Maternal feeding self-efficacy and fruit and vegetable consumption in infants and toddlers.

by

Gloria Angela Koh

Thesis submitted to Flinders University for the degree of

Doctor of Philosophy

College of Nursing and Health Sciences

20 November 2017

TABLE OF CONTENTS

THESIS SUMMARY

Fruits and vegetables (FV) are cornerstones of a healthy diet but adequate consumption remains a challenge in nutrition interventions. In young children, poor exposure and consumption of FV can potentially affect development of preference for FV and lifelong eating habits that may influence health outcomes. Current and future interventions can benefit from identifying the reasons children are not consuming adequate FV. Research in this area is confounded by the scarcity of dietary evidence for young children and limited investigation into the cognitive-behavioural impetus for mothers to offer FV to young children. This thesis examined the multi-directional relationships between maternal feeding self-efficacy, child exposure to new food, feeding behaviour and FV intake in participants in the South Australian Infants Dietary Intake study when aged 4 to 9 months (T1) (n=277) and again when aged 11 to 18 months (T2) (n= 218).

Mothers with healthy infants weighing ≥2500g and ≥37 weeks gestation were recruited post-natally from 11 South Australian hospitals. At 6 months and 13 months postnatal, infants were weighed and measured, and mothers completed a questionnaire exploring their perceptions of child feeding behavior and exposure to new foods. The questionnaires also included the Short Temperament Scale for Infants (T1), Short Temperament Scale for Toddlers (T2), Kessler 10 to measure maternal psychological distress, and five (T1) and eight (T2) items measuring maternal feeding self-efficacy. The frequency (number of occasions) and variety of FV (number of subgroups in each food category) consumed by children were estimated from a 24-hour dietary recall and 2 days food record at T1 and T2.

Structural equation modeling (SEM) was performed using MPlus version 6.11 to assess the relationships between observed and latent variables.

Median (IQR) variety scores were 2(1-3) for fruit (possible score 18) and 3(2-5) for vegetable (possible score 28) at T1, and 3(1-4) for fruit and 4(1-6) for vegetable at T2. The most popular FV consumed were apple (n=108, 45.0%) and pumpkin (n=143, 56.3%) at T1 and banana (n=142, 76.8%) and potato (n=117, 62.2%) at T2. SEM at T1 and T2 revealed that parenting confidence, child exposure to novel food and positive perception of child feeding behaviour predicted maternal feeding self-efficacy which then directly (T1) and indirectly (T2) predicted the variety of vegetables children consume. Furthermore, maternal psychological status indirectly predicted child vegetable variety at T1 through parenting confidence and child exposure to new foods. Despite explaining 14% and 25% variance in child vegetable variety at T1 and T2 respectively, the conceptual model did not predict the variety of fruit intake in children at both time points. This provides evidence that FV intakes are influenced by different behavioural factors and should be examined separately. In conclusion, the direct and indirect roles of maternal feeding self-efficacy in predicting child vegetable variety highlight the importance of targeting maternal feeding self-efficacy as a key strategy towards development of healthy eating in children.

DECLARATION

I certify that this thesis does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any university; and that to the best of my knowledge and belief it does not contain any material previously published or written by another person except where due reference is made in the text.

Signed

Gloria Angela Koh

PREFACE

Funding for the South Australian Infants Dietary Intake (SAIDI) study had been granted prior to the commencement of my candidature. Following commencement of a part-time candidature, I assisted in the attainment of multi-site ethics approval for the study, development of the recruitment protocol and contributed to the questionnaire used in the SAIDI study to include items for measuring maternal feeding self-efficacy and developmental feeding skills. Along with the SAIDI team, I was jointly responsible for subject recruitment at the hospitals, obtaining subject consent, assessments (diet, anthropometrics, questionnaire), subject retention (eg: conducting home visits, calling mothers to remind them of their appointments), data entry, data management and analysis for Time 1 and Time 2 of the study.

Following the progress of my thesis, I identified the need for a more accurate and powerful analysis of data and initiated the investigation into the area of categorical structural equation modelling and was solely responsible for the development of the structural model proposed. I performed all data analysis reported in this thesis.

ACKNOWLEDGEMENTS

This thesis would not have been possible without the support of many important people whom I would like to formally acknowledge and thank.

Firstly, a big thank you from the bottom of my heart to my primary supervisor and co-supervisor, Associate Professor Anthea Magarey and Professor Jane Scott, for their ongoing support, encouragement, patience and understanding. Their expertise and knowledge have been invaluable. I enjoyed every minute of our working relationship and I count myself blessed to have such wonderful supervisors. Thank you to Professor Richard Woodman and Dr. Susan Kim for their suggestions and patience in explaining the basics of Structural Equation Modelling in a language a non-statistician like me could understand. Special mention and thanks to Dr. Leigh Roeger and Pawel Skuza for their passionate and thought-provoking discussions on categorical Structural Equation Modelling using MPlus. Thanks also to Professor Lynne Daniels for her constructive feedbacks.

Many thanks to the SAIDI study team at Flinders University for their contributions to data used in this thesis. They are: Anthea Magarey for coordinating the SAIDI study, Dr. Rebecca Perry, Chelsea Mauch, Kylie Markow, Rachel Elovaris and Dr. Foorough Kavian for recruitment, data collection, entry and management. Thank you for your friendships, the coffee, cakes, tears and jokes.

Thank you to all the families who gave up their time to participate in the SAIDI study. This thesis would not be possible without your interest and dedication.
I would also like to acknowledge SA Health for funding the SAIDI study in which I was also employed part-time as a research assistant. Thank you to Flinders University, my alma mater, and to all University staff for being so helpful and kind to all my queries regarding Research Higher Degree procedures and IT help.

A huge thank you to all staff and students of the Nutrition Dietetics Department at Flinders University. You guys are my home away from home. I will cherish all the memories of corridor chats I had with each of you.

Finally, all my love and thanks to my incredibly supportive family – Deryck, my husband and rock, for your sacrifices, patience and understanding; my children Vincent and Victoria, for always understanding that mummy has to “work” on weekends too and for being the lights of my life; my brother, Dr. Joshua Koh for being the first in the family to graduate PhD and cheering me on; my sisters and best friends for lots of ‘sister therapy’; and for my parents who raise me up to be the best I can be. A big thank you to God and my church family for your prayers and best wishes. I will forever be grateful for all of you!

LIST OF TABLES

LIST OF FIGURES

GLOSSARY OF ABBREVIATIONS

AAP	American Academy of Pediatrics
ABS	Australian Bureau of Statistics
AGHE	Australian Guide to Health Eating
AHEI	Alternate Healthy Eating Index
AHS	Australia's National Health Survey
AI	Adequate Intake
AICR	American Institute of Cancer Research
ALSPAC	Avon Longitudinal Study of Parents and Children
ATP	Australian Temperament Project
AUC	Area Under Curve
BMI	Body Mass Index
BSES	Breastfeeding Self-Efficacy Scale
BSES-SF	Breastfeeding Self-Efficacy Scale Short Form
CAI	Computer Assisted Interview
CFA	Confirmatory Factor Analysis
CFI	Comparative Fit Index
CI	Confidence Interval
CHD	Coronary Heart Disease
COPD	Chronic Obstructive Pulmonary Disease
CRD	Chronic Respiratory Disease
CVD	Cardiovascular Disease
DALY	Disability Adjusted Life Year
DASH	Dietary Approaches to Stop Hypertension diet
DM	Diabetes Mellitus
DQ	Dietary Questionnaire
DNA	Deoxyribonucleic Acid
DONALD	Dortmund Nutritional and Anthropometric Longitudinal Designed study
ECLS-B	Early Childhood Longitudinal study (Birth Cohort)
EPIC	European Prospective Investigation into Cancer and Nutrition study
FFQ	Food Frequency Questionnaire
FITS	Feeding Infants and Toddlers study
FV	Fruits and vegetables
HAPA	Health Action Process Approach
HR	Hazard ratio
IFI	Incremental Fit Index
IGF-I	Insulin-like Growth Hormone
InFANT	Melbourne Infant Feeding Activity and Nutrition Trial
IQR	Inter-quartile range
LBC	Lifestyle Behaviour Checklist
MI	Modification Indices
MING	Maternal and Infant Growth study
ML	Maximum Likelihood
MME	Mini Mental State Examination

MORGEN	Monitoring Project on Risk Factors and Chronic Diseases in the Netherlands
NEAT	Nutrition Education Aimed at Toddlers study
NCD	Non-communicable disease
NCNPAS	National Children's Nutrition and Physical Activity Survey
NDNS	National Diet and Nutrition Survey
NFI	Normed Fit Index
NHANES	National Health and Nutrition Examination Survey
NHMRC	National Health and Medical Research Council
NIF	National Infant Feeding Survey
NNFI	Non-Normed Fit Index
NNPAS	National Nutrition and Physical Activity Survey
NNS	National Nutrition Survey
NOURISH	The Australian NOURISH trial
NSMHWB	National Survey of Mental Health and Well-being
NSW	New South Wales, Australia
OR	Odd Ratio
PUFA	Polyunsaturated Fatty Acid
RCT	Randomised Controlled Trial
RDI	Recommended Dietary Intake
RITQ	Revised Infant Temperament Questionnaire
RMSEA	Root Mean Square Error of Approximation
RNI	Relative Non-Centrality Fit Index
RR	Relative Risk
SAIDI	South Australian Infant Dietary Intake study
SD	Standard Deviation
SEIFA	Socio-economic Indexes for Areas
SEM	Structural Equation Modelling
SES	Socio-economic status
SPSS	Statistical Package for the Social Sciences
SLT	Social Learning Theory
STSI	Short Temperament Scale for Infants
STST	Short Temperament Scale for Toddlers
T1	Time 1
T2	Time 2
T2DM	Type 2 Diabetes Mellitus
TLI	Tucker-Lewis Index
TTS	Toddler Temperament Scale
UK	United Kingdom
U.S.	United States of America
USDA	United States Department of Agriculture
WHO	World Health Organisation
WIC	Special Supplemental Nutrition Program for Woman, Infants and Children
WLS	Weighted Least Square
WLSM	Weighted Least Square Mean
WLSMV	Weighted Least Square Mean with adjusted Variance
WRMR	Weighted Root Mean Square Residual

CHAPTER ONE: INTRODUCTION

Adequate consumption of fruit and vegetables (FV) is a characteristic of a healthy diet (1). Fruit and vegetables provide a cornucopia of nutrients and phytochemicals conferring multiple health benefits (2). There is also a large body of evidence to suggest that high consumption of FV protects against chronic diseases such as cardiovascular diseases (3, 4), chronic respiratory disease (5), diabetes (6, 7) and some cancers (8). The World Health Organisation (WHO) recommended adultsto consume at least 400g of non-starchy FV daily for the prevention of noncommunicable diseases and the alleviation of micronutrient deficiencies (1). In Australia, the National Health and Medical Research Council (NHMRC) recommends the daily consumption by adults of 2 serves of fruit (300g) and 5 serves of vegetables (includes starchy vegetables) (375g) (9). There is currently no global consensus on FV recommendations for children and recommendations can vary from around half the adult daily servings to the equivalent by adolescence (10).

Despite the health benefits of FV, consumption in adults and children as young as 2-years-old falls short of recommendations in many countries (11-15). Findings from dietary studies on infants and toddlers identified some areas of concern such as the high proportion of consumers of fried potatoes in toddlerhood (16), the decrease of vegetable intake between infancy and toddlerhood (17) and the limited variety of fruit and vegetables consumed (18, 19). This is of concern because FV intakes (20-22), food preferences and eating habits (23-25) formed in early childhood have been shown to persist into adolescence and adulthood.

In one of the earliest study examining tracking of dietary intakes from early childhood, Skinner and colleagues found that fruit exposure (R^2= 0.25) and fruit variety (R^2= 0.25) in the first 2 years of life predicted fruit variety at 8 years (n=70) (26). These findings are supported by a more recent study from the Norwegian Mother and Child Cohort Study (n=9025) where the frequency of fruit and vegetable intakes were found to tracked between ages 18 months to 7 years (r ranging from 0.23 to 0.36) (27).

Tracking was also observed in dietary patterns from early childhood to mid-childhood (28, 29), adolescence (30) and adulthood (31, 32). For instance, results from the Avon Longitudinal Study of Parents and Children (ALSPAC) (n=6177) show moderate tracking of dietary patterns (‘processed’, ‘traditional’ and ‘healthy’) at ages 3 years, 4 years, 7 years and 9 years (all $r > 0.35$) at all time points (29). Moreover, evidence from a 21-year follow up from the Cardiovascular Risk in Young Finns Study (n >1000) showed that children’s diet from as young as 3 years tracked into adulthood (31, 32).

Considering that food preferences and eating habits are well established by five years of age (33, 34), examining children’s diet in the first year of life provides important evidence on the early formation of food preferences as infants transition from a milk diet in the first 4 to 6 months to a family diet from 12 months and beyond. This transitional period is often referred to as the weaning period (35). Weaning is important to help children acquire a healthy behaviour toward eating and to learn competencies required for a successful transition from milk to family diet (36). It is postulated that a ‘window of opportunity’ exists in the age 4 to 5 months (weaning period) in which infants will readily accept new tastes of first foods (37) but this acceptance is modulated by the taste of food (35).

The ontogeny of taste posits that infants are born with the innate preference for sweet tastes (38) while preference for salty tastes appears around the age of 4 months and onwards (36). Habituation of these tastes may lead to the poor acceptance of bitter tasting foods such as spinach and broccoli (24).

Food texture also plays an important role in determining food acceptance at weaning (35). Infants need to experience more textured foods at approximately 7 months in order for them to develop the oro-motor skills required for successful self-feeding (37). Delayed introduction of textured foods have been shown to lead to poor dietary outcomes in later childhood (39). For instance, a study conducted by Coulthard, Harris and Emmett on 7821 mother-child dyads from the ALSPAC study found that children who were introduced to ‘lumpy’ foods late (after 9 months) ate less of many food groups at age 7 years, including all fruit and vegetables ($p<0.001$), than children introduced to ‘lumpy’ foods at 6 to 9 months (39). These children also had significantly more feeding problems at 7 years such as not eating sufficient amounts of food (OR= 1.15, 95% CI= 1.03-1.29), difficult to get them to eat food (OR = 1.15, 95% CI= 1.07-1.24) and being choosy/picky with food (OR = 1.16, 95% CI= 1.05-1.28) (39).

Therefore, nutrition intervention targeting infants at the weaning age has the potential to shape long-term food preference and eating habits and should be considered. Studies examining the modifiable determinants of intakes in early childhood provide the evidence needed to inform strategy for effective intervention.

In early childhood, the principal carer (usually the mother) plays an important role in feeding. Mothers can influence children's food intake through their feeding practices (40), feeding styles (41) and food preferences (23, 42). As a primary carer, mothers are often required to make decisions that require them to think on their feet and draw on their reservoir of knowledge while balancing the needs of their child with their own needs and the needs of other family members (43). Therefore, the cognitive processes in which they determine their feeding decisions in the face of obstacles may influence children's feeding and dietary outcomes.

In particular, self-efficacy or self-competency, a component of the cognitive-behaviour change models (44-46), has been identified as an important predictor of a wide range of health behaviours in adults (47) and children (48). In dietary intervention studies, self-efficacy was identified as a significant determinant of intervention success (49-51). Research on FV consumption in school-aged children also showed that children with higher sense of self-efficacy consumed higher amounts of FV (52-54).

The concept of self-efficacy originated from the Social Learning Theory and was introduced by Albert Bandura as a predictor of behavioural change (55). In many studies, self-efficacy explained the discrepancy between intention and health behaviour (56-59). Self-efficacy is a self-judgement of how well one can perform across a variety of situations (60) and unlike self-confidence which is a general measurement of self-worth (61), self-efficacy refers to task-specific competency (60).

Studies examining self-efficacy in infant feeding have primarily focused on breastfeeding self-efficacy (62). Studies examining maternal feeding self-efficacy related to dietary outcomes in infants and toddlers are rare. Besides the published findings of this thesis at Time 1 (19), there is only 1 published study that has examined the link between maternal feeding self-efficacy and FV intakes in children under 2 years of age (63). Both papers reported maternal feeding self-efficacy as a significant predictor of children's FV intakes (19, 63).

While maternal role in early feeding is important, children may also influence feeding outcomes through their feeding behaviours (64). Novel foods are usually approached with a mixture of interest and fear and infants respond to new foods to varying degrees (65). Responsive children were more accepting of novel foods while children with stronger inhibitions towards food had lower dietary variety (66) and were likely to be fussy or picky with their food (64). Mothers respond differently to various child feeding behaviours through their feeding styles or practices which may or may not be detrimental to feeding outcomes (64). This reciprocal relationship is worth exploring as emerging evidence in the study of mother-child feeding interactions involving children aged ≥ 2 years old and child weight status reported significant link between maternal feeding practices such as pressure to eat and modelling of healthy eating with child food fussiness and responsiveness (67-69). To date, no study has explored this interactional relationship in the context of FV consumption in children under 2 years of age.

1.1 THESIS AIMS

This thesis aims to address the gap in the literature identified above by examining the multi-directional relationships between maternal-child factors with fruit and vegetable consumption in a cohort of children aged under 2 years of age. Through structural equation modelling (SEM), this thesis specifically aims to examine:

1. Fruit and vegetable consumption;

2. The relationship between maternal feeding self-efficacy, maternal feeding practices, child exposure to novel foods, child feeding behaviour and socio-demographic factors in predicting child fruit and vegetable variety;

3. The construct validity and reliability of items used in the South Australian Infant Dietary Intake (SAIDI) study to measure maternal feeding self-efficacy, maternal psychological distress and child temperament;

in a cohort of South Australian children aged 4 to 9 months (Time 1, T1) and 11 to 18 months (Time 2, T2).

1.2 THE MODEL

Understanding the reciprocal relationship between maternal and child factors in early feeding is vital to the development of intervention strategies (70). This bi-directional relationship is illustrated in the two models proposed by Davison and Birch in 2001 to explain the interaction between parent and child characteristics in determining child weight status (71, 72). In the first model (Figure 1.1), Davison and Birch proposed an ecological model to present the bigger picture of the multi-faceted systems involved in the assessment of predictors of childhood overweight (71). Socio-demographic and community factors were presented as distal determinants that predict parenting styles and family characteristics such as child feeding practices and parent food preferences (71). Parenting styles and family characteristics in turn exert an influence on child factors to predict child weight status (71).

Figure 1.1 Davison and Birch's ecological model of predictors of childhood overweight (71) has been removed due to copyright restrictions.

