time required for such activities."* (White et al., 2011)

4.4.3.9.2.6 Repeated exposure

Some parents believed that children would need to be exposed to a particular food on a number of occasions before they would accept it. However parents in one study reported offering their child fruit and vegetables on only two to three occasions before deciding if their child liked it and ultimately whether to continue to provide it.

> *"All you can do is when you introduce new flavours for children, it can take ten times for them to have their taste buds adjust to that one little flavour, so it's maybe getting them to try it at least once"* (Pagnini et al., 2007)

> *Many mothers reported that they only offered it to their children 2 or 3 times if the child did not like it. (study indicates that it can take up to eleven exposures before a child accepts a new food)* (White et al., 2011)

4.4.3.9.2.7 Bribery and rewards

Parents frequently spoke of using non-healthy foods such as sweets and crisps and other snacks high in fat and sugar to coax children into eating more fruits and vegetables.

> *"I give them a cookie if they eat everything at lunch"* (Shriver et al., 2010)

> *"So I'll give her that peanut butter and jelly or chicken nuggets, but she'll have to eat a vegetable….it has to balance out"* (Herman et al., 2012)

Parents described how they would use other (non-food) rewards and consequences if their child did or did not eat fruit and vegetables. Several parents described how they would reward their child with praise if they ate the fruit and/or vegetables. Others prevented their children from taking part in activities they enjoyed if they refused to eat them.

> *To keep your child from going out to play if they don't eat their fruits and vegetables* (Papaioannou et al., 2013)

Although parents reported using rewards and punishments as a means to convince their child to consume more, one study reported that they rarely acknowledged this as bribery, believing it to be acceptable behaviour.

> *"Although many mothers reported using rewards and punishments to get their children to eat more (fruits and vegetables), they did not perceive doing so as "bribing…."* (White et al., 2011)

Some parents considered fruit and vegetables to be a treat which can only be given to a child once they have eaten all of their main meal.

> *"Usually if they eat everything then they will get the fruit. I would consider it more of a dessert"* (Johnson et al., 2015a)

4.4.3.9.2.8 Mealtime behaviours

A number of studies reported that mealtime behaviour such as eating together as a family, eating the same food, at a dining table, at a regular consistent time of day facilitates consumption of fruit and vegetables (linked to *environmental context and resources* domain). Parents not eating fruit and vegetables with their children, eating as a family and those that watched television during main meals were less likely to consume or have a preference for vegetables.

> *Traditional family mealtimes were associated with higher intakes…..Family feeding practices (eating together as a family, at the same time and place) are modestly correlated with vegetable consumption (p=0.02)* (Cooke et al., 2003b)

> *"Watching TV during the main meal was associated with a lower consumption and liking of vegetables"* (Sweetman, 2011)

4.4.3.10 Domain 10. Skills

Summary: Data from six studies was coded to this domain. The coding frequency was 18 with 16 barriers and two facilitators identified. Little evidence was found in relation to skills with none relating to professional caregivers. However it was evident that parents lacked a variety of skills needed to provide fruit and vegetables to their child. They expressed a need for practical cooking skills and resources to aid procedural knowledge in relation to such skills (linked with *environmental context and resources* and *knowledge* domain). Although most studies focused on barriers, parents expressed a need and level of awareness for the skills that they lacked, which, proved to be motivators (linked with *motivation and goals* domain) for wanting to provide fruit and vegetables to their children.

4.4.3.10.1 Lack of skills

Parents felt they lacked skills and spoke of not knowing how to cook, combine ingredients and create various recipes.

> *"so something to tell me this is what this is, this is how you make it"* (Sinley and Albrecht, 2015)

> *…parents food preparation skills were reported as barriers to child vegetable consumption* (Hingle et al., 2012)

> *…other parents stated they did not know how to cook* (Hildebrand and Shriver, 2010)

Although a barrier, caregivers were able to identify skills and knowledge (linked with *knowledge* domain) required around procedural instructions and practical advice on how to prepare fruit and vegetables in recipes. They were able to provide suggestions on what types of intervention might improve such skills such as nutrition classes.

> *"I want to learn how to combine fruits and vegetables with the other foods I cook like meat and rice"* (Shriver et al., 2010)

> *There were requests for nutrition education classes including cooking with children* (Hildebrand and Shriver, 2010)

Parents also discussed the role of the media (linked to *social influences* domain) and how information relating to dietary advice can sometimes be unclear due to the sheer abundance of messages.

> *There is Confusion relating to the variety of messages (in the media) regarding the "nutritious eating" and the best ways to prepare certain fruits and vegetables* (Sinley and Albrecht, 2015)

Although the majority of data coded to this domain related to barriers, some parents claimed to produce home cooked meals on a regular basis, suggesting utilisation of good food preparation skills.

> *Seventy percent of respondents (n=301) reported cooking their child's meal from scratch five times a week or more* (Sweetman et al., 2011)

4.4.3.11. Domain 11. Social Influences

Summary: Twenty five studies were coded to this domain, two professional caregiver and 23 parental. The coding frequency was 178, of which 85 were barriers and 93 were facilitators. Professional caregivers believed that child preference influenced provision and that both parents and peers behaviours could have an impact on the child. There was a large body of parental evidence coded to this domain, primarily relating to role modelling behaviours both direct and indirect. Children with parents who consumed greater quantities of fruits and vegetables were more likely to consume more themselves. In general, parents felt that they themselves and others behaviours (e.g. peers) had an influence on their child's behaviours, however they often felt that they did not receive enough support from other family members. They also believed that, at times, others had detrimental effect on their attempts at providing fruits and vegetables, particularly at meal times. Child influence played a large role in guiding parental decisions, either through preference, perceived preference or neophobic tendencies.

Parents appeared to support the idea of allowing their child to adopt a level of responsibility for their own food choices and believed it would support development, helping them to make healthier food choices in the future. However the evidence was somewhat contradictory with some parents believing children would not make the 'right' food choices and did not possess the ability to prepare foods. Child preference and perceived child preference were discussed at length with the taste, texture and appearance of fruit and vegetables believed to influence the choices children make. Parents frequently made decisions based on child preference and enjoyment of food. Many combined fruit and vegetables with other foods to alter the taste or simply did not serve them as they believed the child would refuse to eat them as they had done so at previous attempts (linked with *nature of the behaviours* domain). In some cases parents stated they did not serve fruit and vegetables out of personal dislike and believed that their own behaviours did impact on their child's.

4.4.3.11.1 Professional caregivers

Professional caregivers recognised the importance of role modelling behaviours and believed that children's peers and parents can have both a positive and negative influence on the child's willingness to try fruit and vegetables.

> *….If a child's friends are eating FV, he or she is likely to try it* (Mita et al., 2013)

> *Conversely, if a child's friends say something negative about FV, the child is likely to hesitate to try it* (Mita, 2013)

Caregivers discussed that family and peer networks were especially important in ensuring their toddlers received a consistent message regarding fruits, vegetables and healthy eating (Sinley and Albrecht, 2015)

> *…."one of their peers says 'I don't like that!' and the next one will say, 'I don't like that either!' It's a snowball effect"* (Mita et al., 2013)

4.4.3.11.2 Parents

4.4.3.11.2.1 Role modelling behaviours: direct influences

There was a clear positive link between parental fruit and vegetable consumption and child consumption. The more the parent consumed, the more likely the child was to have a higher intake.

> *Multiple regression analysis indicated that higher fruit and vegetable consumption in children was significantly associated with a higher FV intake in parents* (Wyse et al., 2011)

> *The amount of fruit and vegetables that parents themselves reported eating was a strong predictor of their children's intake with positive correlations between adult's and child's intakes of both fruit and vegetables* (Cooke et al., 2003b)

> *Children's vegetable consumption was most strongly predicted by the child eating food similar to his or her parents for the main meal* (Sweetman et al., 2011)

Several parents also recognised that their behaviours impacted on their children.

> *"My daughter, she'll see and she'll be kind of checking it out and be like, ok, if mom is doing it so let me try this"* (Sinley and Albrecht, 2015)

In addition to this, frequency of displays of role modelling seemed to have a positive influence.

> *Parents reported that their pre-schooler saw them eat fruit and vegetables more times during the past week* (Nanney et al., 2007b)

4.4.3.11.2.2 Importance of parental role modelling behaviours

There was a shared consensus regarding the importance of parental role modelling with all agreeing that their actions were key in shaping their child's behaviours.

> *"I think it's very important for us (as parents) because were role models"* (Hingle et al., 2012)

> *(It's important) "to show your child that you enjoy eating fruit and vegetables"* (Papaioannou et al., 2013)

> *Parents not only acknowledged practicing role-modelling, but emphasized it's importance.* (Hildebrand and Shriver, 2010)

In some studies, parental role modelling was identified as being the main barrier to child consumption.

> *Although the parents/guardians were aware of their influence on children's dietary habits, a lack of parent modelling in terms of FV consumption*

emerged as one of the major barriers to children's FV consumption (Shriver et al., 2010)

4.4.3.11.2.3 Importance of role modelling by others

The role and importance of others such as grandparents, other family members, peers and school were discussed in a number of studies. In general parents discussed how others could have a positive effect on child consumption.

Parents mentioned how different family members can be role models to improve vegetable consumption (Beltran et al., 2011)

Mother or mother-in-law, siblings or sisters or brothers-in-law, and friends were also cited by some as persons whose opinions mattered (Hingle et al., 2012)

Grandparent's opinions and behaviours were regarded highly by some parents and data showed how this influenced what mothers provided to their children, particularly if these behaviours were seen to be "healthy".

"My mom has had some health conditions so she has changed the style of eating that she normally would eat. I'd like to have her approval, and I'd very much like to show her that I am making a conscious effort to feed my son good food." (Hingle et al., 2012)

General negative influences relating to food provided by other family members in the absence of parents were also identified.

"One time (my son) went to my aunt's and came back and would not calm down. And I said 'What did they give him?' I had to call her. I said 'He is entirely too hyped. What is going on with him? Why is he jittery? He can't sit down? What is going on?' She said, Oh yeah, we had some fruit snacks, and we had the regular fruit snacks not the natural kind.' I'm like, 'Oh, Lord. So that's what it is. All that sugar." (Herman et al., 2012)

Parents tended to discuss the impact others dislikes had on the child and the difficulties this created for them when preparing and providing food for the family. Other family members such as siblings and cousins were those that were most frequently named as having a negative influence.

> *"My sister comes over and she doesn't like tomatoes so she'll be like, 'Oh that's disgusting" and then (my kids) look down and then they won't eat it…..They hear them say, 'I don't want to eat that,' or at a certain cousins house and they hear them talk about a certain vegetable that they used to eat and then they won't eat it anymore. It makes it so hard.'* (Sinley and Albrecht, 2015)

Parents often spoke of the effect that others had upon their child's willingness to try fruit and vegetables. Peers, other environments (such as nursery) and siblings were believed to have an influence on the child.

> *You notice your kids won't eat stuff at your house but when he goes to nursery he'll eat it….you can try giving them mashed potato till the cows come home and you get nowhere. They say I don't like it* (Hayter et al., 2015)

> *Barriers included the child or another family members dislike of vegetables* (Norman et al., 2015)

To cope with such barriers, parents frequently reported having to cook a variety of meals for certain family members due to individual preference.

4.4.3.11.2.4 Support mechanisms to create a positive food environment

Parents recognised the role of family as being valuable and an important influence on fruit and vegetable provision and consumption. They believed that creation of a strong family network encouraged healthy eating.

> *A parent who mentioned family as an important value explained that having their family and child eat vegetables was important because it*

> *provided social support to eat healthfully and make good decisions.* (Beltran et al., 2011)

Parents also specified a variety of sources from which they received support to provide fruit and vegetables to their children.

Health agencies, schools, church, government were all listed as support systems for parents. (Fleischhacker et al., 2007)

However an overwhelming lack of support from others and parents feeling isolated and alone was apparent. Parents felt that this lack of support acted as a barrier, preventing them from providing fruit and vegetables to their children.

> On caregivers support systems*…..”That’s a sensitive question. I don’t have one”….”I really don’t have anyone to depend on”* (Fleischhacker et al., 2007)

> *Both focus groups and interview participants discussed the lack of social influences (others/family and friends) to offering healthful foods such as fruits and vegetables to young children* (Sinley and Albrecht, 2015)

4.4.3.11.2.5 Parents preferences and conflicting behaviours

Parents own food preferences and absence of a shared parenting goal, sometimes due to conflicting behaviour appeared to be a barrier to provision. Parents commonly cited their spouse or own dislike of fruit and vegetables as being a barrier to provision (linked with role modelling behaviours in *social influences* domain).

> *“When the children were younger and I served that pasta with ham and peas my husband refused to eat it”….”Our eldest son stopped eating vegetables when he started school because he wanted to be like his dad”* (Norman et al., 2015)

> *“I find it quite hard because I’ve just split up with my son’s dad but (his dad) is really fussy. He doesn’t eat vegetables….so I think when my son*

> *goes round to see (his dad) he comes back being really fussy"* (Hayter et al., 2015)

Mothers also noted how fathers were able to identify the potential impact that their own "bad" behaviours had on the children too.

> *"My husband tells me that I should be a role model because I cook meat and veggies but I only eat the meat"* (Shriver et al., 2010)

4.4.3.11.3 Child Influence

4.4.3.11.3.1 Responsibility and choice

Parents frequently gave examples of how they took on board the choices their child/ren made in a variety of circumstances by making a conscious effort to maintain a level of child involvement. This was spoke of both in a positive and negative manner and included allowing children to make their own FV choices whilst out shopping, giving them freedom of choice at mealtimes and considering involving them in food preparation.

Parents spoke of allowing their child to choose what food they would like to eat which primarily had a positive influence on the parent.

> *…at times, it is after their child's urging that they purchase or prepare a new fruit or vegetable for the family* (Sinley and Albrecht, 2015)

Providing the child with the responsibility of making their own decisions, (guided through parental role modelling) was looked on favourably by some.

> *It'll help them be healthier on their own…their decision making would be a lot better other than choosing the sugar or choosing chips all the time* (Beltran et al., 2011)

However in terms of giving children practical and decision making responsibilities, some parents reacted in a negative way. Parents appeared unconvinced that such actions would prove useful and that children were incapable of performing certain tasks and that allowing them to make decisions could prove costly (linking

up with factors identified in the *environmental context and resources* and *belief about consequences* domains).

> *They doubted their children's abilities to help prepare food and expressed concerns about the safety and time required for such activities* (White et al., 2011)

> *"They (children) get stuff off the shelves, put them in the shopping cart. They want to do everything, but pay for it!"* (Fleischhacker et al., 2007)

4.4.3.11.3.2 Child preference (influencing parent's decision to provide)

Child's preference and perceived child preference appeared to play a large role in determining what food the parent was likely to provide. If a child was thought to "like" or "dislike" a particular type of fruit and/or vegetable then this would have an impact on whether the parent would be likely to provide it or not. Parents spoke often of altering the taste, texture and presentation of food based upon the child's preference (linked in with *nature of the behaviours* domain) to make the food more appealing to child. Such methods helped facilitate the consumption of FV.

> *"My daughter prefers to have parmesan sprinkled on (broccoli) so she thinks it's fairy dust….so she'll eat it that way, but any other way she won't touch it"* (Hayter et al., 2015)

Parents used practical methods such as mixing fruits and vegetables with other foods that the child likes to aid consumption (Papaioannou et al., 2013)

> *…combining them with liked foods, presenting them in a form of soup or sauces or preparing them in the child's favourite way* (Carnell et al., 2011)

However if some parents believed that the child did not like a particular fruit or vegetable this resulted in them not serving it.

> *They won't eat peas for some reason. They say it looks nasty to them so they don't eat peas. So I won't cook peas for them….*(Herman et al., 2012)

> *In some families, the parents had stopped serving vegetables to the children as a result of the children not eating them* (Norman et al., 2015)

4.4.3.11.3 Child food neophobia

Various studies discussed child food preference and neophobic tendencies (Cooke et al., 2003a, Hingle et al., 2012, Norman et al., 2015, Pagnini et al., 2007, Shriver et al., 2010, Vereecken et al., 2010, Wardle et al., 2005). Enjoyment of food in general appeared to be associated with an increase in provision, with parents being more likely to provide if they felt that their child enjoyed eating it.

> *Enjoyment of food also had significant effects…..children who enjoyed food more, ate fruit and vegetables more often* (Cooke et al., 2003b).

Parents of children with stronger neophobic tendencies were much less likely to provide fruit and vegetables to their children.

> *A significant higher consumption of fruit and vegetables was found in children with less negative reactions to foods…..Children who were more neophobic ate fruit less often than their peers.* (Cooke et al., 2003b)

> *Child vegetable preferences, were also reported as barriers to child vegetable consumption.* (Hingle et al., 2012)

4.4.3.11.4 Struggles associated with child preference

Parents and professional caregivers were able to identify that taste, texture and appearance of fruit and vegetables played a large role in determining whether or not the child would be likely to eat what was provided. Professional caregivers and parents alike gave examples of why children would tend to reject food.

> *"My daughter hates the smell and the texture and the taste. Pretty much everything"…."It's a struggle, I can't even get my son to try a tomato"* (Sinley and Albrecht, 2015)

Many parents highlighted the struggle they faced with the child's dislike of various fruits and vegetables. Children were often referred to as picky or fussy eaters,

which in turn impacted on the parents' decision on what they were likely to provide.

> *Fussy eating was discussed at length…"in the past she used to eat the fruits and apples and everything, now she's changed"* (Hayter et al., 2015)

Parents did not provide fruit and vegetables as they found it hard to facilitate consumption and assumed their child would not like them.

> *….As one mother put it, "well it's important (meeting fruit and vegetable guidelines). I would like for her to but I just know that it's a losing battle"* (Hingle et al., 2012)

Parents seemed to find it easier (linked with *belief about capabilities* domain) to get their children to eat fruits than vegetables with some suggesting that their child's aversion had developed as they aged.

> *Parents confirmed that their children consumed more fruits than vegetables and felt that it was much easier to make their children eat fruit than vegetables* (Shriver et al., 2010)

> *"My 5 year old used to eat fruits and vegetables before the age of 3, but after 3 he doesn't like vegetables"* (Shriver et al., 2010)

4.4.3.12 Domain 12. Social/Professional Role and Identity (SPRI)

Summary: Nine studies were coded to this domain, one professional caregiver and eight parental. The coding frequency was 23, of which two were barriers and 21 facilitators. Professional caregivers and parents spoke of their own role and its influence on provision of fruits and vegetables and their child. Personal identity factors such as education, ethnicity and weight were discussed.

4.4.3.12.1 Professional caregivers

Professional caregivers held a high level of responsibility for the child/ren in their care, often adopting a parental-like role. Teachers felt it was their job to teach,

role model, educate and encourage behaviour that would ultimately improve the health of the child (linking up to *motivation and goals* domain).

> *During interviews teachers referred to their students as "my kids", as opposed to "my students"….Researchers found that professional caregivers perceived themselves to be parents at school…they saw themselves responsible for their students health and happiness, not just their academic success*. (Mita et al., 2013)

4.4.3.12.2 Parents

4.4.3.12.2.1 Parental responsibility

Parents believed it was their responsibility to encourage positive values, teach new skills and role model positive behaviours to their child/ren. Mothers had strong opinions that it is an essential part of their job as a mother to ensure their child is "healthy" and believed that their child consuming more fruits and vegetables would help achieve this (linked with *motivation and goals* domain).

> *Across groups, mothers viewed being a good role model and professional caregiver for their children as an important part of their role as a "mother"* (White et al., 2011)

> *"I believe strongly that eating healthfully, including eating more vegetables, is an important part of keeping my child healthy."* (Beltran et al., 2011)

Although parents agreed it was their responsibility to ensure their child was provided with more fruits and vegetables, there was mixed feelings about the extent to which their parental status should influence the child. Some felt that their child should be given a level of responsibility for feeding themselves, whereas others were averse to this idea as they believed that their child were incapable of knowing when they eaten enough - an amount deemed "sufficient" (by the parent).

> *They specifically liked the idea of letting their children serve themselves from small bowls to help their children become more independent, advance developmentally, and learn portion sizes* (Beltran et al., 2011)

> *Most mothers voiced strongly negative reactions to the idea of allowing their preschool-age child to "decide" how much to eat, claiming that their children do not accurately repot when they are full.* (White et al., 2011)

4.4.3.12.2.2 Personal Identity

In one study, parents expressed a negative perception of their own identity, however this acted a facilitator to provision with parents wanting to provide their child with fruits and vegetables so they did not become overweight like them (linked up to *motivation and goals* domain).

> *"I'm having problems and I don't want that for her….after she got that big belly….my kids starting to look like mom and I'm like, I don't want her to get so heavy, like me"* (Fleischhacker et al., 2007)

There was no clear consistent pattern when looking at the data relating to ethnicity and provision of fruits and vegetables. Two studies (Cooke et al., 2003a, Horodynski et al., 2010) found that children who had parents that were white Caucasian were more likely to have higher fruit or vegetable intakes. Conversely, another study concluded that children of Hispanic parents consumed more fruits and vegetables compared with white parents (Papaioannou et al., 2013).

> *Toddlers were more likely to consume vegetables four or more times a week if their mothers were non-Hispanic White (OR: 2.2; 95% CI: 1.3–3.8)* (Horodynski et al., 2010)

4.4.3.12.2.3 SES Factors: Education

There appeared to be a link between parents' education level and their likelihood of provision and child consumption. In one study the higher the parent's education level, the more likely they were to provide fruit and the more likely their children would be to consume vegetables (Cooke et al., 2003b). Another study reported that the higher the mothers' education level, the more fruit and vegetables the child ate (Horodynski et al., 2010).

Parents with more education had children who ate more vegetables (t(550) = 2.72; P=0.007), but no such effect was seen for fruit intake (t(552) = 0.76; P=0.45) (Cooke et al., 2003b)

Maternal education was a predictor of toddler vegetable consumption (Horodynski et al., 2010)

4.4.4 Summary of key results

4.4.4.1 Professional caregivers (i.e. teachers)

There were only two studies containing professional caregiver data and therefore minimal evidence coded to each domain. Four domains (*behavioural regulation, belief about capabilties, memory, attention and decision making processes* and *skills*) contained no professional caregiver data. Participants in both studies highlighted the need for more specific information in relation to knowledge and current recommendations and felt this was central to understanding the impact that overall consumption has on health *(Knowledge).* Teachers relayed positive health messages to children as a means of encouraging children to eat more fruits and vegetables as well as using alternative (and sometimes less healthy) foods as a reward (*nature of behaviours*). Striving to provide the children with a healthy diet for the benefit of their health was a key motivator to provide for professional caregivers in both studies (*motivation and goals*). The majority of teachers in one study (Mita et al., 2013), believed that if they were to use a forceful approach with children it would result in them refusing to eat the fruits and vegetables (*nature of the behaviours*).

Teachers felt they needed to assume the role of “parent” to the child when in their care, having to make responsible and healthy choices which appeared to promote provision (*Social, professional role and identity*). Teachers frequently mentioned lack of parental support, peserverence and encouragement in the home environment, which they felt they had to compensate for during school hours. They were also aware of the potential impact other children had and that they were much more likely to try fruits and vegetables if their peers were doing likewise (*social influences*). Children’s likes and dislikes for various fruits and vegetables in terms of taste and texture were also discussed and how this poses

challenges when attempting to introduce new and different fruits and vegetables (*social influences*).

4.4.4.2 Parents

The majority of data in this evidence synthesis related to parents. These studies identified that the impact of "other family members" (i.e. grandparents) appeared to have a strong influence over fruit and vegetable provision. Other family members were mentioned frequently as having both a positive, but more often, negative impact (*social influences*). Children's own food preference and neophobic tendencies were identified as important barriers, guiding parental decision making in many cases (*social influences*). Encouragement, bribery and disguising of fruits and vegetables were methods regularly used to facilitate consumption, whilst authoritarian parenting practices appeared to have an overall negative impact (*nature of behaviours*). Parents (and professional caregivers) spoke of the health benefits of fruits and vegetables, but sometimes felt that they lacked knowledge relating to specific nutrients and their effects on the body (*knowledge*). Parents who reported being confident in the preparation and cooking of fruits and vegetables were more likely to try new recipes and provide a wider range to their children (*belief in capabilities/nature of behaviours*). Cost, time, availability and accessibility were all other factors primarily considered as barriers to provision (*environmental context and resources*).

Figure 14a: Presentation of refined model of determinants for professional caregivers

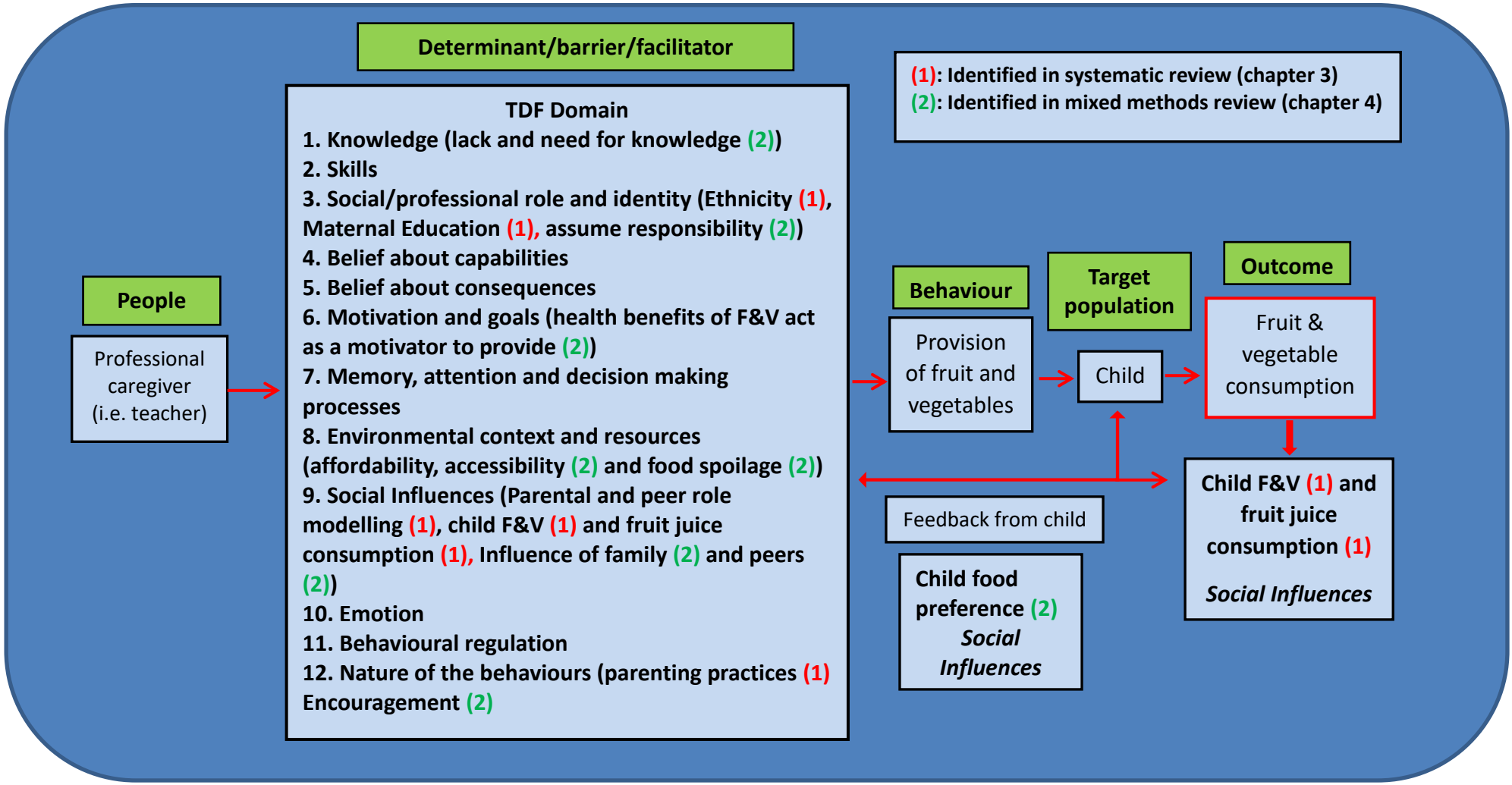
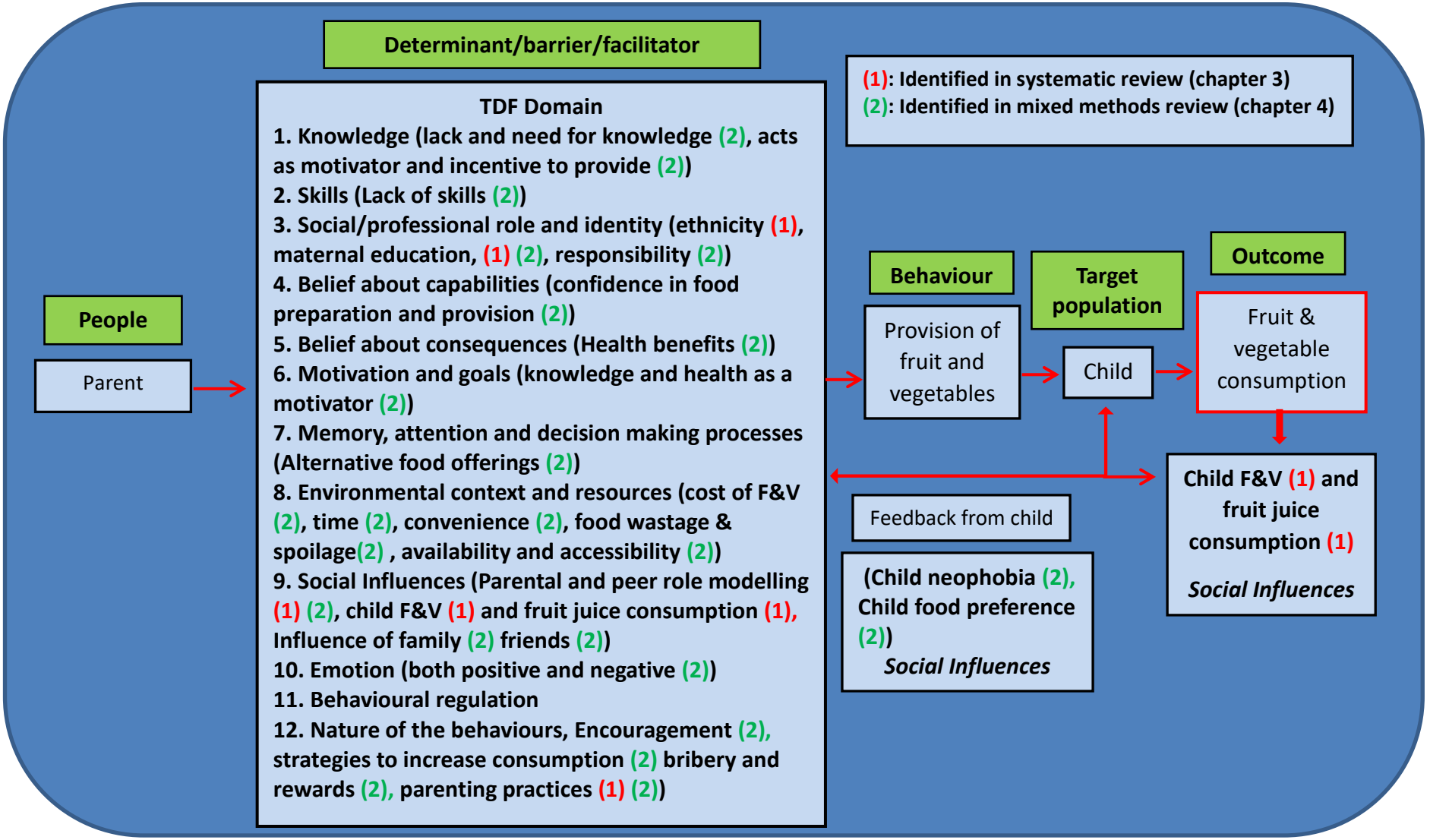


Figure 14b: Presentation of refined model of determinants for parents



4.5 Description of refined model of determinants for professional caregivers and parents

The models presented above include determinants identified in chapter 3 (quantitative systematic review) and barriers and facilitators identified in chapter 4 (mixed methods systematic review). Barriers and facilitators were coded to the corresponding TDF domain/s and added to the diagrams.

There are two separate diagrams to show barriers and facilitators identified in professional caregiver studies (a) and parental studies (b) from the mixed methods review. Evidence was sparse in relation to professional caregivers with only two out of 29 studies containing data. Difficulties would arise when making inferences in relation to this population given the small sample size from which the data was drawn. Therefore I made the decision to omit this population from the next stage of the model development process, focusing primarily on parents.

In chapter 4 (mixed methods systematic review) the following barriers and/or facilitators were identified as having a possible impact on child fruit and vegetable consumption: family members, peer and parental role modelling, child food preference and neophobic tendencies, parental strategies such as encouragement, bribery and disguising fruits and vegetables, use of authoritarian parenting practices, awareness of health benefits and knowledge, confidence in food preparation, time, cost, access and availability of fruits and vegetables.

The impact of “other family members” (i.e. grandparents) appeared to have a strong influence over fruit and vegetable provision and were mentioned frequently as having both a positive but more often than not, negative impact (*social influences*) Children’s own food preference and neophobic tendencies were identified as important barriers, guiding parental decision making in many cases (*social influences*). Encouragement, bribery and disguising of fruits and vegetables were methods regularly used to facilitate consumption whilst authoritarian parenting practices appeared to have an overall negative impact (*nature of behaviours*). Parents and professional caregivers spoke of the health benefits of fruit and vegetables, but sometimes felt that they lacked knowledge relating to specific nutrients and their effects on the body (*knowledge*).

Parents who reported being confident in the preparing and cooking of fruits and vegetables, were more likely to try new recipes and provide a wider array of fruits and vegetables to children (*belief in capabilities/nature of behaviours*). Cost, time, availability and accessibility were all other factors primarily considered as barriers to provision (*environmental context and resources*).

This chapter has highlighted a number of additional determinants (both barriers and facilitators) to fruit and vegetable provision and consumption. Although evidence existed in relation to professional caregivers this was very limited with only two studies out of 29 containing any data. Parental evidence was much more abundant and highlighted the complexities surrounding determinants such as those relating to the *social influences domain* of the TDF. In order to explore the complexities surrounding these determinants and development of the model of determinants it becomes necessary to carry out primary research in the hope of corroborating evidence highlighted here or unearthing new evidence. This is also important to ensure that any subsequent inferences and recommendation made are applicable to the intended population.

Chapter 5: Exploring the barriers and facilitators to fruit and vegetable consumption in preschool children through primary caregiver interviews.

5.1 Introduction

A series of interviews were carried out with primary caregivers (all parents) of pre-school children to draw upon evidence highlighted in chapter 3 and 4 to help further understand the complexities surrounding barriers and facilitators to provision of fruit and vegetable to young children. The previous chapter not only highlighted a number of determinants but also the complexities which exist within this network. For example, the *social influences* domain was highly cited and grandparents were noted as having a strong influence over parental provision which was also shown to effect parental provision, and also child consumption both directly and indirectly. Additionally, children's neophobic tendencies and food preference influenced parental decisions to provide fruit and vegetables and therefore social influences are perhaps not as straightforward as anticipated. To explore the complexities of these relationships and to ensure recommendations are applicable as possible to any population, it is imperative to consider first-hand experience of such behaviours when designing and delivering behaviour change interventions. This is why the decision to speak directly with parents is necessary. It is also important to determine whether evidence that has already been generated previously (within the existing evidence base and throughout this thesis), is further corroborated or refuted. The decision was made to omit professional caregivers from this stage of the research as there was very little evidence derived from both the quantitative and mixed methods studies (chapter 3 and 4). It was felt that exploring the complexities surrounding parental provision would provide greater insight and better scope for making recommendations to support future intervention development.

5.1.1 Phase 3: Aims and objectives of the caregiver interviews (as previously outlined in chapter 2)

Aim: To explore parental views and perceptions of barriers and facilitators to fruit and vegetable provision in young children.

Objectives:

1. To carry out semi-structured interviews with parents of young children to corroborate evidence identified in phases 1 (chapter 3) and 2 (chapter 4).
2. To explore any underrepresented domains highlighted in phases 1 and 2 to unearth new evidence related to determinants.

5.2 Methods

5.2.1 Recruitment of nursery school and primary care providers

I approached three nursery schools (linked with primary schools) in the Tees Valley region of the North East of England (via telephone) to take part in the project. I spoke with either the head teacher or deputy head teacher and provided them with information relating to the project. They were encouraged to speak with other staff members, consider taking part and to contact myself (via email or telephone) the following week should they wish to be involved. One school made contact by telephone and expressed that they would like to take part. I followed this conversation up with an email (Appendix 10), reiterating what had been explained in the initial phone call and included a school consent form (Appendix 11), caregiver participant information sheet (Appendix 12) and consent form (Appendix 13). Following the email, I then made a further follow-up phone call and spoke directly with the headteacher to obtain verbal consent to taking part in the project and to answer any further queries. The head teacher signed the relevant school consent form (Appendix 11) and returned this to me. Once consent was received, I provided the school with a number of parental participant information sheets and consent forms (Appendix 12 and 13), which were distributed to all caregivers of children by nursery staff.

Parents, who after reading the information sheet expressed that they would like to take part, were asked by the teacher to provide a preferred form of contact (email and/or telephone) which the teacher passed on to me. I then made contact with the participant to arrange a suitable time to meet at the school. This meeting took place after the caregiver had had at least one week to read the study information sheet, thereby having the opportunity to further consider taking part and discuss this with others.

On meeting, I ensured that the participant had read the information sheet (Appendix 12) and fully understood what was required of them if they took part, and at this time, also answered any questions that the potential participants had. If the participant still wanted to go ahead, I asked them to complete a participant consent form (Appendix 13) and arranged a suitable time and place to meet and to perform the interview. Interviews took place at the nursery, in a private area agreed with staff.

At the interview the participant was briefed on the study once more and provided with a hard copy of the information sheet. Any further questions the participant had were answered and they were reminded of their right to withdraw at any time. Once the participant was happy and comfortable the interview began.

The nursery schools contacted were all located in areas of high deprivation as it was hoped that results would be applicable to such populations for any follow on research that was designed. However, it is important to note that although the participating nursery school is based in an area of high deprivation, the parents that participated in this study were not necessarily from such a background.

5.2.2 Sampling

A purposive sampling technique was used, whereby a non-representative subset of participants are selected on the assumption that they will provide unique and rich information of value to the study (Suen et al., 2014, Etikan et al., 2016). Recruitment of participants was performed on a first come, first serve basis in order to remain fair, giving caregivers an equal opportunity to take part. The researcher remained aware that this type of approach introduced the possibility of sampling bias occurring. For example; it was likely that those expressing an interest in participating would already have strong views and opinions in relation to the subject (fruits and vegetables). In addition to this biases stemming from gender, and or from being in full-time employment would be likely to occur, given that the majority of caregivers were women and were more likely to be unemployed or in part-time employment. While unavoidable, it was important that the researcher recognised these limitations up front especially when making inferences regarding the data and discussing future recommendations.

A number of nurseries were approached were from similar geographical locations (all within the Tees Valley) which is an area of high deprivation according to the Index of Multiple Deprivation (IMD) (Department for Communities and Local Government, 2010). The first nursery to respond was selected to take part. It was also acknowledged more parents than needed may have been interested in taking part as every parent within the nursery would have received an information sheet. Participants were therefore selected on a first-come, first-serve basis and a potential waiting list held by the researcher should more participants need to be recruited at a later stage. It is important to note that although the participating nursery school is based in an area of high deprivation, the parents that participated in this study were not necessarily from such a background.

5.2.3 Inclusion and exclusion criteria

Inclusion criteria:

- Primary caregivers of a child or children of preschool age (2-5 years) (e.g. parent, grandparent or other family member) including foster carers and any other temporary caregivers;
- Over 18 years of age;
- Have a child or children of preschool age attending one of three nursery schools in the Tees Valley area;
- English speaking.

Exclusion criteria:

- Not a primary caregiver of a pre-school aged child;
- Non-English speaking
- Unable to provide informed consent.

5.2.4 Ethical considerations

The main ethical considerations for this research included recruitment methods, confidentiality, anonymity and withdrawal. Ethical approval was sought and obtained from Durham University's School of Pharmacy, Medicine and Health (as evidenced by Appendix 15).

5.2.4.1 Confidentiality and anonymity

Initial contact with participants was made via a gatekeeper (nursery staff), who then passed on their contact details to me after they had read the project information sheet and expressed an interest in taking part in the interviews. All personal information, including email addresses and telephone numbers disclosed to the researcher were kept confidential. All confidential paperwork was anonymised and stored by the researcher in a locked filing cabinet on site at Durham University. I transcribed all digital recordings of interviews and anonymised these prior to analysis. All recordings were stored on a secure password protected PC and erased from the dictaphone. The recordings were only accessible to me. The names of nursery schools and individuals are not disclosed to protect anonymity. Advice was sought with regard to public liability cover and documented (Appendix 16).

5.2.4.2 Participant withdrawal

Participants were given the option to withdraw consent up until the end of the interview. If a participant indicated that they wanted to withdraw consent in this manner, all data on that individual would have been removed from the system, and removed from the data files and not included in any further analysis or dissemination. However there were no participants that withdrew from the study.

5.2.5 Interview guide development

The TDF has been used to inform the interview guides and support the development of questions for a number of studies in order to explore specific behaviours (Atkins et al., 2017, Lawton et al., 2016, Taylor et al., 2013). Interview questions for this research were developed based on the TDF domains to either, corroborate evidence identified in the mixed methods review or to explore domains that were under represented. For example the *knowledge* domain was highly cited in the review and an example of a question that was asked to corroborate this was: *Are you aware of any recommendations in relation to fruit and vegetable consumption in children?* Conversely one of the domains that was cited less frequently than others was *belief about capabilities* which includes statements relating to caregiver self-efficacy to increase fruit and vegetable provision. Therefore an example question that was asked to explore this domain further was: *How confident do you feel about preparing fruit and*

vegetable in the home? Example questions and corresponding TDF domains can be found in Appendix 14.

Interview questions were formulated based on barriers and facilitators identified in phases 1 and 2 and guided by the TDF with the purpose of exploring data in the most frequently occurring domains. In addition to this, underrepresented domains were investigated further to determine the importance and relevance of any data found here. The interview topic guide consisted of semi-structured questions with the aim of creating a two way conversation whilst allowing the participant freedom of expression in a non-judgemental environment (Adams, 2010). These interviews aimed to ascertain participant's experiences surrounding fruit and vegetable provision of the pre-school child/ren in their care. Discussions were also held regarding any barriers and facilitators to provision that the caregiver had previously experienced. Any additional emergent themes were identified through transcripts.

5.2.6 Data collection

Interviews lasted approximately 30 - 40 minutes and were directed by a series of questions outlined in a pre-determined semi-structured interview guide (Appendix 14). Interviews were performed in order to elicit personal experiences of fruit and vegetable provision. Using this method allowed for further exploration of both barriers and facilitators of provision, as identified in chapters 3 and 4. The decision to undertake interviews was based upon their usefulness in gaining insight into a specific topic area and have been described as being a more "powerful" alternative to questionnaires, allowing the researcher to investigate participants' views in greater depth (Doody and Noonan, 2013). Although it would have also been possible to conduct focus groups, it was felt that interviews would provide a better platform for participants to express their views openly, without the influences a group setting can introduce.

5.2.7 Data analysis

Data were analysed using a thematic content analysis technique which aimed to add contextual interpretation to the results. This method of analysis is derived from grounded theory which incorporates both thematic and content analysis and provides a systematic approach to qualitative data analysis whilst reducing researcher bias and

reliability (Galdas, 2017, Leung, 2015, Noble and Smith, 2015). I transcribed all interview data verbatim, and transcripts were then analysed by me and one of my supervisors (HM) and compared to establish the emergent and recurrent themes in the data. In the first instance, data were open coded, line by line. Descriptive themes were developed based upon grouping patterns and similarity of the coded data. Analytical themes were generated which allowed for a more in-depth summary of the data. Interpretation of the data into analytical themes allowed for relationships between themes to be identified and proved useful in determining whether or not themes were barriers or facilitators to fruit and vegetable provision.

5.4 Results

In total 16 interviews were carried out. Characteristics of participants can be seen in Table 9. Following analysis, data were categorised into six main behavioural themes/areas: health and fruit and vegetable related knowledge, resource, practical and planning, influence of self and others, child influence and parenting practices. All interview participants were anonymised in direct quotes by being assigned an ID number. All children's names (when referred to be parents in direct quotes) have been anonymised and replaced with an X. Questions posed by the researcher (myself) are written in bold text with any additional information provided in square brackets. When describing themes, associated TDF domains are presented in italics.

Table 9: Characteristics of interview participants

Participant ID and (Gender)	Relationship to child	Caregiver Age (years)	Child Gender and age M/F (years)	Ethnicity	Caregiver Employment status
1 (F)	Mother	38	F (8) M (4)	WB	PT
2 (F)	Mother	39	M (3)	WB	FT
3 (F)	Mother	26	M (7) M (3)	WB	PT
4 (F)	Mother	25	M (3)	WB	U
5 (F)	Mother	31	M (4) M (2)	AB	PT
6 (F)	Mother	34	F (11) F (4)	WB	FTS
7 (F)	Mother	32	M (9) F (3)	WB	PT
8 (F)	Mother	39	M (7) F (5) M (3)	WB	PT
9 (F)	Mother	28	F (6) F (4)	WB	PT
10 (F)	Mother	39	F (9) F (3)	WB	PT
11 (M)	Father	40	M (11) F (9) M (3)	WB	FT
12 (F)	Mother	32	M (4)	WB	PT
13 (F)	Mother	37	M (3)	WB	FT
14 (F)	Mother	32	M (4)	WB	PT
15 (F)	Mother	37	F (5) M (3) M (3)	WB	PT
16 (F)	Mother	41	M (11) F (5) M (4)	WB	PT

Ethnicity: WB: White British; Employment status: FT: Full time employment; PT: Part time employment, U: Unemployed, FTS: Full time student

5.4.1 Health and fruit and vegetable related knowledge

5.4.1.1 Importance of eating fruits and vegetables

Parents knew (*knowledge*) that fruit and vegetables were "good" for them and had associated beneficial health effects and some provided examples of this. All believed that eating fruits and vegetables were important in in order to maintain a good state of health and that instilling such behaviours would result in children leading a healthier life in the future. (linked with *beliefs about consequences*).

> *"It's very important to get them off to a good start, get them eating stuff that's good for them while they are little and then they are just used to it. I mean so they'll just eat the fruit and vegetables and good things. It'll stop them getting ill like getting clogged up arteries and a bad heart when they are older."* **I11**

> *"They keep you healthy don't they and stop you getting diseases like strokes and heart attacks and things."* **I15**

> *"Yeah that it stops you getting bad like cancer and heart disease and stuff, I mean it's the main reason I always try to eat mine, I mean you have to worry about stuff like that when you get older don't you"* **I9**

A number of parents spoke of health implications related to weight gain and of their belief (*beliefs about consequences*) that children would become overweight if they did not consume enough fruit and vegetables. This was associated with the development of cardiovascular diseases, cancer and psychological distress. Some parents believed that if their child was overweight then they would get teased by their peers (*beliefs about consequences*). Perceived health consequences acted as facilitators and motivators to parental fruit and vegetable provision.

> *"Errm I think it's quite important to have a balanced diet"*
>
> **Why?**
>
> *"Because it is you know it terms of being healthy and all that and you don't want your kids to be fat do you. You know they'll get picked on and other kids can be awful sometimes, you know cruel."* **I3**

"I mean I don't want my child being unhealthy or putting on lots of weight as that can lead to bullying and all sorts can't it and no one wants that for their child." **I10**

5.4.1.2 Fruit and vegetable properties

When asked about the properties of fruits and vegetables nearly all spoke of them containing vitamins and minerals, however many were unable to name these. Others did not know how these might benefit the body and could not give detail on their associated functions. A small number of parents gave examples of vitamins yet seemed vague and unsure of their answers, often looking for affirmation from me during the interview.

"They have good vitamins and stuff in…is that it? Carrots are supposed to be good for your eyes aren't they?" **I9**

"Well yeah I know they have vitamins and minerals and all that but don't ask me any questions as I have no idea what they are (laughs) or what for just that they are good for you." **I11**

"I know that have them (vitamins and minerals) and that they are good for you but I'm not really quite sure what they are for exactly." **I5**

In contrast some parents seemed more confident in their answers and displayed knowledge of various micronutrients by providing examples of their effects on the body. However there was clearly still some uncertainty in relation their function.

"I know that vitamins and stuff can keep your nails and skin and hair healthy too but you know I'm not quite sure exactly which ones do this…which vitamins I mean. I think it's D for skin but other than that I'm not sure." **I15**

"So green leafy vegetables is your iron and obviously vitamin c as well and folic acid which you can get from broccoli and cabbage that kind of thing." **I8**

5.4.1.3 Knowledge requirements

A number of parents felt that they would like to gain more fruit and vegetable knowledge and believed that this should be provided through the nursery/school setting. They wanted more information (linked in with *environmental context and resources*) in a quick, easy to read format. They also believed that the nursery school had some responsibility to ensure that they included fruit and vegetable knowledge as part of their child's education (*social/professional role and identity*). In addition to this some parents recognised that educational messages should be consistent.

> *"I'd like more from schools as I think they should be more encouraging with school and children in school so that they can give you leaflets and things. Then that way they are teaching the kids too so everyone is basically saying the same sort of stuff. I think it would help parents if they knew a bit more, you know not something like a novel just a quick leaflet."* **I6**

> *"I would like more and I think children should learn a bit more about it at school so they know a bit more about it instead of having just their mam and dad rabbiting on to them about it and how good it is for them. I think maybe they should learn a bit more at school about it."* **I7**

Other parents highlighted the fact that information often goes out of date and suggested that it would be useful if schools provided parents with dietary information once the child started nursery school.

> *"I think it would be a good idea for schools to have more information, particularly when they start school as they need a good diet when they are running around and stuff don't they?"* **I12**

5.4.1.4 Recommendations, guidance and portion sizes

Almost all parents believed that five fruit and vegetables per day was the recommended daily intake, however many questioned this number after making the statement and expressed difficulties with meeting this target. Parents seemed unsure and at times, confused by conflicting messages from different sources such as the media and magazines (linked in with *environmental context and*

resources). It was obvious during interviewing that parents were tired of receiving inconsistent information which, at times made them question its credibility.

> *"Just what you hear about in the media and magazines and things. It changes all the time though doesn't it, it would be nice to know what's exactly right but there you go…. Well it used to be five portions didn't it? I mean I think that's what it used to be but aren't they saying that it should be seven that we are eating now? Mind you it does seem quite a lot, I could prob just about manage to get the five in never mind seven!"* **I10**

One dad discussed how he believed that women paid more attention to advice than men (linked to *social/professional role and identity*).

> *"Well it's just one of them things you know isn't it. You just know it, you hear it all over, if it's not on the news it's in the papers and stuff. They're always dishing out advice on this and that on diets and stuff, I think women listen to all a bit more than us men do (laughs)."* **I11**

When asked, parents were unsure of what a child's portion size looked like and how much this should be. When serving children, the majority of parents made estimations and most indicated that this would be less than an adult's portion. Some spoke of societal expectations of them as parents (linked to with *social, professional role and identity*) i.e. they should know what to provide, given their parental role, yet this was not the case.

> *"It's a handful isn't it, well for an adult. I'm not sure what it is for kids but I'd prob just give them a little bit less than us, you know smaller portions. Then if I'm making stuff I always try to give bigger portions of veg as opposed to meat as it's more important for health and that."***I5**

> *"I don't really know, I suppose I just guess and make it a bit smaller than ours as kids aren't supposed to eat as much as us are they? It can be hard sometimes…just to know I mean. Some things we are just meant to know as parents but you don't."* **I14**

5.4.2 Resource and availability

Parents spoke frequently of the importance of making fruit and vegetables available to their children, however at times believed that this was difficult to achieve. Common barriers given were accessibility (*environmental context and resources*), lack of time (*environmental context and resources*), cost (*environmental context and resources*) and procedural knowledge (*knowledge*), specifically related to the preparation of unfamiliar fruits and vegetables.

5.4.2.1 Accessibility

All parents had access to a variety of supermarkets and voiced their preference of which they preferred to purchase fruit and vegetables from. Although the preferred supermarket differed amongst parents, they gave similar reasons for purchasing or not purchasing fruits and vegetables. Attractive displays, having free fruits and vegetables for children to consume whilst shopping, variety, freshness of produce and reasonable prices and offers encouraged them to buy more fruits and vegetables.

> *"Yeah, well we go to Aldi a lot and we use them for the fact they have a good variety with good dates on, so like the other day we bought some pomegranates and X (son, 5) looked at them like urrgh and wouldn't touch them but X (son, 3) loved them and he called them jewels. So things like mango that are chopped up, here they are cheaper so I don't mind buying him them as he's the only one who will eat them and that's fine. So I'll tend to get all of my fruit from Aldi."* **I5**

> *"We've got Iceland, we've got Tesco and we've got Asda. We have Morrisons quite close too. I tend to use Asda really as it's the prices really and the fruit keeps for longer and the vegetables keep for longer as opposed to Tesco."* **I6**

> ***"****I like Morrisons fruit and veg, I mean I think it's a lot nicer than local; shops and supermarkets like Asda and Tesco that are nearer to me."*

> *"Well I wouldn't say that [that the fruit and veg tends to last a bit longer] I just think when you walk in it looks a lot nicer and fresher and set out nicer than other supermarkets."* **I7**

Conversely, some supermarkets were considered to stock fruit and vegetables that spoiled easily, were overpriced and perceived as having a bad shopping environment (e.g. overcrowded and understocked).

> *"Yeah well we always try and go for the organic but obviously if you are in a rush or depending on where you go and the variety you might just have pick something else. Some can last a long time but some only last a couple of days even though they have got like a longer date on them and you can pull them out and they will have mould on them or gone off."* **I4**

5.4.2.2. Cost and seasonality

Many parents spoke of the changing cost of fruits and vegetables with seasonality. If fruits were in season, produce was reported as being cheaper and hence more obtainable than if they were not. Summer berries were commented on as being expensive in comparison to more popular varieties such as apples and oranges. The changing taste of fruit and vegetables throughout the season was also believed to have an impact on whether or not they would purchase and provide them to their children.

> *"I just go for whatever's on offer and the raspberries and stuff well they get so expensive especially in the colder months when they are harder to get hold of."* **I3**

> *"Well it all depends on the time of the year, I think vegetables are quite cheap it's just I find certain fruits, like strawberries and blueberries and things which are what my little girl eats and they can be quite expensive at certain times of the year."* **I7**

> *"It depends what shops you go to and what time of year as well. I mean I wouldn't get strawberries now (winter months)…well you could get them but they wouldn't taste very nice."* **I1**

5.4.2.3 Cost and convenience

Some parents' spoke of how local grocers were often cheaper, however they did not use these often as supermarkets were more convenient given that they were able to purchase a multitude of items in one place. Bulk buying of items was spoke of often, with many stating they attended the supermarket once a week, given the lack of time due to other commitments such as work and busy lifestyles.

> *"The shop in the local village is closer and it's a bit cheaper. I sometimes go when I've ran out of stuff and yeah it actually tastes a bit better, fresher if you know what I mean. I just don't usually have time to go here every week plus you need all your other stuff too so I just get what I can on the big shop."* **I9**

> *"I just don't have the time to be going round lots of shops with work and that. I probably could save a bit of money if I had chance to shop around but it's just not possible."* **I2**

5.4.2.4 Resource need and labelling

When asked about resources parents may find useful to help increase child fruit and vegetable consumption, many believed they already had enough and didn't tend to use these. However when asked why this was parents stated that they found recipes were often complicated so they generally cooked tried and tested dishes out of habit. They spoke of wanting to know how to prepare fruit and vegetables that were less well known to them, provided it did not take a significant amount of time to achieve. Parents wanted quick, easy, no fuss recipe ideas.

> *"Sometimes, usually online and I've got a few cook books. It's just finding time to do them so I just tend to stick to the same meals and keep giving them weekly."* **I7**

> *"Well I'd sometimes just like to know more ideas of what to do with them as we just have the same stuff all the time and it gets a bit boring."* **I3**

> *"I have loads of cookbooks; I like to look at the pictures more than anything but they seem a bit of a chore when you look at the list of ingredients sometimes."* **I10**

When asked what format parents would like to receive information in, responses were mixed. Some stated they would like it in email format, whereas other wanted a leaflet. Although format differed, the majority were in agreement that it had to be quick and simple to follow.

> *"Probably by email really, as long as it's to the point and you are not being bombarded either."* **I10**

> *"To be honest I'd probably just delete the emails so I'd rather have something in the post, I think it feels more important if you can touch it doesn't it? I mean you pay more attention to it that way, well I do anyway. Whatever it is it needs to be easy to read"* **I11**

Parents stated they needed more information on portion sizes, particularly for fruits and vegetables which they found difficult to gauge at times.

> *"I sort of like leaflets, just colourful with not loads of information and diagrams showing you what a portion is because I think that's actually quite important because sometimes you think that maybe four grapes is not necessarily classed as one portion because it's not enough so you need to know what is actually one portion. You know sometimes a box of strawberries will say seven strawberries is one portion and I think things like that help."***I8**

The need for quick and easy reference material when choosing snacks for children was also apparent. Information on labels was often described as confusing and complicated.

> *"I think it can sometimes be hard to work out what's in things and if there, packets and things can be so confusing. I sometimes go googly eyes just looking at all the numbers, I mean you haven't got time to stand there and work out what it all means. I tend to use the coloured system to be honest*

as a quick measure so if its red I try to stay away or not eat too much of, If its amber then it's not too bad for you and if its green I'll eat it freely." **I10**

"Some veg you pick up and feel a bit daft, I mean it doesn't tell you what to do with it….the exotic fruits and stuff. I like it to say on the back how to cook it and for how long. I suppose it's why I just get the ones I know because I know what I'm doing" **I2**

5.4.2.5 Eating out

A number of parents spoke of the difficulties in providing fruits and vegetables to their child when eating out at restaurants. Some complained that options available were unhealthy and that choice was limited on the children's menus.

"I think it's rubbish, I mean always think that kids menus in restaurants are just chicken nuggets and chips and pizzas and chips and junk food rather than nice food. They don't tend to have, I mean they could make nice spaghetti Bolognese with veg and smaller versions of what's on the adult menu but it always just junky food on the kids menus." **I7**

5.4.3 Practical and planning

5.4.3.1 Meal planning

Provision of fruit and vegetables was facilitated by the planning of meals. If lists were made, recipes agreed prior to shopping trips and food pre-prepared for outings, parents found that they were more likely to increase provision.

"Well it depends how organised you are doesn't it? If we get up on a morning I have like little tubs and stuff and if I'm going to the park I would cut some grapes and X likes cucumber sticks and that kind of thing. So if I'm prepared or think about it the night before then I find it fairly easy." **I8**

Although parents spoke of their intention to plan meals, many did not do this or would abandon plans mid-week due to lack of or time or other commitments.

"I try to but it's having the time in the first place isn't it so you can sit down and plan meals. It's not just thinking of what to cook, it's making the list

and then going to the shops to get them it all takes time which I usually don't have." **I9**

"Yeah I try to but sometimes it doesn't always happen (laughs). Sometimes they go out to friends houses or I have to work late and they go to mams (grandparents) and the plans change a bit. I do try and think about what we will have the day before though as I need to make sure we have the stuff in then if not I can get it beforehand." **I3**

5.4.3.2 Online shopping

Some parents used online shopping and delivery services which they believed saved time and avoided the stresses associated with supermarket shopping such as queuing and parking. Parents also thought that this method of shopping saved money as they were less likely to purchase items that they did not need.

"I do an online shop every week as I just don't have the time and it works really well so we always have some sort of fruit in and bits like that for the kids….. I mean the hard thing is making sure you have all the shopping in so that you can make whatever's on the menu for that night. What I'm saying I suppose it takes a bit of effort but it's worth it." **I15**

5.4.4 Time saving methods

Preparing food in advance and using frozen fruit and vegetables were strategies that parents used frequently, particularly those who had busy lifestyles and were in full time employment. These parents were also strong believers that the whole family should eat the same food at mealtimes.

"Sometimes, I tend to use it more for me and my husband as we like a bit of veg and it's easy to have in isn't it. I always have frozen peas in as you can put them with lots of things and they only take a few minutes to cook too." **I9**

"I've always been very big on he eats what we eat because I don't have time to cook three different meals so I'll batch cook on a weekend and then I put them in little portions in the freezer for him." **I13**

Would all the family eat the same meal?

"Yeah, they don't get a choice [in deciding what meals to eat] to be honest because that's what I've made and they couldn't be too fussy because you can't stand and make all different really." **I8**

5.4.5 Influence of self and others

5.4.5.1 Direct parental influence and preference

Parents were aware that their own behaviour and preferences had an impact on their child's and believed that instilling healthful behaviours from an early age could potentially have an effect on consumption later in life. Some parents displayed feelings of guilt if their child did not want to eat fruit and vegetables and believed this to be a result of their own (or lack of) role modelling behaviours.

"because I'm not a great lover of fruit and I always think if I'd have tried them with fruit a little bit more from an earlier age would it reflect the way they are now. I mean would they eat it a lot more, I mean my little girl she goes to the childminders and they do eat quite a lot of fruit and she actually likes a lot more fruit whereas my little boy never went to the childminder so I obviously brought him up from being a baby and he doesn't eat fruit and I think that's because of me really not giving him it as much." **I7**

"Well I don't really like them [fruits and vegetables] so should I really be making him eat them….if they tasted nice then it would be easier wouldn't it? (laughs)" **I1**

Parents also recognised the behaviour that they themselves exhibited was contradictory to what they expected or wanted to see from the child.

"The thing that I struggle with is that I've been eating to a point where I'm not overeating so I'll leave some food but then you are telling him to clear his plate and he'll go…"well you haven't eaten yours mammy so you're not getting a yoghurt" so I say firstly mammy doesn't want a yoghurt and secondly I'm full so then you think I'll have to try and portion control it a bit

better so you're not leaving food or you are forcing it down as you're thinking I'm leading by example and he's watching me." **I12**

"Broccoli I do but I don't like cabbage, it's a bit like eating grass isn't it? (laughs) I know it's good for you but I just can't bring myself to eat it. I do like parsnips and roasties, stuff like that…I like the sweet tasting veg to be honest. Actually I tell lie because I eat cabbage at the pub when we have lunch but it has cream on it which isn't that good for you is it, but its mashed up and just tastes cheesy so you can't really tell it's cabbage…..I love cheese."……"He (child) likes carrots and peas but doesn't really like much else so i tend to choose one of those to put with his meal." **I14**

Several parents discussed using commercial weight management diets and their online recipes and resources. They adapted family meals to ensure they themselves met these dietary guidelines.

"They have hundreds of recipes on their website...I just type in what I want….last Saturday night I bought two slimming world frozen meals which all three of us shared and thought we'll have half and half and he (child) was eating some of it" **I13**

Parents who thought they were overweight wanted to provide their children with fruit and vegetables so that they did not become overweight themselves.

"I don't want him to end up overweight like me, that's the last thing I want…. well look at me yeah I'm at least a stone over weight (nips belly). I'd love to shift this but don't have time to do anything about it" **I2**

Many also reported serving themselves fruit and vegetables but not their children as they said they had made previous attempts at getting them to eat it but they had refused. Some persevered and said they would serve it again, however the majority omitted it from the child's plate in the belief that it would be wasted.

"I'll just miss, like if we are having something with vegetables I'll just miss the things that the kids don't like off and I'll put other things on. I would put them on me and my partners' plate as we both equally like them." **I7**

5.4.5.1.1 Parental self-efficacy

The majority of parents talked about the skills they possessed with regards to cooking and preparing of fruit and vegetables. Those who felt confident in their own abilities took advice and resources from other family members. Many also spoke of acquiring skills from helping their own parents when they were younger and were also those parents who cooked and allowed their own children to help in fruit and vegetable preparation.

"Me mam, I mean me mam always cooked and friends as well sometimes as they might say oh I've done this or my sister-in-law she's a really good cook and she obviously knows the types of things the kids eat she'll give me tips and say oh the kids will love this." **I8**

Those parents who stated that they did not feel confident in trying new recipes, through fear they would involve a lot of ingredients (adding extra cost) and require a significant amount of time to prepare.

"If I knew they were going to eat I would yeah. They ask for lots of stuff that they have wasted in the past though." **I9**

"Well I get a bit miffed off really because you stand and make it but then no one will eat it so you think well what's the point in bothering….plus it's a waste of ingredients too isn't it so you've wasted time and money so it's easier just to make something that you know they like." **I14**

5.4.5.2 Other caregivers

When asked about the struggles of trying to get their child/ren to eat fruit and vegetables they frequently mentioned the influence of grandparents. Some said grandparents did provide their child with fruit and vegetables and had them on display in their homes. However, they also believed that grandparents felt it their

duty to spoil their children by giving them unhealthy snacks such as sweets, crisps. Many were said to have a designated place in their house for such snacks, which were freely available to the child when in their care.