An examination of the literature on parenting and family environments with child eating revealed that the relationship between maternal feeding and child eating is potentially bi-directional, as evident in another conceptual model proposed by Birch and Davison (Figure 1.2) (72).

Figure 1.2 Birch and Davison's model on the bi-directional relationships between child feeding practices, parent and child eating with weight outcomes (72) has been removed due to copyright restrictions.

In a study published in 2008, Ventura and Birch evaluated the above conceptual model by conducting a systematic review of studies published before January 2007 (n=66) that assessed the association between parenting, child eating and weight variables (73). They concluded that there is strong causal evidence to show that parenting affects child eating and that child eating behaviour mediated the influence of parenting practices on child weight status (73). The relationship between child eating and weight status was however, inconclusive (73). This may be due to the nature of obesity which emerges over time and requires carefully measured longitudinal studies to elucidate the link between child eating and weight status (74).

Studies published post-2007 continue to provide support for the findings of Ventura and Birch's study (70, 75-77). In particular, longitudinal studies conducted in more recent years provided evidence on the bi-directional relationship between maternal feeding practices and child eating behaviours (70, 78, 79). A more recent systematic review by Shloim and colleagues (2015) concluded that there is consistent evidence to support the link between feeding practices such as restriction and pressure to eat with high BMI in children (74). Maternal feeding practices also appeared to be responsive to child eating behaviour (74).

Although research examining the reciprocal relationship between maternal feeding and child eating were primarily concerned with child weight outcomes, the models proposed by Davison and Birch (71, 72) provide the conceptual templates for the examination of determinants of children's dietary intakes. Moreover, findings from research on dietary intakes in young children supported the relationship between maternal feeding practices and child fruit and vegetable intakes (41, 80-83). For instance, a longitudinal study by Gregory *et al* (2011) on 60 children aged 1-year-old (Time 1, T1) and 2-years-old (Time 2, T2) concluded that maternal pressure to eat at T1 predicted lower child fruit frequency at T2 ($\beta = -0.28$, $p<0.05$) while maternal modelling of healthy eating at T1 predicted higher child vegetable frequency at T2 ($\beta = 0.34$, $p<0.01$) (80). Feeding practices, however, did not predict child weight-for-height at T2 (80). Moreover, a longitudinal study on 4 European birth cohorts (n > 9000) examined maternal feeding practices specific to early feeding such as breastfeeding duration and timing of complementary feeding and found them to be predictive of child FV intakes at 2 to 4 years-old (81). Clearly, there is strong rationale to examine the bi-directional relationship between maternal and child early feeding behaviours in relation to FV intakes.

Therefore, a Structural Equation Model (SEM) incorporating socio-demographic factors as distal determinants and the bi-directional link between maternal and child feeding behaviours is proposed in this thesis (Figure 1.3). SEM is chosen as it allows an examination of multi-directional relationships between a number of variables (84). This model also included maternal feeding self-efficacy as a potential predictor of maternal and child feeding and/or child FV intakes and was previously published to report the T1 findings from this thesis (19). Evidence for the inclusion of the variables found in this model is presented in Chapter Two.

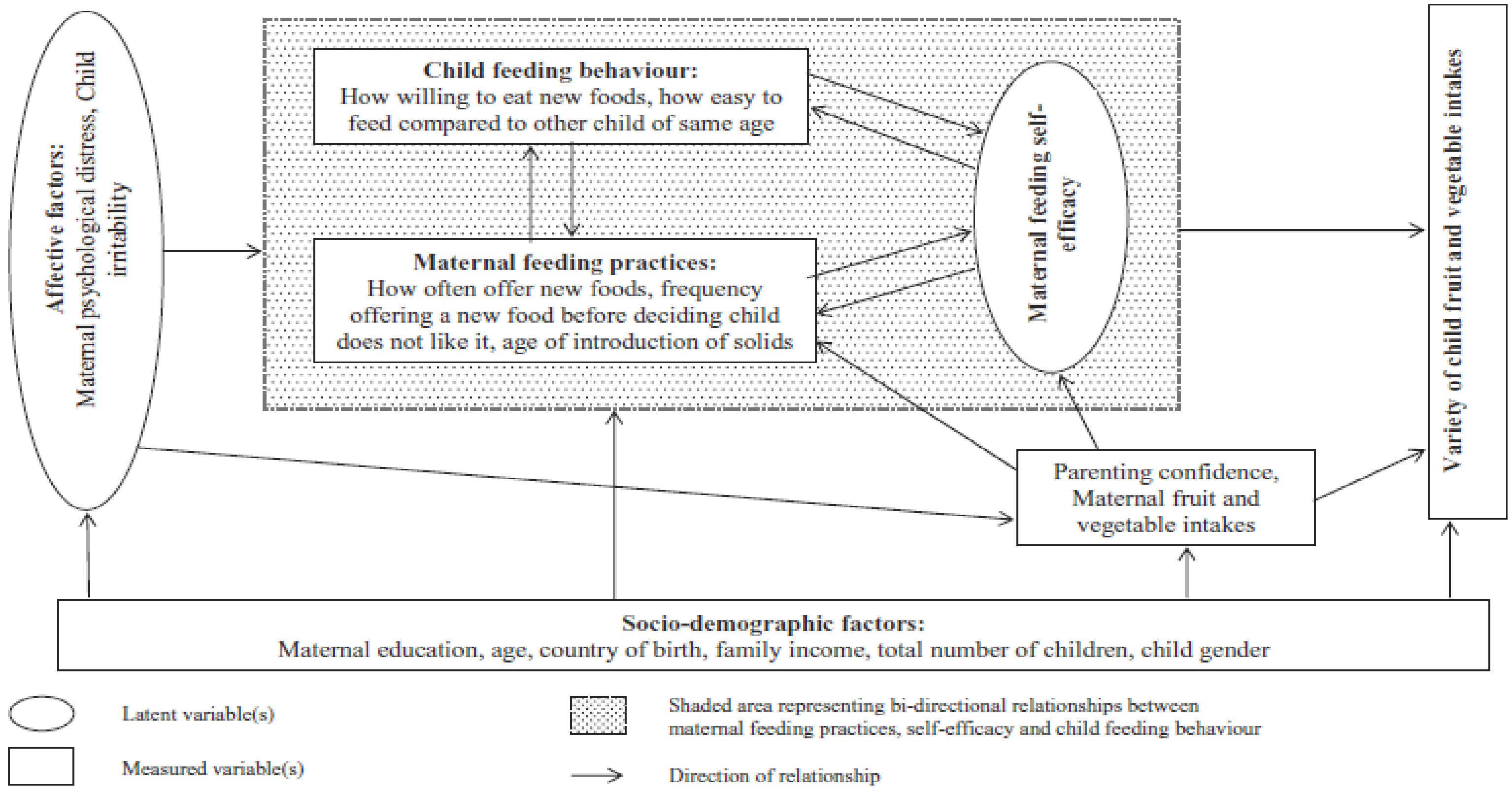


Figure 1.3 The structural equation model proposed in this thesis (19).

1.3 OVERVIEW OF THESIS CHAPTERS

This thesis consists of eight chapters as outlined in Table 1.1 below:

Table 1.1 Outline of thesis chapters

Chapter:	Summary of content:
One: Introduction	Introduction to thesis topic, aims and the structural equation model proposed.
Two: Literature review	Literature review presented in two parts: Part 1 – Fruit and vegetable consumption • definition, recommendations, evidence of intakes, health consequences and the importance of variety Part 2 – Determinants of fruit and vegetable consumption • maternal feeding self-efficacy, socio-demographic factors, maternal intake, role of food exposure, child feeding behaviour Chapter ends with conclusion on literature review.
Three: Methodology	Study design, procedures, data collection, transformation and analysis methods.
Four: The study's cohort	Findings, discussion and conclusions on study response rates, demographic characteristics and feeding practices of the study cohort.
Five: Fruit and vegetable intakes	Findings, discussion and conclusions on maternal and child fruit and vegetable intakes.
Six: Measurement models	Findings, discussion and conclusions on reliability testing and confirmatory factor analyses on items used to measure maternal feeding self-efficacy, maternal psychological distress and child temperament.
Seven: Structural Equation Models	Findings, discussion and conclusions on structural equation modelling of the proposed model at Time 1 and Time 2 of the study.
Eight: Conclusion	Key findings, implications, strengths, weaknesses, suggestions for future research and thesis concluding statement.

CHAPTER TWO: LITERATURE REVIEW

This chapter provides the literature review for this thesis. It includes definitions of terms and concepts vital to the understanding of this thesis. This chapter consists of three main sections.

Section 2.1 provides the literature review on the definition, recommendations, adequacy, consequences and significance of fruit and vegetable consumption, with focus on children's intakes. Section 2.2 presents the literature review on the determinants of fruit and vegetable consumption with focus on maternal feeding self-efficacy. Section 2.3 provides the conclusion from the literature review conducted.

2.1 FRUIT AND VEGETABLE CONSUMPTION

This section defines fruits and vegetables and the variation between countries in categorisation with respect to dietary guidelines. With the focus on children's intake, recommendations for daily intake of fruits and vegetable are discussed and data on consumption presented. Discussion on why adequacy and variety in fruit and vegetable consumption is important is also presented.

2.1.1 Definitions of fruit and vegetable

Botanically, "vegetable" is defined as the "edible part of a plant"(85). Based on this definition, "fruit" is a sub-set of vegetable as "fruit" forms from the flower and comes from the mature ovary of a plant which encloses the seed (9, 85). This definition includes fleshy fruits and dry fruits such as cereal grains, pulses and nuts (85). Despite their botanical definitions, fruit and vegetables are better known by their culinary usage. Therefore, some "vegetables" such as tomatoes and pumpkin which are botanically "fruit" and sweet corn which is botanically a grain or cereal, are considered as "vegetable" because they are consumed as such. Some food, botanically not even considered as a plant such as mushrooms and seaweed, are also considered as "vegetable" (85).

In the dietary guidelines in some countries, fruit and vegetable are grouped together as one food group while in others, they are considered as two separate food groups. Nutritionally, fruit and vegetables are classified based on their low energy-density and the cornucopia of vitamins and minerals they provide for health. Therefore, foods derived from fruit and vegetables, such as jam and jellies that are higher in energy and sugar content, are considered as "extras" or discretionary foods (9). Other plant foods such as herbs and spices, cocoa, coffee beans and tea leaves are also typically grouped separately from the "vegetable" food group. Cereal grains, although botanically a "vegetable", are grouped separately as "grain foods" as they are nutritionally distinct (higher energy-density, protein, iron and B vitamins), while also providing a significant source of dietary fibre when consumed with the bran intact (9).

A discrepancy in the categorisation of "vegetable" comes in the form of potato and starchy tubers such as sweet potato, yam, taro, cassava and manioc. Botanically a "vegetable", potato and starchy tubers are excluded from the "vegetable" food group in some guidelines (1, 86, 87) but included in others (9, 88). Potato contains mostly starch with fibre (especially when consumed with skin), potassium and B vitamins. It has a nutritional profile that resembles the nutritional profile of starchy grain foods (eg: rice, bread, pasta). For this reason, some guidelines place potato, starchy tubers and grain foods in the same food group (89, 90). The exclusion of potato and starchy tubers from the 'vegetable' food group recognises their prominence in certain diets as staple foods and should not be interpreted as a discouragement for consuming them. Rather, potato and starchy tubers were excluded from the 'vegetable' food group in some guidelines as a strategy for encouraging consumption of coloured vegetables to encourage variety within food group (85).

Another discrepancy in the categorisation of 'vegetable' involves the inclusion or exclusion of nuts, legumes, pulses and beans from the vegetable food group. Nuts, legumes, pulses and beans are rich sources of plant protein. Some countries categorise beans, pulses and legumes as 'vegetable' (9, 88) while others (mostly Asian countries) where plant proteins are considered an important protein source, they are grouped with either meat and seafood, or with dairy foods (87, 91). Categorisation of nuts, however, is fairly consistent with most countries grouping them with meat and seafood as 'protein foods' though some variations can be seen as in the case of the Korean Food Tower where nuts are grouped in the 'fats and oils' food group due to their high fat content (87).

The definition of 'fruit' in food guidelines is relatively consistent across the globe. However, the inclusion of fruit juice into the "fruit" food group has recently garnered some debate due to its possible contribution to childhood caries and undesirable child weight status. A 2003 publication of a prospective study on 642 children followed since birth in the Iowa Flouride Study found significant associations between increased fruit juice consumption in children aged 2 to 3 years old and increased risk of dental caries between ages 4 to 5 years (92). However more recent studies examining the association between fruit juice consumption and dental caries reported no significant association (93-95). The discrepancy may be explained by the presence of confounding factors such as socio-economic status (94, 96, 97), the overall quality of the child's diet (95, 98), maternal feeding practices (99, 100) and feeding frequency (101) which were not examined and controlled in the 2003 study (92).

The association between fruit juice consumption and child weight status was also inconclusive (102-104). However, a recent 2015 prospective study on 1163 U.S. children from Project Viva found that higher juice intake at 1 year of age (≥ 16 oz or 473 ml daily) was associated with higher juice intake, sweetened beverage intake and BMI z-score in early (median age 3.1 years, mean (SD) BMI z-score = 0.75 (1.29), and middle (median age 7.7 years, mean (SD) BMI z-score= 0.82 (1.12) childhood (105). This study provided the first evidence that higher fruit juice consumption in infancy tracked to 7 to 8 years of age with implications for undesirable weight gain.

In infancy, fruit juice consumption has been associated with gastrointestinal symptoms, failure to thrive, decreased appetite, loose stools, failure to gain weight and obesity (106). The American Academy of Pediatrics (AAP) recommended that fruit juice should not be offered to infants under 6 months of age and be limited to around 120-180ml (4 to 6 ounces) per day for children aged 1 to 6 years (107); a position adopted by the 2013 Australian Infant Feeding Guidelines (106). Most guidelines consider fruit juice as part of the "fruit" food group (9, 86, 108) but include caution to limit its consumption (86, 106).

This thesis follows the fruit and vegetable definition as per the 2013 Australian Dietary Guidelines and Guide to Healthy Eating (9). Fruits and vegetables are considered as separate food groups and were therefore analysed and discussed separately. Potato, starchy tubers, legumes, beans and pulses are all considered as 'vegetables'. Due to the young age of the study cohort (4 to 18 months old) in this thesis, fruit juice intake was excluded from the fruit group and intake not examined.

2.1.2 The recommendations

2.1.2.1 For adults

Worldwide recommendations for fruit and vegetable consumption generally reflect the World Health Organisation (WHO) recommendation of a minimum of 400g per day of non-starchy fruit and vegetable which usually equates to 5 serves of fruit and vegetable per day (1 serve = 80g) (1, 8, 109). Globally, a mass campaign promoting consumption of fruit and vegetable is referred to as the '5 A DAY' campaign. The US was a participant of this campaign from 1991 (110) until 2007 when the focus shifted to "Fruits and Veggies- More Matters" to reflect the 2005 (111), 2010 (108) and the current 2015-2020 Dietary Guidelines for Americans (112). The US recommendations for fruit and vegetable intakes are based on the level of energy intake with the recommendation of 2 cups of fruit and 2.5 cups of vegetables per day for a reference of 2000 kcal (8368 kJ) per day of energy intake (112). The American recommendations aim to achieve healthy eating patterns (U.S.-style eating patterns, Healthy Mediterranean-Style eating patterns and Healthy Vegetarian Eating Patterns) with strong emphasis on consumption of a variety of vegetables (dark green, red and orange, legumes, starchy and other vegetables) (112).

Other variations to the WHO recommendation can be found in Canada's Food Guide (113) and in the Australian Guide to Healthy Eating (AGHE) (114). The Canadian Food Guide recommends between 7 to 10 servings of fruits and vegetables per day with an emphasis on eating dark green and coloured vegetables (113). The AGHE recommends consumption of 2 serves of fruit (1 serve = 150g) and 5 serves of vegetable (1 serve= 75g) per day (114). This equates to a recommended fruit and vegetable intake of 675g daily; an amount exceeding the WHO recommendation. However, it must be noted that unlike the WHO recommendation, both the Canadian and Australian guidelines include potato and starchy vegetables as vegetable.

2.1.2.2 For children

Currently, there is no global consensus for fruits and vegetables (FV) recommendations for children. Recommendations vary between countries. For example, the Swedish guidelines for children up to 10 years recommend 400 grams of FV consumption daily (excluding potatoes but including a maximum of 100 grams fruit juice) (115) while the guidelines in the UK recommend 5-A-DAY serves of FV for children with a limit of 150ml of 100% unsweetened fruit juice per day (116). In the U.S., recommendations vary depending on child age and gender (Table 2.1) with separate recommendations for weekly variety for vegetable consumption based on vegetable sub-groups (dark green vegetables, red and orange vegetables, beans and peas, starchy vegetables and other vegetables such as bean sprouts, onions and mushrooms) (117).

Table 2.1 U.S. recommendations for daily fruit and vegetable consumption for children*

Gender:	Age group (years):	Recommendation:	Examples of 1 cup:
Fruit:			1 small apple
All	2 to 3	1 cup	1 large banana
	4 to 8	1 to 1.5 cups	32 seedless grapes
			1 large peach or 2 halves canned peaches
Girls	9 to 18	1.5 cups	8 large strawberries
Boys	9 to 13	1.5 cups	3 medium plums
	14 to 18	2 cups	8 large strawberries
			1 small slice (1-inch-thick) watermelon
			1 cup of 100% fruit juice
Vegetable:			3 broccoli spears (5 inch long each)
All	2 to 3	1 cup	2 cups raw leafy vegetables
	4 to 8	1.5 cups	1 large tomato
			1 large sweet potato
Girls	9 to 13	2 cups	1 cup whole or mashed beans
	14 to 18	2.5 cups	1 large ear of corn
			1 medium boiled or baked potato
Boys	9 to 13	2.5 cups	1 cup raw or cooked mushrooms
	14 to 18	3 cups	

*adapted from the U.S. Choose My Plate recommendations (117).

Similar to the U.S., recommendations in Australia are based on child age and gender (Table 2.2). For children under the age of 2 years old, the recommended fruit and vegetable servings were determined through modelling of infant (6 to 12 months) and toddler (13 to 23 months) dietary intake based on food patterns of 2 to 3 year olds due to absence of adequate dietary data for children under 2 years of age (118). For infant diets, recommendations were set to achieve Adequate Intakes (AIs) for all nutrients and Recommended Dietary Intakes (RDIs) for iron and zinc with breast milk as the milk source (118).