> *"Well I know they get lots of crisps and sweets while they are there because they can just get what they want out of the sweet cupboard. Our dad (grandad) won't let them have them until they have ate their tea though. Mind you mam sometimes gives into them, she says that's what nannas are for (laughs)."*

Parents felt unable to challenge their own parents' and family members' choices on what they chose to feed children when in their care. Many did not want to broach the subject as they were taking care of their children to enable them to work. They also did not want to cause conflict or upset their parents and sometimes feared that this could potentially jeopardise childcare arrangements.

> *"Well is near on impossible as you need them to look after them sometimes so you can't really say don't give them this and that you know. I suppose you'd never really know anyway would you…what they give them when you are not there I mean."* **I2**

> *"Well she's looking after him isn't she so I don't want to upset her…the last thing I want is to fall out with her you know as then I'm stuffed for childcare so you know I do have to be careful how I say things sometimes."* **I14**

However parents felt different about approaching childminders, given that they were paying for the care.

> *"No but if I did I could tell them, I mean I'm paying her (childminder) so I think it's a bit different to what it would be if say my sister looks after them. I probably wouldn't interfere with that as she'd be doing me a favour" [response when asked if parents experienced issues with what others fed their children and how they might deal with this]* **I16**

5.4.5.2.1 Child influence

Children had a strong influence over what fruit and vegetables some parents decided to give them. Many omitted items off their child's plate if they had refused them before or stated that they did not like them. This often resulted in parents having to make various meals for different family members. These also tended to be parents who spoke of their children as being "fussy eaters".

> *"No it drives me mad sometimes as you make one thing for someone else and then the other doesn't like it. Generally the kids will eat the same thing but me and my husband like dinner meals, you know shepherd's pie and that but the kids won't eat it so I'll give them fish fingers and waffles as they eat all of that."* **I3**

5.4.5.2.2 Peer influence

Children's refusal of food was believed to be exacerbated by their peers and siblings. If children ate fruit and vegetables with and in the presence of another child who voiced that they had an aversion to eating it then the child was highly likely to do the same.

> *"Yes well sometimes, if one of them won't eat something then the other tends to say….urgh its horrible I don't like it before they have even tried it."* **I3**

> *"I think they do because if his friends were to say that didn't like a certain fruit or vegetable then obviously he'd be like oh I don't like that one either."* **I4**

5.4.6 Support and parenting practices

Parents expressed mixed views when asked if they were receiving enough support to encourage their children to eat fruit and vegetables. Some spoke of partners whom did not like fruit and vegetables so found it difficult to preach to their children, whereas others stated that they had plenty of support.

> *"My partner not liking them makes it a bit more difficult to get my child to eat them as he won't even have them on his plate."* **I6**

> *"Yeah like my husband and my mam… she does give more junky things but mam will obviously buy the strawberries because she knows they like them and the oranges as she knows they like those so she always has fruits and vegetables in for them so they always get a bit of both."* **I8**

Conflicting parenting techniques were clearly evident, with partners and spouses having very different views to each other, and this was particularly poignant when discussing family behaviours and mealtime environments.

> *"Sometimes you know, he [husband] gets angry because he (son) won't eat it then he ends up getting upset and I don't like that. I don't think you should be made to cry to eat something. I always tell him that that's not going to make him like it is it shouting like that. Usually though we eat before he gets in from work so there's none of that really."* **I14**

However some parents noted that disagreements did occur but dealt with them differently and felt that parenting had to be consistent between parents if in the presence of their children.

> *"Yes, well my husband tends to help to get them to eat them too, maybe a bit more than me. What I mean is he's a bit harder on them than me, he likes them to finish all their food off or as much as possible but I do think they get full so say as long as they have eaten some of it they are ok to leave the table…….well sometimes as I think he's being a bit hard but I would never say that in front of the kids, I'd wait until they left the room and them tell him. I think it's important to look as if you're singing from the same hymn sheet even if you aren't (laughs)."* **I10**

5.5 Summary of results

Six main behavioural themes/areas were generated; health and fruit and vegetable related knowledge, resource, practical and planning, influence of self and others, child influence and parenting practices.

Much of the evidence generated in phase 3 corroborates that in phase 2 and some within phase 1. However planning of meals was highlighted as being a facilitator to provision yet parents felt that they were unable to plan effectively due to a number of barriers such as: time and knowledge to plan meals. In addition to this using facilities such as online shopping was perceived as saving time and money. Many of the barriers lie within the *environmental context and resources* domain, however using effective planning strategies (*behavioural regulation*) appears to be one way of overcoming them as identified in phase 3 of this research.

Lack of supportive parenting and/or conflicting parenting strategies were other barriers elaborated on in interviews. Parents stated that they used opposing parenting methods and styles to their spouse/partner (*social influences*) which they found difficult when trying to encourage children to eat more fruits and vegetables. Grandparents behaviours and parenting strategies (*social influences*) were frequently highlighted as barriers to provision.

Parents knew that fruit and vegetables were “good” to eat, had associated beneficial health effects and that eating them was important in maintaining a good state of health, they also suggested that a lack of fruit and vegetable consumption in children would lead to children becoming overweight, developing cardiovascular diseases, cancer, psychological distress and getting teased by their peers. Perceived health consequences acted as facilitators and motivators to parental provision. Caregivers were also confused about the regularity that information changes and suggested that schools provided parents with dietary information (composition and amount), and that it had to be simple to follow.

Parents frequently talked about of the importance of making fruit and vegetables available to their children but also discussed barriers such as accessibility, lack of time, cost and knowledge of how to prepare them. However, they conversely

said that they had access to a variety of supermarkets and had different preferences of where to shop. Many parents spoke of the changing cost of fruit and vegetables with seasonality, but also some parents recognised that local grocers were often cheaper, but less convenient.

Provision was facilitated by the prior planning of meals, however, many parents did not do this or would abandon plans mid-week due to lack of or time or other commitments. Preparing food in advance and using frozen fruit and vegetables were strategies that parents used frequently, particularly those who had busy lifestyles and/or were in full time employment.

Parents were aware that their own behaviour and preferences had an impact on their child's and believed that instilling healthful behaviours from an early age could potentially have an effect on consumption later in life, and recognised the behaviour that they themselves exhibited was contradictory to that which they expected to see from the child.

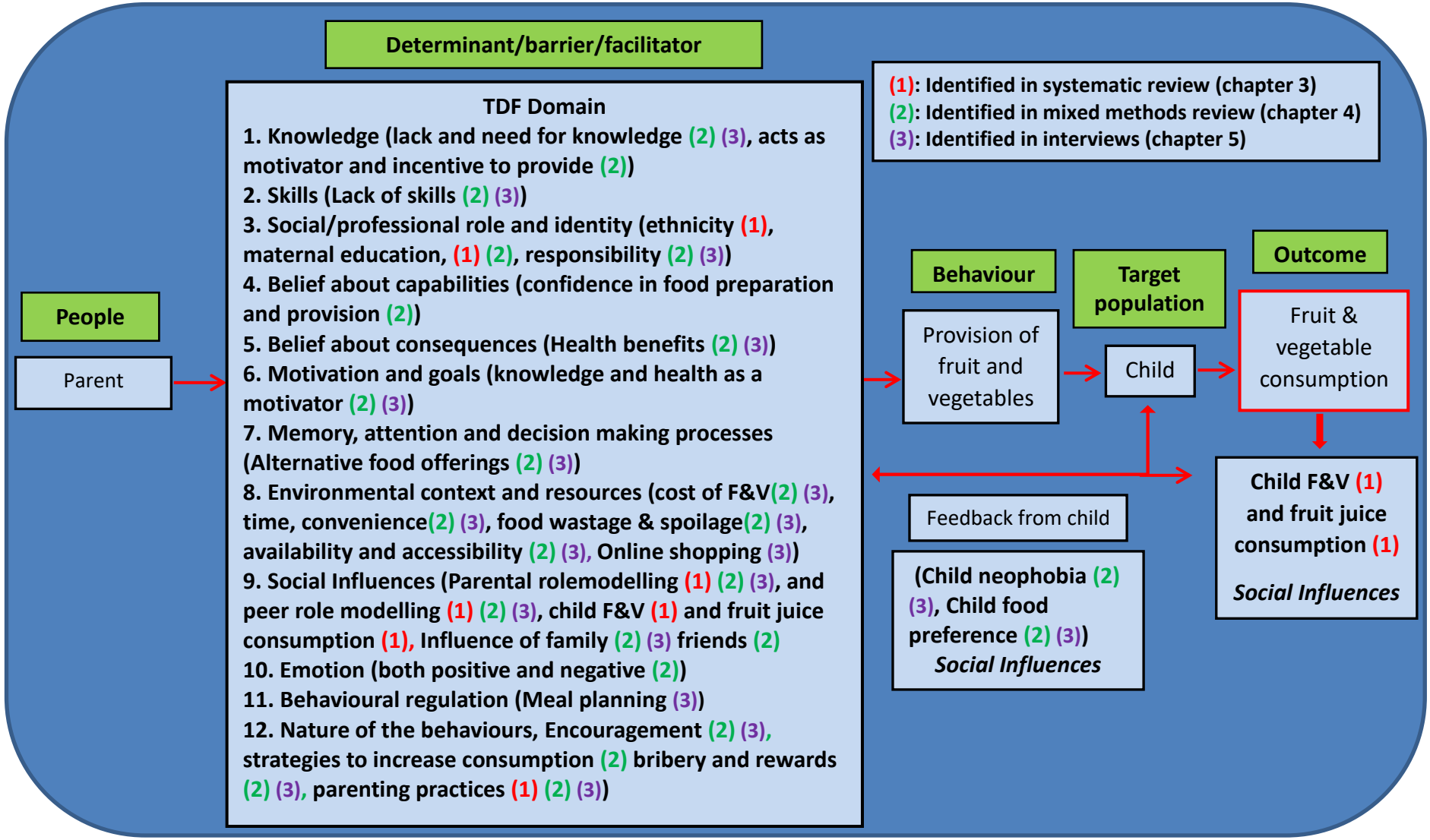
Parents who felt confident in their own abilities took advice and resources from other family members; many spoke of acquiring skills from helping their own parents when they were younger, and were also those parents who cooked and allowed their own children to help in the preparation of fruit and vegetables.

Grandparents and other family members were often cited as influences on the intake of fruit and vegetables in children. Some grandparents did provide their child with fruit and vegetables, but many parents believed that grandparents felt it their duty to 'spoil' their children by giving them unhealthy snacks such as sweets and crisps. Parents reported feeling unable to challenge their own parents' and family members' choices on what they chose to feed children when in their care, and did not want to upset them as they were taking care of their children to enable them to work. When childcare was being paid for however, parents felt more empowered about approaching the subject.

Children's acceptance or refusal of food was believed to be exacerbated by their peers and siblings. If children ate fruit and vegetables with and in the presence of another child who voiced that they had previously voiced an aversion to eating

it then the child was highly likely to eat them too. However, the attitudes of children had a strong influence over what fruit and vegetables some parents provided, and many omitted items off their child's plate if they had refused them previously. Mixed views were given when parents were asked if they received enough support to encourage their children to eat fruit and vegetables; some spoke of partners whom did not like them so said they found it difficult to give the right message to their children, whereas others stated that they had plenty of support. Conflicting parenting techniques were clearly evident too, with some partners and spouses having very different views to each other, and this was particularly noticeable when discussing family behaviours and mealtime environments.

Figure 15: Presentation of final model of determinants



5.6. Description of final model of determinants

The model presented above includes determinants identified in all three phases of this thesis. Interviews verified much of the evidence relating to barriers and facilitators identified in chapter 4 (mixed methods systematic review). However, there were three determinants which appear in all three phases and can be deemed to be play an important role in the fruit and vegetable provision and consumption of young children. These include: parental role modelling, peer role modelling and parenting practices/styles.

In addition to these findings, interviews explored underrepresented domains in phase 2 and highlighted a number of other important factors which may warrant further investigation. Planning appeared to play a vital role in determining whether or not parents were able to provide fruits and vegetables to their children. However, time, cost and accessibility were frequent barriers which prevented plans being made. Some parents overcame this by using resources such as online shopping, preparing recipes in advance, writing shopping lists and buying groceries which were reasonably priced, less likely to spoil and from shops which were easily accessible to them.

Chapter 6: Discussion

6.1 Introduction

This chapter begins by outlining the aim and objectives of this thesis and statements detailing how these were achieved. Determinants identified in each chapter have been presented in a final 'model of determinants' (chapter 5). This model provides a representation of those determinants considered influential in parents providing fruits and vegetables to young children, which ultimately impact on consumption. Using the intervention development approach as outlined by French et al (2012) (French et al., 2012), this chapter will describe what steps have already been addressed to inform a theory based intervention aimed at increasing fruit and vegetable consumption in young children and will then proceed to describe the additional steps which need to be taken. These additional steps will be outlined using one of the determinants (social influences) identified in this thesis as a worked example. This "mapping" of determinants and exploration of behaviour change frameworks allows for the identification of intervention functions that are more likely to initiate a change in behaviour. Both strengths and limitations of the research methods used will be discussed, in terms of each component of research which contributes to this thesis and the overarching methodology used for this thesis. This chapter will conclude by highlighting gaps in the evidence and recommendations will be provided for future research.

6.2. Reminder of general aim and objectives of this thesis

The primary aim and objectives of this thesis are outlined below.

Aim: To suggest evidence based recommendations for the development of a theory based behavioural intervention to increase fruit and vegetable consumption in young children.

Objectives:

1. To systematically review evidence on the determinants of fruit and vegetable intake in young children.

2. To ascertain the barriers and facilitators to fruit and vegetable provision in parents and professional caregivers.
3. To further explore parental views and perceptions of barriers and facilitators of fruit and vegetable provision.
4. To inform, through the development of a conceptual model, theoretically based recommendations and practical strategies for developing an intervention aimed at increasing fruit and vegetable consumption.

This thesis met the aforementioned objectives through the following;

1. Carrying out a systematic review to identify quantitative (cohort and intervention) evidence on determinants of fruit and vegetable consumption in young children
2. Carrying out a meta-synthesis of qualitative evidence to explore barriers and facilitators to parental and caregiver provision of fruit and vegetables to young children
3. Carrying out a series of interviews with parents of young children to confirm and further explore barriers and facilitators identified in the systematic review and meta-synthesis.
4. Development of a conceptual model to show integration of results from each phase of the thesis which will also be used as a tool to direct future intervention development to increase fruit and vegetable consumption in young children via parental and caregiver provision.

6.3 A brief summary of key findings from this research

6.3.1 Phase 1: Quantitative review (Chapter 3)

Evidence from the quantitative review (Chapter 4) suggests that lower fruit juice and SSB intake (*social influences*), non-authoritarian feeding practices (*nature of the behaviours*) , and positive role modelling behaviours (*social influences*) are those determinants most consistently associated with an increase in child fruit and/or vegetable consumption before children reach seven years of age.

6.3.2 Phase 2: Mixed methods review (Chapter 4)

6.3.2.1 Professional caregivers

Exploring caregiver provision behaviours, the mixed methods review found minimal evidence relating to professional caregivers. There were only two studies containing professional caregiver data with limited evidence coded to TDF domains. However expressing a need for specific information in relation to knowledge and current recommendations for fruits and vegetables was important *(Knowledge).* The use of encouragement, positive health messages and rewards (*nature of the behaviours*) were used to promote consumption. Striving to provide the children with a healthy diet for the benefit of their health was a key motivator to provide for professional caregivers (*motivation and goals*). Teachers recognised that if they were to use a forceful approach with children it would result in them refusing to eat the fruits and vegetables (*nature of the behaviours*).

Professional caregivers felt they needed to assume the role of “parent” to the child when in their care, having to make responsible and healthy choices (*social, professional role and identity*). Lack of parental support, perseverance and encouragement in the home environment (*social influences*) were other factors mentioned. Professional caregivers were also aware of the potential impact of peers and that provison was made easier if children observed their friends consuming fruits and vegetables (*social influences*). Children’s likes and dislikes for various fruits and vegetables in terms of taste and texture were also discussed and how this poses challenges when attempting to introduce new and different fruits and vegetables (*social influences*).

6.3.2.2 Parents

Twenty seven studies in the mixed methods review included parental data. Evidence highlighted the impact of “other family members” (i.e. grandparents) who appeared to have a strong influence over fruit and vegetable provision (*social influences*). They were frequently mentioned as having both a positive, but more often, negative impact. Children’s own food preference and neophobic tendencies were identified as important barriers, guiding parental decision making in many cases (*social influences*). Encouragement, bribery and disguising of fruits and vegetables were methods regularly used to facilitate consumption, whilst authoritarian parenting practices

appeared to have an overall negative impact (*nature of behaviours*). Parents spoke of the health benefits of fruits and vegetables, but sometimes felt that they lacked knowledge relating to specific nutrients and their effects on the body (*knowledge*). Parents who reported being confident in the preparation and cooking of fruits and vegetables were more likely to try new recipes and provide a wider range to their children (*belief in capabilities/nature of behaviours*). Cost, time, availability and accessibility were all other factors primarily considered as barriers to provision (*environmental context and resources*).

6.3.3 Phase 3: Interviews (Chapter 5)

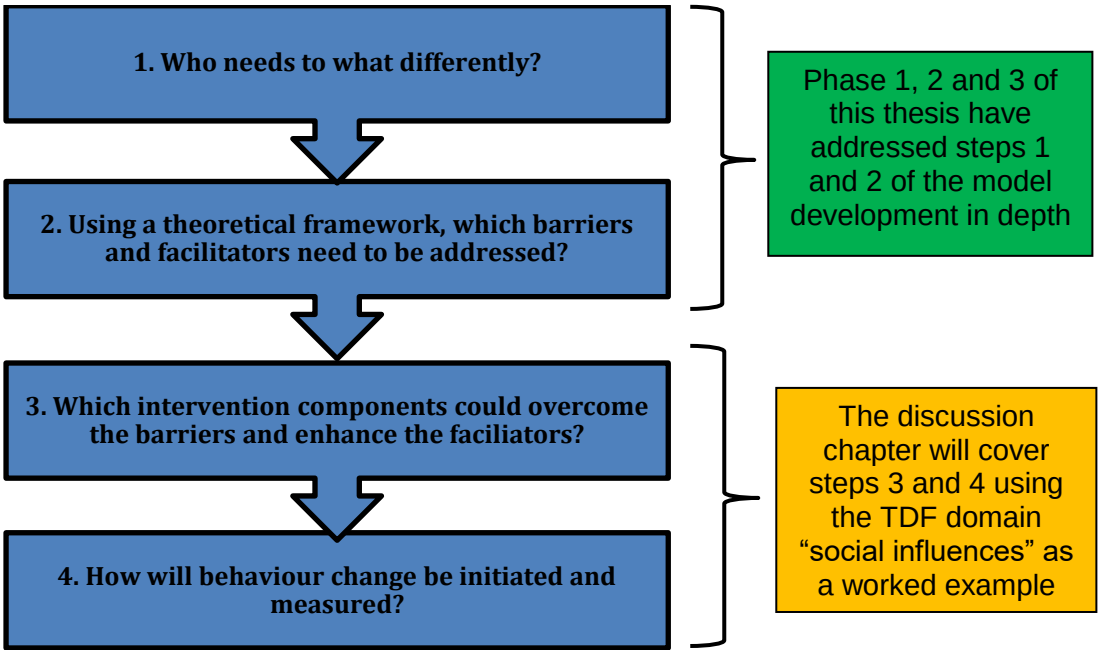
Given the limited evidence in relation to professional caregivers, it was decided to concentrate on primary caregiver provision for the interviews. The majority of the evidence generated in the interviews corroborated that identified in previous chapters. However, planning of meals (*behavioural regulation*) was highlighted as being a facilitator to provision, yet parents felt that they were unable to plan effectively due to a number of barriers such as: time, cost (*environmental context and resources*) and knowledge (*knowledge*). Using services such as online shopping was perceived as saving time and money and appeared to be one effective planning strategy to overcome barriers. Lack of supportive parenting and/or conflicting parenting strategies (*social influences*) were other barriers elaborated on in interviews. Parents frequently mentioned using opposing parenting methods (*nature of the behaviours*) to their spouse/partner which they found difficult to deal with when trying to encourage children to eat more fruits and vegetables. Again, grandparents' behaviours (*social influences*) were frequently highlighted as having an important impact on parental provision.

6.4 Moving forward in intervention development

Identifying the evidence-based determinants of parental fruit and vegetable provision to young children allows for more specific and directive intervention development to increase consumption. Using a theoretical framework to better understand behaviours associated with barriers and facilitators to provision helps us think about which mechanisms and modes of delivery might work best. Facilitation of intervention development using models such as that outlined (French et al., 2012) and introduced in chapter one of this thesis provides a systematic approach which increases the

likelihood of success. Fig 12 below serves as a reminder of this model and shows how it relates to the phases in this thesis.

Figure 16: Model development approach



Adapted from (French et al., 2012)

The importance of increasing fruit and vegetable consumption to reduce both long and short term health risk is important on both a population and individual level. Parental provision plays a significant role in moderating consumption and interventions within this population need to be as targeted and specific as possible in order to increase the likelihood of their success. Additionally, having a number of intervention options available can be advantageous, as what works for one person may not work for another. Examining determinants in depth (as this research has) allows for careful consideration of suggested intervention approaches which not only ensures that barriers and facilitators to provision behaviours are addressed but also that time and resources are used as effectively as possible.

6.4.1 What strategies or approaches, grounded in relevant behaviour change theory are more likely to initiate a positive change in behaviour?

To be able to answer this it is necessary to carry out an intervention mapping exercise which considers previous evidence and understanding of behaviour ensuring transparency and reproducibility for future development. The mapping exercise, driven by the use of the French et al (2012) model allows us to think about how we might begin to develop an intervention.

For the purpose of this discussion and in order to be more specific in relation to targeting changes in behaviour, one domain from the TDF *(social influences)* which was identified as being a determinant of parental fruit and vegetable provision, and subsequent child consumption is used as an example to illustrate the process of intervention development. This determinant has been chosen due to its dominance within the evidence in all 3 phases of this thesis as highlighted in each stage of the development of the model of determinants.

In order to select and tailor an intervention to address the barriers and facilitators identified we need to look at what intervention components can potentially combat the barriers and promote the facilitators. When selecting the most appropriate intervention components it becomes important to think about the following in the context of the topic:

1. **What are we trying to change?**
   Parental fruit and vegetable provision
2. **Why are we trying to change it?**
   To increase child fruit and vegetable consumption
3. **How are we going to change it?**
   By addressing determinants (including barriers and facilitators) to fruit and vegetable provision as identified in the evidence base, e.g. one determinant within the social influence domain that could be either a barrier or facilitator to provision of fruit and vegetables (and subsequent child consumption) was parental role modelling behaviours.
4. **What will be included in the intervention content to initiate a change?**
   Any strategies that aim to increase and enhance positive role modelling.

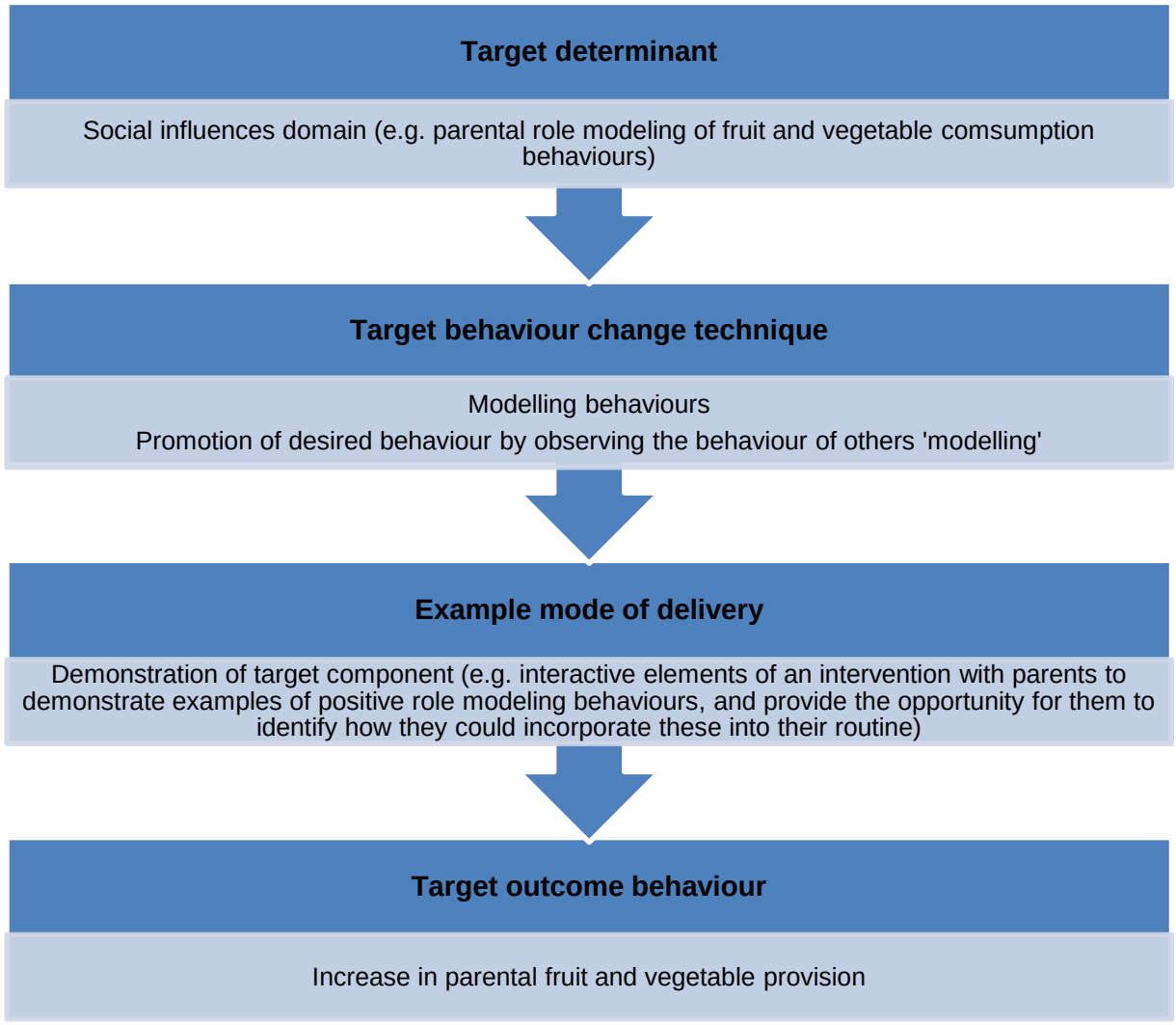
6.4.2 Identification of appropriate behaviour change techniques

During the process of intervention development, it becomes necessary to distinguish between the intervention techniques and how they will be delivered (mode of delivery). For example, the intervention content needs to include elements which aim to change behaviour (e.g. by promoting positive role modelling practices among parents) and the mode of delivery is the mechanisms by which the content will be delivered (e.g. parental observation and rehearsal of positive role modelling behaviours). To determine the content of interventions there are a number of frameworks which guide the mapping and description of the targeted behaviour change techniques. Michie et al 2008 identified a number of techniques aimed at changing behavioural determinants which could be used by non-psychologists in the development of complex interventions (Michie et al., 2008). The list of behaviour change techniques and definitions (referred to as taxonomies) were developed using textbooks, relevant literature and brainstorming of experts in the field. Reliability and definition of these techniques were then tested. Once key behavioural determinants were agreed these were then mapped to appropriate techniques. Appendix 17 shows the consensus process for linking behaviour change techniques with determinants of behaviour. Each of these behavioural determinants correspond to the TDF domains.

6.4.3 What might an intervention which aimed at addressing social influences to increase parental fruit and vegetable provision and child consumption look like?

Using the taxonomy framework as described (Michie et al., 2008) and social influences as an example determinant to target in an intervention, we can identify target behaviour change techniques that are most likely to have a positive impact on the target outcome behaviour by addressing barriers and facilitators to the behaviour. Figure 17 outlines the different elements involved in linking the behaviour change techniques with the example TDF domain determinant of social influences.

Figure 17: Conceptual model of how an intervention to address social influences might work



In this example we have identified that an intervention aimed at addressing social influences would be most likely to work if it included techniques that are modelled to parents which will enable them to provide fruits and vegetables to their children. What also has to be considered is the mode of delivery, i.e. what methods might we use to apply the behaviour change technique. For example the intervention may include group or one to one sessions which discuss the importance of role modelling behaviours and how this impacts on fruit and vegetable provision and child consumption. These could incorporate demonstration of evidence-based positive role modelling behaviours. For example, video footage of parents eating fruits and vegetables in front of their children during meal times (Sweetman et al., 2011, Wyse et al., 2011), eating together as a family (Cooke et al., 2003b) and how parenting styles

can be used to encourage children to eat fruit and vegetables in this context (Alsharairi and Somerset, 2015, Vereecken et al., 2010). Discussion of the video footage and why certain strategies work better than others, parental reflection on what they have observed and planning how they could incorporate these behaviours in their own routines are further behaviour change techniques and modes of delivery that could build on modelling to facilitate adoption.

6.4.3.1 Parental role modelling

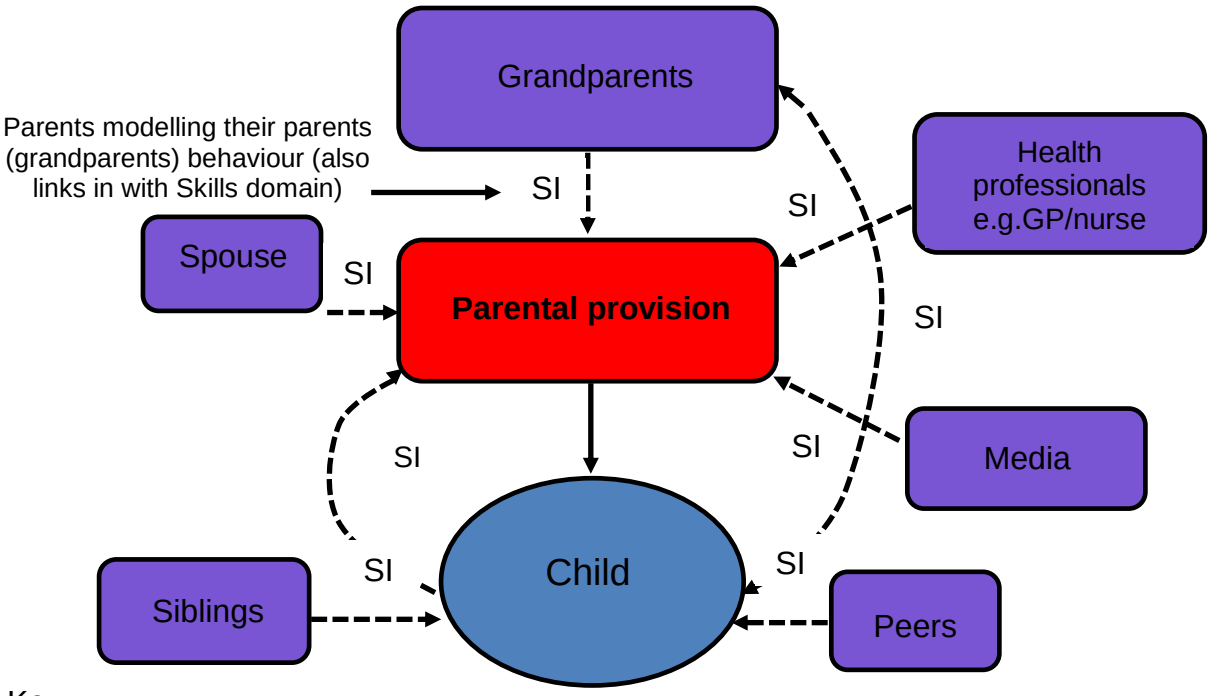
Parental role modelling is often targeted in intervention delivery and a recurring theme which emerged in each phase of this thesis. Parents are not only the gatekeepers of food for children but also the promoters of healthy eating which was a poignant factor as indicated in a number of studies included within the mixed methods review (chapter 4) (Cooke et al., 2003b, Sweetman et al., 2011, Wyse et al., 2011). The review also revealed that frequency of displays of role modelling is also an important factor which seemed to influence consumption; more frequent displays of fruit and vegetable behaviours exhibited by parents resulted in a higher reported child consumption (Nanney et al., 2007a, Wyse et al., 2011). Results also mirror that from more recent studies which attribute lack of parental role modelling as a primary barrier to consumption (Jarvis et al., 2017, Nepper and Chai, 2017). Displays of encouraging behaviours in combination with positive role modelling and praise from parents should be considered for inclusion in future interventions as these were found to be an important predictor of consumption in children below the age of seven (Yee et al., 2017).