Table 2.2 Australian recommendations for daily fruit and vegetable consumption for children*

Gender:	Age group:	Recommendation:	Definition of 1 serve:
Fruit:			
All	7 to 12 months	0.5 serve	20g
	1 to 2 years old	0.5 serve	150g
	2 to 3 years old	1.0 serve	
	4 to 8 years old	1.5 serves	
	9 to 18 years old	2.0 serves	
Vegetable:			
All	7 to 12 months	1.5 to 2.0 serves	20g
	1 to 2 years old	2.0 to 3.0 serves	75g
	2 to 11 years old	5.0 serves	
Girls	12 to 18 years old	5.0 serves	
Boys	12 to 18 years old	5.5 serves	

*recommendations for infants and toddlers (6 months to 2 years old) were from Eat For Health: Educator Guide, page 44 (9) while recommendations for children 2-18 years old were adopted from Eat For Health: Australian Dietary Guidelines, page 42 (119).

2.1.3 Evidence of inadequate consumption

2.1.3.1 Adults

A discrepancy between recommended and actual intake for amount and variety of consumption still exists despite the current '5 A DAY' global effort to increase fruit and vegetable consumption (14, 15). However, inadequate intake is not associated to the status of the country (developed or developing) as evident in the higher intakes of FV in developing countries such as Uganda (mean intake 488.5g/day) (120) and China (mean intake 484.9g/day) (120) compared to intakes in developed nations such as the U.S. (mean intake 444.3g/day) (120), Australia (mean intake 304.2g/day) (121) and Denmark (mean intake 313.8g/day) (122).

In Australia, results from the National Nutrition Survey 1995 showed a majority of adult Australians (89%) did not meet the recommendations for both fruit and vegetables (15). Data from Australia's National Health Survey (AHS) 2007-2008 showed 91% of Australians aged 16 years and above did not meet the recommendations for vegetable serves while around half consumed insufficient fruit (123). Overall, only 6% of the Australian population (aged ≥ 16 years) surveyed were able to meet both the recommendations for daily fruit and vegetable intakes (123). More recent data from the 2011-2012 National Nutrition and Physical Activity Survey (NNPAS) showed only 6.8% of Australians (aged ≥ 2 years) consumed 5 serves per day of vegetables and 54% met their daily fruit recommendation (121). In the U.S, recent data from the Behavioural Risk Factor Surveillance System 2013 showed only 13.1% and 8.9% of American adults met the age and gender specific recommendations for fruit and vegetable intakes respectively (124). A recent report from the UK National Diet and Nutrition Survey (NDNS) in 2014 reported 30% of UK adults (aged ≥19 years) met '5 A DAY' recommendation (125). Generally, women were more likely to meet recommendations for FV than men (15, 126).

Due to the differences in defining FV (what to include and what to exclude), methods in measuring FV intakes and FV recommendations, it is difficult to compare findings on FV consumption between countries. Despite this, it is clear that inadequate intakes are a global problem.

2.1.3.2 Children

Generally, studies around the world have reported poor FV consumption in children. In the U.S., findings from the National Health and Nutrition Examination Survey (NHANES) 2007-2010 showed that 60% of children aged 1 to 18 years did not meet the U.S. Department of Agriculture (USDA) recommendations for fruit intake and 93% did not meet the recommendations for vegetable intake (11). A secondary analysis of the NHANES data between the years 2003 to 2010 on the amount of FV consumed revealed that although children's fruit consumption increased (from 0.55 cup per equivalents 1000 calories in 2003 to 0.62 cup per equivalents 1000 calories in 2010), total vegetable consumption remained unchanged (127). In the U.K., the National Diet and Nutrition Survey (NDNS) for 2008 to 2012 reported only 10% of boys and 7% of girls aged 11 to 18 years old met the "5 A DAY" recommendation (12).

In Australia, the 2007 National Children's Nutrition and Physical Activity Survey (NCNPAS) reported that only 24% and 5% of children aged 14 to 16 years old met the recommendations for fruit and vegetable respectively when fruit juice and potatoes were included (13). Exclusion of fruit juice and potatoes resulted in an even smaller proportion of children meeting the FV guidelines across all age groups to the point of only 1% and none of the children aged 14 to 16 years were able to meet the FV recommendations respectively (13). Older children were less likely to meet the FV recommendations compared to younger children (13). This was also observed elsewhere in the world (11, 12, 128, 129) and from the findings of the more recent Australian Health Survey 2011-12 on children aged 2 to 18 years old in Australia (130).

In contrast with older children, there are limited reports on fruit and vegetable consumption of young children. Assessment of pre-schooler diets revealed a large variation in inadequacy ranging from 3% (131) to 73% (132) children meeting specific recommendations for daily fruit intake, and from none (131) to 46% (132) meeting specific recommendations for daily vegetable intake. Results vary between countries and study cohorts. Differences in definition of FV recommendations and assessment method make comparison difficult. In general, pre-schoolers consumed more fruits than vegetables (131, 133). The most frequently consumed fruits were apple, pear and banana (134) while the most frequently consumed vegetable was white potato, especially in its fried form (132, 134).

Studies on fruit and vegetable consumption in infants and toddlers are even scarcer. Yet, poor food intakes were reported in the diets of children as young as 2 years old

(11). Evidence showing how childhood eating habits and weight status tracked into adulthood (135, 136) further provided the rationale to examine children's diet at the age when foods were introduced to children. Food preferences formed during this critical period of development have the potential to influence lifelong eating habits (13, 137). Table 2.3 summarises population and cohort studies that have reported FV consumption in children under 2 years of age.

Generally, vegetable intake is less likely to meet recommendations than fruit intake in infant and toddler diets (18, 138, 139). More children were consuming fruits than vegetables (138, 140). Fruits were consumed more frequently than vegetables (141) though varieties for fruits and vegetables were limited to ≤ 1 type or sub-group each daily (18, 19). Proportions of consumers and intakes for FV generally increased with age (139, 140, 142) though the only study examining the tracking of FV between 9 months and 18 months of age by Lioret and colleagues reported a significant decrease in vegetable intake at 18 months (OR CI 95% = 2.27, 1.12;4.62, $p<0.05$) (17).

The types of fruits preferred by infants and toddlers were generally available all year round such as apple, banana, pears, grapes and canned peaches (19, 138, 140, 142). There are also evidence to show the popularity of commercially prepared FV in infants' diets (19, 140). Between 12 to 24 months of age, potatoes became the most consumed vegetable in children's diet (138, 140). Moreover, fried potatoes (eg: French fries, chips) become a major contributor towards children's vegetable intakes. The U.S. Feeding Infants and Toddlers Study (FITS) reported that at 24 months old, more than half of the children who consumed potatoes consumed it in its fried forms

(140). However, the popularity of potatoes in children’s diets may be culturally driven as the only non-Western study by Pan Yu and colleagues revealed that Chinese infants and toddlers consumed green leafy vegetables such as Chinese cabbage, spinach and kale over potatoes (142). Caution is however required when comparing findings between studies due to the differences in how FV is defined (inclusion or exclusion of juice and fried potatoes).

In conclusion, the overall findings on fruit and vegetable consumption by infants and toddlers indicate there are many similarities with studies of intake by pre-school and school-aged children. They provide evidence that inadequate consumption begins in infancy and toddlerhood.

Table 2.3 Summary of population and cohort studies reporting fruit (f) and vegetable (v) consumption in infants and toddlers

Study:	**Subjects:**	**Study design, dietary measurement methods and variable definitions:**	**Findings on fruit and vegetable intakes:**
Siega-Riz A.M. *et al* 2010 (140)	n= 2884 and 1596 children aged 4 to 24 months old ; U.S. 2002 (143) and 2008 Feeding Infants and Toddlers Study (FITS) respectively.	Cross-sectional. 1x24-hour dietary recall. Fruit juice included. All forms of potatoes included. Consumers: ate f or v at least once on the day of the recall.	Similar trends in both years. FITS 2002:- F consumers: 43.9% to 91.1% (4 to 14.9 months) consumed; < 90% (15 to 23.9 months). V consumers: 32.1% to 80.8% (4 to 20.9 months); 79.3% (21 to 23.9 months). FITS 2008:- F consumers: 21.8% to 90.2% (4 to 14.9 months); 86.9% (15 to 17.9 months); 92.8% (8 to 13.9 months). V consumers: 25.9% to 72.1% (4 to 20.9 months); 68.1% (21 to 23.9 months). Both FITS:- Most consumed f: baby food apples, bananas, pears and peaches (<12 months); banana, apple, grapes, canned peaches and canned applesauce (≥ 12 months). Most consumed v: baby food sweet potatoes, green beans, squash, peas and carrots (<12 months); French fries or fried potatoes, mashed potatoes, cooked green beans, cooked peas and cooked corn (≥ 12 months).

Table 2.3 continued.

Study:	Subjects:	Study design, dietary measurement methods and variable definitions:	Findings on fruit and vegetable intakes:
Department of Health & Food Standards Agency 2011(139)	n= 2,683 healthy infants and toddlers aged 4 to 18 months; U.K. Diet and Nutrition Survey of Infants and Young Children (2011) (139). Children were randomly selected from the Child Benefit (CB) records covering all four countries in the U.K and children from the Healthy Start sample (144).	Longitudinal, population survey. Food diary completed over four consecutive days. Fruit juice excluded. All forms of potatoes included.	Average f intake: 4-6 months old: 48 g/day 7-9 months old: 73 g/day 10-11 months old: 82 g/day 12-18 months old: 96 g/day Average v intake: 4-6 months old: 52 g/day 7-9 months old: 79 g/day 10-11 months old: 84 g/day 12-18 months old: 74 g/day Average total fv intake: 4-5 months old: 100 g/day 7-9 months old: 152 g/day 10-11 months old: 166 g/day 12-18 months old: 170 g/day

Table 2.3 continued.

Study:	Subjects:	Study design, dietary measurement methods and variable definitions:	Findings on fruit and vegetable intakes:
Lioret S. *et al* 2013 (17)	n= 177 healthy children aged 9 months and 18 months of primiparous mothers from the InFANT (145) study; Australia.	Cohort, longitudinal. InFANT study is a cluster-randomized trial. F and v data reported in this paper were obtained from the control arm of the study. 2x 24-hour multiple pass dietary recalls administered through phone interviews with parents by trained nutritionists. Fruit juice excluded. Non-fat potatoes included. Consumers: ate f or v at least once in the 2 days of intake.	At 9 months: F consumers: 94.9%; median intake 66.3 g/day V consumers: 94.9%; median intake 84.3g/day At 18 months: F consumers: 98.3%; median intake 144.5g/day V consumers: 94.9%; median intake 69.9 g/day F intake at 18 months significantly higher than at 9 months (OR[a]: 4.13, CI95%[b]: 2.16; 7.91, $p \leq 0.001$). V intake at 18 months significantly lower than at 9 months (OR[a]: 2.27, CI95%[b]: 1.12; 4.62, $p<0.05$).

Table 2.3 continued.

Study:	Subjects:	Study design, dietary measurement methods and variable definitions:	Findings on fruit and vegetable intakes:
Koh G.A *et al* 2014 (19)	n= 277; mean age 27 weeks old health full-term infants recruited at birth from 11 South Australian hospitals for the SAIDI study (146); Australia.	Cross sectional. SAIDI study is a cohort, longitudinal study. The fruit and vegetable data reported in this paper were obtained from Time 1 of the study. 1x24-hour multiple pass dietary recall administered through phone interviews by trained dietitians and 2 x food diaries. Fruit juice excluded. Non-fat potatoes included. Consumers: ate f or v at least once in the 3 days of intake. Frequency: number of consumption occasions across 3 days of intake. Variety: number of different sub-groups within each food group consumed across 3 days of intake.	F consumers: 86.6%; median frequency= 4 times; median variety= 2 V consumers: 91.7%; median frequency= 6 times; median variety= 3 Most consumed fruits were apple, banana, commercial infant mixed fruits, pear and commercial infant fruit. Most consumed vegetables were pumpkin, carrot, potato, sweet potato and homemade vegetable dishes.

Table 2.3 continued.

Study:	Subjects:	Study design, dietary measurement methods and variable definitions:	Findings on fruit and vegetable intakes:
Byrne R., Magarey A. & Daniels L. 2014 (138)	n= 551 aged 12-16 months old; healthy full-term infants recruited at birth for the NOURISH (147) and SAIDI (146) studies; Australia.	Cross-sectional. NOURISH is a randomized-controlled trial. F and v data reported in this paper were obtained from the control arm of the study at Time 2. SAIDI is a cohort longitudinal study. F and v data reported in this paper were obtained from Time 2 of the study. 1x24-hour multiple pass dietary recall administered via phone interviews by trained nutritionists. Fruit juice excluded. Non-fat potatoes included. Consumers: ate f or v at least once in the day of the recall.	Consumers: 87% (f) and 77% (v); median intake= 131g/day (f) and 89g/day (v). Most frequently consumed f: banana, sultana, strawberry and seedless green grapes. Most frequently consumed v: cooked carrots, potato and broccoli.
Foterek K., Hilbig A. & Alexy U. 2015 (18)	n= 281 children aged 6 to 9 months; DOrtmund Nutritional and Anthropometric Longitudinal Designed (DONALD) study (148); Germany.	Longitudinal, open cohort. 3-day weighed dietary records. Variety: number of individual f and v eaten (>10g) at least once in the 3 days of diet record. Juices included. All forms of potatoes included.	Total intake: 69 g/day (f); 45 g/day (v) Variety score: 2.0 (f); 2.5 (v)

Table 2.3 continued.

Study:	Subjects:	Study design, dietary measurement methods and variable definitions:	Findings on fruit and vegetable intakes:
Pan Yu *et al* 2016 (142)	n= 1,350 children aged 6 to 35 months; Maternal and Infant Growth (MING) study (149). Children were recruited from maternal and child care centres in eight cities in China.	Cross-sectional study. 1 x 24-hours dietary recall via face-to-face interview with primary caregiver by trained interviewers. Fruit juice included. All forms of potatoes included. Consumers: ate f or v at least once on the day of the recall.	F consumers: 6-8 months old: 48% 9-11 months old: 55% 12-14 months old: 62% 15-17 months old: 55% 18-20 months old: 68% 21-23 months old: 73% Vconsumers: 6-8 months old: 37% 9-11 months old: 57% 12-14 months old: 77% 15-17 months old: 71% 18-20 months old: 83% 21-23 months old: 84% Most consumed f: apple, banana, citrus fruits, grapes and kiwi. Most consumed v: Chinese cabbage, carrots, spinach, kale and tomatoes.

[a]Odds ratio
[b]Confidence Interval

2.1.4 Consequences of inadequate consumption

Adequate and varied consumption of FV is an important characteristic of a balanced and high quality diet (150-152). In growing children, a diet high in FV may help to promote healthy teeth and bone growth (153, 154), weight management (155, 156) and improve sleeping patterns (157). Moreover, FV are good sources of fibre, vitamins and minerals (158) that help with bowel and digestive health and protect against non-communicable diseases (NCD) (1). Non-communicable diseases (NCD) is the current global leading cause of deaths (159). The contribution of NCD to mortality rates is projected to increase globally by 15% between 2010 and 2020, mostly due to an ageing world population and the steep decline in mortality rates from infectious diseases (160). Globally in 2013, the principal causes of NCD deaths were cardiovascular diseases (17.3 million, 45.1% NCD deaths), cancers (8.2 million, 21.4% NCD deaths), chronic respiratory diseases (4.3 million, 11.3% NCD deaths) and diabetes (3 million, 7.8% NCD deaths) (159).

The key modifiable dietary risk factors that contributed to the burden of disease from NCD were excessive salt intake, inadequate FV consumption, excessive alcohol consumption and high intakes of saturated and trans fats (161). Of these, inadequate FV consumption was responsible for an estimated 5.2 million deaths in 2013 (159).

In Australia in 2011, inadequate consumption of FV was estimated to account for 62,751 (3.4% total) Disability Adjusted Life Year (DALY) per year (162); an increase from the 55,000 DALYs (2.1% total) per year reported in 2003 (163). These figures are higher than for diets high in processed meats (1.4% total DALY), saturated fat (0.7% total DALY), sodium (0.3% total DALY) and sweetened beverages (0.3% total DALY) (162).

Moreover, there is evidence to show a potentially protective effect of FV intakes on the development of chronic diseases in later life (164). Evidence for the burden of disease attributable to inadequate FV intakes and the link between fruit and vegetable consumption and the top 4 causes of NCD mortality rates (cancer, cardiovascular diseases, chronic respiratory diseases and diabetes), obesity and future protection against future diseases are presented below.

2.1.4.1 Cancers

A global estimation by Lock *et al* in 2005 revealed that increasing individual FV consumption by 600g daily would reduce the burden for stomach, oesophageal, lung and colorectal cancer by 19%, 20%, 12% and 2%, respectively (165). In Australia in 2011, a diet low in fruit was estimated to account for 20% of the disease burden of mouth and pharyngeal cancer, oesophageal cancer and laryngeal cancer while a diet low in vegetables was estimated to account for 21% of the burden due to laryngeal, mouth and pharyngeal cancer (162).

The relationship between fruit and vegetable consumption and risk of cancer is well studied. Generally, research shows that adequate consumption of FV is beneficial against the development of certain cancers but to date, no protective effects have been firmly established (166). The discrepancies of results reported in various studies across the globe make it difficult to accurately determine the strength of the relationship between fruit and vegetable intakes and cancer risk. For example, in an earlier report in 1997, the World Cancer Research Fund (WCRF) and the American Institute of Cancer Research (AICR) concluded that there was ‘convincing’ evidence for the protective effects of fruit and vegetables on cancer of the oesophagus, mouth, pharynx, stomach, colon, rectum and lungs (167) but lowered the strength of the evidence for these cancers in their 2007 report (8). The main reason for this change was new evidence from large prospective studies that do not support the results observed in earlier studies (166). Many of the earlier studies failed to control for possible confounding factors such as alcohol and tobacco which were shown to cause large increases in the risk for several cancers and were usually associated with low fruit and vegetable intakes (166). The heavy reliance on case-control studies in the 1997 report also presented a form of bias as control subjects may not be representative of the general population (eg: more health conscious) and study subjects may over-estimate their usual fruit and vegetable intakes in response to being studied or reported intakes post-diagnosis of cancer (166).