6.5 Complexities of targeting social influences as an example determinant

The social influence domain was one of the most frequently coded domains in the mixed methods study (chapter 4) being coded 178 times. Additionally, data were coded to this domain in all three phases of the research demonstrating it as a consistent determinant. There are a number of additional social influences which were also shown to have an impact on parental provision, such as the behaviours and influences of the wider family, health professionals, peers and the media. These social influences do not exist in isolation and collectively work together, creating an overall impact on provision which can be somewhat complex. Figure 18 illustrates some of the complexity of social influences identified in this thesis, and how these might

interact with one another, followed by a discussion of the evidence relating to the actors involved in the wider social influences domain. This provides an example of why complexity will need to be addressed in interventions targeting parental behaviours.

Figure 18: Wider social influences as a determinant of parental fruit and vegetable provision



Key

	Key behaviour
	Secondary behaviour
	Examples of different actors involved in wider social influence domain

SI: Social influences

6.5.1 Influence of grandparents

Grandparents were found to have an important influence on parental provision in this research and in many instances were primary providers of fruits and vegetables. However, grandparents also play the role of parents to their children (the child's parent) and many parents in the interviews reported learning to cook and prepare vegetables on observation of their own parents doing this as they were growing up. This intergenerational social influence (via role modelling) and inclusion of grandparents become important factors to consider for future intervention development.

There is very little research which investigates grandparents influences on child fruit and vegetable consumption and they are rarely the primary targets in intervention delivery (Roberts and Pettigrew, 2010, Speirs et al., 2009). A newly published systematic review which examined grandparents influences on the dietary intake of children found only 16 studies, nine of which reported on attitudes and feeding practices which have a negative effect on food consumption and seven which highlighted the conflict of parenting practices between parents and grandparents (Young et al., 2018). This review concluded that more targeted work with grandparents is required to further define the mechanisms by which grandparents' knowledge, attitudes and feeding behaviours may influence child dietary intake. A recent qualitative study exploring parental views on promotion of fruit and vegetable consumption stressed the importance of capturing the effects of extended family and how this impacts on parental provision in order to improve intervention delivery (Nepper and Chai, 2017).

Many grandparents play a significant role in the lives and subsequently the diets of children with over 40% caring for their grandchildren on a weekly basis; children under the age of five being four times more likely to be looked after by grandparents than older children (Age UK, 2017). Parents in the mixed methods review spoke of how they relied on grandparents for child care, particularly when they worked and this was corroborated in the interviews. Grandparents have been known to "spoil" their grandchildren and literature suggests that many use unhealthy foods with which to express their love (Roberts and Pettigrew, 2010). Such behaviours have been frequently described as a barrier to parental provision and child fruit and vegetable consumption (Farrow, 2014). In the interviews carried out in this research (Chapter 5)

parents stated that they often found such issues difficult to tackle with fear of upsetting childcare arrangements. However, some parents also spoke of grandparents being supportive in the diets of their children, providing them and their children with meals abundant in vegetables and ensuring that fruit was always accessible, hence facilitating consumption. There remains a large gap in the research as far as grandparent involvement is concerned, which is important given the significance of their role. There is a clear need for further understanding of grandparent's behaviours to capitalise on their role, improve their child-feeding practices, and build upon existing facilitators which can also be utilised to support parental provision.

6.5.2 Other important social influences emerging from this thesis

Figure 18 illustrates how siblings, peers, other family members (e.g. spouse), health professionals (e.g. GP's, nurses) and the media also form part of the complex network of social influences and this will vary depending upon contact with the parent and/or child. In addition, the child themselves influence parental decisions on fruit and vegetable provision adding an extra dimension to this network. Each of these influences have been discussed in more detail in the mixed methods review (Chapter 4). However, determinants in other domains are also linked with social influences, such as the example of skills included in Figure 18. Additionally, parenting style which was categorised in the nature of behaviours domain is related to social influences and also emerged as being particularly important in parental fruit and vegetable provision; this example illustrates the further level of complexity which needs to be addressed. .

There have been many studies which have investigated parenting feeding styles and practices and its interaction with child food consumption. The authoritative feeding style has been consistently linked to a higher consumption of fruits and vegetables and healthy eating in general in children (Hoerr et al., 2009, Olvera and Power, 2010, Patrick et al., 2005, Vollmer and Mobley, 2013). As described in chapter 1 an authoritative feeding style is characterised by one which exhibits clear rules, yet provides explanation, encourages independence and warmth to the child and has shown to provide significant results in terms of increasing fruit and vegetable consumption in comparison to a more forceful/authoritarian or permissive style (Hughes et al., 2008, Rodgers et al., 2013). This also supports findings from all three phases of this thesis. For example, results from the quantitative systematic review

found that maternal authoritarian practices were associated with a decrease in child consumption of fruits and vegetables (Alsharairi and Somerset, 2015). However Gregory et al (2011) found this association for fruits only (Gregory et al., 2011). Results from the mixed methods study and interviews found that those parents who reported using forceful parenting methods to enhance consumption were also those that stated their child/ren often refused to eat fruits and vegetables. Alternatively, those that reported using non-forceful methods coupled with encouraging children to make their own choices (e.g. letting them serve themeselves vegetables at meal times) reported an increase in consumption.

Conversely, a recent study which examined authoritative parenting style in 281 parents as a predictor of pre-schoolers consumption found no association for fruit ($p=0.98$) or vegetable ($p=0.24$) yet did for child taste preference ($p=<0.05$) (Shriver et al., 2018). However, this was a cross sectional association and only 16% (n=44) of the parents were classed as authoritative which is a relatively low sample size from which to make inferences. A recent update of a systematic review published after the completion of this research reported that interventions for increasing fruit and vegetable consumption in children five years and younger which targeted parenting practices resulted in a small increase in fruit and vegetable consumption (Hodder et al., 2018). This review included 63 trials with a total of 11,698 participants undertaken in a range of countries, however almost half (46%) were carried out in the USA. Thirty nine of these studies targeted parenting practices and a large proportion of these involved repeated exposure of a variety of fruits and vegetables, rather than targeting specific parenting styles to increase consumption. Evidence was also deemed to be of low methodological quality with very little data to support long term effectiveness (Hodder et al., 2018). Terminology used to describe parenting styles and practices are frequently used interchangeably in the literature which can also lead to confusion when interpreting findings. Classification of parenting style can often prove challenging, utilising a wide range of subjective measures such as the Comprehensive General Parenting Questionnaire (CGPQ); the Comprehensive Feeding Practices Questionnaire (CFPQ) and the Child Feeding Questionnaire (CFQ) (Birch et al., 2001, Musher-Eizenman and Holub, 2007, Sleddens et al., 2014). Using such measures leaves results open to bias in over reporting or underestimating of values reported leading to error in estimations of any differences reported as they rely on participant

reporting and judgement. Moreover, many of these measures have been validated in older populations, specifically school-aged children and adolescents and therefore their use within young children becomes questionable and must remain so until further exploratory work has been carried out.

Although there are a plethora of determinants which have been identified throughout this research, some being a higher predictor of child fruit and vegetable consumption than others, what is clear is that they cannot be considered on an individual basis. It is the interplay of determinants which requires careful consideration. There is a need for more longitudinal evidence to investigate associations and their long term effects. Although there are many determinants to consider, there is now a clear call for newly developed interventions to be grounded in theory to ensure the correct behavioural components are being targeted with the aim of increasing overall impact and effectiveness, which also addresses the complex interplay between determinants (Ong et al., 2016).

6.6 Measuring changes in behaviour

Having discussed intervention techniques which could possibly be used to initiate a change in behaviour, there is also a need to consider how behaviour change might be measured (as outlined in step 4 of the French model) (French et al., 2012). Currently there are a number of ways in which parental fruit and vegetable provision and child consumption are measured. As discussed in chapter 1, measurement is commonly undertaken through the use of weighted food measures, diet diaries, food records, 24-hour recall and food frequency questionnaires (Bell et al., 2013, Burrows et al., 2010, Ortega et al., 2015). Yet many of these measures are subjective and depend on memory and accuracy of reporting which can sometimes be unreliable (Livingstone et al., 2007, Shim et al., 2014, Wilson et al., 2008, Foster and Adamson, 2014). More often than not child consumption is taken as a proxy measure of provision which can be confusing when examining evidence on effectiveness of interventions. However there is a need to distinguish between provision and consumption and this is necessary for more directive intervention development for interventions aimed at increasing parental provision behaviours. Ideally both need to be measured so that true intervention effects can be seen. For example, if only child consumption is measured there is a potential to disregard any intervention effect or change which has

occurred due to a change in the parental provision behaviours which is the key outcome of interest.

6.7 Strengths and limitations of this research

There are a number of strengths and limitations which have been discussed previously within corresponding chapters. However, overarching methodology is discussed here, along with any additional strengths and limitations of importance relating to each phase.

6.7.1 Mixed methods approach

Using mixed methods allowed for the consideration of both quantitative and qualitative data with the aim of increasing the validity of the findings.

The use of mixed methods has been frequently described positively, particularly as a method that provides a deeper and broader understanding of any studied phenomena, that when using only one method, cannot be truly achieved (McKim, 2017). There is also evidence to suggest the reader has more confidence in the results of studies that have used a combination of approaches, due to the particular phenomena being examined from many different angles (Creswell and Poth, 2017).

A strength of the mixed methods approach was that the different methodologies were deployed sequentially and therefore it was possible to use the findings to inform the collection of subsequent data which contributed towards the development of new evidence-based knowledge. This PhD has followed a sequential mixed methods approach, integrating findings from each component/phase as the research programme progressed. This has generated useful data in helping to understand a variety of determinants and how these effect fruit and vegetable provision and consumption in young children.

However, there are some drawbacks to using such methods. For example, the time taken to design, collect and analyse data proved lengthy. In addition, resources (including researcher time and funding) were limited, which is a common factor in the majority of PhD projects. Integrating evidence generated by mixed methods can prove difficult and challenging due to the very different techniques and results each method

encompass. However, steps were taken to overcome this by using a framework approach and model development as a means of merging data, providing a clear picture of determinants.

6.7.2 Quantitative systematic review (Chapter 3)

6.7.2.1 Inclusion of studies

The systematic review provided a foundation of evidence relating to determinants surrounding fruit and vegetable consumption in young children. This review examined prospective (cohort) and intervention (RCT's and non-RCT's) evidence that quantified an association between a determinant and child fruit and vegetable consumption.

A decision was made to exclude all studies which demonstrated a non-temporal, cross sectional association (justified by the aim to only include studies of a higher quality in the review). However on reflection, and in and ideal world if there were no resource (time and researcher capacity) restrictions, it could have been useful to include cross sectional studies to add to the body of evidence and also to corroborate and strengthen the results.

In addition, the decision was made to exclude all studies that had a specific focus on breast/bottle feeding and weaning of infants. This was primarily due to the review team feeling that this population should be studied separately and had already been studied and reported on in a number of other reviews (Moller et al., 2013, Wijndaele et al., 2009) and that excluding these studies would keep the review manageable and focused. However, some of these studies did include fruit and vegetable data, yet had to be excluded according to the a priori inclusion and exclusion criteria for this review.

In addition, although all studies were checked by two reviewers to ensure that no relevant data was missed, the possibility that this may have happened must be noted.

6.7.2.2 Methods of analysis

The tool used to analyse the data for this review was the SEM as originally agreed and carried out by the research team. However as I chose to use a framework (the TDF) as a method of analysis for this PhD, the data had to be mapped onto the framework, as shown in the model of determinants at the end of chapter 3. The

purpose of this was to maintain consistency throughout the thesis and I believed it to be a useful approach with which to systematically categorise behavioural data. However, this did mean duplicating work, and if I were able to go back in time and start my PhD again, I would have chosen to use the TDF in the systematic review from the outset.

6.7.3 Interviews with parents (Chapter 5)

Interview participants were selected from a purposive sample and recruited on a first come, first serve basis. This technique may have introduced selection bias to the sample, with those who responded being keen to take part and more likely to provide their children with fruit and vegetables on a regular basis than those who did not. Additionally the sample was deemed not fully representative of the intended population as we had hoped to recruit parents from a low socio-economic background living in areas of high deprivation, however, while recruited parents did live within areas of high deprivation they were not necessarily of a low socio-economic background. Therefore the generalisability of the results to similar populations is somewhat questionable. The decision was made to omit professional caregivers from the interviews that were carried out in chapter 5. There was very little evidence for this population in both the quantitative and mixed methods reviews and therefore a judgement was made to carry out interviews with parents only. However, evidence in this population does warrant further investigation. If professional caregivers were interviewed this could have strengthened the research, given that there is a dearth of evidence in this area. Comparing both populations would have been ideal, yet it must be remembered that this is a PhD thesis and the resources in terms of time and man power were limited. Additionally it was believed that choosing to focus on parents by building on pre-existing (and more substantive) evidence would be more advantageous. This was particularly true when drawing inferences form emerging data and using these to make recommendations for future intervention development.

6.7.4 Theoretical framework

The TDF was used as an analysis framework and data collection tool in the mixed methods review and interviews respectively. Although it is well used within the implementation science arena to inform health service related interventions targeting health professionals (Debono et al., 2017, Thomas and Mackintosh, 2014, Yamada et

al., 2017), this is the first known study that operationalises this tool targeting parents to help develop diet-related behavioural change interventions, which in turn mediates child behaviour (consumption).

Recent developments have seen evidence emerge for the implementation of dietary guidelines in children (Grady et al., 2018) yet these have not been used to investigate healthy behaviours. The body of evidence for the utilisation of such methods in adults is more established, particularly in those interventions which encompass changes in health behaviours, many of which have shown promise (Atkins et al., 2017). Although the ultimate focus of this research is young children's consumption of fruit and vegetables, it is adult (parental) behaviours that are to be targeted to initiate positive changes meaning at some level they will be comparable to existing data in adults. The TDF provided a logical and comprehensive approach which is relatively easy to use for non-psychologists. It has also been proposed that an intervention which has been developed using a theoretical framework such as this is more likely to be effective (Cane et al., 2012, Michie et al., 2005).

There are of course a number of limitations that must be considered when using the TDF. The TDF was not originally developed for the purpose with which it was used in this thesis (i.e. the specific target population and for the purpose of secondary analysis). When developing the TDF coding manual, so that it could be used within the context of this research, a level of subjectivity was used when refining the TDF domains and interpreting their meanings. However, any discrepancies or questionable interpretation was discussed and resolved by myself and NH in discussion with health psychology experts whom were familiar with these methods. This does mean that data could have potentially been coded to the wrong domain, dependent upon researcher interpretation, however, the chances of this occurring was minimised by double checking of coded data.

6.7.5 Model development

An in depth process of model development was used throughout this thesis to integrate results from all three phases, and to provide what is believed to be, a complete picture of the complex determinants of parental provision of fruit and vegetables to pre-school aged children, and subsequent child consumption. This

approach also offered a systematic process that complemented the overarching sequential mixed methods approach. Using model development strengthened the methodological quality of this research, drawing results from both reviews and the interviews together.

An area which has been highlighted for further development of the TDF is the triangulation of findings from data generated in studies with model development (Atkins et al., 2017). However there is an element of abstractness and researcher interpretation when devising a model, which must also be recognised. Ensuring the development of the model is performed in a systematic way, with the aim of incorporating a high level of understanding at each phase helps reduce misinterpretation of results (Sallis et al., 2015).

6.8 Conclusion and recommendations

This research has provided a holistic picture of the complex evidence-based determinants that may influence parental fruit and vegetable provision and child consumption. The proposed intervention development process using social influences as an example determinant illustrates how evidence reported on in this thesis may be taken forward. Yet there are other wider issues within the complex system which should be taken on board. Importantly how evidence may sit within a whole systems approach to tackling behaviours such as fruit and vegetable consumption to address public health issues such as obesity needs to be considered. Although the intervention development process outlined here is specific in nature, further behavioural exploration at a wider level (drawing upon environmental and policy level determinants) is possible using the same methods, and attempts have been made to do so (Seppälä et al., 2017).

Public Health England (PHE) and NICE are now advocating a whole systems approach in the hope that healthy lifestyle behaviours such as fruit and vegetable consumption are addressed at both local and national levels (Local Government Association, 2017, Tedstone, 2018). The recently published Childhood Obesity Plan incorporates this advice, highlighting the complexities faced when attempting to change behaviours to improve health but maintaining the importance of doing so, with action needed from a number of stakeholders (e.g. government, industry, schools)

(Department of Health and Social Care, 2017). However, there will always remain a need to understand determinants at an individual level as this information will ultimately form the building blocks of any systematic approach. In addition to this considering the interplay of determinants and how they relate to one another will add to depth of understanding, supporting intervention development.

Eliciting successful intervention components within different populations and settings must be established before behaviour change can be implemented effectively at all levels. Once we know what works, “the active intervention ingredients”, there will be an added confidence in applying these changes at a wider level. Furthermore, given that individuals making positive behaviour changes need to function effectively within their environments it becomes vital to consider system level issues alongside individual level components (Davis et al., 2015). Similarly maintenance of such interventions has proven difficult to achieve in the long term and will need to be assessed (Kwasnicka et al., 2016). Only then can effective, and more importantly, sustainable changes be made.

Using frameworks such as the TDF in parent populations as adopted in this research is relatively new and requires further exploration to determine its usability and effectiveness. Moreover, this is believed to be the only study that combines use of the TDF and taxonomies of behaviour change to make recommendations to inform an intervention aimed at increasing fruit and vegetable consumption in young children. This research has captured what is considered to be an inclusive range of determinants including barriers and facilitators to child fruit and vegetable provision and consumption. Using these findings and mapping process as outlined, it is now possible to design and pilot an intervention which includes components that are considerably more likely to be effective.

6.8.1 Evidence generated in this thesis that warrants further exploration

A number of determinants relating to parental fruit and vegetable provision were identified and explored throughout this thesis. Much of the evidence generated corroborates similar literature, adding to this body of evidence. However, the design of this research and methods used have allowed for a systematic, thorough and in depth exploration of these determinants. This thesis has led to a wider understanding

of these determinants and unearthed a number of other, less studied, yet equally important contributory factors such as those outlined in the intricate network of social influences. Grandparents were found to play a much larger role in provision than expected. Further research to explore the role of grandparents (and other family members) needs to be carried out to understand how they might best support parental provision. This will also allow for the development of interventions which target other family members such as grandparents which seems sensible in the current climate, where they have often adopted the main caregiver role.

Following a lack of evidence pertaining to the role of professional caregivers in fruit and vegetable provision, they were dropped following the mixed methods review and therefore not included in the interviews. There is a need for further research with this population to explore how nursery, childminder and pre-school based interventions to improve fruit and vegetable provision and consumption in these settings could work more effectively. Additionally, how these settings and professional populations could potentially support parental provision for consumption in the home environment is worth further exploration to promote consistency of provision amongst caregivers.

This research has provided an exhaustive exploration of determinants and highlighted the importance of addressing parenting styles and practices, which should be included in every intervention aimed at increasing fruit and vegetable provision. This may take the form of simple parenting classes which aim to establish and enhance positive behaviours to increase consumption. On becoming a parent, there is no guidance on how best to use parenting skills. Therefore educating parents on how to be more encouraging and exhibit behaviours that lead to an increase in consumption would prove a useful addition to any fruit and vegetable intervention.

There is now a need for the development of interventions to take into account the complex interplay of determinants to support parental provision as highlighted in this thesis. This research provides the foundation for proposing a feasibility study which includes intervention components using relevant behaviour techniques. This will allow for testing and refinement of the proposed intervention prior to implementation. This would also provide an opportunity to assess whether such interventions would

be transferable to a variety of contexts. For example, would they work within different cultural environments or in single parent families etc.

Finally, this research has utilised a theoretical framework, promoting a systematic uptake of research findings ensuring intervention development is evidenced based and applicable to the settings in which they are to be delivered. Such methods are easily accessible to researchers and gives assurance to those with a non-psychology background that theory is incorporated in a robust and logical manner. This research also adds to accumulative bank of evidence within the implementation science arena.

6.8.2 Recommendations for future research

The following research priorities and recommendations can be made based upon the findings of this research and are outlined below:

1. The role of grandparents (and other wider social influencers) needs to be further explored and considered in intervention development, given their importance within a young child's life. Understanding and improving grandparents' child-feeding practices could be a valuable approach in intervention development to improve the diets of young children.

2. A feasibility study should be developed using evidence on determinants generated from this research. This should include relevant intervention components and appropriate behaviour change techniques which are theoretically underpinned.

3. Interventions should utilise experience and skills of grandparents to increase parental fruit and vegetable provision. This should include involving the child in fruit and vegetable preparation at an early age would draw upon the concept of intergenerational social influence.

4. More research is needed to explore the role of professional caregivers in the provision of fruits and vegetables to young children. This should include settings such as nurseries, pre-schools and childminders.

5. Researchers need to consider working with or at least having a greater understanding of younger children. This may include accessing and enrolling on courses that specifically look at engaging with this age group in research. This will allow for children's perspectives to be considered.

6. All interventions should include components that address positive parenting practices and the use of positive parenting styles to increase consumption.

7. Parental provision and child consumption should be measured simultaneously, using appropriate and validated measures.

8. Researchers should consider using public involvement or co-production to inform any future intervention development as this will increase depth of understanding of determinants surrounding parental provision and child consumption of fruits and vegetables.

9. Employing implementation science and the use of theoretical frameworks, such as the TDF should be utilised more widely to explore system level barriers and faciltators to behaviour change. This is particularly true for researchers with minimal or no psychological training, to ensure a theoretical grounding.

6.8.3 Implications for policy and practice

The question of responsibility and who should bear that in relation to driving forward changes for a positive food environment is somewhat ambiguous. Children rely on parents and other caregivers and, as is clear from this research, the strongest evidence was associated with the TDF domain of *social influences*. However, as many interventions are directed at an individual level, evidence to support application at a wider environment and policy level is lacking. It becomes easy to target parents as those responsible for ensuring their children are consuming enough fruits and vegetables. Yet this is not the case as can be seen from the many other social influences impacting on the primary caregiver and their ability to provide (Figure 18).

Others such as family members, friends, health professionals, the wider community, environment and policy level determinants all play a role and therefore accountability should not lie with one as without addressing the other effectiveness of any intervention would be diluted. With this in mind and the fact that those interventions or changes that are made at a policy level are likely to have the greatest impact, we need to think about how we might adopt an upstream way of thinking that could potentially have a wider influence. This would involve systems thinking and in particular the food system and consideration of what drivers and barriers exist within the system to create a change. An example of this may be to identify and target levers which result in implementation of local authority healthy eating policies to help drive changes on broad scale.

There is also scope to introduce taxation, as with the recent UK sugar levy with the aim of reducing population sugar consumption in an attempt to lower levels of obesity. Increasing the price of energy dense "junk" foods will make healthier alternatives such as fruits and vegetables more affordable, in turn making them more accessible to parents. This will not only encourage parents to buy these foods for their children but there is a strong likelihood that they will chose to consume more themselves. It would therefore be assumed that provision would not only be increased directly but also through parental modelling which has been identified as a key determinant of child consumption.

How might we use tools such as the TDF to help achieve this?

The versatility of the TDF has been demonstrated in this thesis. It has been adapted and used for secondary data analysis in the mixed methods review and informed data collection tools in the caregiver interviews including being utilised in the model development process to map and provide a picture of influential determinants. Given the breadth of its application within the implementation science arena there is scope for evaluating interventions on a much wider scale. The use of models such as the SEM are currently employed to identify and map determinants from individual to policy levels as is evident in the recently published report *'The Role of Law in Achieving the Healthy People 2020 Nutrition and Weight Status Goals of Increased Fruit and Vegetable Intake in the United States'* (Crawford P, 2018). It may be

suggested that a similar approach be taken in the UK. It is possible to use the TDF as opposed to or to complement models such as the SEM, provided it is adapted effectively and operationalised for use. This method would provide an added depth of understanding and potentially capture a wider range of behavioural factors that other approaches do not.

Alternatively, it would be possible to use the TDF to identify levers (at all levels) within a food system which can be targeted in order to improve access and uptake of healthier foods. It may also be used for gauging impact of local authority interventions which are currently embedded within local food systems. We must also remember that such interventions are context specific and require the involvement and responses from several stakeholders, e.g. policy makers, food industry, public and environmental health and the public. Therefore the TDF could also be used to produce a ‘systems map’, similar to the model of determinants produced in this thesis which may help guide policy makers in their decision making processes. Using tools such as the TDF to further understand policy levers to address determinants strives as a platform for bridging the gap between policy and research whilst remaining inclusive and mindful of the need for cross agency working to improve diet and increase fruit and vegetable consumption.

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Appendices

Appendix 1: Search strategy for quantitative systematic review

	Medline and Embase via Ovid
1	(Determin*4 or correlates or factors or predict*3 or associate*3 or interaction or influence*1 or temperament or beliefs or attitudes or knowledge or perceptions or views or intentions or facilitators or barriers or experiences or prevent*3 or reduc*5 or increas*3 or promot*3 or education or curriculum or program*3 or polic*3 or media or campaign or review or intervention*1 or initiative*1 or strategy*3 or evaluation or trial).mp. [mp=title, abstract, original title, name of substance word, subject heading word, protocol supplementary concept, rare disease supplementary concept, unique identifier]
2	(Infant* or Toddler* or Preschool* or Nurser*).mp. [mp=title, abstract, original title, name of substance word, subject heading word, protocol supplementary concept, rare disease supplementary concept, unique identifier]
3	((Fruit*1 or Vegetable*1 or juice or sugar sweetened beverage*1 or fizzy drinks or soft drinks or junk food or fast food or processed food or unhealthy food or takeaway food or non-core food or energy dense food or high fat food or fatty food or nutrient poor food or unhealthy diet or healthy eating or portion size or empty calories or confectionery or sweet*1 or dessert*1 or chocolate*1 or cake*1 or biscuit*1 or burger*1 or chip*1 or crisp*1 or snack*1 or breakfast or lunch or dinner or obes*6 or overweight).mp. [mp=title, abstract, original title, name of substance word, subject heading word, protocol supplementary concept, rare disease supplementary concept, unique identifier]
4	3 not (allerg*3 or dental caries)
5	(physical activ*5 or inactiv*3 or exercise*1 or outdoor or TV or Television or Tele or sedentary or (screen adj time)).mp. [mp=title, abstract, original title, name of substance word, subject heading word, protocol supplementary concept, rare disease supplementary concept, unique identifier]
6	1 AND 2 AND (4 OR 5)
7	6 not (cerebral palsy or asthma or cystic fibrosis or autism).mp. [mp=title, abstract, original title, name of substance word, subject heading word, protocol supplementary concept, rare disease supplementary concept, unique identifier]
	Cinahl and Psychinfo via Ebsco
S1	TX (Determin*4 or correlates or factors or predict*3 or associate*3 or interaction or influence*1 or temperament or beliefs or attitudes or knowledge or perceptions or views or intentions or facilitators or barriers or experiences or prevent*3 or reduc*5 or increas*3 or promot*3 or education or curriculum or program*3 or polic*3 or media or campaign or review or intervention*1 or initiative*1 or

	strategy*3 or evaluation or trial)
S2	TX (Infant* or Toddler* or Preschool* or Nurser*)
S3	TX (Fruit*1 or Vegetable*1 or juice or sugar sweetened beverage*1 or fizzy drinks or soft drinks or junk food or fast food or processed food or unhealthy food or takeaway food or non-core food or energy dense food or high fat food or fatty food or nutrient poor food or unhealthy diet or healthy eating or portion size or empty calories or confectionery or sweet*1 or dessert*1 or chocolate*1 or cake*1 or biscuit*1 or burger*1 or chip*1 or crisp*1 or snack*1 or breakfast or lunch or dinner or obes*6 or overweight)
S4	TX S3 not (allerg*3 or dental caries)
S5	TX (physical activ*5 or inactiv*3 or exercise*1 or outdoor or TV or Television or Tele or sedentary or (screen n1 time))
S6	TX S1 AND S2 AND (S4 OR S5)
S7	TX S6 not (cerebral palsy or asthma or cystic fibrosis or autism)
	BNI via Healthcare Databases supplied by ProQuest
1	((Determin*4 or correlates or factors or predict*3 or associate*3 or interaction or influence*1 or temperament or beliefs or attitudes or knowledge or perceptions or views or intentions or facilitators or barriers or experiences or prevent*3 or reduc*5 or increas*3 or promot*3 or education or curriculum or program*3 or polic*3 or media or campaign or review or intervention*1 or initiative*1 or strategy*3 or evaluation or trial)).ti,ab
2	((Infant* or Toddler* or Preschool* or Nurser*)).ti.ab
3	((Fruit*1 or Vegetable*1 or juice or sugar sweetened beverage*1 or fizzy drinks or soft drinks or junk food or fast food or processed food or unhealthy food or takeaway food or non-core food or energy dense food or high fat food or fatty food or nutrient poor food or unhealthy diet or healthy eating or portion size or empty calories or confectionery or sweet*1 or dessert*1 or chocolate*1 or cake*1 or biscuit*1 or burger*1 or chip*1 or crisp*1 or snack*1 or breakfast or lunch or dinner or obes*6 or overweight)).ti.ab
4	(allerg*3 or dental caries).ti.ab
5	3 not 4
6	(physical activ*5 or inactiv*3 or exercise*1 or outdoor or TV or Television or Tele or sedentary or (screen adj time)).ti.ab.
7	1 AND 2
8	5 OR 6
9	7 AND 8
10	(cerebral palsy or asthma or cystic fibrosis or autism).ti.ab.
11	9 not 10
	Assia and SocAbstracts via ProQuest
1	ab,ti(Determin*4 or correlates or factors or predict*3 or associate*3 or interaction or influence*1 or temperament or beliefs or attitudes or knowledge or perceptions or views or intentions or facilitators or barriers or experiences or prevent*3 or reduc*5 or increas*3 or promot*3 or education or curriculum or program*3 or polic*3 or media or campaign or review or intervention*1 or initiative*1 or strategy*3 or evaluation or trial)
2	ab,ti(Infant* or Toddler* or Preschool* or Nurser*)

3	ab,ti(Fruit*1 or Vegetable*1 or juice or sugar sweetened beverage*1 or fizzy drinks or soft drinks or junk food or fast food or processed food or unhealthy food or takeaway food or non-core food or energy dense food or high fat food or fatty food or nutrient poor food or unhealthy diet or healthy eating or portion size or empty calories or confectionery or sweet*1 or dessert*1 or chocolate*1 or cake*1 or biscuit*1 or burger*1 or chip*1 or crisp*1 or snack*1 or breakfast or lunch or dinner or obes*6 or overweight)
4	ab,ti(allerg*3 or dental caries)
5	S3 NOT S4
6	ab,ti(physical activ*5 or inactiv*3 or exercise*1 or outdoor or TV or Television or Tele or sedentary or (screen near time))
7	S1 AND S2
8	S5 OR S6
9	S7 AND S8
10	ab,ti(cerebral palsy or asthma or cystic fibrosis or autism)
11	S9 NOT S10
	Web of Knowledge via Thomson Reuters
1	((Determin*4 or correlates or factors or predict*3 or associate*3 or interaction or influence*1 or temperament or beliefs or attitudes or knowledge or perceptions or views or intentions or facilitators or barriers or experiences or prevent*3 or reduc*5 or increas*3 or promot*3 or education or curriculum or program*3 or polic*3 or media or campaign or review or intervention*1 or initiative*1 or strategy*3 or evaluation or trial) AND (Infant* or Toddler* or Preschool* or Nurser*)) AND ((Fruit*1 or Vegetable*1 or juice or sugar sweetened beverage*1 or fizzy drinks or soft drinks or junk food or fast food or processed food or unhealthy food or takeaway food or non-core food or energy dense food or high fat food or fatty food or nutrient poor food or unhealthy diet or healthy eating or portion size or empty calories or confectionery or sweet*1 or dessert*1 or chocolate*1 or cake*1 or biscuit*1 or burger*1 or chip*1 or crisp*1 or snack*1 or breakfast or lunch or dinner or obes*6 or overweight) NOT (allerg*3 or dental caries) OR (physical activ*5 or inactiv*3 or exercise*1 or outdoor or TV or Television or Tele or sedentary or (screen near time)))
2	NOT (cerebral palsy or asthma or cystic fibrosis or autism)