Table 2.4 below summarises the conclusions from major cancer prevention reports regarding the protective effect of fruit and vegetables while Table 2.5 presents a summary of the dose-response relationship for fruit and vegetable consumption and selected cancers reported by the WCRF and AICR (8). Overall, the strongest evidence linking low fruit and vegetable intakes with cancer was observed for stomach, oesophagus, mouth/oral cavity and colorectal cancers. The strongest dose-response relationship was found for oesophageal cancer, followed by mouth/pharynx/larynx and stomach cancers (8).

Table 2.4 Conclusions from the major cancer prevention reports regarding the protective effect of fruit (F) and vegetables (V)¶.

Organisation	Highest Evidence 'Convincing'*	Moderate Evidence 'Probable'**	Lower Evidence 'Possible/Limited'***
World Cancer Research Fund and American Institute for Cancer Research 2007 (8)	-	Mouth (F&V) Pharynx (F&V) Larynx (F&V) Oesophagus (F&V) Stomach (F&V) Lung (F&V)	Nasopharynx (F&V) Colon & rectum (F&V) Pancreas (F) Liver (F) Lung (V) Ovary (V) Endometrium (V)
International Agency for Research on Cancer 2003 (168)	-	Oesophagus (F&V) Stomach (F) Colon & rectum (V)	Mouth (F&V) Pharynx (F&V) Larynx (F&V) Kidney (F&V) Colon & rectum (F) Bladder (F) Stomach (V) Lung (V) Ovary (V)
WHO/FAO 2003 (1)	-	Oral cavity (F&V) Oesophagus (F&V) Stomach (F&V) Colon & rectum (F&V)	-
UK Department of Health 1998 (169)	Oesophagus (F&V)	Stomach (F&V) Colon & rectum (V)	Breast (F&V)
World Cancer Research Fund and American Institute for Cancer Research 1997 (167)	Mouth (F&V) Pharynx (F&V) Oesophagus (F&V) Stomach (F&V) Colon & rectum (V) Lung (F&V)	Larynx (F&V) Pancreas (F&V) Breast (F&V) Bladder (F&V)	Ovaries (F&V) Cervix (F&V) Endometrium (F&V) Thyroid (F&V) Liver (F&V) Prostate (V) Kidney (V)

¶table adopted from 'Position Statement: Fruit, vegetables and cancer prevention', Cancer Council Australia 2007 (170).
*evidence from at least two independent cohort studies, or at least five case-controlled studies with direction of effect generally consistent with evidence for plausible mechanisms.
**evidence from at least two independent cohort studies, or at least five case-controlled studies of good quality with homogenous results, and evidence for plausible mechanisms.
***evidence from more than one study type and at least two independent cohort studies of good quality, homogenous results, the presence of dose-response and strong evidence for plausible mechanisms.

Table 2.5 Summary of dose-response relationship for fruit and vegetable consumption and selected cancer types[€].

Cancer type	Dose-response:
Oesophagus	**Fruit:-** Per 50g/day increase: 22% reduced risk 30% reduced risk (citrus fruits) **Vegetable:-** Per 50g/day increase: 31% reduced risk
Mouth/Pharynx/Larynx	**Fruit:-** Per 100g/day increase: 18% reduced risk 24% reduced risk (citrus fruits) **Vegetable:-** Per 50g/day increase: 28% reduced risk
Stomach	**Fruit:-** Per 50g/day increase: 17% reduced risk **Vegetable:-** Per 50g/day increase: 15% reduced risk 21% reduced risk (green-yellow vegetables) 57% reduced risk (green leafy vegetables) 30% reduced risk (tomatoes) 25% reduced risk (raw vegetables)
Lung	**Fruit:-** Per 80g/day increase: 6% reduced risk (cohort studies) 20% reduced risk (case-control studies)

[€]Source: World Cancer Research Fund and American Institute for Cancer Research 2007 (8).

As presented in Table 2.5 above, the dose-response relationship was generally stronger for vegetables than fruits. This observation was further supported by a more recent study by Bofetta and colleagues using data from 142,605 men and 335,873 women from the European Prospective Investigation into Cancer and Nutrition (EPIC) study (171). In a paper published in 2010, the EPIC team reported that intake of fruits showed a weaker inverse association with cancer risk compared with total vegetables (100g/day increase of total fruits, Hazard Ratio = 0.99, 95% CI = 0.98 to

1.00) (171). Interestingly, they further reported that the reduced risk of cancer associated with high intake of vegetables was only found in women (Hazard Ratio = 0.98, 95% CI= 0.97 to 0.99) and not men. This may be due to the fact that more than half of the women in the study (56.8%) reported total fruit and vegetable intakes at the highest quintile while 62.8% men consumed fruits and vegetables at the lowest quintile (171). In a 2014 paper, the EPIC team reported that the risk of cancers of the upper gastrointestinal tract was inversely associated with fruit intake but not vegetable intake; cancer risk for colorectal cancer was inversely associated with total fruit and vegetable intakes, and lung cancer risk was inversely associated with fruit intake and not vegetable intake (172). These findings (presented in Table 2.6 below) support the dose-response findings of the 2007 WCRF and AICR review previously presented in Table 2.5 above.

Table 2.6 Adjusted Relative Risks (95% Confidence Intervals) for intakes of fruit and vegetable in relation to cancer risk in the European Prospective Investigation into Cancer and Nutrition (EPIC) study*.

Cancer site:	Fruit:	Vegetable:
Mouth, pharynx, larynx and oesophagus	0.93 (0.81,1.05)[a]	0.75 (0.53,1.04)[a]
Stomach	0.94 (0.87,1.02)	0.85 (0.70,1.02)
Colorectum	0.97 (0.93,1.01)[b]	
Liver	-	-
Biliary tract	-	-
Pancreas	1.02 (0.92,1.13)	1.07 (0.87,1.33)
Lung	0.94 (0.88,1.01)	0.94 (0.83,1.07)
Breast	1.03 (0.98,1.08)	1.02 (0.91,1.14)
Cervix	0.83 (0.72,0.98)	0.85 (0.62,1.10)
Endometrium	-	-
Ovary	1.10 (0.99,1.23)[c]	0.90 (0.71,1.14)[c]
Prostate	-	-
Kidney	1.08 (0.94,1.23)[a]	0.93 (0.66,1.29)[a]
Bladder	0.98 (0.90,1.05)	0.96 (0.81,1.14)
Lymphoma	0.99 (0.81,1.19)	1.04 (0.96. 1.13)

*Table adopted from Bradburry *et al* 2014 paper (172). Approximately 470,000 participants included in most analyses, except for cancers of breast, cervix, endometrium and ovary (approximately 330,000 women) and prostate cancer (approximately 140,000 men). Values shown are per 100 grams/day increase in fruit or vegetable intake unless stated otherwise.
[a]per 40 grams/day increase in fruit or vegetable intake.
[b]for combined fruit and vegetable intakes.
[c]per 80 grams/day increase in fruit or vegetable intake.

How fruit and vegetables protect against cancer is unclear although many different mechanisms were proposed (9). Fruit and vegetables are good sources of a range of vitamins, minerals, antioxidants, fibre and phytochemicals that are thought to protect against some cancers (170). This can be achieved through a number of mechanisms such as reduction of the oxidative damage to DNA caused by free radicals, reduction of the formation and activation of carcinogens, and altering the cellular and enzymatic activity that are important in cancer development (170). Some vegetables that are high in folate such as green leafy vegetables are also thought to be protective against cancers caused by high levels of homocysteine in the blood and DNA hypomethylation (119). Vitamin C found in fruit and vegetables (particularly in citrus fruits) was found to be protective in some studies while carotenoids found in orange, red and yellow vegetables may help with the maintenance of immune function (119). Other phytochemicals such as lycopenes (found in tomatoes), dithiolthiones (found in cruciferous vegetables) and allyl sulphites (found in garlic) were also studied for their potentially protective effect against cancer (8). Consumption of fruit and vegetables which contribute to adequate intakes of dietary fibre was also shown to be protective against colorectal cancer (8, 173, 174), though the exact mechanism for this is unclear. There is also evidence to show that the cancer- protective effect against oxidative damage can only be effective when fruit and vegetables were consumed from childhood or early adult life (175).

Adequate fruit and vegetable consumption may also protect against cancer indirectly through its association with healthy weight status. Obesity is a risk factor for colorectal, renal, pancreatic, oesophageal, liver, gallbladder, breast and endometrial cancers (1, 8, 168). Moreover, a recent study by Zhang and colleagues (2015) on more than 75,000 women and 34,000 men using data from the Nurses' Health Study and the Health Professionals Follow-Up study showed that childhood obesity (independent of adult obesity) was a significant risk factor for colorectal cancer in adults, particularly women (176). This provides prospective evidence in support of the importance of adequate fruit and vegetable consumption from childhood.

2.1.4.2 Cardiovascular diseases (CVD)

Globally, coronary heart disease (CHD) and stroke due to low fruit and vegetable intakes were estimated to be responsible for approximately 1.8 million and 474,000 deaths per year, respectively (165). An increase in 600 grams/day of total fruit and vegetable intakes was estimated to reduce the global burden of CHD and stroke by 31% and 19% respectively (165). A comprehensive systematic review and dose-response meta-analysis of prospective cohort studies published up to August 2013 concluded that the average reduction of cardiovascular diseases (CVD) mortality risk was 4% for each additional serving per day of fruit and vegetables combined, 5% for fruit consumption and 4% for vegetable consumption (177). Recent data from Australia estimated that inadequate intakes of fruits and vegetables contributed to 19% of the burden of cardiovascular diseases (CVD) (162). This is a highly significant contribution in comparison to CVD burden due to obesity (21%), high cholesterol (16%) and tobacco use (12%) (162).

The evidence linking CVD to inadequate fruit and vegetable intakes is consistent. Significant inverse relationships between fruit and vegetable intakes and CHD and stroke were found in large meta-analyses of prospective cohort studies (3, 4, 178, 179). The findings from these studies are summarised in Table 2.7 below.

Table 2.7 Summary of findings from meta-analyses of prospective cohort studies on the association between fruit (F) and vegetable (V) consumptions and cardiovascular diseases.

Study:	Sample:	Findings*:
Joshipura K.J. *et al* 1999 (179)	75,596 women (34 to 59 years); Nurses' Health Study (180); 38,683 men (40 to 75 years); Health Professional Follow-Up Study (181); 8-year follow-up (1986 to 1994); 987 stroke events.	Highest versus lowest quintile of FV intake: RR for stroke = 0.69, 95% CI = 0.52-0.92. RR (95% CI) for stroke for increase in 1 serve daily: - 0.94 (0.90-0.99) (FV) - 0.68 (0.49-0.94) (cruciferous vegetables) - 0.79 (0.62-0.99) (green leafy vegetables) - 0.81 (0.68-0.96) (citrus fruits) Increase in 2 serves of FV daily; RR = 0.96, 95% CI= 0.93-1.00. Intakes of legumes and potatoes not associated with stroke risk.
Dauchet L. *et al* 2006 (3)	91,379 men, 129,701 women 9 prospective cohort studies (7 U.S., 2 Finland); 5 to 19 year follow up; 5007 coronary heart disease (CHD) events.	Total studies reported inverse association with CHD risk: - n=6 for FV intake - n=6 for fruit intake - n=7 for vegetable RRs for CHD per 1 portion/day increase: - 0.79 to 0.97 (FV) - 0.81 to 0.95 (fruit) - 0.60 to 0.98 (vegetable) Reduction of CHD risk per 1 portion/day increase: - 4% (FV) - 7% (fruit)
He F.J. *et al* 2007 (178)	278,459 men and women; 3 independent cohort studies (9 U.S., 4 Europe); median 11 years follow-up; 9143 CHD events.	RR (95% CI) for CHD compared to < 3 servings/day of FV: - 0.93 (0.86-1.00) (3-5 FV servings/day) - 0.83 (0.77-0.8) (> 5 FV servings/day)

Table 2.7 continued.

Study:	Sample:	Findings*:
Hu D. *et al* 2014 (4)	760,629 men and women; 20 prospective cohort studies (6 U.S., 8 Europe, 6 Asia); 16,981 stroke events.	RR (95% CI) for stroke for highest versus lowest level of intake: - 0.79 (0.75-0.84), I^2= 16.6% (FV) - 0.77 (0.71-0.84), I^2=52.3% (fruit) - 0.86 (0.79-0.93), I^2= 40.3% (vegetable) Inverse associations found for (RR, 95%CI): - Citrus fruits (0.72, 0.59-0.88) - Leafy vegetables (0.88, 0.79-0.98) - Apples/Pears (0.88, 0.81-0.97) Stroke risk per increase of 200g/day: - 32% decrease (fruit) - 11% decrease (vegetable)

*RR- relative risk; CI- Confidence Interval; I^2- heterogeneity among studies with I^2 =25% (low), 50% (moderate), 75% (high) (4).

According to a meta-analysis of 9 prospective cohort studies by Dauchet and colleagues, an increase of 1 portion/day of fruit and vegetables led to a 4% decrease in CHD risk (3). When fruits and vegetables were analysed separately, an increase of 1 portion/day of fruit intake lead to 7% decrease in CHD risk while estimation for vegetables was not determined due to the heterogeneity of data reporting associations between vegetable intakes and CHD risks (3). Moreover, exceeding the daily recommendations for fruit and vegetables (>5 serves/day) provided a protective effect with 17% reduction of CHD risk compared to those who consumed <3 serves of fruit and vegetables per day (178).

Total fruit and vegetable intake contributed to a reduction of 6% stroke risk per 1 serve/day increment in intake (179) with up to 21% stroke risk reduction reported when comparing the lowest and highest level of fruit and vegetable intakes (4). In the most recent meta-analysis conducted by Hu and colleagues (2014), fruit contributed to the largest decrease (32% per 200g/day increase in fruit intake) in stroke risk with citrus fruits being the top contributor to the reduction of stroke risk (28% risk reduction) when types of fruits were analysed separately (4). This result supports the findings from the 1999 meta-analyses by Joshipura and colleagues using data from the Nurses' Health and Health Professional Follow-Up studies which reported 19% reduction of stroke risk per 1 serve/day increment of citrus fruits (179).

Fruits and vegetables protect against CVD through various mechanisms. Components with anti-oxidant activity (eg: vitamin C and E) and phytochemicals found in fruits and vegetables may reduce risk of inflammation, haemostasis and the formation of atherogenic plaques that lead to CVD (119). Studies conducted on the effects of vitamin C and beta-carotene supplementation on CVD and stroke risks produced inconclusive results with some studies showing a protective effect while others reported no effect (182-184). Importantly, reviews on antioxidants and CVD suggest that the CVD protective effect of fruits and vegetables may be due to the presence of various nutrients found in the whole fruits and vegetable and not necessarily from supplementation of single antioxidants (183, 185). Findings from the meta-analyses of large prospective cohort studies that were previously discussed seemed to provide weight to this observation with citrus fruits (rich in vitamin C) found to reduce stroke risk (4, 179).

Potassium and magnesium found in fruits and vegetables may reduce the incidence and mortality attributable to CVD (186). Potassium was found to be inversely associated with blood pressure and arrhythmias (186, 187). Dietary folate and vitamin B12 are important for the metabolism of homocysteine (186) and can be found in lentils, spinach, broccoli, asparagus and other dark green leafy vegetables (119). Elevated blood homocysteine levels is suggested as an important predictor of CVD risk (188). However, meta-analyses of studies on the use of dietary supplementation of folate reported lowering of plasma homocysteine that did not lead to reduction of CVD risk (188, 189), further lending credence to the theory that the protective effect of fruit and vegetables may be due to consumption of whole fruits and vegetable. Like citrus fruits, increasing intake of green leafy vegetables (rich in folate) was found to be protective against stroke in prospective cohort studies (4, 179).

Inadequate intake of fibre is an important predictor of CVD (119). In Australia alone, a diet low in fibre was responsible for 34,206 DALYs and 10% burden due to CVD in 2011 (162). High dietary fibre intakes were linked to lower rates of CVD, mainly through the lowering of plasma cholesterol levels (119). Fibre may also help to protect against CVD risk by decreasing the insulinemic response of carbohydrates as high levels of insulin were found to promote dyslipidemia, hypertension, atherosclerosis and abnormalities in blood clotting factors (186).

The phytoestrogen and isoflavone content found in legumes such as soy beans were also suggested to play a role in reducing CVD risk through their cholesterol lowering, anti-oxidative and anti-inflammatory effects (190, 191). However, it is unclear if the CVD protective effect is specifically due to isoflavones or consumption of legumes/soy foods.

Besides the food components found in fruits and vegetables, obesity is an important risk factor for CVD which has been linked to poor fruit and vegetable intakes and a range of poor lifestyle factors (1). It is possible that the protective effect of fruits and vegetables may be due to a set of lifestyle attributes that prevents unhealthy weight gain. Therefore, studies on the effect of whole diets on the risk of CVD while controlling for lifestyle confounders such as the Mediterranean (192) and DASH (193) Diets may provide a better understanding on the role of fruits and vegetables in lowering CVD risk than studies focusing on specific nutrients alone.

2.1.4.3 Chronic respiratory diseases (CRD)

Chronic respiratory diseases (CRD) refers to chronic diseases of the airways and lungs such as asthma, chronic obstructive pulmonary disease (COPD), lung cancer, sleep apnoea and occupational lung diseases (194). The link between fruit and vegetable intakes and risk of lung cancer has been previously discussed in Section 2.1.4.1.

Currently, there is no known estimate of CRD burden attributable to inadequate fruit and vegetable consumption. Emerging evidence generally shows an inverse association between fruit and vegetable intakes and risk of COPD and asthma (195, 196). In a review on 22 studies (4 cohort, 2 case-control, 16 cross-sectional) by Boeing and colleagues (2012), consumption of fruit was found to be inversely associated with COPD risk with risk reduction ranging from 24% (per increase of 100 grams of fruit/day) to 54% (if consume ≥ 93 grams of vegetable/day and ≥ 131 grams of fruit/day) (197). An inverse association between fruit intake and COPD respiratory symptoms such as sputum production and chronic cough was also observed in cross-sectional and cohort studies (198, 199).

Type of fruit consumed may also be important with evidence of a decrease of COPD risk with greater apple intake (≥ 3 apples/week) (200). Higher consumption of whole fruits such as apples and pears was found to reduce COPD mortality risk by 51% in a European cohort study on 12,763 men aged 40-59 years old (25-year follow up) (201). Consumption of at least 5 apples/week was also found to be associated with better lung function (measured as Forced Expiratory Volume 1, FEV_1) in a prospective cohort study on 2512 UK men aged 45-59 years (5-year follow up) (202).

Compared to fruit intake, only a few studies have reported an association between vegetable intake and COPD risk (200, 203-205). To date, no studies have reported significant associations between vegetable intake and lung function, COPD mortality risk and COPD respiratory symptoms.