Appendix 2: Information extracted from included studies

Intervention studies	**Prospective studies**
Reference ID	Reference ID
Author	Author
Publication year	Publication year
Country	Country
Language of study	Study name
Study name	Sample size
Population	Age range
Sample size	Average age
Age range	Sex (M:F)
Average age	Ethnicity
Sex (M:F)	Socioeconomic status (SES)
Ethnicity	Study design
Socioeconomic status (SES)	Sample recruitment
Study design	Representativeness of sample
Sample recruitment	Follow-up period (for prospective cohort studies)
Representativeness (of sample to the general population)	Level of determinant/correlate
Intervention details	Primary outcome, (measured by)
Control group details	Secondary outcome, (measured by)
Setting (where the intervention was delivered)	Analysis type
Determinant targeted (child behavioural, modifiable parental, environmental)	Effect estimate (crude/ adjusted)
Theoretical model	
Intervention provider	
Number of sites	
Duration of intervention	
Follow-up	
Primary outcome, (measured by)	
Secondary outcome, (measured by)	
Analysis type	
Effect estimate (crude/ adjusted)	

Appendix 3: Characteristics table of included prospective studies (including the longitudinal control group data from Randomised Controlled Trials)

No	Author, year and country	Study design/name	Participants (n)	Age at baseline measurement and duration of study	Setting	Assessment time-points/follow-up	Outcome and measurement tool	Determinant/s and domain level	Association (fruit and vegetable (F&V) unless otherwise stated)	Quality score (max 6)
1	Alexy 1999 Germany	Prospective cohort Dortmund Nutritional and Anthropometrical Longitudinally Designed Study (DONALD)	205 (51% boys) Volunteer sample of families interested in the long-term nutrition and health of their children	Age: 3 years Study duration: 3 years	Study centre	3, 4 and 5 years	Fruit consumption 3-day weighed diet record	**Individual** ↑Fruit juice consumption	**Vegetable consumption not measured in this study** **-^{F}**	4 (Int)
2	Alsharairi 2015 Australia	Data used from the Longitudinal Study of Australian Children (LSAC)	4911 (50% boys) A mixture of two representative cohorts of the LSAC study	Age: 6-7 years (data is available for 8-9 years also, however not considered here)	Home	4-5 and 6-7 years	Fruit and vegetable intake (using exploratory factor analysis) Questionnaire and face-to-face interviews	**Interpersonal** ↑ Maternal authoritarian feeding practices ↑ Paternal authoritarian feeding practices ↑ Paternal restrictive feeding practices	**+** (G only) **0** (B only) **+** **-**	5 (Int)
3	Foterek 2015 Germany	Prospective cohort Dortmund Nutritional and Anthropometrical Longitudinally Designed Study (DONALD)	281 (53% boys) Volunteer sample of families interested in the long-term nutrition and health of their children	Age: 6-7 years of age.	Study Centre and family home	Infancy, 3 - 4 years and 6 - 7 years	Fruit and vegetable intake 3-day weighed dietary records	**Individual** ↑ % commercially prepared, compared with homemade food	Infancy: **-^{V}** Pre-school children (3-4 years): - (b only)	4 (Int)
4	Gregory 2011 Australia	Prospective cohort Recruited from The Child and Family Health Study	78 mothers and their 1 year old child	Age: 12 months Study duration: 12 months	home	1 and 2 years	Fruit and vegetable consumption Child Food Frequency Questionnaire (CFFQ)	**Interpersonal** ↑Maternal pressure to eat ↑Maternal modelling ↑Restriction	**-^{F}, 0^{V}** **0^{F}, +^{V}** **0^{F}, 0^{V}**	4 (Int)

No	Author, year and country	Study design/name	Participants (n)	Age at baseline measurement and duration of study	Setting	Assessment time-points/follow-up	Outcome and measurement tool	Determinant/s and domain level	Association (fruit and vegetable (F&V) unless otherwise stated)	Quality score (max 6)
5	Grimm 2014 USA	An analysis of data from both the Infant Practices Study (IFPS II) and the Year 6 Follow-Up (Y6FU) Study	1078 respondents (parents) with complete outcome data for children at 6 years and exposure data from infancy (49% boys)	Age: 6 years Study duration: 6 years	Home (survey and telephone)	Monthly in infancy (up to 12 months) and 6 years	Frequency of fruit and vegetable intake at 6 years	**Individual** ↑ F&V intake ↑Age of introduction of F&V	**0** **+**	5 (Int)
6	Louzada 2012 Brazil	RCT (longitudinal control group data only)	300 mothers and their full term infants (≥37 weeks gestation) from maternity wards	Age: 6 months Study duration: 8 years (data considered up to the 3-4 year assessment for the purpose of this study)	home	6 months, 12 to 16 months, 3 to 4 years	Fruit and vegetable consumption 24-hour dietary recall (using illustrations to quantify portion size)	**Individual** Sex (difference between B&G; ref G) ↑Age	**0** **0**	4 (Int)
7	Oliveira 2015 Various	Prospective analysis of data from 3 cohort studies (Generation XXI from Portugal; ALSPAC from the UK and EDEN from France)	12,739 mothers and their children (Generation XII n=4227; ALSPAC n=7620; EDEN n=892), (~50% boys)	Age: 4-5 years Study duration: 5 years	Various	4-6, 12-15, 24 and 48-54 months	Fruit and vegetable consumption FFQ	**Individual** ↑ Problematic eating behaviours	**-**	5 (Int)
8	Sahota 2015 UK	Prospective cohort Born In Bradford 1000 (BIB) study	Multi-ethnic cohort of 1259 singleton infants whose mothers had completed a FFQ at 12 months post-birth as part of the larger BIB cohort (n=12, 453)	Age: 12 months Study duration: 18 months	home	12 and 18 months	Fruit and vegetable consumption FFQ	**Individual** Ethnicity (difference between different ethnic groups; ref = British white) British Pakistani	**+^{F}, -^{V}**	5 (Int)

No	Author, year and country	Study design/name	Participants (n)	Age at baseline measurement and duration of study	Setting	Assessment time-points/follow-up	Outcome and measurement tool	Determinant/s and domain level	Association (fruit and vegetable (F&V) unless otherwise stated)	Quality score (max 6)
9	Talvia 2006 Finland	RCT (Longitudinal control group data only) Special Turku Coronary Risk Factor Intervention project (STRIP)	522 mothers and infants recruited at 5-month routine infant check at well-baby clinics as part of the larger STRIP project.	Age: 12 months Duration: 11 years (data considered up to 7 years for the purpose of this review)	Study centre	1 – 7 years	Fruit and vegetable consumption Food records	**Individual** Sex(difference between B&G; ref G)	**-**[B]	4 (Int)
10	Valmorbida 2014 Brazil	RCT (cohort study nested in a RCT)	388 children and their parents, recruited at health centres during the third trimester of pregnancy (51.8% male)	Age: 6 months Duration: 2-3 years	Health centres and homes	6-9 months, 12-16 months and 2-3 years	Fruit and vegetable consumption (daily serves) Structured questionnaires and 24-hour dietary recall	**Individual** Sex(difference between B&G; ref G) ↑Number of siblings Dietary patterns: ↑Soft/sugary drink ↑Sweets ↑F&V (in infancy) ↑Time before weaning **Interpersonal** ↑Maternal education ↑Paternal education ↑Maternal occupation ↑Paternal occupation ↑Family income ↑Maternal weight	**0** **0** **-**[V]**, 0**[F] **0** **+**[F]**, 0**[V] **0** **0** **+** **0** **0** **+**[F]**, 0**[V] **0**	4 (Int)

No	Author, year and country	Study design/name	Participants (n)	Age at baseline measurement and duration of study	Setting	Assessment time-points/follow-up	Outcome and measurement tool	Determinant/s and domain level	Association (fruit and vegetable (F&V) unless otherwise stated)	Quality score (max 6)
11	Vilela 2013 Portugal	Prospective birth cohort Generation XXI	705 singleton children (51.3% boys) and their mothers recruited from level III maternity units as part of an original cohort (n= 8647)	Age: 2 years Duration: 2 years	unclear	2 and 4-5 years	Fruit and vegetable consumption FFQ, Food Records, Interviews	**Individual** Dietary patterns: ↑Sweets ↑Salty snack ↑Soft drink ↑Dairy ↑Meat ↑White meat & fish **Interpersonal** ↑Maternal Education	 **-** **-** **-** **0** **0** **0** **0**	5 (Int)
12	Vollrath 2012 Norway	Prospective cohort Norwegian Mother and Child Study	6,997 mothers and their infants	Age:18 months Duration: 7 years	unclear	18 months, 3 years and 7 years	Fruit and vegetable consumption FFQ	**Individual** Child Temperament; ↑Externalising (Hyperactive/ Aggressive) ↑Surgency (Active/Sociable) ↑Internalising (Anxious/ Dependent)	 **-** **+** **0**	5 (Int)

NR, not reported; F&V, fruit and vegetables; [F], fruit only; [V], vegetable only; RCT, randomised controlled trial; B, boys; G, girls; FFQ, food frequency questionnaire; ↑, increasing; Int, intermediate; - , negative association; +, positive association; 0, no association

Appendix 4: Characteristics table of included intervention studies

No	Author, year and country	Participants (n)	Age at baseline (mean (SD) OR range	Study design and setting	Description of Intervention and who delivered it.	Theory	Duration of intervention and follow-up	Outcome and measurement tool	Determinant/s and level	Association	Quality score
1	Bayer 2009 Germany	64 kindergartens (2 samples of children n=1318/1340)	5-6 years	Cluster RCT; Kindergarten	"TigerKids" 12 month behavioural intervention program. Primary aim to enhance regular PA and to modify habits of food and drink consumption. Focusing on establishing a health behaviour pattern that might be maintained outside of the day-care setting, e.g. at home Teachers	SLT	Duration: 2 years Follow-up: 12-20 months	F&V consumption Questions embedded in a parental questionnaire of the Bavarian Health Survey (FFQ)	**Individual** Sex (difference between B&G; ref G) **Interpersonal** ↑Parental Education	**0** **+**	4 (Int)
2	Cameron 2014 Australia	542 mother /infant pairs. 389 in dietary analysis, I: 191, C: 198 (46% male)	0.31 (0.11) years	Cluster RCT; Parent groups at various locations (government funded)	The Infant Feeding Activity and Nutrition Trial (INFANT). Early childhood obesity prevention intervention implemented in first-time parent groups using an anticipatory guidance approach (health practitioner support) Dietitian	Parenting support theory	Duration: 20 months Follow-up: 4 months and 20 months	F&V consumption Telephone administered multiple pass 24hour recall	**Interpersonal** ↑Maternal Education; ↑Maternal Age	**+^{V}, 0^{F}** **-^{V}, 0^{F}**	5 (Int)
3	De Bock 2011 German	377, I: 194, C: 183 (53.2% male)	4.26 (0.78) years	Cluster RCT; Pre-school	15x 2 hour nutrition-expert delivered (15x 2-hour) sessions over 6 months with 5 actively involving parents, focusing on role-modelling and nutrition needs of child	SLT and Zajonc's exposure effect	Duration: 6 months Follow-up: 6 and 12 months	F&V consumption FFQ	**Individual** Sex (difference b/w B&G; ref G) Immigrant background; Ethnicity (difference between different ethnic groups; ref = German natives) Non German natives **Interpersonal** ↑Maternal education	**0^{B}** **0** **0**	4 (Int)

No	Author, year and country	Participants (n)	Age at baseline (mean (SD) OR range	Study design and setting	Description of Intervention and who delivered it.	Theory	Duration of intervention and follow-up	Outcome and measurement tool	Determinant/s and level	Association	Quality score
4	De Coen 2012 Belgium	1589, I: 1032, C: 557	3-6 years	Cluster RCT	Health promotion intervention with the child as the centre of focus situated within several layers (family, friends, pre-primary, primary schools, community stakeholders, local policy and media) Research Team	SEM	Duration: 2 years Follow up: 19 months	Daily F&V consumption FFQ	**Individual** ↑SES ↑Age Sex (difference between B&G; ref G)	**0** **0** **0**^{B}	4 (Int)
5	Haire-Joshu 2008 USA	1658, I: 759, C: 899	2-5 years	Group randomised nested cohort	"High 5-Kids" program. A home-based intervention focused on educating parents to provide a positive F&V environment for their children. Encourages modelling of positive eating behaviours. Parent Educators	SCT and an Ecological Framework	Duration: Unclear Follow-up: 7 months (average)	F&V consumption Saint Louis University for kids FFQ	**Individual** Child weight (association only seen in children of ideal weight) Child weight (in overweight and obese children) **Interpersonal** ↑Parent weight	**+** **0** **0**	5 (Int)
6	Klohe-Lehman 2007 USA	91 mother/ child pairs (~50% male)	2.1 years	Non-randomised study	Multi-component intervention promoting nutritious food choices, lifestyle changes for good health and weight loss, behavioural modification and PA. Registered dietitians	SCT	Duration: 8 weeks Follow-up:24 weeks	Servings of F&V per day FFQ	**Individual** ↑Age **Interpersonal** ↑Mothers Age Mothers employment status (never been employed compared with those who had or were currently employed)	**-**^{F}**, 0**^{V} **-**^{V}**, 0**^{F} **+**^{F}**, 0**^{V}	NR: low quality (non-randomised and small sample size)

No	Author, year and country	Participants (n)	Age at baseline (mean (SD) OR range	Study design and setting	Description of Intervention and who delivered it.	Theory	Duration of intervention and follow-up	Outcome and measurement tool	Determinant/s and level	Association	Quality score
7	Leahy 2008 USA	75 (50% male)	4.4 (0.1) years	Within subject crossover	An intervention aimed at varying energy density and portion size of young children's meal intake to reduce energy intake whilst increasing vegetable intake. Teachers	NR	Duration:4 weeks Follow-up: 4 weeks	Vegetable consumption Food items weighted using validated equipment (digital scales) and researcher recorded observations	**Individual** ↑Age ↑body weight; ↑height; ↑BMI; **Interpersonal** Maternal feeding practices	**Fruit not measured in this study** **0**^{V} **0**^{V} **0**^{V} **0**^{V} **0**^{V}	NR: low quality as non randomised and small sample size)
8	Natale 2014 USA	28 childcare centres, I: 12, C: 16. Participants: 1211 children, 1080 parents and 122 teachers	46.72 (11.8) months	RCT	Intervention delivered over one school year and included; 1. Menu modification, 2. A child's healthy lifestyle curriculum and 3. An adult (teacher and parent focused). Curriculum specialists, Program staff, Teachers and Parents	NR	Duration: 12 months Follow-up: End of school year (approx. 10 months)	F&V consumption Questions based on the Healthy Kids Checklist (a 32 item rating scale targeted at children in pre-school through parental responses on their behalf)	**Individual** Sex (difference between B&G; ref G) ↑Age Ethnicity Dietary patterns: F&V consumption	**0** **0** **0** **+**	4 (Int)
9	Nyberg 2015 Sweden	14 pre-school classes, I: 7, C: 7 Participants: Total n=241, I: 129, C: 112 (51% boys)	6.2 (0.3)	Cluster RCT	6 month intervention including; 1. Health information for parents, 2. Motivational interviewing with parents and 3. Teacher-led classroom activities with children. Teachers and counsellor (for motivational interviewing element)	SCT	Duration: 6 months Follow-up: post intervention and 6 months	F&V intake Validated parent-proxy questionnaire, the Eating and Physical Activity Questionnaire (EPAQ)	**Individual** Sex (difference between B&G; ref G)	**+**^{V}**, 0**^{F}	5 (Int)

No	Author, year and country	Participants (n)	Age at baseline (mean (SD) OR range	Study design and setting	Description of Intervention and who delivered it.	Theory	Duration of intervention and follow-up	Outcome and measurement tool	Determinant/s and level	Association	Quality score
10	O'Connell 2012 USA	96 (56% male)	3-6 years	RCT	Six-week intervention aimed at increasing vegetable consumption involving repeated exposure to 3 unfamiliar/disliked vegetables. Teachers	NR	Duration: 6 weeks Follow-up: 6 and 12 weeks	Vegetable consumption Child Feeding Questionnaire (CFQ) and Weighted vegetable intake	**Interpersonal** ↑Peer F&V consumption Parent feeding practices: ↑pressure; ↑restriction	**Fruit not measured in this study** **+^{V}** **0^{V}** **0^{V}**	4 (Int)
11	Reinaerts 2007 Netherlands	939 in total. n= 122 included for purpose of this review – (age group 1: 4-5 years) I:49, C:73 (49.5% male)	4-5 years	RCT	Two multi-component health promotion interventions aimed at improving F&V intake based on two objectives; 1. Increasing children's daily F&V consumption 2. Creating an environment to support child's F&V consumption. Various: Teacher/school employee, parent	NR	Duration: 9 months Follow up: 9 months	F&V consumption Pre-structured food recall and FFQ	**Individual** ↑Age Sex (difference between B&G; ref G) Immigrant background; Ethnicity (difference between different ethnic groups; ref = Dutch natives and Non Dutch natives	**+^{F}, 0^{V}** **+^{V}, 0^{F}** **+^{V}, 0^{F}**	NR: low quality (small sample size)
12	Whaley 2010 USA	821, I: 412, C: 409 (49% male)	23-24 months	Non-randomised study	Women Infants and Children (WIC) study sample with matched control. The Child Health and Intervention Research Project (CHIRP) primary aim to influence the food and beverage intake, PA, and/or television watching of children 1 to 5 years via one-on-one education. WIC Staff	Stages of change and TM	Duration: 8 months Follow-up: 12 months	F&V consumption Survey, Enhanced WIC child questionnaire and one to one dialogue	**Individual** ↑Age	**-^{V},+^{F}**	3 (Low)

No	Author, year and country	Participants (n)	Age at baseline (mean (SD) OR range	Study design and setting	Description of Intervention and who delivered it.	Theory	Duration of intervention and follow-up	Outcome and measurement tool	Determinant/s and level	Association	Quality score
13	Witt 2012 USA	263, I: 165, C: 98 (53% male)	4-5 years	RCT	"Color Me Healthy" (CMH). A multi-component interactive nutrition and PA intervention which uses colour, music, and exploration of the senses to teach children about healthful eating and PA. Teachers/parents	NR	Duration: 6 weeks Follow-up: 1 and 12 weeks	F&V consumption FFQ, 3-day food diary and a General health survey	**Individual** Sex (difference between B&G; ref G) ↑SES **Environmental** ↑Experience/education level of teacher ↑Classroom size Timing of snack given (in childcare centre)	**0** **0** **0** **0** **0**	5 (Int)
14	Wolfenden 2014 Australia	30 preschools, 394 parents. 15 intervention schools: 208 parents; 15 control schools: 186 parents	4.3 (0.6)	Cluster RCT	Intervention consisted of four 30min telephone contacts delivered weekly over one month and resources including a guidebook that contained information about healthy eating for children. Trained telephone interviewer	SET	Duration: 1 month Follow-up: 18 months	F&V intake F&V subscale of the Children's Dietary Questionnaire (CDQ)	**Interpersonal** ↑Maternal education ↑Paternal education Family income	**0** **0** **0**	4 (Int)

NR, not reported; F&V, fruit and vegetables; [F], fruit only; [V], vegetable only; RCT, randomised controlled trial; SCT, social cognitive theory; SEM, socio-ecological model; SET, socio-ecological theory; SLT, social learning theory; TM, transtheoretical model; B, boys; G, girls; FFQ, food frequency questionnaire; ↑, increasing; Int, intermediate, I, intervention; C, control; SES, socioeconomic status; - , negative association; + , positive association; 0, no association

Appendix 5: Search strategy for mixed methods review

	Medline and Embase via Ovid
1	(Determin*4 or correlates or factors or predict*3 or associate*3 or interaction or influence*1 or temperament or beliefs or attitudes or knowledge or perceptions or views or intentions or facilitators or barriers or experiences or prevent*3 or reduc*5 or increas*3 or promot*3 or education or curriculum or program*3 or polic*3 or media or campaign or review or intervention*1 or initiative*1 or strategy*3 or evaluation or trial).mp. [mp=title, abstract, original title, name of substance word, subject heading word, protocol supplementary concept, rare disease supplementary concept, unique identifier]
2	(Infant* or Toddler* or Preschool* or Nurser*).mp. [mp=title, abstract, original title, name of substance word, subject heading word, protocol supplementary concept, rare disease supplementary concept, unique identifier]
3	((Fruit*1 or Vegetable*1 or obes*6 or overweight).mp. [mp=title, abstract, original title, name of substance word, subject heading word, protocol supplementary concept, rare disease supplementary concept, unique identifier]
4	3 not (allerg*3 or dental caries)
5	1 AND 2 AND 4
6	5 not (cerebral palsy or asthma or cystic fibrosis or autism).mp. [mp=title, abstract, original title, name of substance word, subject heading word, protocol supplementary concept, rare disease supplementary concept, unique identifier]

	Cinahl and Psychinfo via Ebsco
S1	TX (Determin*4 or correlates or factors or predict*3 or associate*3 or interaction or influence*1 or temperament or beliefs or attitudes or knowledge or perceptions or views or intentions or facilitators or barriers or experiences or prevent*3 or reduc*5 or increas*3 or promot*3 or education or curriculum or program*3 or polic*3 or media or campaign or review or intervention*1 or initiative*1 or strategy*3 or evaluation or trial)
S2	TX (Infant* or Toddler* or Preschool* or Nurser*)
S3	TX (Fruit*1 or Vegetable*1 or obes*6 or overweight)
S4	TX S3 not (allerg*3 or dental caries)
S5	TX S1 AND S2 AND S4
S6	TX S5 not (cerebral palsy or asthma or cystic fibrosis or autism)

	BNI via Healthcare Databases supplied by ProQuest
1	((Determin*4 or correlates or factors or predict*3 or associate*3 or interaction or influence*1 or temperament or beliefs or attitudes or knowledge or perceptions or views or intentions or facilitators or barriers or experiences or prevent*3 or reduc*5 or increas*3 or promot*3 or education or curriculum or program*3 or polic*3 or media or campaign or review or intervention*1 or initiative*1 or strategy*3 or evaluation or trial)).ti,ab
2	((Infant* or Toddler* or Preschool* or Nurser*)).ti.ab
3	((Fruit*1 or Vegetable*1 or obes*6 or overweight)).ti.ab
4	(allerg*3 or dental caries).ti.ab
5	3 not 4
6	1 AND 2 AND 5
7	(cerebral palsy or asthma or cystic fibrosis or autism).ti.ab.
8	6 not 7

	Assia and SocAbstracts via ProQuest
1	ab,ti(Determin*4 or correlates or factors or predict*3 or associate*3 or interaction or influence*1 or temperament or beliefs or attitudes or knowledge or perceptions or views or intentions or facilitators or barriers or experiences or prevent*3 or reduc*5 or increas*3 or promot*3 or education or curriculum or program*3 or polic*3 or media or campaign or review or intervention*1 or initiative*1 or strategy*3 or evaluation or trial)
2	ab,ti(Infant* or Toddler* or Preschool* or Nurser*)
3	ab,ti(Fruit*1 or Vegetable*1 or obes*6 or overweight)
4	ab,ti(allerg*3 or dental caries)
5	S3 NOT S4
6	S1 AND S2 AND S5
7	ab,ti(cerebral palsy or asthma or cystic fibrosis or autism)
8	S6 NOT S7

	Web of Knowledge via Thomson Reuters
1	((Determin*4 or correlates or factors or predict*3 or associate*3 or interaction or influence*1 or temperament or beliefs or attitudes or knowledge or perceptions or views or intentions or facilitators or barriers or experiences or prevent*3 or reduc*5 or increas*3 or promot*3 or education or curriculum or program*3 or polic*3 or media or campaign or review or intervention*1 or initiative*1 or strategy*3 or evaluation or trial) AND (Infant* or Toddler* or Preschool* or Nurser*)) AND ((Fruit*1 or Vegetable*1 or obes*6 or overweight) NOT (allerg*3 or dental caries))
2	NOT (cerebral palsy or asthma or cystic fibrosis or autism)

Appendix 6: Information recorded in data extraction template for included studies

Information extracted
Study id/pubmed id
Author
Year
Country
Age
Design
Number of participants
Sample/recruitment
Findings/direct quotes
Author conclusions
Comments
Author Email
Quality Assessment- score yes/no = 1 (maximum score 12)
Research questions clearly stated
Approach appropriate for the research question
Qualitative approach clearly justified
Study context clearly described
Role of the researcher clearly described
Sampling method clearly described
Sampling strategy appropriate for the research question
Method of data collection clearly described
Data collection method appropriate
Method of analysis clearly described
Analysis appropriate for the research question
Conclusions supported by sufficient evidence

Appendix 7: Theoretical Domains Framework, Domains and Constructs Coding manual (Adapted from Michie et al 2005, Cane et al 2012 and Heslehurst et al 2014)

Domains and Constructs	Examples of relevant data
1: Knowledge *(An awareness of the existence of something)* • Knowledge *(including knowledge of condition /scientific rationale)* • Procedural knowledge *(Knowing how to do something)* • Schemas + mindsets + illness representations	Parent or caregiver's knowledge as a determinant of their behaviour which may influence pre-schoolers fruit and vegetable (F&V) consumption. Including: • Statements about having/not having/wanting knowledge of risk factors/benefits of the behaviour and its impact on the child. ➢ Knowing/not knowing/wanting to know how and when to do the behaviour. ➢ Knowing/not knowing/wanting to know why they should do the behaviour. ➢ Knowledge maybe correct/incorrect. In the context of this study, relating to knowledge of future comorbidity and related risk factors/potential health benefits of F&V consumption for the child.
2: Skills *(An ability or proficiency acquired through practice)* • Skills development *(The gradual acquisition or advancement through progressive stages of an ability or proficiency acquired through training and practice)* • Competence *(One's repertoire of skills, and ability especially as it is applied to a task or set of tasks)* • Ability *(Competence or capacity to perform a physical or mental act. Ability may be either unlearned or acquired by education and practice* • Interpersonal skills *(An aptitude enabling a person to carry on effective relationships with others, such as an ability to cooperate, to assume appropriate social responsibilities or to exhibit adequate flexibility)* • Practice *(Repetition of an act, behaviour, or series of activities, often to improve performance or acquire a skill)* • Skill assessment *(A judgment of the quality, worth, importance, level, or value of an ability or proficiency acquired through training and practice)* • Coping strategies	Parent or caregiver's skills as a determinant of their behaviour which may influence pre-schoolers F&V consumption. Including: • Statements relating to the skills and capabilities of performing/facilitating the F&V behaviour. ➢ Not possessing, wanting to develop or improve any skills which may enhance the performance of the behaviour. In the context of this study statements may relate to having or wanting to develop food preparation skills required to prepare healthy meals to facilitate fruit and vegetable consumption of pre-schoolers.

Domains and Constructs	Examples of relevant data
<u>3: Social or Professional Role and Identity (Self-standards)</u> *(A coherent set of behaviours and displayed personal qualities of an individual in a social or work setting)* • Professional identity *(The characteristics by which an individual is recognised relating to, connected with or befitting a particular profession)* • Professional role *(The behaviour considered appropriate for a particular kind of work or social position)* • Social identity *(The set of behavioural or personal characteristics by which an individual is recognizable [and portrays] as a member of a social group)* • Identity *(An individual's sense of self defined by a) a set of physical and psychological characteristics that is not wholly shared with any other person and b) a range of social and interpersonal affiliations (e.g., ethnicity) and social roles)* • Professional boundaries *(The bounds or limits relating to, or connected with a particular profession or calling)* • Group identity *(The set of behavioural or personal characteristics by which an individual is recognisable [and portrays] as a member of a group)* • Organisational commitment *(An employee's dedication to an organisation and wish to remain part of it. Organisational commitment is often described as having both an emotional or moral element and a more prudent element)* • Social and group norms • Alienation (Estrangement from one's social group; a deep seated sense of dissatisfaction with one's personal experiences that can be a source of lack of trust in one's social or physical environment or in oneself; the experience of separation between thoughts and feelings)	Parent or caregiver's social or professional role and identity as a determinant of their behaviour which may influence pre-schoolers F&V consumption • This includes statements relating specifically to their own role rather than the roles of others. ➢ Statements relating to the caregiver's views on their professional role and identity. ➢ Statements relating to the parent's/caregivers views on their social role and identity. E.g. It is/is not my job to/it's my role to….my responsibility to do the behaviour. In the context of this study professional role could relate to the extent the caregiver feels their role has an impact upon them performing the behaviour. i.e. the parents own personal views and expected responsibilities in their role as mother (also in comparison to peers), caregiver etc. Personal identity (for example their own weight issues, ethnicity etc.) and how this may impact upon them providing/facilitating their/child's behaviour.

Domains and Constructs	Examples of relevant data
4: Beliefs about Capabilities (Self-efficacy) *(Acceptance of the truth, reality, or validity about an ability, talent, or facility that a person can put to constructive use)* • Self-confidence *(Self-assurance or trust in one's own abilities, capabilities and judgment)* • Perceived competence *(An individual's belief in his or her ability to learn and execute skills)* • Self-efficacy *(An individual's capacity to act effectively to bring about desired results, as perceived by the individual)* • Perceived behavioural control *(An individual's perception of the ease or difficulty of performing the behaviour of interest)* • Self-esteem *(The degree to which the qualities and characteristics contained in one's self- concept are perceived to be positive)* • Empowerment *(The promotion of the skills, knowledge and confidence necessary to take great control of one's life as in certain educational or social schemes; the delegation of increased decision-making powers to individuals or groups in a society or organisation)* • Professional confidence *(An individual's belief in his or her repertoire of skills, and ability especially as it is applied to a task or set of tasks)* • Control of behaviour and material and social environment • Optimism (The confidence that things will happen for the best or that desired goals will be attained) • Pessimism (The attitude that things will go wrong and that people's wishes or aims are unlikely to be fulfilled)	Parent or caregiver's beliefs about capabilities as a determinant of their behaviour which may influence pre-schoolers F&V consumption. • This includes evaluative statements relating to their confidence and/or judgements in facilitating or performing the behaviour. ➢ These statements may relate to their **ability** or **inability** to perform or facilitate the behaviour. ➢ Statements relating to expectations of carrying out behaviour due to beliefs of competency in performing the behaviour. For example; ▪ I find it difficult/easy to do the behaviour. ▪ I do/don't feel confident/able/capable/competent to do the behaviour. ▪ I know [behaviour] will be/won't be successful because I am/am not very effective at performing the task. In the context of this study statements could include; How the parent or caregiver perceives their confidence in being able to encourage/influence the child's fruit and vegetable consumption.

Domains and Constructs	Examples of relevant data
5: Beliefs about Consequences (Anticipated outcomes/attitude) *(Acceptance of the truth, reality, or validity about outcomes of a behaviour in a given situation)* • Beliefs *(The thing believed; the proposition or set of propositions held true)* • Outcome expectancies *(Cognitive, emotional, behavioural, and affective outcomes that are assumed to be associated with future or intended behaviours. These assumed outcomes can either promote or inhibit future behaviours)* • Characteristics of outcome expectancies *(Characteristics of the cognitive, emotional and behavioural outcomes that individuals believe are associated with future or intended behaviours and that are believed to either promote or inhibit these behaviours. These include whether they are sanctions/rewards, proximal/distal, valued/not valued, probable/improbable, salient/not salient, perceived risks or threats)* • Anticipated regret *(A sense of the potential negative consequences of a decision that influences the choice made: for example an individual may decide not to make an investment because of the feelings associated with an imagined loss)* • Consequents *(An outcome of behaviour in a given situation)* • Unrealistic optimism *(The inert tendency for humans to over-rate their own abilities and chances of positive outcomes compared to those of other people)* • Salient events / sensitisation / critical Incidents *(Occurrences that one judges to be distinctive, prominent or otherwise significant)* • Attitudes • Contingencies *(A conditional probabilistic relation between two events. Contingencies may be arranged via dependencies or they may emerge by accident)* • Reinforcement *(Increasing the probability of a response by arranging a dependent relationship, or contingency, between the response and a given stimulus. A process in which the frequency of a response is increased by a dependent relationship or contingency with a stimulus)* • Punishment *(The process in which the relationship between a response and some stimulus or circumstance results in the response becoming less probable; a painful, unwanted or undesired event or circumstance imposed as a penalty on a wrongdoer)* • Consequents *(An outcome of behaviour in a given situation)* • Rewards *(proximal / distal, valued / not valued, probable /improbable) (Return or recompense made to, or received by a person contingent on some performance)* • Incentives *(An external stimulus, such as condition or object, that enhances or serves as a motive for behaviour)* • Sanctions *(A punishment or other coercive measure, usually administered by a recognised authority, that is used to penalise and deter inappropriate or unauthorised actions)*	Parent or caregiver's beliefs about consequences as a determinant of their behaviour which may influence pre-schoolers F&V consumption • This includes statements relating to beliefs about the potential outcomes for preschool children if they do/do not consume fruit and/or vegetables. . ➢ Statements relating to positive/negative consequences of doing/not doing the behaviour. Positive/negative consequences to themselves or others (the child) ➢ Statements relating to doing of the behaviour being directly related to receiving rewards or punishments. For example; ▪ If I do/do not do the behaviour, X,Y,Z will happen In the context of this study this may relate to beliefs that if my child doesn't eat enough F&V they will become obese. In addition to this it could include statements relating to caregivers (pre school assistant, relative, friend etc.) being reprimanded for not facilitating preschool children's fruit and veg consumption.