The evidence for vegetable intake and COPD risk stems from vegetables as a component of a healthy diet. In 2007, Varraso and colleagues published their findings from a prospective cohort study on 72,043 U.S. women (16-year follow up) and 42,917 U.S. men (12-year follow up) and reported that higher intakes of a 'prudent diet" (high in fruits, vegetables and fish) significantly reduced COPD risks by 25% and 50% for women and men respectively (206, 207). Moreover, a 3-year randomised controlled trial (RCT) by Keranis and colleagues on 120 COPD patients reported significantly improved lung function in the intervention group (diet high in fruits and vegetables) (208). However, this result was contrasted by the findings of a 12-week RCT by Baldrick and colleagues which reported no significant improvement in lung function, oxidative stress and systemic inflammation in the intervention group (n=81) (209). The difference in the RCT findings suggests that a longer duration of intervention is required to produce a therapeutic effect.

The link between fruit and vegetable intake and asthma and wheezing is well studied. A comprehensive 2014 systematic review and meta-analysis by Seyedrezazadeh and colleagues on 12 cohorts, four population-based case-control studies and 26 cross-sectional studies concluded that total fruit and vegetable intake was inversely associated with risk of asthma in both adults and children (RR=0.54, 95% CI= 0.41-0.69). A detailed summary of the key significant findings from this meta-analysis is presented in Table 2.8.

Interestingly, Seyedrezazadeh and colleagues also found that higher maternal consumption of fruits and vegetables during pregnancy had no protective effect towards future asthma development in children (5); a finding supported by the most recent meta-analysis on 31 published studies on the link between dietary patterns and asthma (210). This paper by Lv and colleagues also concluded that the Mediterranean diet (a diet pattern high in plant foods, low or moderate in meat and dairy foods) may be protective against asthma and wheezing in children (210).

The association for risk of wheezing and asthma is generally more obvious for fruit than vegetables, especially when pertaining to apple consumption (5, 197). Apple is a rich source of quercetin, which may explain why apple in particular, provides a protective effect against CRD (211). Quercetin is a flavonoid thought to provide an anti-inflammatory and anti-allergic effect against asthma development and progression (212). Besides quercetin, other flavonoids such as isoflavones found in soy, were also studied for its effect on asthma but current evidence to support flavonoid supplementation for prevention of asthma in humans is inconclusive (195, 213).

Table 2.8 Summary of the key significant findings from the Seyedrezazadeh *et al* 2014 paper (5).

Condition:	Findings*:
Risk of wheezing	Fruit: - Inverse association:- • Total: RR=0.81, 95%CI=0.74-0.88, I^2=83.1% (2 C, 13 CS) • Adults: RR= 0.69, 95%CI= 0.49-0.96, I^2=17.5% (1 C, 1 CS) • Children: RR= 0.81, 95%CI=0.74-0.88, I^2=83.1% (1 C, 13 CS) - 21% risk reduction in cross-sectional studies (13 CS) - RR= 0.64, 95%CI= 0.42-0.98, I^2= 71.9% (apples) (2 CS) - RR=0.68, 95%CI=0.60-0.76, I^2= 35.2% (citrus) (4 CS) Vegetables: - Inverse association:- • Total: RR=0.88, 95%CI=0.79-0.97, I^2=83.7% (1 C, 10 CS) • Children: RR= 0.88, 95%CI=0.79-0.97, I^2=83.7% (1 C, 9 CS) - 14% risk reduction in cross-sectional studies (10 CS) - RR=0.50, 95%CI=0.35-0.70, I^2=40.1% (tomatoes)
Risk of asthma	Fruit: - Inverse association:- • Total: RR=0.84, 95%CI=0.80-0.90, I^2=70.0% (5 C, 5 CC, 14 CS) • Adults: RR=0.77, 95%CI=0.68-0.87. I^2=84.4% (3 C, 2 CC, 4 CS) • Children: RR= 0.90, 95%CI=0.86-0.94, I^2=24.5% (2 C, 2 CC, 8 CS) - 22% risk reduction in cohort studies (5 C) - 16% risk reduction in cross-sectional studies (14 CS) - RR=0.84, 95%CI= 0.78-0.91, I^2=52.8% (apples) (1 C, 2 CC, 4 CS) - RR= 0.86, 95%CI= 0.78-0.96, I^2=60.7% (citrus) (1 C, 1 CC, 3 CS) Vegetables: - Inverse association • Total: RR=0.88, 95%CI=0.82-0.95, I^2=83.8% (2 C, 3 CC, 13 CS) • Adults: RR= 0.84, 95%CI= 0.74-0.96, I^2=92.7% (1 CC, 5 CS) - 13% risk reduction in cross-sectional studies (13 CS)

*RR- Relative Risk, CI- Confidence Interval, I^2- heterogeneity among studies with I^2 =25% (low), 50% (moderate), 75% (high) (4); C- Cohort study, CC- Case-control study, CS- Cross-sectional study.

The lung exists in an oxygen-rich environment where a tight control of redox balance is required to prevent oxidative stress that may lead to inflammation and infection of the airway and lung cells (214). Though theoretically sound, the benefit of the supplementation of dietary antioxidants such as vitamins C and E over the consumption of whole foods such as fruits and vegetables in the prevention of CRD is not well established (195). Besides vitamins C and E, vitamin D was also studied in its protective role against the susceptibility and severity of infections leading to lung disease but evidence in this area is limited by the lack of human supplementation studies and the difficulties in isolating the indirect effect of vitamin D from sun exposure from the direct effect of vitamin D supplementation on CRD progression (195).

Some minerals such as sodium, magnesium and selenium have been found to be protective of respiratory conditions though current evidence is sparse and inconclusive (195). Polyunsaturated fatty acids (PUFAs) found in nuts, seeds, soy and leafy vegetables were also postulated to provide protection against CRD through its role in enzymatic pathways and inhibition of the production of inflammatory mediators (214). However, evidence for the role of PUFAs in CRD is limited to studies using omega-3 oil supplementation from marine sources. Even so, a Cochrane review of evidence concluded that there is currently insufficient evidence to recommend the supplementation of omega-3 PUFAs in asthma (215).

Overall, there is adequate evidence from cross-sectional and case-control studies to support the inverse association between fruit and vegetable intakes and CRD. However, due to the lack of prospective cohort studies and RCTs, the current evidence for the association between intake of fruit and vegetable and CRD risk is considered ‘probable’ (197) while the inconsistency and scarcity of findings from supplementation studies limit understanding of the exact mechanism of action on how high intakes of fruits and vegetables protect against CRD.

2.1.4.4 Diabetes mellitus

Diabetes mellitus or Type 2 diabetes (T2DM) is a progressive condition in which the body becomes resistant to the effects of insulin and gradually loses the capacity to produce enough insulin in the pancreas (216). Diabetes mellitus is genetically linked and is strongly associated to modifiable lifestyle factors (216). Currently, the global prevalence of diabetes among adults 18 years and older has risen from 4.7% in 1980 to 8.5% in 2014 with an estimated 1.5 million deaths directly caused by diabetes in 2012 (217). Current estimates in Australia showed around 5.4% Australian adults aged 18 years and over with diabetes (218). High blood plasma glucose was directly responsible for 2.7% of DALYs in Australia (162). Importantly, the prevalence of type 2 diabetes has significantly increased in the paediatric population in the last 30 years (219, 220), making what was previously termed as adult-onset diabetes no longer unique to adults.

Currently, there is no known estimate of diabetes burden attributable to inadequate fruit and vegetable consumption. Evidence to date suggested that consumption of fruit and vegetables does not appear to be directly associated with the risk of type 2 diabetes (119). Table 2.9 summarises the five meta-analyses of prospective cohort studies that provided evidence towards this conclusion.

Table 2.9 Summary of findings from 5 meta-analyses of prospective cohort studies for evidence on the association between fruit (F) and vegetable (V) consumption and risk of Type 2 Diabetes mellitus (T2DM).

Study:	Characteristics:	Findings*:
Hamer M. & Chida Y. 2007 (221)	5 studies n=167,128 4858 T2DM cases 13 mean follow-up years	Consumption of ≥ 5 serves/day of FV not associated with risk reduction of T2DM (RR= 0.96, 95% CI= 0.79-1.17, p>0.05)
Carter P. *et al* 2010 (6)	6 studies n=223, 512 9581 T2DM cases Median 13.4 follow-up years	Highest versus lowest consumption: F: HR= 0.93, 95%CI= 0.83-1.01, p>0.05 V: HR= 0.91, 95% CI= 0.76-1.09, p>0.05) FV: HR= 1.0, 95%CI= 0.92-1.09, p>0.05 Higher consumption of green leafy vegetables significantly reduced risk of T2DM by 14% (HR= 0.86, 95%CI= 0.77-0.97, p<0.05)
Li M. *et al* 2014 (222)	10 studies n=434,342 24,013 T2DM cases Median 11 follow-up years	Per 1 serving/day increase: F: RR= 0.93, 95%CI= 0.88-0.99, p>0.05 V: RR= 0.90, 95%CI= 0.80-1.01, p<0.01 Increase of 0.2 serving/day of green leafy vegetable: 13% risk T2DM risk reduction (RR= 0.87, 95% CI= 0.81-0.93, p>0.05)
Wu Y. *et al* 2015 (223)	9 studies n=472,159 33,545 T2DM cases 4.6 to 20 follow-up years	Per 1 serving/day increase: F: RR=0.99, 95%CI= 0.97-1.0, p=0.05 V: RR= 0.98, 95%CI= 0.95-1.01, p>0.05 FV: RR= 0.99, 95%CI= 0.98-1.0, P>0.05
Wang P. *et al* 2016 (7)	15 studies n= 518,243 35,005 T2DM cases 4 to 24 follow-up years	Highest versus lowest intake: F: RR= 0.91, 95%CI= 0.87-0.96, p<0.05 Blueberries: RR= 0.75 (95%CI= 0.81-0.93, p<0.05 Green leafy vegetables: RR= 0.87, 95%CI= 0.57-0.90, p<0.05 Yellow vegetables: RR= 0.72, 95% CI= 0.57-0.90, p<0.05 Cruciferous vegetables: RR= 0.93, 95%CI= 0.88-0.99, p<0.05

*RR- Relative Risk, HR- Hazard Ratio, CI- Confidence Interval.

Despite the general non-association between total fruit and vegetable consumption and risk of T2DM, consumption of certain types of fruit and vegetables seem to confer some protection against T2DM (6, 7, 222). Results from 3 meta-analyses consistently showed a T2DM risk reduction of around 13% with greater consumption of green leafy vegetables (6, 7, 222). Moreover, a most recent meta-analysis by Wang and colleagues provided evidence of T2DM risk reduction of 25%, 28% and

7% with the consumption of blueberries, yellow and cruciferous vegetables respectively (7).

A few theories were proposed to explain why certain fruit and vegetables may be protective against T2DM. Fruit and vegetables are good sources of fibre which has been shown to reduce postprandial glucose responses through their low energy-density and glycaemic load (224). However, evidence from the meta-analyses of prospective cohort studies to date do not support this theory (224). Green and yellow vegetables are also rich sources of phytochemicals such as carotenoids that act as antioxidants (225). Antioxidants were shown in some supplementation studies to be protective against T2DM (226, 227). Furthermore, magnesium, which can be found in green leafy vegetables, was shown to be inversely associated with T2DM risk (228-230). Fruit and vegetables may also lower the risk of T2DM indirectly through their role in weight gain, which is an established risk factor for T2DM (216, 231). Further evidence linking fruit and vegetable and weight gain is presented the Section 1.2.4.5 below.

2.1.4.5 Overweight and obesity

Overweight and obesity are defined as excessive fat accumulation that may impair health (232). In adults, WHO defines overweight and obesity as a Body Mass Index (BMI) $\geq$ 25 kg/m^2 and $\geq$ 30 kg/m^2 respectively; in children 5 years and under, overweight and obesity are defined as weight-for-height > 2 standard deviations (s.d) and > 3 s.d above the WHO Child Growth Standards median respectively; in children between the ages 5 to 19 years, overweight and obesity are defined as BMI-for-age >

1 s.d and > 2 s.d. above the WHO Growth Reference median respectively (232). In 2014, an estimated 52% of the world adults (232) and around 41 million children aged 5 years and under were overweight or obese (233). In Australia, 63.4% adults and 27.4% children were overweight or obese in 2014-2015 (234). Currently, there is no known estimates for the burden of obesity specifically attributed to inadequate fruit and vegetable consumption. Fruit and vegetables are low in energy-density and high in fibre which promote satiety and were theorised to help prevent obesity (155, 156). However, reviews of evidence to date reported inconsistent findings and do not seem to support an association between fruit and vegetable intake and weight (156, 235, 236).

In one of the earliest review on the association between fruit and vegetable consumption and weight, Tohill and colleagues examined 16 (15 cross-sectional, 1 prospective, n=366,995) and 2 studies (1 prospective, 1 cross-sectional, n=17,982) in adults and children respectively (236). They found that only 8 out of the 16 studies in adults and 1 study in children reported a significant association between fruit and vegetable consumption and weight (236). In studies reporting significant associations, the findings differ between gender and between fruit and vegetable consumption (236). The same conclusion was reached by a review conducted by Rolls and colleagues in the same year for intervention studies (n=4 studies) where subjects were advised to increase fruit and vegetable intake to help weight management, though the 2 randomised controlled trials (RCTs) reviewed in their paper reported significant weight loss (-17.2 and -10.8 respectively) after 3 weeks of trial where fruit and vegetables were provided to the study subjects (155).

Later reviews continue to produce inconsistent results. In 2009, Newby reviewed 14 studies (3 prospective cohorts, 10 cross-sectional, 1 case-control) and concluded that prospective studies consistently did not show an association for fruit and vegetable intake with weight while findings from cross-sectional studies were mixed (235). Newby also reported that in children aged 2 to 14 years old, fruit and vegetable consumption was not associated with changes in weight and BMI (235). The same conclusion for children was reached in a 2011 review by Ledoux, Hingle and Baranowski (156). In their paper, they examined 11 prospective studies and found a weak association between increased fruit and vegetable intake and slower weight gain in adults while higher fruit and vegetable intakes were found to be associated with decreased adiposity in experimental studies (156). This conclusion, however, was not supported by two reviews on RCTs published in 2014 (237, 238). The findings from these two reviews are limited by the short duration of intervention (between 4 to 52 weeks) and a modest dose of fruit and vegetable (around 1.5 serves/day) (237, 238).

A more recent and larger review and meta-analysis on 17 RCTs published up to July 2015 with follow-up duration between 9 months to 24 years reported some positive outcomes (n=563,277) (239). The authors reported an inverse association between fruit intake and change in weight (per 100 g increase, β= -13.68g/year, 95%CI= -22.97 to -4.40) and waist circumference (per 100 g increase, β= -0.04 cm/year, 95% CI= -0.05 to -0.02) but no significant association was found for combined fruit and vegetable intake with weight and waist circumference (239). When comparing the highest to lowest intakes, the highest intake of combined fruit and vegetable decreased adiposity risk by 9% (OR=0.91, 95% CI= 0.8-0.99) while the highest intakes of fruit and vegetables decreased adiposity risk by 17% each (OR=0.83, 95% CI= 0.71-0.99) (239). Despite the inverse associations found, the weight and waist circumference changes (per 100g increase of fruit) were small, especially when considering that the difference between the highest fruit intake to the lowest fruit intake was only 300g (239). The authors also highlighted that the quality of studies included in their review was poor and that there was high heterogeneity between the studies (239).

Clearly, strong and conclusive statements regarding fruit and vegetable intake and weight cannot be made as evidence in this area of study is still at its infancy. However, studies on dietary patterns favouring high intakes of fruit and vegetables reported positive outcomes for weight loss (240-242); indicating that there may be some benefit in increasing fruit and vegetable consumption in the context of a whole diet towards weight loss.

As briefly discussed in Sections 2.1.4.1, 2.1.4.2 and 2.1.4.4, obesity is a well-established risk factor for cardiovascular diseases, diabetes mellitus and some cancers (243). Considering the lack of evidence for a prospective link (235, 237, 238), poor fruit and vegetable intake may be a proxy for poor lifestyle choices and low socio-economic status (244-246), and may not be directly or independently responsible for adiposity. Future longitudinal studies should consider examining multi-directional models to unravel the complex interactions between fruit and vegetable consumption, adiposity and risk of chronic diseases.

2.1.4.6 Future health benefits

The strongest evidence linking fruit and vegetable consumption in childhood to risk of chronic diseases in later life came from the Boyd Orr cohort, which consisted of over 4,000 U.K. children aged between 0 to 19 years who completed a one-week diet inventory between year 1937 to 1939 (164). Using data from the Boyd Orr cohort, Ness and colleagues published a paper in 2005 reporting their findings on the association between childhood (mean age = 7.5 years) fruit and vegetable intake and risk of cardiovascular disease and stroke (164). Data on all-cause mortality and deaths attributable to cardiovascular diseases and stroke were obtained for 4028 participants of the study from death certificates and National Health Service Central register up to August 2000 (164). The authors found an inverse association between childhood intake of vegetables with risk of stroke; the odds ratio for highest versus lowest quintile of intake was 0.40 (95% CI = 0.19 to 0.83, p for trend <0.01) (164).

In a separate analysis on the same cohort with 60-year follow-up, an inverse association between fruit intake and risk of cancer was also found (247). The odds ratio for highest versus lowest quintile of intake was 0.62 (95%CI = 0.43 to 0.90, p for trend <0.02) (247). Interestingly, at a 65-year follow-up involving analysis of adult blood samples for insulin-like growth factors (IGF-I), Martin and colleagues reported that IGF-I levels were positively associated with vegetable-rich diets (r = 0.90, p<0.01) (248). IGF-I plays a vital role in somatic growth regulation in early life and is positively associated with some cancers and inversely associated with diabetes and coronary heart disease (248). Therefore, the findings from Martin and colleagues' paper may have provided evidence of a potential mechanism explaining the prospective link between fruit and vegetable intakes and the risk of chronic diseases. In summary, the findings from these studies suggest that childhood fruit and vegetable intake may have a prospective and protective effect against mortality attributable to chronic diseases such as cancer and stroke.

2.1.5 The importance of fruit and vegetable variety

In recent years, the recommendations for fruit and vegetable consumption around the world have evolved beyond recommendations for total consumption to include variety as discussed in Section 2.1.2. For example, the U.S. recommendations provide detailed weekly serve recommendations for vegetables from 5 different sub-groups based on children's age group and gender (117). Canadians are encouraged to "*eat at least one dark green and one orange vegetable each day*" (113) while Australians are recommended to "*Enjoy a wide variety of nutritious foods from these five groups every day:- plenty of vegetables, including different types and colours, and legumes/beans*" (10). Eating at least one fruit and one vegetable from different sub-groups is also an easy and convenient way to meet fruit and vegetable recommendations (2, 113) and contributes to daily nutrient requirements (119). Variety adds to the enjoyment of food and may be protective against a range of diseases (119). The role of fruit and vegetable variety in total consumption and the risk of chronic diseases is discussed below.

2.1.5.1 Variety, diet quality and risk of chronic diseases

Consuming a variety of different coloured fruits and vegetables is important because different colours in fruits and vegetables correspond to different combinations of nutrients and phytochemicals conferring an array of health benefits (2). Table 2.10 summarises the key nutrients and non-nutrients found in fruits and vegetables, their sources and potential health benefits.

Table 2.10 Key nutrients and non-nutrients found in fruits and vegetables, their sources and potential health benefits*.

Nutrient:	Source:	Health benefits:
Vitamins C & E, β-carotene, polyphenols, flavonoids & carotenoids	Pumpkin, sweet potato, carrots, cantaloupe, apricots, spinach, kale, broccoli, citrus fruits, berries, guava, blackcurrants, apples.	Immune system, vision, skin health, bone health, cancer protection, heart health, respiratory health.
Lycopene & Resveratrol	Tomatoes, grapefruit, capsicums, grapes, peanuts.	Cancer protection, heart health, lung health, anti-inflammatory.
Isoflavones	Soybeans.	Menopause, cancer protection, bone health, joint inflammation, cholesterol lowering.
Lutein	Green leafy vegetables.	Eye health, cancer protection, heart health.
Anthocyanidins	Berries, plums, onions, radishes, red potatoes.	Vascular health.
Allium compounds	Onions, leeks, chives.	Cancer protection.
Folic acid	Green leafy vegetables, avocado, oranges.	Cancer protection, heart health.
Soluble and insoluble fibre	All fruits and vegetables	Gastro-intestinal health, cancer protection, heart health, weight management, diabetes prevention and management.

*information sourced from various sources, but primarily from "Position Statement: Fruit, vegetables and cancer prevention" from Cancer Council Australia (170) and "What are phytonutrients?" from Fruits & Veggies: More Matters, U.S. (249).

Variety in intake also dilutes toxins such as aflatoxin, pesticides, nitrates, goitrogens, saponins and enzyme inhibitors that can be found in fruits and vegetables (250). Evidence presented in Section 2.1.3.2 shows that the variety of fruits and vegetables eaten by children is limited. Poor variety was also observed in adults' diets. In Australia, the report on the modelling system that informed the development of the current guidelines showed that Australians would need to increase their green vegetable intakes by 30%; in red and orange-coloured vegetables by 140% and other vegetables (other than potatoes) by 90% in order to achieve optimal variety in vegetables consumed (118).

A review on dietary quality showed that dietary patterns characterised by diverse fruit and vegetable consumption were generally linked to positive health outcomes (251). For instance, a study on the link between the Alternate Healthy Eating Index (AHEI) and colorectal cancer (n=492,382) found a significant decrease in the risk of colorectal cancer in men (252) while a study by Fung and colleagues on 121,700 subjects from the Nurses' Health Study found that the AHEI was inversely associated with several biomarkers for CVD risk (253). The AHEI included dark green, orange vegetables and legumes in its scoring standards and is one of the few diet quality score that considered variety within the vegetable food group to reflect the shift in the U.S. guideline from '5-A-DAY' to "Fruits and Veggies-More Matters" (111).

Despite the potential health benefits from including diverse fruits and vegetables in whole diets, evidence linking fruit and vegetable variety and chronic diseases is inconclusive. Table 2.11 below summarises the findings from recent cohort studies examining the link between the variety in fruit and vegetable consumption and the risk of chronic diseases.

Table 2.11 Summary of findings from major studies on the link between variety of fruit (f) and vegetable (v) intake with risk of chronic diseases.

Study:	Sample:	Design:	Findings*:
Coronary heart disease (CHD) & stroke			
Bhupathiraju S.N. & Tucker K.L. 2011 (254)	1159 adults (45 to 75 years); Puerto Rican Health Study (255). 251 subjects with CHD, 908 healthy subjects.	Cross-sectional. Intake in past 12 months: Semi-quantitative Food Frequency Questionnaire (FFQ). Variety: total number of unique f & v consumed ≥ 1/month in the past 12 months. Potatoes, legumes and fruit juices excluded. 10-year coronary heart disease risk: Framingham Risk Score (FRS) (256) in participants free of CHD. Fasting serum C-reactive protein (CRP) measured.	F & v variety inversely associated with FRS (β= -0.06, $p<0.05$) and serum CRP (β= -0.004, $p<0.05$). Highest versus lowest tertile for f & v variety: Adjusted odds for high CRP = 0.68 (95%CI= 0.49-0.94).
Griep L.M.O. *et al* 2012 (257)	20,069 adults (20 to 65 years); Monitoring Project on Risk Factors and Chronic Diseases in the Netherlands (MORGEN) Study.	Prospective population-based cohort. 10-year follow-up. Previous year intake: semi-quantitative FFQ containing 178 food items, including 9 fruit items and 13 vegetable items. Variety: total number of unique f & v consumes ≥ once fortnightly in the past 12 months.	F & v variety correlated with total f & v intake (r=0.81, $p<0.001$), f intake (r=0.72, $p<0.001$) and v intake (r=0.53, $p<0.001$). F & v variety associated with nutrient intakes, especially vitamin C (r=0.70, $p<0.05$). F & v variety not associated with CHD and stroke risks.

Table 2.11 continued.

Study:	Sample:	Design:	Findings*:
Coronary heart disease (CHD) & stroke			
Bhupathiraju S.N. *et al* 2013 (258)	71,141 women; Nurses' Health Study (180); 42,135 men; Health Professional Follow-Up Study (181). 2582 CHD case in women. 3607 CHD case in men.	Prospective cohort. Intake:126-item semi-quantitative FFQ (every 4 years). Variety: number of unique fruit and vegetables consumed ≥ once/week. Potatoes, legumes and fruit juices excluded.	F & v variety not associated with CHD risk.
Cancers			
Buchner F.L. *et al* 2010 (259)	452,187 adults; European Prospective Investigation into Cancer and Nutrition (EPIC) study. 1,613 diagnosed with lung cancer.	Prospective cohort. 8.7-year follow-up. Previous year intake: validated country-specific FFQ. Variety: number of f & v consumed ≥once fortnightly. Legumes and potatoes excluded.	Higher v variety decreased risk of lung cancer (HR =0.77, 95%CI = 0.64-0.94). Higher f & v variety decreased risk of lung cancer (HR = 0.88, %95 CI = 0.82-0.95). Significance only observed in current smokers.
Buchner F.L. *et al* 2011 (260)	452,185 adults; EPIC study. 874 diagnosed with bladder cancer.	Prospective cohort. 8.7-year follow-up. Previous year intake: validated country-specific FFQ. Variety: number of f & v consumed ≥ once fortnightly.	F & v variety not associated with risk of bladder cancer.

Table 2.11 continued.

Study:	Sample:	Design:	Findings*:
Cancers			
Juernink S.M. *et al* 2012 (261)	452,269 adults; EPIC study. 475 diagnosed with gastro-oesophageal cancer.	Prospective cohort. 8.4-year follow-up. Intake: country-specific methods (eg: measured hot meals, dietary questionnaires (DQ), diet records, semi-quantitative FFQ and non-quantitative FFQ). Some interviewer administered, some self-reported. 33 types of v and 16 types of f included in calculation for variety. Potatoes and fruit juices excluded. Variety: number of f & v consumed ≥once fortnightly.	F & v variety significantly decreased risk of oesophageal squamous cell carcinoma (HR = 0.88, 95% CI = 0.79-0.97). F variety inversely associated with risk of oesophageal squamous cell carcinoma (p-trend<0.005). Significance only observed with increase of 2 types of f & v.
Leenders M. *et al* 2015 (262)	521,448 adults; EPIC study. 3,370 diagnosed with colon cancer.	Prospective cohort. 13-year follow up. Previous year intake: centre-specific dietary questionnaires; 7-day records (UK and Sweden). 5 sub-types of f and 8 sub-types of v considered in the variety score. Variety: number of fruit and vegetable sub-types consumed ≥ once fortnightly.	F & v variety not associated with risk of colorectal cancer.

Table 2.11 continued.

Study:	Sample:	Design:	Findings*:
Diabetes mellitus (DM)			
Cooper A.J. *et al* 2012 (263)	3,704 adults; EPIC study (Norfolk arm of the study). 653 diagnosed with DM.	Prospective, case-cohort. 11-year follow up. Intake: self-completed 7-day food diary validated against weighed food records, 24-h urine collections and blood biomarkers. Composite dishes containing f & v disaggregated. Potatoes and juices not included. Variety: number of different f & v consumed ≥once/week.	F & v variety correlated significantly with total f & v (r=0.60, p<0.05). Additional 2 f & v variety: risk of DM decreased by 8% (HR= 0.92, 95%CI= 0.87-0.97). DM risk with highest versus lowest tertile of intake: F variety: HR= 0.67, 95% CI = 0.54-0.84, p<0.001. V variety: HR = 0.68, 95% CI = 0.56-0.84, p<0.001.
Cognitive health			
Ye X. *et al* 2013 (264)	1412 Puerto Rican adults (45 to 75 years); Boston Puerto Rican Health Study (255).	Cross-sectional. Global cognitive function: Mini Mental State Examination (MME). Previous year intake: validated semi-quantitative FFQ with 223 items; interviewer-administered. Beans and starchy v (eg: potatoes, cassava) not included. Variety: sum of different f & v consumed ≥once/month. Possible f variety score = 0 to 27; possible v variety score = 0 to 26.	F & v variety associated with high MMSE score (p trend<0.05); remained significant after adjusting for total f & v. F variety associated with better cognitive domains – executive function, memory and attention (p trend<0.05 for all).

*HR – Hazard Ratio; CI - Confidence Interval; RR – Relative Risk.

Evidence from prospective studies showed no association between variety of fruit and vegetable with risk of CHD and stroke. However, eating a variety of fruit and vegetables seemed to be protective against future risk of CHD in healthy adults; as demonstrated by Bhupathiraju and colleagues using data from the Puerto Rican Health Study (254).

The findings for cancer risk varied and were dependent on the type of cancer in question. Most of what we know about fruit and vegetable variety and cancer risk comes from the EPIC study. Fruit and vegetable variety decreased the risk of lung (259) and oesophageal (261) cancers but not bladder (260) and colorectal cancers (262). In particular, vegetable variety seemed to be important to protect against lung cancer (259) while fruit variety was inversely associated with oesophageal cancer (261).

Other studies have examined the link between fruit and vegetable variety and diabetes mellitus (263) and cognitive function (264). Generally, they found favourable outcomes but further investigation is required to understand the mechanisms of how fruit and vegetable variety protects against diabetes and poor cognitive health.

2.1.5.2 The role of variety in increasing child fruit and vegetable consumption

Variety is an important factor in explaining the acquisition of new food acceptance at the weaning age (35). Gerrish and Mennella conducted one of the earliest experiments to gauge if exposure to a variety of flavours at weaning led to greater acceptance of carrots (the target vegetable) in forty-eight formula-fed infants who had just started on rice cereal as first food (265). Infants were randomly assigned to 3 groups:- carrots only, potatoes only and a variety of vegetables that did not include carrots, and carrot intakes were evaluated after a 9-day exposure period (265). The researchers reported that infants in the carrot only and variety groups consumed around 1.8 and 1.7 times more carrots respectively after the exposure period while no significant change in carrot intake was observed for infants in the potatoes only group; indicating that not only exposure to a variety of vegetables led to greater acceptance of a new vegetable (carrot) but infants were also able to discriminate flavours between two different vegetables (potatoes versus carrots) (265).

In a later study on 74 infants aged 4 to 9 months, Mennella and colleagues further demonstrated the importance of fruit and vegetable variety when infants exposed to pears (target fruit) and a variety of fruits between meals consumed significantly more pears while consumption of green beans was unaffected (266). In a second study, they reported that infants who consumed a variety of vegetable between and within meals ate more green beans (target vegetable), carrots and spinach (266). In both studies, inclusion of variety within food groups increased consumption of the target fruit or vegetable.

A more recent study by Coulthard and colleagues added weight to earlier studies on the role of variety exposure when infants in their study ate more pea puree (target vegetable) ($p<0.05$) when exposed to a variety of vegetable purees (n= 16, mean pea puree intake = 45.6g) versus infants offered pea puree only (n= 15, mean pea puree intake= 22.6g) at 6 months of age (267). Maier and colleagues expanded on this area of research by examining the effect of timing to variety and concluded that offering a variety of foods within the same day and alternating the variety across three days resulted in higher acceptance of novel foods compared to offering the new foods individually for three days (1 new food per day) (268).

Studies on older children have also shown that offering a variety of fruit and vegetables to children increased consumption of fruits and vegetables (269-272). In a U.S. study on 61 children aged 3 to 5 years attending a childcare facility, offering a variety of fruits and vegetables as snacks increased the likelihood of selection ($p<0.001$) and increased children's consumption of both fruit ($p<0.001$) and vegetables ($p<0.001$) (269). However, the authors also reported a positive correlation between the number of vegetables liked with the variety of vegetables eaten ($p<0.01$) (269), indicating the role of food preference in determining intake. Furthermore, offering variety increased the likelihood of fruit and vegetables being selected but not the likelihood of them being eaten after selection (269). This suggests that although offering variety promoted autonomy and greater fruit and vegetable consumption, children still consume fruit and vegetables that they already liked (269, 273).

A more recent in-home study on the influence of choice on child vegetable intake by researchers in the Netherlands (n=70, mean age= 3.7 years) (271) supported the findings of the above American study. Children consumed more vegetables (mean intake= 57.7g) when they were given the choice of two types of vegetables at dinner than when they were only given one type of vegetable (mean intake= 48.5g) (271). Baseline vegetable liking predicted higher consumption of vegetables ($p<0.001$), again highlighting the role of preference in determining intake in older children (271). However, the freedom to choose and consume the fruit and vegetables preferred is also dependent on the availability of variety. For example, a plate waste study conducted in the U.S. on 294 first to fifth graders attending schools offering salad bars reported that the presence of the salad bars was not associated with greater fruit and vegetable consumption ($p<0.05$) (270). However, the variety of fruits and vegetables offered at the salad bars was positively related to greater fruit and vegetable consumption ($p<0.05$), even after adjusting for child's grade and gender (270). The authors postulated that offering greater variety made it more likely that children would find and consume their preferred fruits and vegetables (270).

An American study based on the analysis of observational data from 22 elementary schools supports the findings from the above studies (272). The authors reported an increase of 12% in the proportion of children eating at least 1 serve of fruit or vegetable for each additional fruit or vegetable item offered (increase in variety) and a relationship between the number of fruit and vegetable items on offer with the number of servings taken ($p<0.01$) (272).

Importantly, there is evidence to show that food variety acquired in early childhood predicts food variety in later life (26, 274). A 2002 study by Skinner and colleagues reported that fruit variety in the first two years of life predicted fruit variety at 8 years of age (R^2=0.25) (26). Later studies on larger cohorts further support the tracking of variety and food preferences (274, 275) with one study reporting tracking to early adulthood (274).

Clearly, offering a variety of fruits and vegetables increases the acceptance of these foods at weaning (35, 65, 265-268, 275). Variety allows infants to build their food repertoire (35, 65) and develop food preferences that track into adulthood (274). In older children with established food preferences, providing a variety of fruit and vegetables enables children to choose and consume the fruits and vegetables they are familiar with (65, 269-271).

2.2 DETERMINANTS OF FRUIT AND VEGETABLE CONSUMPTION

This section presents the literature review on the determinants of child fruit and vegetable consumption, with focus on maternal feeding self-efficacy and the socio-demographic and behavioural determinants examined in this thesis.

2.2.1 Maternal feeding self-efficacy

2.2.1.1 Definition and history

The terms "self-esteem" or "confidence" and "self-efficacy" are used interchangeably in the literature but are essentially two different concepts that are highly correlated (276). Self-esteem or confidence is concerned with one's overall self-worth (61), but self-efficacy or self-competency is defined as a self-judgement of how well one can perform at specific tasks (60). Therefore, maternal feeding self-efficacy is defined as the mother's self-evaluation on her performance at child feeding tasks.

The concept of self-efficacy stemmed from the work in the area of social learning theory by Miller and Dollard in 1941 (277). The social learning theory (SLT) is based on the idea that people learn by watching what others do and that cognitive processes are central to understanding behaviour and decision-making (277). In a paper published in 1977, an American psychologist, Albert Bandura, proposed a theoretical framework that focused on 'self-efficacy' as a predictor of behavioural change (55); expanding the SLT to what is now known as the Social Cognitive Theory (SCT) (44).

According to Bandura, self-efficacy exerts its influence on behaviour change through four processes:- cognitive, motivation, affective and selection (278). Bandura argued that much of human behaviour is "*purposive and is regulated by fore-thought embodying cognized goals*" and that the stronger the perceived self-efficacy, the higher the goal setting and the firmer the commitment to the goal (278). He posited that the ability to self-influence through personal challenge and self-evaluation of reaction towards attainment of goals form the major cognitive mechanism of motivation (278). Self-efficacy can also affect how much stress and depression one experiences in challenging situations and explains why people select activities that complement best with their pre-existing cognitive skills (278). Using an example from the area of early feeding, Figure 2.1 summarises the self-efficacy framework proposed by Bandura that was adapted into the breastfeeding self-efficacy framework developed by Cindy-Lee Dennis in 1999 to explain the relationship between self-efficacy, its antecedents, consequences and behaviour outcomes (279).

Figure 2.1 Bandura's concept of self-efficacy in the Breastfeeding Self-Efficacy framework has been removed due to copyright restrictions.
Modified from Dennis C. 1999 (279).

Since its introduction by Bandura, self-efficacy has been incorporated into a number of other models explaining health behaviours such as the Health Belief Model (45), the Theory of Reasoned Action (280), the Theory of Planned Behaviour (46), the Theory of Protection Motivation (281) and the Health Action Process Approach (HAPA) (282). Collectively these models are known as cognitive models and have shown success in predicting fruit and vegetable consumption in adults and children (283-287).