Domains and Constructs	Examples of relevant data
<u>6: Motivation and Goals (Intention)</u> *(Mental representations of outcomes or end states that an individual wants to achieve)* • Goals: distal / proximal *(Desired state of affairs of a person or system, these may be closer (proximal) or further away (distal))* • Goal priority *(Order of importance or urgency of end states toward which one is striving)* • Goal / target setting *(A process that establishes specific time based behaviour targets that are measurable, achievable and realistic)* • Goals: autonomous /controlled *(The end state toward which one is striving: the purpose of an activity or endeavour. It can be identified by observing that a person ceases or changes its behaviour upon attaining this state; proficiency in a task to be achieved within a set period of time)* • Intention *(A conscious decision to perform a behaviour or a resolve to act in a certain way)* • Stability of intention/certainty of intention *(Ability of one's resolve to remain in spite of disturbing influences)* • Transtheoretical model and stages of change *(A five-stage theory to explain changes in people's health behaviour. It suggests that change takes time, that different interventions are effective at different stages, and that there are multiple outcomes occurring across the stages)* • Intrinsic motivation • Commitment	Parent or caregiver's motivation and goals as a determinant of their behaviour which may influence pre-schoolers F&V consumption • Statements relating to their goals, aims, desired end result of doing the behaviour. ➢ Statements relating to other goals which may interfere with the behaviour. ➢ Statements relating to factors which increase/decrease their motivation to perform the behaviour. ➢ Statements relating to setting goals to achieve the end result. ➢ Statements relating to the importance or priority of the behaviour influencing their motivation to perform it. **Of Note: Any statements in relation to achieving a goal are coded here, however the means and steps of reaching the goal are coded in the Behavioural Regulation domain.** In the context of this study this could include; ▪ Time constraints due to other priorities which compete with doing this behaviour. ▪ Parents/caregivers setting objectives in relation to performing the behaviour – an ultimate aim. (the step by step manner of achieving this behaviour would be coded in behaviour regulation) e.g. a parent may set a goal of increasing a child's F&V consumption to X pieces of fruit per day in X amount of weeks (goal). They intend to this by step by step increments of X pieces of fruit per day (behaviour regulation). (Note: Intentions – things I want to do; Goals – things I want to achieve)

Domains and Constructs	Examples of relevant data
<u>7: Memory Attention and Decision Processes</u> *(The ability to retain information, focus selectively on aspects of the environment and choose between two or more alternatives)* • Memory *(The ability to retain information or a representation of a past experience, based on the mental processes of learning or encoding retention across some interval of time, and retrieval or reactivation of the memory; specific information of a specific past)* • Attention *(A state of awareness in which the senses are focussed selectively on aspects of the environment and the central nervous system is in a state of readiness to respond to stimuli)* • Attention control *(The extent to which a person can concentrate on relevant cues and ignore all irrelevant cues in a given situation)* • Decision making *(The cognitive process of choosing between two or more alternatives, ranging from the relatively clear cut to the complex)*	Parent or caregiver's memory, attention and decision processes as determinants of their behaviour which may influence pre-schoolers F&V consumption • This relates to statements surrounding the ability to remember or forget to do/not to do tasks, responsibilities, duties etc. to facilitate the behaviour. ➢ May include decision making, cognitive thinking – considering their child's preference (social influence). In the context of this study this could include; ▪ Making decisions about food based on the reading of labels and the cognitive processing of balancing which is better or worse for the child. ▪ The parent/caregiver may forget to make a shopping list which means certain food are/are not bought, impacting ultimately on the child F&V consumption. These decision making processes can result in being drawn to alternative products which may be the right/wrong decisions in facilitating health. Note: Decision making processes may be influenced by feedback from the child

Domains and Constructs	Examples of relevant data
8: Environmental Context and Resources *(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)* • Environmental stressors *(External factors in the environment that cause stress)* • Resources / material resources (availability and management) *(Commodities and human resources used in enacting a behaviour)* • Organisational culture/climate *(A distinctive pattern of thought and behaviour shared by members of the same organisation and reflected in their language, values, attitudes, beliefs and customs)* • Salient events / critical Incidents *(Occurrences that one judges to be distinctive, prominent or otherwise significant)* • Person x environment interaction *(Interplay between the individual and their surroundings)* • Knowledge of task environment *(Knowledge of the social and material context in which a task is undertaken)*	Parent or caregiver's environmental context and resources as determinants of their behaviour which may influence pre-schoolers F&V consumption • This includes any statements relating to resources, equipment and organisational structures or cultures that are either present or absent which may impact on behaviour and ultimately pre-school children's consumption of F&V. ➢ Wanting resources/equipment/changes in the organisational structure to facilitate performing the behaviour. ➢ Statements relating to equipment and resources that are available to perform/carry out the behaviour being sufficient/insufficient. In the context of this study examples may include; ▪ Resources cost/expense of F&V. ▪ Availability of F&V in the local environment e.g. home, childcare, shopping etc. ▪ Unavailable resources, equipment, cookbooks or additional resources parents/caregivers believe are required to facilitate F&V consumption. E.g. to prepare food.

Domains and Constructs	Examples of relevant data
9: Social Influences *(Those interpersonal processes that can cause individuals to change their thoughts, feelings, or behaviours)* • Social pressure *(The exertion of influence on a person or group by another person or group)* • Social norms *(Socially determined consensual standards that indicate a) what behaviours are considered typical in a given context and b) what behaviours are considered proper in the context)* • Group conformity *(The act of consciously maintaining a certain degree of similarity to those in your general social circles)* • Social comparisons *(The process by which people evaluate their attitudes, abilities, or performance relative to others)* • Group norms *(Any behaviour, belief, attitude or emotional reaction held to be correct or acceptable by a given group in society)* • Social support *(The apperception or provision of assistance or comfort to others, typically in order to help them cope with a variety of biological, psychological and social stressors. Support may arise from any interpersonal relationship in an individual's social network, involving friends, neighbours, religious institutions, colleagues, caregivers or support groups)* • Power/hierarchy *(The capacity to influence others, even when they try to resist this influence)* • Intergroup conflict *(Disagreement or confrontation between two or more groups and their members. This may involve physical violence, interpersonal discord, or psychological tension)* • Group identity *(The set of behavioural or personal characteristics by which an individual is recognizable [and portrays] as a member of a group)* • Learning and modelling *(In developmental psychology the process in which one or more individuals or other entities serve as examples (models) that a child will copy)* • Organisational culture/climate *(A distinctive pattern of thought and behaviour shared by members of the same organisation and reflected in their language, values, attitudes, beliefs and customs)* • Organisational development • Leadership *(The processes involved in leading others, including organising, directing, coordinating and motivating their efforts toward achievement of certain group or organisation goals)* • Team working • Professional boundaries/roles • Management commitment • Supervision • Champions • Social comparisons • Identity *(An individual's sense of self defined by a) a set of physical and psychological characteristics that is not wholly shared with any other person and b) a range of social and interpersonal affiliations (e.g., ethnicity) and social roles)* • Group identity *(The set of behavioural or personal characteristics by which an individual is recognizable [and portrays] as a member of a group)* • Social identity *(The set of behavioural or personal characteristics by which an individual is recognizable [and portrays] as a member of a social group)* • Organisational commitment/alienation • Feedback • Conflict—competing demands, conflicting roles • Change management • Crew resource management • Negotiation	Parent or caregiver's social influences as a determinant of their behaviour which may influence pre-schoolers F&V consumption. • This may include statements expressing the influence of others on doing the behaviour (including the influence of feedback from the child and its impact on the parent/caregivers decision making processes). ➢ Statements relating to role modelling of the behaviour by others which may have an impact upon pre-schoolers F&V consumption. ▪ For example; Parents/caregivers exhibiting behaviour which may have an influence on the child's behaviour e.g. parental consumption of F&V in the presence of the child (role modelling). In the context of this study this may include wider family members, children's peers, social norms influenced by the media and group norms relating to different cultural groups e.g. religious groups, vegetarianism etc.

Domains and Constructs	Examples of relevant data
10: Emotion *(A complex reaction pattern, involving experiential, behavioural, and physiological elements, by which the individual attempts to deal with a personally significant matter or event)* • Fear *(An intense emotion aroused by the detection of imminent threat, involving an immediate alarm reaction that mobilises the organism by triggering a set of physiological changes)* • Anxiety *(A mood state characterised by apprehension and somatic symptoms of tension in which an individual anticipates impending danger, catastrophe or misfortune)* • Affect *(An experience or feeling of emotion, ranging from suffering to elation, from the simplest to the most complex sensations of feelings, and from the most normal to the most pathological emotional reactions)* • Stress *(A state of physiological or psychological response to internal or external stressors)* • Depression *(A mental state that presents with depressed mood, loss of interest or pleasure, feelings of guilt or low self-worth, disturbed sleep or appetite, low energy, and poor concentration)* • Positive / negative affect *(The internal feeling/state that occurs when a goal has/has not been attained, a source of threat has/has not been avoided, or the individual is/is not satisfied with the present state of affairs)* • Burn-out *(Physical, emotional or mental exhaustion, especially in one's job or career, accompanied by decreased motivation, lowered performance and negative attitudes towards oneself and others)* • Cognitive overload / tiredness *(The situation in which the demands placed on a person by mental work are greater than a person's mental abilities)* • Anticipated regret • Threat	Parent or caregiver's emotions as a determinant of their behaviour which may influence pre-schoolers F&V consumption • This relates to statements which express personal emotional reaction/state to performing the behaviour. These could be positive/negative emotional states which impact on them performing the behaviour. ➢ Could include any statements relating to fear, embarrassment, stress, depression, happiness, elation etc. when doing the behaviour. In the context of the study this may include; ▪ Parents/caregivers expressing worry/fear/anxiety in relation to nutrition and health. ▪ Other emotions may include frustration and annoyance of child not eating F&V; hence the behaviour is not being met. ▪ Positive expression of emotions may include; happiness, feeling proud, excited that the child in their care has tried something new. ▪ Parents/caregivers expressing feeling of unexpected surprise in relation to their child exhibiting the behaviour. ▪ Feelings of guilt/pressure/ may be expressed when parent/caregiver faces challenges in relation to facilitating the consumption of pre-schoolers F&V intake.

Domains and Constructs	Examples of relevant data
11: Behavioural Regulation *(Anything aimed at managing or changing objectively observed or measured actions)* • Self-monitoring *(A method used in behavioural management in which individuals keep a record of their behaviour, especially in connection with efforts to change or regulate the self; a personality trait reflecting an ability to modify one's behaviour in response to situation)* • Action planning *(The action or process of forming a plan regarding a thing to be done or a deed)* • Barriers and facilitators *(In psychological contexts barriers/facilitators are mental, emotional or behavioural limitations/strengths in individuals or groups)* • Goal / target setting *(A process that establishes specific time based behaviour targets that are measurable, achievable and realistic)* • Implementation intention *(The plan that one creates in advance of when, where and how one will enact a behaviour)* • Goal priority *(Order of importance or urgency of end states toward which one is striving)* • Generating alternatives • Feedback • Moderators of intention-behaviour gap • Project management	Parent or caregiver's behavioural regulation as a determinant of their behaviour which may influence pre-schoolers F&V consumption. • This could include statements relating to showing evidence of goal/target setting to achieve the behaviour. ➢ Self monitoring towards a target – graded tasks in behavioural regulation to meet the goal that he is being aimed for. In the context of this study this may include; ▪ The planning of meals in advance, ensuring shopping lists are made prior to shopping trip. ▪ Parents/caregivers considering (pre-planning) alternative means of achieving the behaviour e.g. providing an alternative foodstuff which the child may like as opposed to what is offered in the first instance. ▪ Setting incremental target to achieve the desired goal.

Domains and Constructs	Examples of relevant data
12: Nature of the Behaviours • Routine/automatic/habit • Breaking habit *(To discontinue a behaviour or sequence of behaviours that is automatically activated by relevant situational cues)* • Direct experience/past behaviour • Representation of tasks • Stages of change model *(A model that proposes that behaviour change is accomplished through five specific stages: Pre-contemplation, Contemplation, Preparation, Action, and Maintenance)*	The nature of Parent or caregiver's behaviours which may influence pre-schoolers F&V consumption. • Statements including type, frequency, duration and intensity of past or current behaviour including routines and habits [however statements about future or planned behaviour goals are coded In motivational goals] ➢ Could include statements relating to the conduct of the parental/caregiver behaviour. ➢ Descriptions of parent/caregivers used in the past or present which facilitate or act as a barrier to preschool consumption of F&V. In the context of this study examples could include; ▪ Parents/caregiver habit of providing fruit as treat/reward for, bad/good habit formation that influences F&V intake. ▪ Parenting styles (authoritarian, authoritative/negotiate or passive) which may have an influence on the behaviour. ▪ Hiding vegetables in food to disguise what is actually being provided. ▪ The majority of meals being homecooked or processed.

Appendix 8: Characteristics of all included studies

No	Author, year and country and design	Research question/aim	Participants (n) and setting	Sampling and recruitment	Theoretical /methodological approach	Data collection	Data analysis	Results	Quality score (max 6)
1	Bauer, 2012, Dakota, USA Survey	To better understand the prevalence and consequences of food insecurity	Parents or caregivers of kindergarten aged children already enrolled in the Bright Start study (n=432 dyads)	Letters of invitation were distributed to all kindergarten parents from a baseline survey sample of participants of the Bright Start study.	Not reported	Questionnaire on child dietary intake, the home food environment and food security. Food security assessed with a standard 6-item scale.	Hierarchical linear regression models to examine associations	Almost 40% of families reported experiencing food insecurity. Children from food-insecure households were more likely to eat some less healthful types of foods, including items purchased at convenience stores and food insecure parents reported experiencing many barriers to accessing healthful foods. Food insecure parents were more likely to report that their family does not like fruit and vegetables (F&V).	Good
2	Beltran, 2011, Texas, USA Qualitative; Interviews	To generate and test parents understanding of values and associated reason statements to encourage effective food parenting practices	Parents of 3-5 year old children (n=16), home/telephone interviews	Participants recruited via flyers posted throughout the Texas Medical Centre, online announcements on the Baylor College of Medicine, the Children's Nutrition Research Centre web sites and contacts with families listed in the research database. Participants filled in an online screening tool and were assessed for eligibility	Self-determination Theory including motivational messages to increase F&V consumption tailored to personal value statements	Interviews (semi-structured: intensive and cognitive) to explore parents understanding of concept values and important values and to test understanding of these.	Coding of responses to statements with the development of emerging themes	Most common core values identified in the semi-structured interviews were religion/spirituality, family and health which appeared invariant across parent ethnicity.	High

No	Author, year and country and design	Research question/aim	Participants (n) and setting	Sampling and recruitment	Theoretical /methodological approach	Data collection	Data analysis	Results	Quality score (max 6)
3	Carnell, 2011, UK Mixed methods; Interview and diary/survey data	To confirm the presence of specific of specific parental feeding behaviours as studied previously and to record any newly emerging behaviours and to chart and classify the different motivations for feeding practices reported by parents, including parents perceptions that they are aware of or responding to the child's appetite and other characteristics.	Parents of 3-5 year old children (n=36), 14 completed the telephone interview and 22 the diary.	Parents were recruited from a sample of participants who took part in the first wave of a large community survey of parental feeding in 3-5 year old children.	Not reported	Telephone interview: 30-60 min interview about how they fed their child. A topic guide including key questions and suggested follow-up probe questions was developed using the main aims of the study to shape the course of the interview. Dairy: A blank diary was given to be completed on one week day and one weekend day.	A thematic framework was developed with which the results were summarised against. All or nothing scores were given to each sub-theme generated for each participant for both interviews and diaries, allocating a score of '1' where there was at least one instance of that sub theme in the text and '0' where there was not. Inter-rater reliability was also tested for the framework analysis.	There was evidence of instrumental feeding, rules surrounding mealtimes, child involvement and parental flexibility in relation to feeding. Almost all parents described responding to children's appetite traits consistent with growing evidence for genetically influenced individual differences in children's appetite.	Good-very good

No	Author, year and country and design	Research question/aim	Participants (n) and setting	Sampling and recruitment	Theoretical /methodological approach	Data collection	Data analysis	Results	Quality score (max 6)
4	Cooke 2003, London, UK Survey	To examine the contribution to F&V eating in children of potential predictive variables within the domains of demographics, parental feeding practices and personality traits	Parents or principal caregivers of 2-6 year old children (n=564)	22 London nurseries invited to take part in a study of children's food preferences. The survey was publicised with posters displayed in the nurseries, and questionnaires left for staff to distribute to parents	Not reported	Via questionnaire to include both parental and child F&V intake, demographic data, child food related characteristics (6 item scale) and contained 3 items to measure parental feeding practices.	Multiple regression analyses	Demographic variables associated with child's vegetable consumption were mother's education and child's age and gender. Only ethnicity was sig associated with fruit consumption. Family mealtimes were associated with a higher intake of vegetables but not fruit. Child characteristics (food neophobia and enjoyment of food) were strongly related to the consumption of F&V.	Good
5	Crombie, 2008, , Scotland, UK Survey	To investigate the maternal factors associated with poor diet among disadvantaged children.	Mothers of 2 year old children living in areas of deprivation (n=300)	A random sample of children aged 2 years from general practices in the most deprived deciles were recruited. Practice staff identified potential participants	Questionnaire developed using a social cognition approach, The Theory of Planed Behaviour	Mothers were interviewed at home using a structured questionnaire on a laptop computer which was filled in by the researchers but interviewees were shown questions. Where appropriate stem questions were derived from the Theory of Planned Behaviour	Logistic regression analysis	Most children (85%) were classified as having a poor diet. Mother's general knowledge of healthy eating was high, but did not predict the quality of the children's diet. Lower frequencies of food preparation and serving with raw ingredients, providing breakfast daily and the family eating together were also associated with a poorer diet. An increased risk of a poor diet was also associated with finding it difficult to provide 2-3 portions of fruit daily.	Limited

No	Author, year and country and design	Research question/aim	Participants (n) and setting	Sampling and recruitment	Theoretical /methodological approach	Data collection	Data analysis	Results	Quality score (max 6)
6	Fleischhacker, 2007 USA Qualitative; Interviews	To provide research necessary to help bridge the gap between the household and childcare setting by exploring the concepts and knowledge of F&V's of primary care providers of pre-schoolers	Primary care providers of pre-schoolers, all African American Head Start childcare centre	By direct approach from 3 randomly selected classrooms, from a Headstart childcare centre	The Theory for the Ecology of Human Development, Theory of Meaningful Learning, Ecological Model of Predictors	Structured interviews, using picture cards	Theory of Meaningful Learning guided data analysis, frequency scored concepts based on responses/scores with which a common concept map was constructed	Participants showed a basic understanding of F&V and desire to partner with the childcare setting in teaching their pre-schoolers about F&V. Grocery shopping was a key venue where this sample learned about F&V and taught their pre-schoolers about F&V. However dissatisfaction with local grocery outlets and F&V availability.	High
7	Hayter, 2015, Islington and Cornwall, UK Qualitative; Focus groups and interviews	To explore using qualitative methods, parental perceptions of feeding their children in order to inform the development of a nutrition intervention.	Parents of pre-schoolers whose child attended children's centres in two deprived populations.(n=39 participants)	Sampling was carried out at two levels, by cluster (children's centres) and individually within each centre. A maximum variation sampling method was used to purposively select children's centres, ensuring that four centres with different levels of prior experience in delivering nutrition activities. Within each centre individual participants were recruited through posters displayed in the reception area and through centre staff who approached those accessing the service.	Not reported	Four focus group sessions, and 4 individual family interviews driven by a topic guide consisting of both open and semi-structured questions.	Framework analysis	Accounts of feeding were related to dealing with the practicalities of modern life, in particular the cost of food and the need to manage on a restricted household budget. Time pressures, a lack of perceived knowledge and confidence in preparing food and managing conflict over food choices between family members were also strong themes.	High

No	Author, year and country and design	Research question/aim	Participants (n) and setting	Sampling and recruitment	Theoretical /methodological approach	Data collection	Data analysis	Results	Quality score (max 6)
8	Herman, 2012, Pennsylvania, USA Qualitative; Focus groups	To understand the contextual factors that might influence how low-income mothers felt about addressing these behavioural targets and mothers aspirations in feeding their children	Biological mothers of pre-school aged children (n=32).Temple University	Mothers recruited from clinics of the Special Supplemental Nutrition Program for Women, Infants and Children (WIC) in receipt of benefits. A member of the research team approached women in the waiting rooms of clinics. Flyers were also placed in centres	Not reported	7 Focus groups, led by an interview guide focusing on three domains. 1. Eating occasions, 2. Foods and beverages in the home and 3. Portion sizes	Thematic analysis, inductive, following the constant comparative method.	Six themes emerged with three about aspirations mothers held in feeding their children and three about challenges to achieving these aspirations. Aspirations included; 1. Prevent hyperactivity and tooth decay by limiting children's sugar intake, 2. Use feeding to teach their children life lessons about limit setting and structure and 3. Be responsive to children during mealtimes to guide decisions about portions. Challenges included being nagged by children and undermined by other family members.	High

No	Author, year and country and design	Research question/aim	Participants (n) and setting	Sampling and recruitment	Theoretical /methodological approach	Data collection	Data analysis	Results	Quality score (max 6)
9	Hildebrand, 2010, South-Central, USA Mixed methods. Qualitative; Focus groups and survey	To use the Transtheoretical Model of Behaviour Change to determine whether low-income African Americans were in proportionally different stages of change for increasing F&V to their young children and identify differences in decision making, self-efficacy and the use of cognitive and behavioural strategies related to F&V availability.	Low income African American parents with child/ren enrolled in Head Start programme (n=116)	Convenience sample	Transtheoretical Model (TTM) of Behaviour Change	Survey (n=94) Focus groups (n=22)	Chi test and analysis of variance used to analyse survey data and content analyses was performed with focus group data	Parents in action/maintenance stage (54%) served significantly more F&V and used behavioural processes significantly more often than those in the precontemplation/contemplation stages. Focus groups revealed that in general, parents understood the health benefits of F&V's. There was lack of consensus on ability to prepare tasty F&V recipes. Some parents stated they did not know how to cook and that their variety of F&V was limited. Requests for nutrition education classes were also discussed.	Good
10	Hingle, 2012, Texas, USA Qualitative; Interviews	To explore factors underlying parent's motivations to use vegetable parenting practices (VPP)	Primary care giver of a 3-5 year old child (n=15)	Recruitment via flyers displayed throughout the Medical Centre and added to the children's hospital website. Additionally, participants were recruited from the Children's Nutrition Centre's volunteer database.	Model of Goal Directed Vegetable Parenting Practices (MGDVPP) (An adaptation of the Model of Goal Directed Behaviour)	One to one in-depth telephone interviews (interview script developed using constructs from the MGDVPP)	Data coded and analysed using deductive thematic analysis. A code book was developed using constructs corresponding to the MGDVPP which facilitated analysis.	Parents believed vegetable consumption was important and associated with child health and vitality. Motivations to engage in specific VPP were described in terms of emotional responses, influential relationships, food preferences, resources and food prep skills. Parents used diverse VPP to encourage child intake.	High

No	Author, year and country and design	Research question/aim	Participants (n) and setting	Sampling and recruitment	Theoretical /methodological approach	Data collection	Data analysis	Results	Quality score (max 6)
11	Horodynski, 2010, USA Survey	To examine whether and how toddler fruit and vegetable consumption is associated with maternal fruit and vegetable consumption, mothers perceptions of toddlers as 'picky' eaters, maternal efficacy and sociodemographics of the family.	Primary caregiver (including grandmothers)/toddler dyads enrolled on Early Head Start programme (n=399)	At Head Start sites, Early Head Start staff recruited primary caregiver	Not reported	Survey inc the Feeding Self-efficacy Scale, Toddler-Parent Mealtime Behaviour Questionnaire and Mother and Toddler FFQ	Linear and logistic regression	Toddlers less likely to consume vegetables four or more times a week if their mothers viewed them as 'picky' eaters (OR: 2.5), did not consume four or more times a week themselves (OR: 10.1) and were African American (OR.2.2)	Limited
12	Johnson, 2015, Colorado, USA Qualitative; Interviews	To gather qualitative data regarding mothers decisional processes related to preparing a dinner meal plate for her pre-schooler.	Low-income mothers (n=30) 15 Latino and 15 African American, Children's Eating Laboratory, University of Colorado.	Mothers approached and recruited from Head Start pre-schools in the Denver area. Flyers were displayed in the centre along with researchers presenting study details to both staff and parents.	Bronfenbrenners Ecological Systems Theory and Expectancy Value Theory	In a laboratory setting, mothers were asked to plate up a meal for their child whilst describing the procedure, followed by a set of questions related to how the dish was usually served, who usually did this, how they decided on the amount, how their child's likes and dislikes influenced their decisions etc	Researchers analysed data applying basic principles of Grounded Theory. A coding manual was produced for further analysis. In final analysis phase quotes representing derived codes were examined for patterns and relationships and higher order themes identified. In addition researchers developed a model depicting how themes were theorised to relate to an overall conceptual framework for decision, motivations and goals for how mothers serve portions of food to their children.	Three themes emerged. 1 Portion sizes differ for "good" eater and "picky" eaters; 2. Mothers know the "right" amounts to serve their child and 3. Mothers have emotional investments in their children's eating.	High

No	Author, year and country and design	Research question/aim	Participants (n) and setting	Sampling and recruitment	Theoretical /methodological approach	Data collection	Data analysis	Results	Quality score (max 6)
13	Mita, 2013, North Carolina, USA Qualitative; Interviews	To qualitatively assess preschool teachers perceived motivation, facilitators and barriers related to getting pre-school children to eat F&V's	Pre-school (Head Start) teachers or teaching assistants, over the age of 18 working with 3-5 year old children (n=28)	Convenience sample. Researchers recruited teachers during staff meetings and in individual classrooms	Information-Motivation-Behavioural Skills (IMB) model	One-to-one interviews, using a standardised interview guide, including major questions along with probes	Coding manual developed using common codes identified in the data, reliability, refinement of manual, followed by analysis of quotations within codes to determine emerging themes which were articulated against the IMB model.	Participants reported the need for FV related information (Information) to improve FV consumption in children, perceived themselves to be parents at school (Motivation), and reported using conditional rewards and punishment statements to get pre-schoolers to eat F&V (Behavioural Skills)	High
14	Nanney, 2007a Country: USA Survey (Telephone)	To present cross sectional data that identifies the association between frequency of eating homegrown produce among rural parents and their preschool children and overall intake	Parents of preschool aged children (2-5 years) enrolled at one of 16 parents as teacher's program sites.	Recruitment was undertaken by parent educators (via the parents as teachers programme). Recruitment strategies included personal invitation and flyers	Not reported	Telephone interviews including a FFQ (29 items), Saint Louis University for Kids FFQ including questions about the home and community food environment (role-modelling, frequency of eating fast food etc)	Odds Ratio's used to identify if dietary intake and food environment varied by frequency of eating homegrown fruit and vegetables. ANCOVA conducted.	Significant differences found in overall fruit and vegetable diets and quality between all groups. Furthermore frequency of eating homegrown fruit and vegetables provided a positive home environment.	Good

No	Author, year and country and design	Research question/aim	Participants (n) and setting	Sampling and recruitment	Theoretical /methodological approach	Data collection	Data analysis	Results	Quality score (max 6)
15	Nanney, 2007b Country: USA Survey (Telephone)	To examine the degree to which the national message '5 a Day the color way' has been translated to parents and preschool children in a rural setting by examining their consumption, patterns and barriers to purchasing colour specific fruit and vegetables.	Parents of preschool children aged 2-5 (n=1658)	Recruited by their parent educator via personal invitations and flyers.	Not reported	Saint Louis University for Kids FFQ. Two registered dietitians independently categorised each questionnaire fruit and veg as either red, green, orange/yellow, white or purple/blue	Summary scores of the total fruit and vegetables eaten by colour for the parent and the child. Recoding and logistic regression and odds ratios were conducted.	40% of parents (n=668) and 26% of children (n=425) ate from all 5 colours in the previous week. Only one child and no parents attained perfect adherence to guidelines. Disliking the taste and not being in the habit of purchasing colourful fruit and vegetables were significant predictors for not meeting recommendations for red, yellow/orange and green varieties.	Limited
16	Norman, 2015, Stockholm, Sweeden Qualitative; Document analysis	To describe parent's concerns about their children's diet and PA habits and to describe barriers to change	Parents (n=84) with pre-school aged children who had participated in a Motivational Interviewing session and chose a target behaviour of either diet or PA	Archival data gathered unobtrusively from memos taken after a Motivational Interviewing session as part of the parental support programme, A Healthy School Start.	Motivational Interviewing	Memos taken by the MI counsellor previously	Thematic analysis. Parental concerns were analysed based on the part of the memos where parents stated their goals for behaviour change. Memos were sorted into Diet and PA groups and themes and sub themes identified. A thematic map was developed throughout and barriers to change identified	Three themes were identified regarding children's dietary habits: amount of food consumed influenced by behaviour in the family, eating situations influenced by stressful everyday life and family interplay, and food choices influenced by stressful everday life and family interplay.	Intermediate

No	Author, year and country and design	Research question/aim	Participants (n) and setting	Sampling and recruitment	Theoretical /methodological approach	Data collection	Data analysis	Results	Quality score (max 6)
17	Omar, 2001, Michigan, USA Qualitative; Focus groups	To assess nutritional needs and barriers in establishing healthy eating habits in toddlers	Low-income caregivers of toddlers (n=20), local childcare facility	Recruitment took place via an Early Headstart Program for Women, Infants and Children (WIC)	Not reported	Focus groups using semi-structured open-ended questions	Content analysis using the Non-numerical Unstructured Data Indexing Searching and Theorizing qualitative software program	Major barriers identified were; work schedules, cost of food, inadequate time to shop, plan and prepare nutritional meals, Caregivers expressed concern for the nutritional wellbeing of their toddlers.	Low
18	Pagnini, 2007, Australia Qualitative; Focus groups	**To investigate the perceptions of parents of young children aged 2-5 years regarding childhood overweight and obesity**	Mothers of pre-school children (n=32), Early childhood facilities	Directors of the centre/pre-schools distributed a recruitment flyers to parents	Not reported	Focus groups, conducted using a series of non-judgmental discussion questions (derived from the research question)	Thematic analysis	Mothers were concerned more about their children being underweight rather than overweight which increased the stress around their eating. Food treats were perceived as entitlements. Mothers believed that they were responsible for child's eating. Parents made suggestions for solutions to barriers but wanted support for their role.	Intermediate

No	Author, year and country and design	Research question/aim	Participants (n) and setting	Sampling and recruitment	Theoretical /methodological approach	Data collection	Data analysis	Results	Quality score (max 6)
19	Papaioannou, 2013, Alabama and Texas, USA Mixed methods; Focus groups and survey questions	To examine the moderating effects of feeding styles on the relationships between food parenting practices and F&V intake in low-income families with pre-school aged children	Primary caregivers of children attending Head Start schools in 3 regions of the USA (n=667)	Participants were already part of a larger study to investigate barriers and facilitators to F&V intake among pre-school aged children. Participants were recruited through Head Start Centres.	Nominal Group Technique (NGT)	Focus groups using the NGT, which elicits responses to single questions, followed by a card sort task to understand how responses were cognitively organised. Dietary recall also collected.	Multidimensional scaling and cluster analyses used to produce cognitive structures parents used to organise sort tasks, Multivariate general linear modelling (MANOVA) to show diff in feeding practices and sig effects of feeding style and Moderated multiple regression analysis to examine moderating role of feeding practices and child F&V intake	The indulgent feeding style moderated the relationship between food parenting practices and child F&V intake.	Good