2.2.1.2 The role of maternal feeding self-efficacy in early childhood

In children's first year of life, studies on maternal feeding self-efficacy have mainly focused on the relationship between breastfeeding self-efficacy and breastfeeding initiation (62, 288), exclusivity (62, 289-292) and duration (62, 288, 291, 293, 294). There is consistent evidence from cross-sectional and prospective cohort studies showing a positive association between breastfeeding self-efficacy and longer breastfeeding duration (288, 292, 294). For example, in the most recent study published in 2016, Ip and colleagues conducted a prospective cohort study on 562 mothers recruited within 72-hours postpartum from a teaching hospital in Guangzhou, China and reported that although all mothers initiated breastfeeding while in hospital, the proportion of mothers who breastfed exclusively was 14.8%, 2.0% and 0.2% at 1, 4 and 6 months respectively and that higher breastfeeding self-efficacy scores at recruitment were significantly associated with a lower hazard of discontinuation of exclusive breastfeeding before 6 months postpartum (HR= 0.88, $p<0.001$) (289).

To date, evidence from randomised controlled trials support enhancement of maternal breastfeeding self-efficacy as a strategy to promote breastfeeding initiation and maintenance through education, family, peer and professional support (62, 290, 291, 295). Low self-efficacy was also found to be associated with higher maternal perception of insufficient breastmilk (296, 297); one of the most common reasons given by mothers for early discontinuation of breastfeeding (289, 292). In a review on randomised controlled trials, systematic reviews and cohort studies published between year 2000 to 2009, Meedya, Fahy and Kable concluded that the three main factors that influenced women's breastfeeding decisions were breastfeeding intention, self-efficacy and social support (298). Of these three factors, breastfeeding intention and self-efficacy are intrinsic factors that may be bi-directional in nature; the higher the self-efficacy, the higher the intention to breastfeed longer (goal-setting) and the achievement of breastfeeding intention further enhances mother's sense of self-efficacy (298). The findings from this review support the outcomes from an earlier study by Cindy-Lee Dennis on 522 Canadian mothers where breastfeeding progress (r=0.55, $p<0.001$), feeding infant as planned (r= 0.43, p<0.001) and satisfaction with infant feeding method (*r*= 0.37, p<0.001) were found to be the three strongest predictors of breastfeeding self-efficacy at 1-week postpartum (299).

In contrast to breastfeeding, there is limited research examining the link between maternal feeding self-efficacy and the dietary outcomes of young children. Studies on children's diets that included measurement of self-efficacy were primarily concerned with self-efficacy to explain the dietary and weight outcomes of interventions. For example, an evaluation on 1104 school-aged children and their families from the Expanded Food and Nutrition Education Program (300) in the U.S reported significant increases post-intervention in parenting self-efficacy in modelling fruit and vegetable consumption, making fruit and vegetables available and in planning and encouraging fruit and vegetable consumption in children (p<0.05 for all) (49).

Despite the theoretical rationale for the link between maternal feeding self-efficacy and children's diet (301), there are only 5 studies published to date that provide quantitative evidence for this relationship. Of these, only 2 studies examined the association between maternal feeding self-efficacy and fruit and vegetable intakes in children aged under 2 years:- one of which was the published findings of this thesis at Time 1 (19) and the other a cross-sectional Australian study conducted by Campbell and colleagues on sixty 1-year-olds and eighty 5-year-olds recruited from Maternal and Child Health Centres and kindergartens in Victoria (63). In the study by Campbell and colleagues, maternal self-efficacy to promote healthy eating was found to be positively associated with vegetable intake in 1-year-olds (*r*= 0.31, p<0.05) and fruit and vegetable intakes in 5-year-olds (*r*=0.42 for fruit and 0.34 for vegetable, p<0.005) (63).

The other three studies examined the role of maternal self-efficacy with fruit and vegetable outcomes in school-aged children. In year 2000, Kratt, Reynolds and Shewchuk reported the findings of their study on parental self-efficacy concerning consumption and serving of fruit, juice and vegetables, and the fruit and vegetable intakes of their children (n=1,196) (302). The children were participants in the High 5 Alabama project in the U.S and were fourth graders at the time of the study. The children were divided into two groups based on their self-report on home fruit and vegetable availability. Kratt and colleagues found that in the group that reported low to medium level fruit and vegetable availability, parental self-efficacy influenced parental fruit and vegetable intakes (*r*= 0.22, p<0.05) which in turn predicted child fruit and vegetable intakes (*r*= 0.10, p<0.05) (302). However, the indirect effect was very small and insignificant (*r*= 0.02, p>0.05) (302). In the low availability group, parental self-efficacy directly predicted parent fruit and vegetable intakes (*r*= 0.32, p<0.05) but not child's intake (302). The authors concluded that availability of fruit and vegetables moderated child fruit and vegetable consumption through its effect on parental self-efficacy (302).

In the same year, Cullen and colleagues published the findings from their cross-sectional study on 109 fourth and sixth graders in the U.S (303). They measured parental self-efficacy in modelling fruit and vegetable consumption, planning consumption and making fruit and vegetables available in the home and found that planning self-efficacy was positively correlated with children's fruit consumption (r=

0.23, p<0.05) and total fruit, juice and vegetable availability (r= 0.33, p<0.001) (303).

In an Australian study, West and Sanders (2009) developed a questionnaire to measure child behaviour issues related to eating, activity and overweight (Problem Scale) and included items measuring parent confidence in managing each of the problem behaviours (self-efficacy) (Confidence Scale) (304). The questionnaire, now known as the Lifestyle Behaviour Checklist (LBC), was psychometrically tested on 182 families with and without overweight/obese child aged 4 to 11 years old (304). The LBC accurately classified 91.1% of the study participants and had high internal consistencies for the Problem (α= 0.97) and Confidence Scales (α= 0.92) (304). The authors also noted that parents with overweight/obese children reported lower scores (mean score = 171.8, SD = 41.3) in the Confidence Scale than parents with healthy weight children (mean score = 237.8, SD= 25.6) (304).

Table 2.12 below provides a detailed summary of the 5 studies presented above. The study by Kratt, Reynolds and Shewchuk (2000) is the only study reporting an indirect influence of parental feeding self-efficacy on children's fruit and vegetable consumption. All the studies presented utilised different questionnaires to measure parental/maternal feeding self-efficacy. Unlike the 33-item Breastfeeding Self-Efficacy Scale (BSES) (305) and its shortened 14-item version, Breastfeeding Self-Efficacy Scale Short Form (BSES-SF) (306) that were psychometrically tested in various populations and adapted into many languages (307-314), there is currently no standardised and psychometrically tested measurement tool to evaluate parental/maternal feeding self-efficacy related to children's consumption of foods and their related feeding behaviours. The closest attempt is found in the Lifestyle Behaviour Checklist developed by West and Sanders (2009) but the Confidence Scale in the LBC included parental self-efficacy in addressing child activity and weight-related behaviours and is not specific to the issue of child feeding (304).

Table 2.12 Detailed summary of the five published studies examining maternal feeding self-efficacy and child fruit (f), juice (j) and vegetable (v) intakes.

Study:	Sample:	Design & Measurements:	Findings[¶]:
Kratt P., Reynolds K. & Shewchuk R. 2000 (302)	1,196 parent-child (4th graders) from the High 5 Alabama Project, U.S.	Cross-sectional, cohort. Parent: 31-item questionnaire regarding availability of fv in the home. Sample divided into two groups: low to medium availability, high availability; 2 questions asking for average number of servings of fv eaten daily over last year. Child intake: 1 x 24-hour dietary recall to determine number of fv serves consumed. Self-efficacy questionnaires: - Parent: serves fv; eats fv at specific meals and snack times (5-point Likert scales) Child: asks parent for fv; help with preparation of fv at home; eat fv at specific meals and snack times (3-point Likert scales) Multi-group structural equation modelling.	Reliability of self-efficacy questionnaires: Parent: α = 0.89 Child: α = 0.86 Medium to high availability group: Parent self-efficacy —(0.22*)→ Parent fv intake —(0.10*)→ Child fv intake Parent self-efficacy - - (0.02, p>0.05) - -→ Child fv intake Low availability group: Parent self-efficacy —(0.32*)→ Parent fv intake
Cullen K.W. *et al* 2000 (303)	109 parent-child (4th to 6th graders) recruited from schools in Houston, Texas, U.S.	Cross-sectional. Children completed 2x food records in the classroom. Parent self-efficacy: 23-items; modelling fv consumption, planning and encouraging fv consumption, making fv available in the home (5-point Likert scales). Spearman correlations.	Modelling self-efficacy → food (0.26*) and lunch preparations (0.21*); v (0.24*) and total fjv availability (0.25*). Planning self-efficacy → food (0.23*) and lunch preparations (0.26*); f (0.26***), j (0.24*), v (0.28***) and total fjv (0.33**) availability. Availability self-efficacy → food preparation (0.26***); f (0.36***), j (0.31***), v (0.29***) and total fjv (0.41***) availability; f (0.24*) and total fjv accessibility (0.24*).

Table 2.12 continued.

Study:	Sample:	Design & Measurements:	Findings[¶]:
West & Sanders 2009 (304)	182 Australian; childhood obesity trial and an exploratory study; 101 families with and 81 without obese children (4-11 years old).	Prospective cohort. Children: measured height and weight used to calculate BMI Parents: completion of the Lifestyle Behaviour Checklist (LBC) - 26 items; 2 Scales (Problem & Confidence) - Problem Scale: parents rate the extent to which they experienced child problematic behaviours related to eating, activity and weight status (7-point Likert scale) - Confidence Scale: parents rate their confidence to address child problematic behaviours related to eating, activity and weight status (10-point Likert scale) Validity and reliability testing.	Reliability: Problem Scale (α = 0.97) Confidence Scale (α = 0.92) Test-re-test stability over 12 weeks: Problem Scale (0.87**) Confidence Scale (0.66**) Predictive validity: Correctly classified 91.1% participants Problem Scale (0.76***) better predictor of child weight status than Confidence Scale (-0.36***) Parents with overweight/obese children reported lower scores (mean score = 171.8, SD = 41.3) in the Confidence Scale than parents with healthy weight children (mean score = 237.8, SD= 25.6).
Campbell K. *et al* 2010 (63)	Mothers of 1-year (n=60) and 5-year-old (n-80) children recruited through Maternal and Child Health Centres and kindergartens in Victoria, Australia.	Cross-sectional; 2 time points. Child diet: collected using the Eating and Physical Activity Questionnaire (EPAQ) which was validated against a 24-hour recall in the same cohort (n=90). Self-efficacy (5-point Likert scale): promoting healthy eating (5 items); refusing child's request for unhealthy food (4 items); promoting physical activity and limiting screen time (3 items)	1-year-olds: - Maternal self-efficacy for promoting healthy eating: Cake (-0.26**) Maternal self-efficacy for limiting unhealthy foods: Cordial (-0.26*); Cake (-0.34**) 5-year-olds: - Maternal self-efficacy for promoting healthy eating: Water (0.24*); Cordial (-0.24*); Fruit (0.42***); Vegetables (0.34***)

Table 2.12 continued.

Study:	Sample:	Design & Measurements:	Findings[¶]:
Koh G.A. *et al* 2014 (19)	277 mother-infant dyads from the South Australian Infant Dietary Intake (SAIDI) study. Infants aged 4 to 9 months old.	Cross-sectional. Child diet: measured using 1x 24-hour diet recall and 2-days food records. Number of fv sub-groups consumed calculated (fv variety). Maternal self-efficacy: 5-items from the self-efficacy questionnaire used in the Nutrition Education Aimed at Toddlers (NEAT) project (5-point Likert scale). Other items in questionnaire: how often mothers offer new foods to child (5-point Likert scale); how many times mothers would offer a new food before deciding that child dislikes the food (Once, 2–5 times, 6–10 times, 11–15 times and ≥16 times); how willing child was to eat new foods (5-point Likert scale); parenting confidence (5-point Likert scale). Confirmatory factor analysis, structural equation modelling.	Maternal self-efficacy questionnaire: Reliability (α = 0.99) Good construct validity[€] (χ^2/df <2, RMSEA <0.06, CFI/TLI >0.95, WRMR <0.90) Predictors of maternal feeding self-efficacy: Parenting confidence (0.36**); frequency offering new food (0.40**); how often offer new foods (0.26*); child willing to eat new foods (0.70**) Predictors of child vegetable variety: Maternal feeding self-efficacy (0.61*); parity (-0.50**) Structural model achieved good fit[€] (χ^2/df <2, RMSEA <0.06, CFI/TLI >0.95, WRMR <0.90).

*p <0.05, **p<0.01, ***p<0.001, SD – standard deviation, α – Cronbach's alpha, [€]good fit achieved when χ^2/df <2, RMSEA <0.06, CFI/TLI >0.95, WRMR <0.90 (84).

2.2.1.3 The role of maternal psychological health

Psychological health is a recognised antecedent to self-efficacy (55, 279). The evidence that poor psychological health compromises parenting is well established (315-317). Parental depression is linked to a variety of parenting behaviours that can negatively affect child growth (318-322) and development (316, 323-325) through lower levels of maternal responsiveness (326), high levels of maternal intrusiveness (327), ineffective discipline (316, 328) and obesogenic maternal feeding styles (329, 330) and behaviours (331). Evidence from the literature suggests that these associations may not be direct and may be mediated by parenting self-efficacy (326, 332, 333).

Parenting self-efficacy is known in the literature to be inversely associated with parental mental health (317, 334, 335). For instance, an Australian cross-sectional study on 83 primiparous Australian mothers attending a residential parent-infant program (child age: 0-12 months) found that parenting self-efficacy was inversely correlated with maternal depression (β= =-0.26, $p<0.05$), anxiety (β= -0.33, $p<0.05$) and attachment insecurity (β= -0.25, $p<0.5$) (336). Subsequently, a prospective Canadian study by Cost *et al* (n= 171) reported that maternal self-efficacy was associated with postpartum depression (r= -0.52, $p<0.05$) and that this association tracked between 3 to 18 months postpartum (317). Tracking was also observed in a large U.S. cohort study (n>5000) where mother-child dyads were studied at baseline (11-42 months), first follow-up (1 year later) and second follow-up (at kindergarten) (334). This study concluded that maternal depressive symptoms persisted through early childhood (334). Moreover results from the Longitudinal Study of Australian Children (LSAC) (n= 4879) showed that although maternal depression was the highest in first year postnatal and gradually decreased over the course of the study, mothers who reported low and high levels of depression consistently did so throughout the 6 to 7 years of the study (335). Parenting self-efficacy, poor relationship quality, child development problems and stressful life events were identified as risk factors for maternal depression in this study (335).

Maternal depression undermines parenting because it reduces child-oriented goals, undermines attention to child, increases negative appraisals and reduces parenting competence (315). In a meta-analysis of 46 observational studies, Lovejoy and colleagues concluded that maternal depression was associated with negative maternal behaviours (r = 0.20, $p<0.01$) and that this association was moderated by the timing of depression, with current depression associated with the largest effect (r= 0.22, $p<0.01$) (316). Moreover, studies examining the link between maternal depression and maternal feeding styles reported association between maternal depression with forceful (330) and restrictive feeding styles (329, 330).

Maternal depression may also affect child feeding practices. A U.S study by Morrissey (2014) using data from the Early Childhood Longitudinal Study-Birth Cohort (ECLS-B) from four waves of the study (Wave 1 = 9 months, n=10,700; Wave 2 = 2 years, n= 7400; Wave 3 = preschool, n= 6000; Wave 4 = kindergarten entry, n= 4750) reported that moderate to severe depression in mothers was associated with negative feeding and parenting practices such as putting infants to bed with a bottle (β= 0.03, $p<0.01$), days in the week the family eats dinner at a regular time (β= -0.0.33, $p<0.001$), hours a day child watches tv (β= 0.03, $p<0.05$) and putting child to bed by 9:00 pm (β= -0.03, $p<0.05$) (331). A qualitative systematic review by Dennis and McQueen (2016) also showed that mothers who were depressed in the early postpartum period were at increased risk for shorter breastfeeding duration, breastfeeding difficulties and decreased levels of breastfeeding self-efficacy (337). Depressed women were also less likely to initiate breastfeeding and do so exclusively (337).

There is limited evidence examining maternal depression and its link to early child food intake but the evidence so far suggests that maternal depression may detrimentally affect child's diet (338, 339). In a study using data from the Norwegian Mother and Child Cohort Study, Ystrom and colleagues studied the role of maternal negative affectivity (depression, anger, self-esteem) at 30 weeks gestation, 6 months postnatal and 18 months postnatal in predicting child dietary patterns at 18 months postnatal, and found that mothers with negative affectivity were more inclined to feed their children an unhealthy diet (β= 0.09, 95%CI= 0.07, 0.10) (n=27763) (339). Analyses on data from 689 mother-infant dyads in the Maryland Special Supplemental Nutrition Program for Woman, Infants and Children (WIC) showed that maternal stress, depression and overall psychological distress were associated with higher energy intakes in infants aged 0-4 months (β= 0.02, 0.04, 0.02 respectively) and higher intakes of breads and cereals in infants aged 4-6 months (β= 0.12, 0.19, 0.04 respectively) (338).

Poor diet and negative feeding styles are often linked to child under- or over-weight (330). Many studies have reported an association between maternal depression and child growth outcomes. Studies on children from developing countries consistently reported an association between maternal depression and child underweight or stunting (320, 340). A systematic review and meta-analysis of these studies showed that children with depressive mothers were more likely to be underweight (OR= 1.5, 95% CI = 1.2, 1.8) or stunted (OR = 1.4, 95% CI= 1.2, 1.7) (320). This study also found that around 23% and 29% fewer children would be underweight or stunted if they were not exposed to maternal depression (320). Studies conducted on children from developed countries reported mixed results (321, 341). The difference may be explained by the moderating role of socio-economic status (SES). A recently published systematic review by Mech *et al* on 30 studies concluded that parental obesity and depression were strong risk factors for childhood obesity in cohorts with low SES whereas in cohorts with high SES, long maternal working hours and permissive parenting style were found to be strong predictors (342).

Clearly, maternal psychological health is linked to parenting self-efficacy, feeding styles, feeding practices, child food intake and growth. It is therefore an important predictor in early childhood studies and should be considered.