No	Author, year and country and design	Research question/aim	Participants (n) and setting	Sampling and recruitment	Theoretical /methodological approach	Data collection	Data analysis	Results	Quality score (max 6)
20	Peters, 2014, South Australia Qualitative; Focus groups	To qualitatively explore perceptions, perceived influences, facilitators and barriers when providing healthy foods for young children via focus groups with parents of children with healthy versus unhealthy diets.	Parents of 2-5 year old children (n=20)	Purposeful sampling technique used to recruit a subset of parents who consented to future contact in another research project. Invitation to participate was by email or postal mail. Parents were selected according to their child's F&V consumption – both parents of children with high and low (healthy and unhealthy) scores were recruited in order to make comparisons.	No specific theory described. Healthy v's unhealthy groups were chosen with the purpose of comparing good versus bad programmes to ascertain influencing factors with parents of children who consumed more F&V per day compared with parents who consumed less. Parental knowledge of general nutrition was also assessed.	Semi-structured focus groups based on predetermined discussion prompters.	Open-coded thematic analysis where both pre-determined and emerging concepts and themes are generated.	Similarities were identified across both groups including an intention to provide healthy food for their children with most parents involving their child in some level of meal preparation and most families dining together for the evening meal. Main points of difference included parents in the healthy group having more partner support in relation to child diet, a willingness to say no without wavering. A majority of parents in the unhealthy group attempted to disguise vegetables and healthy foods for their child and reported experiencing increased levels of stress regarding their child's fussy eating	High

No	Author, year and country and design	Research question/aim	Participants (n) and setting	Sampling and recruitment	Theoretical /methodological approach	Data collection	Data analysis	Results	Quality score (max 6)
21	Rodriquez-Oliveros, 2011, Mexico, USA Qualitative; Focus groups	**To explore perceptions and practices of key obesity determinants among parents of pre-school children attending childcare centres**	Parents of pre-school children (n=38)	Convenience sample recruited by written invitation at the childcare centres in Mexico City	Not reported	Focus groups, using an interview guide to explore the following topics; 1. Childhood obesity causes and consequences, 2) Child feeding practices, 3) Healthful and unhealthful food for young children, 4) Significance of PA in childhood and 5) PA – promoting factors and barriers	Content analysis focussing on lexical, expression, and relations text analysis. Coding catalogue developed according to main themes, subthemes and emerging themes.	A number of barriers to healthy eating were identified including; parental time constraints, permissive feeding styles, unhealthful food prep practices, lack of knowledge about nutrition, food advertisement and high availability of unhealthful foods in public places. Facilitators to healthful eating; recognition of childhood overweight prevention and consequences and healthy food choices.	High
22	Sherry, 2004, Georgia, USA Qualitative; Focus groups	**To engage mothers of pre-school children from culturally and economically different backgrounds in focus group discussions to explore maternal attitudes, concerns and practices related to child feeding and to examine maternal perceptions and concerns regarding child weight.**	Socioeconomically diverse, White, Hispanic and African American mothers (n=101) of children aged 2-less than 5 years old. Conference rooms at Health Department clinics	The Georgia Division of Public Health staff approached and recruited parents from three Atlanta metropolitan area WIC clinic waiting rooms	Not reported	Structured focus groups including a series of questions adapted from the Child Feeding Questionnaire	Thematic analysis	Mothers wanted to provide good nutrition, the majority wanted children to avoid eating too many sweets and processed foods. Mothers prepared food their children liked , accommodated specific requests and used bribes/rewards to accomplish their feeding goals. The majority believed their children were prevaricating when they said they said they were full and mothers encouraged them to eat more.	High

No	Author, year and country and design	Research question/aim	Participants (n) and setting	Sampling and recruitment	Theoretical /methodological approach	Data collection	Data analysis	Results	Quality score (max 6)
23	Shriver, 2010, Mid-Western USA Mixed methods; Focus groups and Survey	**To determine relationships between self-efficacy, decisional balance, and processes of change and Stages of Change (SOC) related to fruit and vegetable (FV) availability among Hispanic Head Start parents.**	Hispanic parents/guardians of a child between the ages of 2-5 (n=113). Two Head Start Centres	Convenience sample. Recruitment via poster in Head Start centres and posted to the homes of parents/guardians. Two separate cohorts were recruited. The first participated in a survey and the second focus groups.	Transtheoretical Model of Behaviour Change (TTM)	6 part survey containing a series of questions related to (TTM) Focus group questions were based on results of survey and individual TTM constructs	Survey: Descriptive analysis. Stages of Change categorised for further analysis (ANOVA) into contemplation stages. Focus groups: Content analysis with themes categorised into individual TTM constructs.	60% of participants were in pre-action stages. Compared to those parents in higher stages, intentions of parents in lower stages to serve more F&V were impeded by cost and prep time (p=0.028). Focus groups confirmed low self-efficacy as the common barrier to serving more F&V.	Good
24	Sinley, 2015, Nebraska, USA Qualitative; Focus groups and Interviews	To explore the topic of F&V intake of American Indian toddlers within the framework of the Information-Motivation-Behavioural Skills (IMB) Model by conducting focus groups with primary caregivers and interviews with community stakeholders.	Primary caregivers (including parents/carers and stakeholders) of American Indian toddlers aged 2-5 years, Urban settings servicing the American Indian community in Nebraska	Non-probability convenience and snowball sampling methods were used through which the researcher recruited interested participants at a variety of community events who then recruited additional participants from their networks. The researcher spent extensive time in communities prior to recruitment. Took place at community health fayres, through flyers, online social media and newsletter for American Indian Community Centres and reservations	Information-Motivation-Behavioural Skills Model (IMB)	Focus groups: A written script was used to guide the focus groups and questions were based on the IMB model constructs to extract information about perceptions related to F&V intake among American Indian toddlers. Interviews: An interview protocol used to guide interviews, included questions related to experiences that the	Qualitative content analysis strategies. Themes developed which were assessed for applicability to the IMB model. A fruit and vegetable food frequency questionnaire was used to obtain daily average F&V intakes	Peer support, food insecurities, cultural norms, self-efficacy, and skills to prepare F&V were all communicated as being issues which impact on their ability to provide F&V to toddlers. They expressed a desire to increase their knowledge regarding F&V including variety, benefits, and recommendations for consumption.	High

						interviewee's had working with the children and their families. Challenges and perceptions to addressing nutrition and health in American Indian communities was discussed			

No	Author, year and country and design	Research question/aim	Participants (n) and setting	Sampling and recruitment	Theoretical /methodological approach	Data collection	Data analysis	Results	Quality score (max 6)
25	Sweetman, 2011, UK Survey	To examine associations between mealtime characteristics and preschool vegetable consumption and liking.	Primary caregivers of children aged 2-5 (n=434)	Recruited via posters in preschools and centres. Data for this study was drawn from the Poppets study which aimed to identify elements of the environment associated with healthier diets in preschools.	Not reported	Questionnaire on frequency of family meals, food preparation and the social and environmental context of family mealtimes.	Univariate and multiple linear regression analysis.	Children's vegetable consumption predicted eating approximately the same food as their parents, using ready-made sauces and cooking from scratch. Children's liking for vegetables was predicted by eating approximately same food as their parents and use of pre-prepared dishes.	Good-very good
26	Vereecken, 2010, Belgium Survey	To investigate the role of parent and child characteristics in explaining children's fruit and vegetable intakes.	Parents of pre-schoolers (mean age 3.5 years)	Invitation by letter sent home to parents	Not reported	Child and parent fruit and vegetable intake using the Children's general fruit and vegetable FFQ, including questions asking how often parents consumed fruit and vegetables. General parenting styles using scales of laxness, overactivity and support/positive interactions. Parental feeding practices, with a caregivers feeding styles questionnaire and child characteristics	Bivariate Pearson correlation coefficients and linear regression analysis	Significant positive association between children's fruit and vegetable intake and parent's intake and a negative association with children's negative reactions to food. Child-centred feeding practices were positively related to children's fruit and vegetable intake, whilst parent-centred feeding practices were negatively related to children's vegetable intakes. No general parenting style dimension or child characteristic explained differences in children's fruit and vegetable intake.	Good-very

						using the EAS Temperament Survey for Children and the Reactions to Food Scale of the Colorado Childhood Temperament Inventory			

No	Author, year and country and design	Research question/aim	Participants (n) and setting	Sampling and recruitment	Theoretical /methodological approach	Data collection	Data analysis	Results	Quality score (max 6)
27	Wardle, 2005, UK Survey	To investigate the relationship between parental control, food neophobia, and fruit and vegetable consumption in preschool children.	Parents of preschool children aged 2-6 years (n=572)	22 nursery schools were invited to take part in the survey. The survey was publicised with posters displayed in the nurseries	Not reported	Intake of F&V of children and parents using single items based on those in the Dietary Instrument for Nutrition, Parental control of feeding using the Parental Control Index and Child's eating style using The Child Food Neophobia Scale.	Bivariate Pearson product moment correlation coefficiants, t-tests and hierarchical multiple regression.	72% of adults and 69% of children ate fruit once per day or less; 72% of adults and 81% of children ate vegetables once per day or less. Parental F&V consumption and children's food neophobia were strong predictors of children's F&V consumption and both were associated with parental control.	Good
28	White, 2011, 8 states in USA Qualitative; Focus groups	To develop and test nutrition messages and supporting content with low-income mothers for use with theory-based interventions addressing fruit and vegetable consumption and child-feeding practices	Low-income mothers (n=95). Research facilities	Professional recruitment facilitators used a stratified randomisation technique with participants from databases of area residents willing to participate in the research	Not reported	Focus groups (6 formative and 6 evaluative)	Thematic analysis, including observation notes taken in focus group	Messages on role modelling, cooking and eating together, having patience when introducing new food items, and allowing children to serve themselves were well received. Mothers preferred messages that emphasised their role as a teacher and noted benefits such as their children becoming more independent. Mothers commonly doubted children's ability to accurately report when they are full and disliked messages encouraging mothers to allow children to decide whether and how much to eat.	Intermediate

No	Author, year and country and design	Research question/aim	Participants (n) and setting	Sampling and recruitment	Theoretical /methodological approach	Data collection	Data analysis	Results	Quality score (max 6)
29	Wyse, 2011 Country: Australia Survey (Telephone)	To identify characteristics of the home food environment associated with F&V consumption in a sample of Australian preschool children.	Parents of 2-5 year old children (n=396)	All eligible preschools within the study area were invited to take part. At consenting schools a researcher distributed study information.	Not reported	A cross sectional telephone Survey. Children's F&V intake using the Children's Dietary Questionnaire (CDQ). Characteristics of the home food environment including parental role-modelling of F&V and consumption, pressure to eat, parental provision of F&V, availability of F&V in the home, accessibility of F&V in the home, mealtime practices and family eating policies	Multiple regression analysis	Positive associations between child F&V consumption and parental F&V intake, F&V availability, F&V accessibility, the number of occasions each day that parents provided their child with F&V and allowing children to eat only at set meal times all or most of the time.	Very good

Appendix 9: Examples of coded results data for each domain that were either barriers (red) or facilitators (green) to provision

Domain	Data/quote/comment	Notes	Author/ref
Behavioural regulation	Although no significant differences in other TTM constructs were detected, parents/guardians in the action/maintenance stages reported having higher self-efficacy to serve fruit and vegetables (F&V) and using cognitive and behavioural processes to serve more F&V to their children more frequently than parents/guardians in lower SOC.	Having experience of doing the behaviour (providing recommended FV portions to pre-schoolers) increases the likelihood of repeating it and increasing provision. Linked	**Shriver 2010**
Behavioural regulation	1. To schedule meals that include F&V at the same times every day	Pre-planning meals so that they occur at the same time every day and always include F&V	**Papaioannou 2013**
Belief about capabilities	Parents and guardians in the action/maintenance stages reported having higher self-efficacy to serve fruit and vegetables	having experienced performing the behaviour/providing recommended portions of FV/day to pre-schoolers, increases confidence to continue performing the behaviour	**Shriver 2010**
Belief about capabilities	Focus group participants indicated that they often prepare the same meals repeatedly and “get into ruts” because they lack confidence to try new recipes and offer a variety of different fruits and vegetables to their family.	Caregivers lacking confidence to try new recipes, impacting on F&V provision to child.	**Sinley 2015**

Domain	Data/quote/comment	Notes	Author/ref
Belief about capabilities	Self-efficacy for serving fruits and vegetables at home appeared to be high.	Parents believing that they are highly capable of serving F&V	**Hildebrand 2010**
Belief about capabilities	Other important factors were stating that providing 2–3 portions of fruit daily was not easy	Parents finding it difficult to provide 2-3 portions of fruit per day.	**Crombie 2008**
Beliefs about consequences	Overall, participants perceived that eating FV among pre-schoolers is linked to children's positive health outcomes.	– teachers believing that if the children eat FV it will have positive effect on their health	**Mita 2013**
Beliefs about consequences	‘‘I believe strongly that eating healthfully, including eating more vegetables, is an important part of keeping my child healthy’’	If their child eats more vegetable they will be healthy	**Beltran 2011**
Beliefs about consequences	….and I just want them to have good eating habits in the long run.’’	The belief that if they eat veg while they are young this will improve chances of maintaining healthy eating habits throughout life	**Hingle 2012**
Belief about consequences	Parents listed F&V which they believed would benefit the child and help prevent obesity…*orange, banana, tangerine, apple, strawberry, watermelon* etc	Parents believing if the child eats these then will help maintain a healthy weight.	**Rodriguez-Oliveros 2011**
Belief about consequences	*“…they are with me from 8.30 until 2.30 and they need some type of vegetables or fruits in their body to keep them going through the day”*	Teachers believing that F&V will fuel the child for the day.	**Mita 2013**

Domain	Data/quote/comment	Notes	Author/ref
Beliefs about consequences	*When you eat healthy food, certain types of vegetables they boost the, I guess endorphins in your brain are to think better versus the sluggish foods, the slower foods that carbohydrates and sugars and, so, I guess it'll help you with the brain and then healthy, you know*	Key message BAC - If the child does/does not consume enough veg will harm/aid brain function	**Beltran 2011**
Beliefs about consequences	After she got that big belly (I started to talk to the childcare providers about food). My kids starting to look like mom. And, I'm like, I don't want her to get so heavy, like me….	Parent believes the child will end up like them - Mother having a negative self-perception of herself however acts as a facilitator to provide more F&V to child.	**Fleischhacker 2007**
Beliefs about consequences	''It's very important because I worry if she's getting enough iron and vitamins …	The parent believing that the child will suffer/be deficient in vitamins as a consequence of them not providing the vegetables.	**Hingle 2012**
Beliefs about consequences	"…I cook fruits and vegetables because they have nutrients"	Parents believing that F&V contain nutrients and that's why they cook and provide them.	**Shriver 2010**
Beliefs about consequences	*The nutritious attribute of getting the vitamins and minerals and all of that from the vegetables and how it really aids into being a healthier person.[gives] them the energy that they need*	That if the child consumes more veg they are able to derive vita and minerals from them, making them a healthier child and supplies energy which they need	**Beltran 2011**

Domain	Data/quote/comment	Notes	Author/ref
Beliefs about consequences	. It'll help them be healthier on their own.. Their decision making would be a lot better other than choosing the sugar or choosing chips all the time (Hispanic parent).	That the child would make healthier decisions when they are alone (without family) if they ate more vegetables and as a family	**Beltran 2011**
Beliefs about consequences	Mothers reported that children would often say they were full so they could go play or avoid eating a food item they disliked.	Belief about consequences of permissive parenting style - Mothers believing that if children were left to decide they would inaccurately report they were full when not	**White 2011**
Beliefs about consequences	The older two won't eat Brussels sprouts but I normally just put a couple on there. And eventually they will try them and like them. I think it's just the learning isn't it?	If keep giving child the child will learn to like them	**Carnell 2011**
Beliefs about consequences	…..or ''Oh, you're going to be so big and strong.''	– teachers believing that F&V is good for the children (they say this to encourage them to eat it so nature of behaviours, however in this context I believe the teachers think this too so can be coded as belief about consequence as well)	**Mita 2013**
Beliefs about consequences	*Teachable moment: Teach the child that eating F&V will make them strong and healthy*	Belief about the health benefits	**Papaioannou 2013**

Domain	Data/quote/comment	Notes	Author/ref
Beliefs about consequences	"Why cook vegetables if he does not eat it?"	provision of F&V will be wasted	**Shriver 2010**
Beliefs about consequences	They don't really eat hardly anything (CW2), I can't find a way where I can just give it to her and make her enjoy the fruits and veg	The parent doesn't feel able to influence the child's behaviour	**Hayter 2015**
Emotion	Sad, frustrated, upsetting, exhausted	Feeling experienced when children reject the food	**Mita 2013**
Emotion	and you are spending all of your money getting where you need to go and it's horrible; because I have to tell those kids I don't have enough money for you to have vegetables at lunch."	Feeling awful as not able to provide for their child	**Sinley 2015**
Emotion	Sometimes I will take em (referring to kids), I will pick one up you know what I mean, but I just get overwhelmed. It is just so much, like I can't debate on whether or not, you know, you try not to have so much junk food.	Feeling overwhelmed (stressed) impacts upon ability to do the behaviour	**Fleischhacker 2007**
Emotion	"It's very important because I worry if she's getting enough iron and vitamins because sometimes when I take her to the doctor, he'd say it's just a little bit on the low side	Worry about child's health – negative emotion but acts as a facilitator	**Hingle 2012**
Emotion	Parents expressed concerns regarding food choices were connected to vegetables and fruits,	Parents being concerned/worried - negative emotion but acts as a facilitator	**Norman 2015**

Domain	Data/quote/comment	Notes	Author/ref
Emotion	Across formative and evaluative groups, mothers reported that they realized and relished being role models for their children.	Relished the fact (proud) that were seen as role models for their children	**White 2011**
Emotion	"I noticed that [the child] came home and said that he had eaten skin coloured beans with ground beef. 'What, did you eat chili con carne?' 'Yes, it was really good', he said, and I would never have thought that!	Parent showing feelings of surprise the child has eaten an unfamiliar/non-family meal and liked it	**Norman 2015**
Knowledge	A teacher said, ''children are with me 8:30 until 2:30 and they need some type of vegetables or fruits in their body to keep them going through the day.''	**–** knowing that F&V help the body	**Mita 2013**
Knowledge	Teachers reported that they used F&V-related information (eg, where an apple comes from) to get pre-schoolers to eat F&V during mealtimes.	using F&V information to encourage consumption	**Mita 2013**
Knowledge	As one community stakeholder concisely stated, "It's the knowledge and desire to cook healthy food for your family"…(that will help parents provide)	Knowing that having the knowledge will increase provision	**Sinley 2015**
Knowledge	One teacher said, ''.How the fruits and vegetables can be good for their body health, I want to learn more about that.''	- A need to know more about the body and how F&V are good for it	**Mita 2013**

Domain	Data/quote/comment	Notes	Author/ref
Knowledge	Participants (parents and professional caregivers) communicated that a lack of knowledge regarding dietary guidelines for children	Lack of knowledge in relation to child nutrition/guidelines	**Sinley 2015**
Knowledge	*Parent's responses when asked to list different types of F&V: carrots, corn, salad, greens, apples, oranges, french fries…*	Perceived knowledge of what constitutes a vegetable	**Fleischhacker 2007**
Knowledge	*"Usually if they eat everything, then they will get the fruit. I would consider it more of a dessert."*	Parent believing that fruit is a dessert like food	**Johnson 2015**
Knowledge	''Fruits and vegetables are healthier than a bag of chips.''	Aware that F&V are healthier alternatives to other foods	**Shriver 2010**
Knowledge	Another said some fruits "have a lot of sugar, like the canned fruit"	Knowledge that various fruits contain excess sugar…belief that this is similar to canned fruit	**Fleischhacker 2007**
Knowledge	*"She said 'Oh, yeah, we had some fruit snacks, and we had the regular fruit snacks, not the natural kind.' I'm like, 'Oh, Lord. So that's what it is. All that sugar'"* (Parent discussing child whose behaviour has altered after consuming processed snacks at a relative house – linking up with *social influences*)	Knowledge – parents believing that sugars that are not considered to be "natural" are bad for child.	**Herman 2012**
Knowledge	*"use the least amount of cooking oil possible"* (Parent discussing healthful cooking practices)	Parents belief that offering soup with vegetables in is "healthy" for their child	**Rodriguez-Oliveros 2011**
Knowledge	In general, parents understood the health benefits provided by fruits and vegetables.	Aware of health benefits associated with F&V consumption	**Hildbebrand 2010**

Domain	Data/quote/comment	Notes	Author/ref
Knowledge	Nearly all parents believed that fresh F&V are best and that frozen and canned vegetables contain a lower amount of nutrients.	Incorrect knowledge	**Shriver 2010**
Knowledge	Most parents believed children should eat fruit and vegetables three times each day for good health.	Health benefits - Parents believing that children should consume F&V 3x per day – incorrect as needs to be more	**Nanney 2007a**
Knowledge	The risk of a poor diet was significantly increased if mothers thought the recommendations were that children should eat less than five pieces of fruit and vegetables	Mothers believing it is recommended that children should eat less than 5 pieces of fruit per day	**Crombie 2008**
Knowledge	Something you need 3-5 a day, don't eat that either	Stating that need to eat 3-5 F&V a day but that they do not achieve this (even though incorrect)	**Fleischhacker 2007**
Knowledge	*Fruits and vegetables are nutritious, good for you, help you grow…*	Knowledge of what vegetables are and are for	**Fleischhacker 2007**
Knowledge	*The level of mother's general knowledge about the benefits of a healthy diet was very high.*	Mothers knowledge relating to health benefits of F&V consumption is good	**Crombie 2008**
Knowledge	''I serve F&V to my kids because I want to give them healthy food. F&V are the most important food of the day'' and ''I cook F&V because they are healthy and have nutrients.''	Parents possessing the knowledge in relation to the health benefits of F&V – know that F&V have nutrients	**Shriver 2010**
Knowledge	"They have something with acids, fluoride acid….fruits are high in proteins"	Perceived knowledge of what effect vegetables have on the body	**Fleischhacker 2007**

Domain	Data/quote/comment	Notes	Author/ref
Knowledge	*"The more vegetables a child intakes is best for them than like the more starchy;*	Incorrect info: Parent believing that starchy foods are not good for the child	**Johnson 2015**
Knowledge	"Pears give you iron *….carrots make your teeth strong and your eyesight*"	Facilitator – however, Incorrect knowledge	**Fleischhacker 2007**
Knowledge	''Fruits and vegetables help maintain a stable weight.''	health benefits – weight	**Shriver 2010**
Knowledge	*Fruits and vegetables give you regular, good bowel function, keep skin healthy, help eyesight…gives you energy, makes the body feel great…gives you self-esteem…fights infection*	reasoning for eating F&V based upon Knowledge	**Fleischhacker 2007**
Knowledge	More fruit and vegetables could help prevent cancer.	Mothers having the knowledge and being aware that consuming more fruit and veg could help prevent cancer	**Crombie 2008**
Knowledge	Like some fruits and vegetables help, like reduce the risk of cancers and stuff like that."	Knowing about certain health benefits of F&V	**Sinley 2015**
Knowledge	*Caregivers requested information regarding specific health benefits of fruits and vegetables….as one focus group participant stated "I don't even know what all of the vegetables are so something (resource) to tell me this is what it is good for"*	Caregivers wanting know about health benefits of increased F&V consumption	**Sinley 2015**

Domain	Data/quote/comment	Notes	Author/ref
Knowledge	Several parents/guardians expressed a lack of knowledge about how to cook vegetables for their children, and that they needed tips on how to offer FV and how to combine them with other food their children liked. Nearly all parents were interested in learning tasty and easy recipes that would be appealing to their children, particularly for vegetables.	Lack of procedural knowledge relating to cooking veg	**Shriver 2010**
Knowledge	‘‘Just recently I’ve planted a veggie patch with the kids and trying to read more books about getting them involved in planting and the watering and the whole growing cycle so they could have a bit more of a connection with what will come into their mouths this summer, you know as the salad bowl comes to the table’’	parents reading, using resources and wanting to know more so that they can grow own veg	**Peters 2014**
Memory, attention and decision making	Parents chose to use F&V for snacks instead of things like cookies and chips	Choosing to provide healthy F&V snacks rather than unhealthy alternatives	**Papaioannou 2013**
Memory, attention and decision making	Countering, or replacing a less healthful behaviour with a healthful one was also a commonly used behavioural strategy.	Choosing a healthier behaviour over an unhealthy behaviour	**Hildebrand 2010**

Domain	Data/quote/comment	Notes	Author/ref
Memory, attention and decision making	If you've got five minutes while someone's having . . . a sleep or something like that, you can pre-cut the vegetables for later on that evening and things like that. So you don't have to rush later and think, oh my goodness I want to cook this now I haven't got the time to do it	making a conscious effort to decide to prepare the veg as opposed to doing other tasks	**Hayter 2015**
Memory, attention and decision making	*Parents did not want to think about fruits and vegetables when eating out/when shopping.*	Most parents did not want to think about F&V	**Shriver 2010**
Memory, attention and decision making	**..**When I'm in a rush I feel overwhelmed	forgetting to do the behaviour due to feeling overwhelmed	**Fleischhacker 2007**
Memory, attention and decision making	To ensure that their children would eat what was offered, many mothers made ''known favourites''	Parental decision to make familiar food that the child likes on the basis that it will get eaten rather than preparing F&V.	**White 2011**
Memory, attention and decision making	*Lack of children's preferences for fruits and vegetables, especially vegetables, emerged as a negative aspect of serving them to children.*	Child's lack of preference for F&V – esp veg having an impact on parental decision to serve it	**Shriver 2010**
Memory, attention and decision making	*Mothers identified with the idea that "new foods take time"*	decision process of offering alternative foods rather than forcing foods if they believed the child doesn't like it straight away	**White 2011**

Domain	Data/quote/comment	Notes	Author/ref
Memory, attention and decision making	Inadequate child–parent interplay also appeared as a barrier, where parents failed to recognise the child's preference for vegetables.	Lack of attention to cues from child i.e. preferences	**Norman 2015**
Environmental context and resources	The majority of teachers mentioned that children reject eating FV because of the texture (eg, mushy FV) and appearance (eg, black spots on bananas) of FV	**–** food being spoilt/not good quality so children refusing to eat it	**Mita 2013**
Environmental context and resources	Community stakeholders suggested that these programs have been effective at addressing numerous aspects related to fruit and vegetable intake, "They were learning the value of hard work and exercise with gardening…and what's good to eat and how to eat it."	Success due to opportunity to access the program	**Sinley 2015**
Environmental context and resources	Participants claimed to provide healthy food in the home (fruit, vegetables and healthy snacks) for children to independently access.	F&V made readily available for children	**Peters 2014**
Environmental context and resources	3. To place F&V where your child can easily reach them	Ensuring that the F&V is accessible to the child	**Papaioannou 2013**
Environmental context and resources	Multiple regression analysis indicated that higher fruit and vegetable consumption in children was significantly associated with having fruit and vegetables stored in a ready-to-eat format,	Parents ensuring F&V can be easily accessed in a ready to eat format increases likelihood of child consumption.	**Wyse 2011**

Domain	Data/quote/comment	Notes	Author/ref
Environmental context and resources	Parents were most likely to agree that there was little variety of fruit and vegetables where they buy groceries (P = .003)	no variety – shops not having a varied selection on offer/available	**Bauer 2012**
Environmental context and resources	The supermarket is sometimes really overcrowded….I don't like long lines (expressed by majority of primary care providers)	Having to queue for food in shops being a barrier to purchasing	**Fleischhacker 2007**
Environmental context and resources	Some parents/guardians thought that it was difficult to eat in restaurants. However the majority of parents/guardians did not want to think about F&V when eating out	F&V provision difficult in restaurants	**Shriver 2010**
Environmental context and resources	Many discussed how grocery shopping (for F&V) is money and they do not like to spend money on food	Barrier to F&V purchasing	**Fleischhacker 2007**
Environmental context and resources	Parents felt the school environment had a negative influence, particularly school canteen options: "but what they (schools) class as healthy is not…and you can't get a single piece of fruit in the canteen"	fruit not being available in the canteen	**Peters 2014**
Environmental context and resources	"They (nursery school) do give them snacks at school, like fruits and vegetables, but it's not as often. They should really give them more"	Caregivers believe that school/daycare should provide/offer more F&V and more frequently than they currently do – parents passing the responsibility	**Sinley 2015**

Domain	Data/quote/comment	Notes	Author/ref
Environmental context and resources	"I noticed that [the child] came home and said that he had eaten skin coloured beans with ground beef. 'What, did you eat chili con carne?' 'Yes, it was really good', he said, and I would never have thought that.	Child eating varied diet (including veg) away from the home environment as other providers (e.g. school) possibly offering alternative options than what is offered at home. – child being provided with variety of F&V away from the home acts as a facilitator	**Norman 2015**
Environmental context and resources	[my daughter] is eating a lot more vegetables now since she's started school dinners because she's seeing other children around her eating them and she's slightly better at school because they've got all their friends. And they're all [eating], aren't they?	Nursery environment encouraging consumption (linking up with SI – influence of others)	**Hayter 2015**
Environmental context and resources	Many parents had a perception that 'healthy food' was too costly, for example: Having fresh fruits and vegetables on a daily basis is expensive	Expense of providing fresh F&V	**Hayter 2015**
Environmental context and resources	The results from the survey revealed that the intentions to serve more fruits and vegetables were significantly impeded by the negative aspects…including costs	Cost being a barrier to F&V consumption	**Shriver 2010**

Domain	Data/quote/comment	Notes	Author/ref
Environmental context and resources	Caregivers communicated that affordability limits them in their purchases of fruits, vegetables, and healthful foods in general.	Being able to afford the F&V highlighted as a barrier	**Sinley 2015**
Environmental context and resources	One of my big concerns is sometimes, like right now the vegetables and fruits are in season, yeah, they're cheap but once you get in winter months the stuff that's cheap now goes skyrocketing in price and sometimes money's thin	– It's ok when vegetables are in season but when they are not is more difficult to provide	**Omar 2001**
Environmental context and resources	Some parents thought that fruits and vegetables were among the cheaper foods to buy…"The guys [market stall holders] that sell the fruit for a pound…they're great"	Accessibility - only those parents who had access (lived near to markets/good accessibility) thought this. - Accessibility being a facilitator	**Hayter 2015**
Environmental context and resources	Because we get paid monthly, so the week before it's pay day we're really skint and it's like running the cupboards and freezer down…	Affordability of fresh F&V, particularly at the end of the month.	**Hayter 2015**
Environmental context and resources	Several parents/guardians expressed a lack of knowledge about how to cook vegetables for their children, and that they needed tips on how to offer FV and how to combine them with other food their children liked. Nearly all parents were interested in learning tasty and easy recipes.	Parents wanting recipes their children will like - Both lack of recipes/knowledge but also evokes a willingness to know in the parents, therefore acting as a facilitator? Lack of skills and resources facilitates a willingness to learn and provide.	**Shriver 2010**

Domain	Data/quote/comment	Notes	Author/ref
Environmental context and resources	Like, it's a hand in hand thing. If I want to cook healthy meals for my family but I don't have the resources	Not having resources to provide F&V	**Sinley 2015**
Environmental context and resources	The results of the FV survey revealed that the intentions of parents/guardians' in lower SOC to serve more FV were significantly impeded by the negative aspects of making FV available, including the cost of FV, the amount of time necessary for preparing FV, and the number of trips to the store necessary to purchase FV…	Cost being a barrier to F&V consumption	**Shriver 2010**
Environmental context and resources	Requests for nutrition education classes included…new recipes…	Lack of resource: Parents wanting new recipes on how to prepare F&V	**Hildebrand 2010**
Environmental context and resources	Nearly all parents were interested in learning tasty and easy recipes that would be appealing to their children, particularly for vegetables.	Lack of resource, particularly for vegetables	**Shriver 2010**
Environmental context and resources	On supermarket shopping: I need the food so I got to get someone to take me (many relied on family, neighbours, a taxi-like service, or public transport to get to and from the grocery store)	Barrier to F&V purchasing	**Fleischhacker 2007**

Domain	Data/quote/comment	Notes	Author/ref
Environmental context and resources	"And a lot of the time you have no transportation to get to the store….and all you are spending all of your money getting to where you need to go and it's horrible; because I have to tell those kids I don't have enough money for you to have vegetables at lunch"	Lack of transportation/money, impacts on provision. Transport costs leave no money for F&V.	**Sinley 2015**
Environmental context and resources	…they (parents) were more likely to report that where they buy groceries the fruit and vegetables were in poor condition.	Parents reporting that F&V is spoilt, therefore would not be likely to purchase.	**Bauer 2012**
Environmental context and resources	''Not only can it be costly to purchase it, as opposed to some other less healthy options, but then if it's not used within a short amount of time then it gets thrown out.''	Cost and wastage	**Hingle 2012**
Environmental context and resources	Caregivers communicated concerns regarding best practices to keep their food from becoming harmful to their families. As one participant stated, "Some (vegetables) are worse than others"	Food being unsafe/spoilage, impacting upon whether or not the caregiver buys/provides it.	**Sinley 2015**
Environmental context and resources	Several parents mentioned the possibility of increased pesticide with increased vegetable consumption if food was not properly washed and peeled	Parents expressing concern relating to them providing more veg – children will be more likely to be exposed to pesticides which are used on plants (and the associated dangers) making parents less like to purchase/provide	**Hingle 2012**

Domain	Data/quote/comment	Notes	Author/ref
Environmental context and resources	….they (parents) frequently purchased canned or frozen because of the extended shelf-life, **convenience** and expense.	Using frozen veg because of convenience, cost and shelf-life, in an effort to increase veg provision.	**Hildebrand 2010**
Environmental context and resources	[discussing Frozen veg] That's handy for stuff like shepherd's pie, I just chuck in those mixed veg and that's fine	Using frozen produce	**Hayter 2015**
Environmental context and resources	On supermarket shopping: "Sunday paper is my best friend" (some used coupons when shopping to afford F&V)	Facilitator to F&V purchasing	**Fleischhacker 2007**
Environmental context and resources	Children from families who consumed home-grown fruits and vegetables more frequently preferred more fruits and vegetables.	Availability and source – children from these families who were provided with more F&V, preferred to eat more	**Nanney 2007a**
Environmental context and resources	Caregivers discussed gardening programs as an option to improve availability and defer the cost of fruits and vegetables.	Need to improve availability and alleviate expense of purchasing F&V to increase provision. - Recognising and suggesting ways of improving availability	**Sinley 2015**
Memory, attention and decision making	Parents chose to use F&V for snacks instead of things like cookies and chips	Choosing to provide healthy F&V snacks rather than unhealthy alternatives	**Papaioannou 2013**
Memory, attention and decision making	Countering, or replacing a less healthful behaviour with a healthful one was also a commonly used behavioural strategy.	Choosing a healthier behaviour over an unhealthy behaviour	**Hildebrand 2010**

Domain	Data/quote/comment	Notes	Author/ref
Memory, attention and decision making	If you've got five minutes while someone's having . . . a sleep or something like that, you can pre-cut the vegetables for later on that evening and things like that. So you don't have to rush later and think, oh my goodness I want to cook this now I haven't got the time to do it	making a conscious effort to decide to prepare the veg as opposed to doing other tasks	**Hayter 2015**
Memory, attention and decision making	However, the majority of parents/guardians did not want to think about F&V when eating out	Most parents did not want to think about FV while shopping	**Shriver 2010**
Memory, attention and decision making	When I'm in a rush I feel overwhelmed. Sometimes I will take em (referring to kids), I will pick one up you know what I mean, but I just get overwhelmed. It is just so much, like I can't debate on whether or not, you know, you try not to have so much junk food.	Feeling overwhelmed and sometimes choosing to buy unhealthy alternatives as opposed to F&V due to the influence of the child/ren/wide choice available.	**Fleischhacker 2007**
Memory, attention and decision making	To ensure that their children would eat what was offered, many mothers made ''known favourites'' or asked their children what they wanted to eat.	Parental decision to make familiar food that the child likes on the basis that it will get eaten.	**White 2011**
Memory, attention and decision making	Lack of taste preferences for F&V, especially vegetables, emerged as a negative aspect of preparing and serving F&V to children.	Child's lack of preference for F&V – esp veg having an impact on parental decision to serve it	**Shriver 2010**

Domain	Data/quote/comment	Notes	Author/ref
Memory, attention and decision making	Mothers identified with the idea that ‘‘new foods take time’’ and liked an emphasis on having ‘‘patience’’ with their children during the process. Some mothers were also receptive to the idea that helping children develop a taste for many types of food would lead to easier family meal preparation.	decision process of offering alternative foods rather than forcing foods if they believed the child doesn't like it straight away	**White 2011**
Memory, attention and decision making	Inadequate child–parent interplay also appeared as a barrier, where parents failed to recognise the child’s preference for vegetables.	Lack of attention to cues from child i.e. preferences	**Norman 2015**
Motivation & Goals	As positive motivators, the majority of professional caregivers mentioned that they wanted to expose pre-schooler to healthy food at school…..they also mentioned that they wanted to help their students develop healthy eating habits for a child’s development and growth, because their students may not be exposed to healthy food at home	**–** teachers expressing wanting to expose pre-schoolers to healthy food at school.	**Mita 2013**
Motivation & Goals	‘‘I serve FV to my kids because I want to give them healthy food. F&V are the most important food of the day’’ and ‘‘I cook FV because they are healthy and have nutrients.’’	health benefits of F&V for the child was the main motivator for parents provision of F&V	**Shriver 2010**

Domain	Data/quote/comment	Notes	Author/ref
Motivation & Goals	Several parents wished to increase their child's vegetable consumption.	Goal of wanting to increase child's vegetable consumption	**Norman 2015**
Motivation & Goals	While all parents emphasized it was very important for children to eat adequate amounts of vegetables each day, most stated that their children did not regularly meet vegetable consumption guidelines.	Children not meeting recommended guidelines and parents understanding the importance of them doing so hence having an influence on them striving to provide more veg.	**Hingle 2012**
Motivation & Goals	Most mothers reported having busy, sometimes hectic schedules. For some, this busy schedule extended to the evening meal, which they described as ''quick'' or ''rushed.''	competing priorities for time - busy and rushed meal preparation	**White 2011**
Motivation & Goals	That it is difficult to find time to cook in the evening.	- time constraints in the evening competing with wanting to cook fresh meals	**Bauer 2012**
Motivation & Goals	The results of the F&V survey revealed that the intentions of parents/guardians' in lower SOC to serve more FV were significantly impeded by the negative aspects of making F&V available, including the cost of F&V, the amount of time necessary for preparing F&V, and the number of trips to the store necessary to purchase F&V compared to parents/guardians in higher SOC (P <.05).	Provision of F&V requires more shopping trips	**Shriver 2010**

Domain	Data/quote/comment	Notes	Author/ref
Motivation & Goals	Reasons for not meeting the guidelines were often framed as ‘‘being in a struggle’’ or a ‘‘losing a battle’’ with children. As one mother put it, ‘‘Well, it’s important. I would like for her to but I just know that it’s a losing battle.’’	Lack of motivation to provide veg…seemingly pointless due child’s behaviour	**Hingle 2012**
Nature of the behaviours	Study participants also stated that they encourage their students to eat F&V by saying *“Fruits and vegetables are good for you…..oh you are going to be so big and strong”*	actively encouraging children	**Mita 2013**
Nature of the behaviours	“I really feel it’s education, that’s the main thing… I think it’s education all the way through.	Perception that increased education is needed (for children)	**Sinley 2015**
Nature of the behaviours	“I'm trying to encourage them. I don't want to run them away from either, you know, I feel like there is a fine line . if you push too hard depending on the child they may not be accepting of that..”	Encouraging behaviour however aware that being forceful could have the opposite effect.	**Mita 2013**
Nature of the behaviours	*“Challenges are sometimes parents…they won’t eat with their children at home, their families won’t eat fruits and vegetables…it’s something new that’s being introduced to them, so trying to get them to at least try it, that’s a major challenge”*	**–** Parents not physically sitting down and eating with the child having an impact at school. Teacher feels like they are unwilling to try because of home F&V environment	**Mita 2013**

Domain	Data/quote/comment	Notes	Author/ref
Nature of the behaviours	*Parents included some form of fruit, vegetables or juice in most meals.*	Providing F&V in most meals	**Papaioannou 2013**
Nature of the behaviours	*"A lot of times she'll ask for something sweet like "Can I have a biscuit?" and I'll say, "No, but you can have a yoghurt or an apple or a banana,"*	Bargaining with the child, offering them a healthy alternative to the energy dense snack initially asked for	**Carnell 2011**
Nature of the behaviours	Parents provided their children with fruit and vegetables more than three times a day.	Providing children with F&V more than 3x per day	**Wyse 2011**
Nature of the behaviours	*Mother's views on the provision of fruits was that they were not likely to provide 2-3 portions of fruit daily*	Majority of parents agreed that they were not likely to provide 2-3 portions of fruit or vegetables daily	**Crombie 2008**
Nature of the behaviours	*"I serve fruits and vegetables to my kids because I want to give them healthy food….Fruits and vegetables are the most important food of the day and I cook them because they are healthy and have nutrients"*	Cooking and provision of F&V	**Shriver 2010**
Nature of the behaviours	Teachable moments (responses as to what to teach your child/teachable moments) To tell your child what will happen to them if they eat to many bad foods	Telling the child consequences of consuming "bad" foods	**Papaioannou 2013**

Domain	Data/quote/comment	Notes	Author/ref
Nature of the behaviours	*Multiple linear regression analysis revealed liking for vegetables was negatively predicted by use of pre prepared dishes for the child's main meal…there were persistent negative associations with using ready-made sauces for the child's main meal (p=0.05).*	Parent providing ready-made meals, reduces child's preference/liking in turn reducing F&V intake	**Sweetman 2011**
Nature of the behaviours	*…"That's handy (frozen veg) for stuff like shepherd's pie, I just chuck in those mixed veg and that's fine"*	Convenience of frozen veg	**Hayter 2015**
Nature of the behaviours	Parents stated they did not know how to cook (coded in skills) and that their variety of fruits and vegetables was limited.	Parents using few F&V in dishes (likely to be through habit formation)	**Hildebrand 2010**
Nature of the behaviours	More parental control was positively associated with children's food neophobia (*r*_0.26),	The more controlling parents were, the higher the chances were that the child would take a dislike to the food	**Wardle 2005**
Nature of the behaviours	*A significantly lower consumption of vegetables was found in children with parents that used more parent-centred (authoritarian) practices*.	Those parents exhibiting a more parent-centred approach were likely to have children who ate less vegetables	**Vereecken 2010**
Nature of the behaviours	Simple regression analysis found statistically significant positive associations ($p < 0.003$) between children's fruit and vegetable consumption and only allowing children to eat at set meal times.	Parents having set rules (only allowing children to eat at set meal times) increases child F&V consumption	**Wyse 2011**

Domain	Data/quote/comment	Notes	Author/ref
Nature of the behaviours	The earlier the age that children had been introduced to fruit and vegetables, the greater the child's current intake	Parent having fed their child F&V from an early age were more likely to grow up eating more F&V	**Cooke 2003**
Nature of the behaviours	*Mothers described their efforts at length, including deliberately increasing the amount of food put on children's plates and playing games*	– parents deciding on how much food to put on the plate, purposively increasing the amount	**Pagnini 2007**
Nature of the behaviours	*Some parents used high levels of practical methods (e.g. played a game to get children to eat F&V)*	Strategy to increase consumption	**Papaioannou 2013**
Nature of the behaviours	Table 2: Concepts and themes: Disguising food - So children don't really know when they are eating vegetables (because they won't otherwise eat them)	hiding vegetables to promote F&V consumption	**Peters 2014**
Nature of the behaviours	Food presentation: I made the food into pictures on her plate. She ate well and was persuaded to sample one or two new things: baby spinach leaves, red pepper and a sliver of vegetable tart.	Presenting vegetables in a more aesthetically appealing way to a child to encourage consumption	**Carnell 2011**
Nature of the behaviours	''we have the plates there and then put, you know, like salad and fish or whatever might be in the middle and then they get it themselves onto their own plate so sort of then yeah, doing it themselves so they sort of choose how much they eat''	putting the salad on the table so that child can get what they want – giving them the responsibility for their own serving	**Peters 2014**

Domain	Data/quote/comment	Notes	Author/ref
Nature of the behaviours	(strategies employed by mothers to increase consumption): having children participate in cooking	– allowing children to cook with them	**Pagnini 2007**
Nature of the behaviours	*"She likes making little cakes and jellies and things and she'd made some jelly frogs and we put some cubes of pineapple into that and some cake and things so it wasn't just pure jelly"*	Adding fruit to recipes to increase fruit intake	**Carnell 2011**
Nature of the behaviours	Many mothers reported that they did not involve their children in food preparation activities. They doubted their children's abilities to help prepare food and expressed concerns about the safety and time required for such activities.	Children not being involved in any food prep activities.	**White 2011**
Nature of the behaviours	*"All you can do is when you introduce new flavours for children, it can take ten times for them to have their taste buds adjust to that one little flavour, so it's maybe getting them to try it at least once"*	– repeatedly providing the F&V in the hope that they will eventually eat more/like the food	**Pagnini 2007**
Nature of the behaviours	*Many mother reported that they only offered it to their children 2 or 3 times if the child did not like it. (study indicates that it can take up to eleven exposures before a child accepts a new food)*	Mothers reporting offering of new foods to encourage F&V intake – however sometimes not enough times for it to be accepted.	**White 2011**

Domain	Data/quote/comment	Notes	Author/ref
Nature of the behaviours	In fact, fruit was spoken of more as a discretionary food than a fruit. *"Usually if they eat everything, then they will get the fruit. I would consider it more of a dessert."*	If child eats all of their meal, only then will they be provided with fruit - bribery	**Johnson 2015**
Nature of the behaviours	*Traditional family mealtimes were associated with higher intakes…..Family feeding practices (eating together as a family, at the same time and place) are modestly correlated with vegetable consumption (p=0.02)*	Those children who experienced traditional family mealtimes/environments were more likely to consume more veg than those who did not	**Cooke 2003**
Nature of the behaviours	Watching TV during the main meal was associated with lower consumption of and liking of vegetables	Having an eating environment that has a TV in it, the less likely children are to consume F&V	**Sweetman 2011**
Skills	Focus group participants stating that they want to be told how to make it (prepare F&V) …"so something to tell me this is what, this is, this is how you make it"	Lack of instructions - need for recipes/instructions on how to prepare F&V recipes	**Sinley 2015**
Skills	Parent food preparation skills were also reported as barriers to child vegetable consumption.	Parents needing the skills necessary to facilitate vegetable provision	**Hingle 2012**
Skills	Other parents stated they did not know how to cook	Lack of cooking skills, not knowing how to	**Hildebrand 2010**
Skills	''I want to know how to offer F&V to my kids.''	want to develop skills to encourage child F&V consumption – lack of skills	**Shriver 2010**

Domain	Data/quote/comment	Notes	Author/ref
Skills	There were requests for nutrition-education classes included cooking with children,	Parents not having cooking skills - wanting to be involved in practical sessions with their children	**Hildebrand 2010**
Skills	There was confusion relating to the variety of messages indicating the best ways to prepare certain fruits and vegetables. (parents)	Lack of and wanting the correct skills to prepare F&V	**Sinley 2015**
Skills	Seventy percent of respondents (n_301) reported cooking their child's meal from scratch five times a week or more. Twenty-three percent (n_97) cooked from scratch three or four times per week and 7% (n_30) less than three times per week	Parents utilising skills which enable them to cook from scratch and provide meals (containing F&V) to their children	**Sweetman 2011**
Social Influences	Other children can also create barriers or become facilitators for teachers trying to get preschoolers to eat FV. If a child's friends are eating FV, he or she is likely to try it.	– peer role modelling encourages children to eat FV	**Mita 2013**
Social Influences	Conversely, if a child's friends say something negative about FV, the child is likely to hesitate to try it.	**–** peer role modelling impacting negatively making the child hesitate/not consume the FV due to peers reactions/tastes/likes/dislikes	**Mita 2013**
Social Influences	Caregivers discussed that family and peer networks were especially important in ensuring their toddlers received a consistent message regarding fruits, vegetables, and healthy eating.	Positive education/messages from others is important to encourage FV consumption	**Sinley 2015**

Domain	Data/quote/comment	Notes	Author/ref
Social Influences	teacher reported, ‘‘.one of their peers says ‘I don't like that!’ and the next one will say, ‘I don't like that either!’ It's a snowball effect.’’	**–** peer role modelling impacting negatively making the child hesitate/not consume the FV due to peers reactions/tastes/likes/dislikes	**Mita 2013**
Social Influences	Multiple regression analysis indicated that higher fruit and vegetable consumption in children was significantly associated with: higher fruit and vegetable intake in parents,	If parents ate more in sight of children the child would also be likely to consume more F&V	**Wyse 2011**
Social Influences	The amount of fruit and vegetables that parents themselves reported eating was a strong predictor of their children’s intake with positive correlations between adult’s and child’s intakes of both F&V	Role-modelling - The more fruit parents consumed the more fruit children were likely to consume	**Cooke 2003**
Social Influences	Children’s vegetable consumption was most strongly predicted by the child eating food similar to his or her parents for the main meal.	Role-modelling of behaviours – the parent eating inform of their child and eating the same food (F&V) - the child is more likely to mimic this behaviour	**Sweetman 2011**
Social Influences	Caregivers discussed the importance of role modelling and commented on their skills in serving as an example in eating fruits and vegetables. For example, “My daughter, she’ll see and she’ll be kind of checking it out and be like, ok, if mom is doing it so let me try this.”	Parents recognising the importance of positive F&V role modelling	**Sinley 2015**

Domain	Data/quote/comment	Notes	Author/ref
Social Influences	parents reported that their preschooler saw them eat fruit and vegetables more times during the past week.	Children observing their parents eating F&V – role modelling healthful behaviours	**Nanney 2007a**
Social Influences	One mother described her and her husband's roles as "I think it's very important for us (as parents) because were role models"	Recognising the importance of parents as role models believing that children will eat more veg if they see their parents doing so	**Hingle 2012**
Social Influences	(It's important) "to show your child that you enjoy eating fruit and vegetables"	Role-modelling behaviour – parent showing the child that they enjoy eating F&V too in order to encourage consumption	**Papaioannou 2013**
Social Influences	Parents not only acknowledged practicing role-modelling, but emphasized its importance.	Parents recognising the importance of their role-modelling skills and how this may impact on their child. If they role model healthful behaviours showing that they are trying to increase their own F&V intake then their children are more likely to mimic this behaviour**.**	**Hildebrand 2010**
Social Influences	Although the parents/guardians were aware of their influence on children's dietary habits, a lack of parent modelling in terms of FV consumption emerged as one of the major barriers to children's FV consumption (Table 2).	parents belief that their own F&V behaviours (lack of) impacted on child's F&V behaviours	**Shriver 2010**

Domain	Data/quote/comment	Notes	Author/ref
Social Influences	Parents mentioned how different family members can be role models to improve vegetable consumption.	Family members acting as role – models to the children to increase veg consumption	**Beltran 2011**
Social Influences	"My mom has had some health conditions so she has changed the style of eating that she normally would eat. I'd like to have her approval, and I'd very much like to show her that I am making a conscious effort to feed my son good food.''	Grandparents influencing mother decision to provide vegetables – mother wanting grandparents approval and to show that she can cook "healthy" foods	**Hingle 2012**
Social Influences	"One time [my son] went to my aunt's house and came back and would not calm down. And I said, 'What did they give him?' I had to call her. I said, 'He is entirely too hyped. What is going on with him? Why is he jittery? He can't sit down? What is going on?' She said, 'Oh, yeah, we had some fruit snacks, and we had the regular fruit snacks, not the natural kind.' I'm like, 'Oh, Lord. So that's what it is. All that sugar'".	Other family members knowingly providing foods containing unnatural sugars when in their care – regardless of parents preference/wishes	**Herman 2012**

Domain	Data/quote/comment	Notes	Author/ref
Social Influences	"My sister comes over and she doesn't like tomatoes so she'll be like, 'Oh that's disgusting" and then (my kids) look down and then they won't eat it…..They hear them say, 'I don't want to eat that,' or at a certain cousins house and they hear them talk about a certain vegetable that they used to eat and then they won't eat it anymore. It makes it so hard.'	Family members having an influence on child's F&V consumption – role modelling behaviours that are unhealthy influencing the child	**Sinley 2015**
Social Influences	*You notice that your kids won't eat stuff at our house, but when he goes to nursery . . . he'll eat it (CW2) and They come home [from nursery and say] I had mashed potato. And it's sort of, did you like it? Yes, I want it at home now.*	child wanting to eat it as seen others eating it at nursery (peer modelling) facilitator but can be both positive and negative depending on food – peer behaviour acting as a facilitator	**Hayter 2015**

Appendix 10: Email to head teacher

Dear <insert head teachers name>,

Thank you for your interest in the facilitators and barriers to ***"The fruit and vegetable consumption of pre-school children project"*** I have attached the information sheet and consent form that your nursery staff will hand out to parents / caregivers once we start the project.

Just as a reminder, we want to interview parents / caregivers of your nursery school children to try to identify and explore their experiences of getting pre-school aged children to eat fruit and vegetables to help inform the design of a future research project in this area. We will ask the parents / caregivers to attend a one-off interview, lasting between thirty to forty minutes, in a private room at your school.

I have also attached a consent form that you should sign on behalf of your school before we can begin recruitment of parents / caregivers.

Thank you again for your interest.

With best wishes,

Mrs Claire O'Malley
PhD Research Student,
Durham University, UK.

Tel: +44 (0)191 334 0460
Email: c.l.omalley@durham.ac.uk

Appendix 11: Consent form for schools

Study Number:
Participant ID code:

CONSENT FORM FOR SCHOOLS

Exploring the facilitators and barriers to fruit and vegetable consumption of pre-school children

Please initial box

I confirm that I have read and understood the information sheet provided for this project; I have had the opportunity to ask questions and have had these answered satisfactorily.	
I understand that taking part is voluntary and that I am free to withdraw my school from participating at any time, without giving a reason.	
I understand that anonymity and confidentiality will be maintained at all times and that the data gathered will be used for the final report and subsequent publications but that the schools will not be identified in any way.	
I understand that the information provided will be kept secure in a locked filing cabinet and all personal data will be destroyed after five years.	

_____	_____	_____
Name of head teacher	Signature	Date
_____	_____	_____
Name of person taking consent	Signature	Date

Appendix 12: Information sheet for caregivers

INFORMATION SHEET
Exploring the facilitators and barriers to
fruit and vegetable consumption of pre-school children

Durham University are inviting you to take part in a study to help identify and explore different opinions and views on food provision to pre-school children, in particular fruits and vegetables. Taking part will involve being interviewed by a researcher from Durham University.

What is the purpose of the study?
We would like know more about provision of food to preschool children, in particular your thoughts and opinions relating to fruits and vegetables. The answers you give may help inform the design of a future research project in this area.

Why have I been chosen?
All parents or caregivers with a child or children in ##### nursery are being invited to take part in an interview. Taking part is entirely voluntary and it is up to you whether or not you take part.

What will taking part involve?
You would attend a one-off interview to hear your views by a researcher from Durham University. You will be asked to complete a consent form to confirm that you agree to take part prior to the interview. The interview will take place in a quiet, private place/room within the school and will be recorded using a dictaphone. All the information collected in the interview will be anonymised and kept confidential. The questions you will be asked will be specifically on your experience of children eating, or not eating, fruit and vegetables.

What do I have to do?
We would ask you to give us between 30-40 minutes of your time to allow a researcher from Durham University to interview you about your experiences of pre-school children eating fruit and vegetables.

What are the possible benefits of taking part?
There are no direct benefits to you, however your views may help to shape future interventions that may help other parents or caregivers encourage children in their care to eat a better diet.

What are the possible risks of taking part?
The purpose of this study is to understand your experience of the challenges of getting pre-school children to eat fruit and vegetables. It is unlikely that discussing this will be distressing, but if you feel at any point that you don't want to continue, you can just ask the researcher to stop the interview.

Do I have to take part?
It is up to you to decide whether or not to take part. If you decide to take part, you are free to drop out at any time and without giving a reason. A decision to stop or not to take part will not affect you or your child / children in any way.

What happens when the research stops?
The interview recordings will be transcribed and anonymised and analysed by the researchers at Durham University. Following this the anonymous results will be compiled as part of a PhD thesis. It is possible that the results might be written up for presentation at a conference or for a journal publication. You or your child / children will be not be identified in any of the results.

Will my taking part in the study be kept confidential?
Yes. All the information collected in the interview will be kept confidential. All information collected will be stored in a locked filing cabinet within the School of Medicine, Pharmacy and Health. We will confidentially destroy any personal details about you after 5 years. Please note that the researcher would have to breach confidentiality should you disclose any details of criminal activity during your interview.

Who is organising and funding the evaluation?
The School of Medicine, Pharmacy and Health within Durham University is organising and conducting the study which is part of a PhD project funded by Fuse, the Centre for Translational Research (Further information on Fuse is available at http://www.fuse.ac.uk). This study has been reviewed and approved by Durham University School of Medicine, Pharmacy and Health Ethics committee.

Who should I contact if I have any concerns?
If you have any concerns regarding your participation in this study you can contact the lead investigator (Prof Carolyn Summerbell: carolyn.summerbell@durham.ac.uk, 0191 334 0542) and/or the ethics committee chair (Dr David Ekers: david.ekers@durham.ac.uk, 0191 334 0838).

Thank you for taking the time to read the information.

If you have any further questions, or if you are happy to take part in an interview, please contact Claire O'Malley to organise a convenient date, time and place.

Mrs Claire O'Malley, PhD Research Student, Durham University, UK.

Tel: +44 (0)191 334 0460 **Email:** c.l.omalley@durham.ac.uk

Appendix 13: Consent form for caregivers

Study Number:
Participant ID code:

CONSENT FORM FOR PARTICIPANTS

Exploring the facilitators and barriers to fruit and vegetable consumption of pre-school children

Please initial box

I confirm that I have read and understood the information sheet provided for the interview; I have had the opportunity to ask questions and have had these answered satisfactorily.	
I understand that my taking part is voluntary and that I am free to withdraw at any time, without giving a reason.	
I understand that anonymity and confidentiality will be maintained at all times and that my data will be used for the final report and subsequent publications but that I will not be identified.	
I understand that the information I provide will be kept secure in a locked filing cabinet and my personal data will be destroyed after five years.	
I understand that only the researchers will hear what I say in the interview. I agree to being interviewed and for the interview to be recorded.	

_____	_____	_____
Name of participant	Signature	Date

_____	_____	_____
Name of person taking consent	Signature	Date

Appendix 14: Semi-structured interview guide, example questions and corresponding TDF domains

General questions

- Can you tell me a little bit more about your role as caregiver to the pre-school child/ren in your care? (i.e. are you a parent, grandparent, carer etc.) *(Social or Professional Role and Identity, Social Influences)*

- Are you the main provider of food/meals/snack to the pre-school child/ren in your care? *(Social Influences)*

- Can you share with me some typical examples of meals/snacks you provide to the child/ren in your care? *(Behavioural Regulation)*

- Can you tell me more about the types of fruits and vegetables that you and your family eat? *(Nature of the Behaviours)*

- How important do you think it is for children to eat fruits and vegetables? *(Beliefs about Consequences)*

Examples of more specific questions (depending on previous answers)

- Do you buy fruits and vegetables? If so, how often? *(Environmental Context and Resources, Nature of the Behaviours)*

- Are you aware of any recommendations in relation fruit and vegetable consumption in children? *(Knowledge)*

- Do your child/ren like fruits and vegetables? If yes, what types of fruit/and or vegetables do they prefer?

- Do you prepare fruit/and or vegetables at home? If so how easy is it for you to do this? *(Social Influences)*

- How confident do you feel about preparing fruit and vegetables in the home? *(Belief about Capabilities)*

- Is there anything that you think may help you provide more fruit and/or vegetables to your child? *(Environmental Context and Resources, Behavioural Regulation, Social Influences)*

- Does your child eat fruit and/or vegetables outside of the home? *(Environmental Context and Resources)*

- Do you ever encourage your child/ren to eat fruit and/or vegetables? If yes, how would you do this? *(Nature of the Behaviours, Social, Influences)*

- Is it easy to access fruit and vegetables where you live? i.e. are there shops close by? *(Environmental Context and Resources)*

- How do you feel about the cost of fruits and vegetables? *(Environmental Context and Resources, Emotion)*

- Do others (i.e. family members/friends/nursery staff) support you in trying to get your child/ren to eat fruit and/or vegetables? *(Social Influences)*

- Do you like to eat fruit and/or vegetables? *(Nature of the Behaviours, Social Influences)*

- In what type of situations do you find it difficult to provide your child/ren with fruit and veg? *(Environmental Context and Resources, Social Influences)*

Appendix 15: Ethical approval letter

Durham University
School of Medicine, Pharmacy and Health

Shaped by the past, creating the future

Dr David Ekers
Clinical Senior Lecturer
Chair, School of Medicine, Pharmacy and Health Ethics Sub-Committee

Clare O'Malley
School of Medicine, Pharmacy and Health
Durham University

25th August 2016

Dear Clare

Re: Ethics Application ESC2/2016/MSC05
Exploring the barriers and facilitators to fruit and vegetable consumption in preschool children in primary caregiver interviewers

Thank you for sending the above application to the School of Medicine, Pharmacy and Health Ethics Sub-Committee for proportionate ethical review. I reviewed this project as Chair of the committee. The project is an evaluation and review by the full committee is therefore not required. No significant ethical issues were identified, and I am pleased to confirm Durham University ethical approval for the evaluation.

This approval is given on the following basis:

- That data generated for this study is maintained and destroyed as outlined in this proposal and in keeping with the Data Protection Act.
- If you make any amendments to your study, these must be approved by the committee prior to implementation.
- At the end of the study, please submit a short end of study report (ESC3 form) to the School ethics committee.

Please do not hesitate to contact me should you have any questions. Good luck, I hope that the evaluation goes well.

With best wishes,

David Ekers

Appendix 16: Public liability cover email

MOORE H.J.

From: ROBINSON C.
Sent: 11 July 2016 10:42
To: MOORE H.J.
Cc: MANLEY J.
Subject: RE: Public liability cover request for research study

Dear Helen,

From the information you have given below and the fact that the study is interview based only, there will be no issues with our usual University covers applying.

Best wishes,
Claire

Claire Robinson ACII
Insurance Manager
Durham University
Procurement Service
Mountjoy Centre
Holly Wing
Stockton Road
Durham
DH1 3LE

T: +44 (0)191 334 9266
E: claire.robinson@durham.ac.uk

www.dur.ac.uk/procurement/

From: MOORE H.J.
Sent: 11 July 2016 10:31
To: ROBINSON C.
Subject: Public liability cover request for research study

Dear Claire,

We are about to submit a project proposal to the SMPH ethics committee and remembered that we need to have confirmation of insurance cover. The project comprises interviews of parents of pre-school aged children to establish any facilitators and barriers of fruit and vegetable intake. We will only be interviewing the parents of the children and the interviews will take place on the nursery site. This project is not subject to any external ethics committee (NHS or other).

Many thanks for your help.

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Best wishes, Helen.

Dr Helen Moore
Post Doctoral Research Associate, School of Medicine, Pharmacy and Health
Wolfson Research Institute
Durham University Queen's Campus
Stockton-on-Tees
TS17 6BH
United Kingdom
Tel: +44 (0) 191 334 0469
Email: helen.moore@durham.ac.uk

Appendix 17: Table linking behaviour change techniques with determinants of behaviour (Michie et al., 2018)

Technique for behaviour change	Technique for behaviour change										
	1	2	3	4	5	6	7	8	9	10	11
Goal/target specified: behaviour or outcome											
Monitoring											
Self-monitoring											
Contract											
Rewards: incentives (inc. self-evaluation)											
Graded task, starting with easy tasks											
Increasing skills: problem –solving, decision-making, goal-setting											
Stress management											
Coping skills											
Rehearsal of relevant skills											
Role-play											
Planning, implementation											
Prompts, trigger, cues											
Environmental changes (e.g. objects to facilitate behaviour)											
Social processes of encouragement, pressure, support											
Persuasive communication											

	1	2	3	4	5	6	7	8	9	10	11
Information regarding behaviour, outcome											
Personalised message											
Modelling/demonstration of behaviour by others											
Homework											
Personal experiments, data collection (other than self-monitoring of behaviour)											
Experiential: tasks to gain experiences to change motivation											
Feedback											
Self-talk											
Use of imagery											
Perform behaviour in different settings											
Shaping of behaviour											
Motivational interviewing											
Relapse prevention											
Cognitive restructuring											
Relaxation											
Desensitisation											
Problem-solving											
Time management											
Identify/prepare for difficult situation/problems											

Key

	Agreed use
	Uncertain
	Disagreement
	Agreed non-use

Techniques judged to be effective in changing each domain	
1	**Knowledge**
2	**Skills**
3	**Social/Professional role and identity**
4	**Belief about capabilities**
5	**Beliefs about consequences**
6	**Motivation and goals**
7	**Memory, attention, decision processes**
8	**Environmental context and resources**
9	**Social influences**
10	**Emotion**
11	**Behavioural regulation/action planning**