2.2.1.4 The role of child temperament

According to Bandura, self-efficacy is influenced by task difficulty, effort expenditure, vicarious experiences, physiological and mood states, social or verbal persuasion and outcome expectancies, which shape success and failure experiences (278). The influence of child temperament on maternal self-efficacy most likely falls in the context of “task difficulty” and “outcome expectancies”. Difficult child temperament is characterised by fussiness, irritability, reactivity and frequent crying coupled with low soothability and manage-ability (343). A mother who is successful in soothing and comforting her child will most likely gain a greater sense of self-efficacy but if the mother repeatedly fails to calm her child, this may impact negatively on her sense of self-efficacy (344).

In one of the earliest studies examining the relationship between maternal self-efficacy and infant temperament, Porter and Hsu studied maternal self-efficacy at pre-natal (n = 60), one month post-natal (n= 52) and three months post-natal (n= 50) and found an inverse correlation between infant temperament and maternal self-efficacy at 3 month post-natal (r= -0.37, $p<0.05$) (345). In a more recent study, infant negative reactivity was found to be associated with maternal self-efficacy (β= -0.35, $p<0.001$) in a prospective cohort of 110- mother-child dyads recruited at birth in a medical centre in Pennsylvania (346). Furthermore, negative infant reactivity was found to have predicted greater infant weight gain when maternal self-efficacy was low (β= 0.38, $p<0.05$) while the opposite was true when maternal self-efficacy was high (β= -0.37, $p<0.05$) (346).

Infant temperament may also affect maternal self-efficacy through its link with maternal depression. Parents with irritable infants experience more stress, depression and lower parenting self-efficacy (347). A meta-analysis of 193 studies published in 2011 concluded that maternal depression was significantly related to higher levels of internalising (r= 0.23), externalising (r= 0.21), general psychopathology (r= 0.24), and negative affect/behaviour (r= 0.15) and to lower levels of positive affect/behaviour (r= -0.10) in children (all $p<0.001$) (348).

Mothers who perceive their children to be difficult or fussy may also respond with negative feeding practices that may lead to poor child diet quality. For instance, a study on 698 primparous mothers with infants aged 2-7 months from the NOURISH study found that mothers of infants with difficult temperament reported lower awareness of satiety cues (β= -0.32, $p<0.05$), were more likely to use food to calm (β= 0.14, $p<0.05$), and had high concern regarding child overweight (OR = 1.8, 95%CI= 1.23, 2.49) and underweight (OR= 2.0, 95%CI= 1.41, 2.84) (349).

Difficult child temperament may also affect child diet quality. Results from the Norwegian Mother and Child Cohort Study showed that negative child temperaments at 1.5 years predicted higher consumption of sweet foods and drinks with difficult children at age 1.5 years less likely to consume fruit and vegetables daily at ages 3 and 7 (350, 351). A separate study in Belgium on 755 parents of pre-schoolers (mean age 3.5 years) found that child negative reactions to food were inversely correlated with child fruit (β= -0.25, $p<0.001$) and vegetable (β= -0.34, $p<0.001$) intakes (352).

Difficult child temperament may also affect child eating/feeding behaviours. The associations between maternal feeding style, maternal depression, child temperament and eating behaviours were explored in two cross-sectional UK studies (353). The authors found that maternal controlling feeding was predicted by child temperament, eating behaviours and maternal mental health (n=48 parent-child dyads, children aged 2-5 years) (354) and that children with more emotional temperaments displayed more food avoidant behaviours such as slowness in eating (β= 0.24, $p\leq0.001$) and food fussiness (β= 0.25, $p\leq0.001$) (n=241, children aged 3-8 years) (353). Moreover, studies conducted on infants at the weaning period also reported associations between infant temperament such as shyness, emotionality, negative reactions to food and low approachability to lower acceptance of novel foods (355, 356). Negative infant temperaments such as poor self-regulation, distress, low soothability, negative affectivity and emotionality were also found in a systematic review to be associated with higher BMI and rate of weight gain in infants and pre-schoolers (357); providing evidence to link child temperament to growth outcomes.

Clearly, maternal self-efficacy, feeding practices, depression, child temperament and feeding behaviours are linked, but the current lack of studies utilising multi-directional models impedes understanding of the mechanisms in which these variables interact with each other to produce dietary and growth outcomes in children. An American study by Braungart-Rieker and colleagues on a cohort of low SES pre-schoolers (aged 3-6 years) examining psychosocial pathways to childhood obesity using a mediation SEM model (358) is one of the most recent attempts to understand the complex relationships mentioned above. The findings of this study are summarised in Figure 2.2 below.

Figure 2.2 Findings from the mediation model proposed by Braungart-Rieker et al (2014) (358) has been removed due to copyright restrictions.

2.2.2 Other determinants of fruit and vegetable consumption in early childhood

2.2.2.1 Socio-demographic determinants

Socio-economic status

Socio-economic status (SES) is usually measured using income, education level, occupation and Socio-economic Indexes for Areas (SEIFA) as proxies. Despite the different proxies used, the association between child FV intakes and SES is consistent (359). According to a 2006 quantitative systematic review of 98 studies examining determinants of FV intakes in children aged 6 to 18 years, parental level of education produced the most consistent outcome when used as a proxy for SES (359). All 11 studies in the review that examined the association between parental level of education with child FV reported significant positive associations compared with seven out of fourteen papers for family income and nine out of eleven for parental occupation (359). The consistent association between higher parental education and higher FV consumption may be explained by the higher level of nutrition knowledge among parents who are more higherly educated (360).

Conversely, lower SES was found to be associated with higher reliance on discretionary or ‘junk’ foods (361) and takeaway meals (362). Thus, SES is an important predictor of FV consumption. In studies that rely on volunteers and/or require participants with a good level of literacy, SES can be an important confounder.

Cultural determinants

Studies examining the association between child FV intakes and cultural determinants reported inconsistent findings. Cultural influence on FV consumption may be measured through the use of proxy variables such as race (also referred to as ‘ethnicity’), country of birth and immigration status (native or non-native). The examination of the influence of culture on FV intakes is confounded by the presence of multiple factors such as level of education, income, dietary laws, religion and food beliefs (363).

Although there is evidence to show that immigrants consumed more FV compared to natives (364), other studies reported the opposite (365, 366). The inconsistency in the findings may be explained by the presence of other factors such as age, immigrant generation and country of birth (363) which may reflect the level of food acculturation and nutrition transition experienced post-migration.

The food transition for immigrants from low income countries (eg: South and Southeast Asia) after migration to high income countries is more abrupt and radical (367). The globalised and industrialised food market in the high income host country increases accessibility and availability to ultra-processed foods (usually high in saturated fat, sugar and refined carbohydrates) and a stable supply of fresh foods (367). However, food acculturation is not a linear process as research indicates that immigrants may find novel ways to cook traditional dishes, and to exclude or include new foods in their diets (368, 369). There is also evidence to show that food acculturation is bi-directional where the host country adopts certain food cultures from the migrant communities, hence diversifying their food choices (370). However, how this affects fruit and vegetable intakes of the natives is unclear.

Child gender

Evidence from studies on gender differences in FV intakes is inconclusive. Results from the most comprehensive review on the determinants of FV consumption in children aged 6 to 18 years concluded that child gender is one of the strongest determinants of FV intakes in children (359). In this 2006 review by Rasmussen and colleagues, 27 studies out of 49 reviewed reported that girls consumed more fruit and vegetables than boys while 18 reported no differences and 4 reported boys ate more fruit and vegetables than girls (359). In contrast, a 2014 review by Noia and Bryd-Bredbenner on low income children and adolescents aged <20 years, reported that in

11 out of the 14 studies reviewed, there were no gender differences in FV intakes (371). It is unclear why such discrepancies exist but studies examining the modifiable mediators of gender effect on FV intakes may shed some light on the subject.

In 2008, a longitudinal study on 896 Norwegian children aged 12.5 to 15.5 years old reported that preference was the strongest mediator of the difference in FV intakes between boys and girls (372). The authors of this study proposed a mediator model consisting of 6 modifiable mediators (accessibility, modelling, intention, preferences, self-efficacy and knowledge) with gender as the independent variable and FV intake as the outcome variable (372). The resulting analysis revealed that preference alone explained 81% of the gender difference in FV intakes (372). The findings of this study support the findings from an earlier cross-sectional study by Cooke and Wardle (2005) on 1291 U.K. children aged 4 to 16 years where girls were found to like fruits ($p<0.05$) and vegetables ($p<0.001$) more than boys, and boys were found to like fatty and sugary foods ($p<0.005$), meat ($p<0.001$), processed meat products ($p<0.001$) and eggs ($p<0.05$) than girls (373). Interestingly, a study by Cooke *et al* in 2004 on 564 parents of children aged 2 to 6 years old reported a significant gender difference only for vegetable intake and not for fruit intake (42). This suggests that besides food preferential differences between genders, behavioural differences for fruit and vegetable consumption may exist and that fruit and vegetables should be examined as two separate outcomes. Moreover, there is some evidence to show that different maternal feeding practices may explain the gender differences in FV intake although evidence in this area is limited and inconclusive (374). Despite discrepancies in the findings discussed above, child gender is potentially an important determinant of FV intake.

2.2.2.2 Maternal intake

In early childhood, mothers are the gate-keepers of children's diet (147) and are therefore, in a unique position to expose children to fruits and vegetables. In addition, studies on children of various ages have reported an association between parental (predominantly mothers) FV and child FV intakes. In a study on 191 five-year-old girls, Fischer and colleagues reported that parents who consumed more FV had daughters who consumed more FV (r=0.23, $p<0.05$) (375).

In 2004, Bere & Klepp reported a significant correlation between parental and child FV intakes (r=0.23, $p<0.05$) in 1950 Norwegian children aged 10-12 years- old (376). Positive associations between parental and child FV intakes were also found in children aged 2 to 5 years-old (n=73, r=0.30,$p<0.001$, all respondents were mothers) (377) and 4 to 12 years-old (n=1739, r=0.14, $p<0.001$, 85% respondents were mothers) (378). The 2006 systematic review by Rasmussen and colleagues reported that 8 out of the 9 papers on parental and child FV intakes reported a positive association, making parental FV intake one of the most consistent predictor of fruit and vegetable intake in children (359).

2.2.2.3 Repeated exposure to novel foods

Exposure to foods can change children's food preferences and subsequently intakes (35). The evidence is so consistent, powerful and universal that 'exposure' is considered the 'gold standard' to explain food preference and intakes in children (35). In one of the earliest studies on the effect of exposure on child food preferences, Birch and Marlin conducted two experiments on 2-year-old children (n=6 in Experiment 1 and n=8 in Experiment 2) where the children were exposed to 5 types of novel cheeses (Experiment 1) and 5 types of novel fruits (Experiment 2) over a 26-day and 25-day period respectively (379). They found direct correlations between frequency of exposure to food preferences in both experiments (r=0.95, $p<0.02$ in Experiment 1 and r=0.97, $p<0.01$ in Experiment 2) and reported that an exposure of 8 to 10 times was necessary before preferences began to change significantly (379). Moreover, almost all of the children studied (13 out of 14) selected the foods they were most familiar with when foods were presented subsequently, indicating consistency of results within and between study subjects (379).

In a later study by Sullivan and Birch on 36 infants at weaning age (4 to 6 months old), increased intake of green beans or peas was reported after 10 exposures ($p<0.001$) (380) while a study on 39 infants aged 4- to 7-months reported a minimum of 8 exposures was required before a significant increase in intake of a novel fruit was observed (381). Similarly, a study published in 2007 on the effect of repeated exposure on the consumption of initially disliked vegetable reported increase in the amount consumed that by the eighth exposure, intakes of the vegetable increased more than 4 times from the baseline intake (268). Moreover the effect of exposure seemed to be accumulative; eg: as more new foods were added to the child's food repertoire, the less exposure was required before these new foods became accepted (382). However it is currently still unknown how many times a new food needs to be offered before it is accepted by infants (65). Frequency of exposure before a food is accepted varies between individuals and is dependent on the type of food being offered as sensory properties of food can also play a role in determining food acceptance (35).

While visual, touch and smell exposure can influence food acceptance in children (383, 384), it is important that they taste the new food, especially older children (≥ 2 years old) (35) as they place greater emphasis on the hedonic value of food and are more likely to increase intake of a new food if they are told that it tastes good over being told that the food is good for them (356).

Children were also more willing to eat new vegetables if they were given tangible rewards for their efforts, though this practice remains controversial as rewards may undermine children's natural motivation (385). For instance, in a randomised trial by Wardle and colleagues on 156 parent-child dyads of children aged 2 to 6 years, parents who were assigned to the 'Exposure' group reported greater increases in liking and consumption of the 'target' vegetable in children compared to parents in the 'Control' and 'Information' groups (386). Later studies expanded on this earlier study by Wardle *et al* and added a reward with exposure as an intervention strategy (387, 388). They generally reported positive intake outcomes when reward was used in conjunction with exposure (387-389) though there are studies that cautioned against this practice, reporting instead decreased preference and intakes (390, 391). A 2011 review by Cooke and colleagues concluded that the effect of reward and exposure is dependent on the outcome (intake or liking) and the 'target food' (liked versus disliked) (392). The use of reward with exposure generally led to increased intake of the 'target food' while the opposite was true for increasing liking of the food if the 'target food' was already liked (392). Yet, despite the positive effect of repeated exposure on the acceptance, preference and consumption of novel foods, current evidence shows that most parents would offer a new food a limited number of times (around 5 times) before deciding that their children dislike the food (35).

It is also important that children are offered fruit and vegetables continuously before any change in intakes can be observed. In a 2014 study, Barends and colleagues showed that a continuous 18-day exposure to vegetables exclusively at the weaning period resulted in higher intake of vegetables at the 19^{th} day of exposure (almost doubled) and that weaning exclusively with vegetables resulted in 38% higher vegetable intake at 12 months of age compared to children weaned with fruits ($p<0.05$) (393). Findings may also differ depending on the vegetable that was offered to children at the weaning period. For example, one recent longitudinal experimental study reported higher intake and preference of carrots (a sweet vegetable) to green beans (a bland tasting vegetable) throughout the 18 months of the study, regardless of whether children were in the control (n=18) or intervention group (n=18, repeated exposure of $\geq$12 daily exposures) (394). The acceptance of green beans may be difficult to favour at weaning and may require a higher intensity of exposure as green beans alone or as part of a variety of vegetables offered within or between meals (395).

Timing of exposure also plays an important role in determining food acceptance. From a developmental point of view, 'sensitive periods' exist for children to learn to accept new foods (396-398) and interventions aiming to increase intake of novel foods should consider offering these foods during these 'sensitive periods'. For example, there is evidence to show that fruits and vegetables are the least preferred foods at weaning (399) but despite this, acceptance was greater at weaning than at 2 years of age or older (274).

A number of studies have shown an association between fruit and vegetable exposure at the weaning period to fruit and vegetable intakes in later childhood (42, 274, 400, 401). In 2002, Skinner and colleagues conducted the first ever longitudinal analysis on the link between early fruit and vegetable exposure to fruit and vegetable variety in later years (26). They examined 70 white American mother-child dyads and found that fruit variety of school-aged children was predicted by fruit exposure (R^2=0.25, p<0.001) and variety (R^2= 0.25, p<0.001) in the first 2 years of life (26). In a more recent longitudinal study, Lange and colleagues studied 203 children from the beginning of the weaning period to 15 months of age and reported that the earlier vegetables were introduced, the higher infants' acceptance of vegetables was at 15 months of age (p<0.05) (399). Moreover, a UK study by Coulthard and colleagues on 7866 mother-child dyads from the Avon Longitudinal Study of Parents and Children (ALSPAC) found that age of introduction to home-cooked foods moderated the association between frequency of exposure to home-cooked fruit and vegetables at 6 months and children's fruit and vegetables consumption at 7 years of age (β=0.14, p<0.001) (402).

The link between age of introduction of fruit and vegetables and subsequent intake may be explained by the difference in maternal feeding practices. In a 2014 study, Coulthard, Harris and Fogel found that infants who were weaned late (>5.5 months old) and weaned to single taste vegetable consumed significantly less of the novel vegetable compared to infants weaned late (>5.5 months old) to multiple vegetable tastes ($p<0.05$) or infants weaned earlier (≤ 5.5 months old) (267). This provides further evidence that early introduction to vegetables is linked to its better acceptance and consumption while the effects of later weaning may be compensated through exposure to a variety of vegetables. It is therefore clear the age of introduction is an important determinant of young children's fruit and vegetable intakes through its role in early exposure.

2.2.2.4 Child feeding behaviour

Child feeding behaviours such as neophobia and fussy/picky eating have been associated with poor fruit and vegetable consumption (24, 403, 404). Although correlated to each other (405), neophobia and picky/fussy eating are behaviourally and theoretically distinct from each other (64). Food neophobia is generally regarded as the reluctance to eat or the avoidance of novel foods while picky/fussy eating is defined as inadequate consumption of a variety of foods through rejection of familiar and unfamiliar foods (64).

Neophobia has strong genetic links (24). The age of onset is debatable with evidence showing that this behaviour peaks between ages 2 to 6 years and decreases with age (64). Although most children show some degree of caution in response to novel foods, it is estimated that around 20-30% children are significantly neophobic (24). Higher neophobia has been found to be associated with poorer consumption of fruits and vegetables in young children (66, 406). For instance, a study conducted by Cooke and colleagues on 109 parents of 4 to 5 year olds attending four London primary schools reported that neophobia was associated with lower consumption of fruit and vegetables (r = -0.27, $p<0.01$) but no such association was found for intake of starchy and snack foods (406). A more recent Australian study using data obtained from the NOURISH and South Australian Infants Dietary Intake (SAIDI) studies (n=330) found a significantly higher number of neophobic children were consuming a lower variety of fruits and vegetables at 24 months of age (407). Interestingly, this study also found that neophobic children were obtaining a greater proportion of their daily energy intakes from discretionary foods (407).

Picky/fussy eating is linked to higher tactile, cognitive and affective sensitivity (408). Picky/fussy eating extends further than food neophobia with picky/fussy eaters rejecting food not merely based on taste alone but on textures, smell and sight of the food as well (64). Depending on the study cohort, rates of picky/fussy eating in children can vary from 8% to 50% (409). Moreover, a 2007 Canadian study by Dubois and colleagues on 1498 children from the Longitudinal Study of Child Development reported that the proportion of children reported as ‘picky eaters’ tracked between ages 2.5 to 4.5 years (410).

Picky/fussy eating has been associated with lower intakes and poor variety of fruit and vegetables in children (403, 404, 411). For example, an American study on one hundred and seventy-three 9-year-old white girls reported that picky eaters ate significantly less fruit and vegetables (*r* =-0.19, $p \leq 0.05$) (404). Using structural equation modelling, the authors found that girls' fruit and vegetable intakes at age 9 was strongly associated with girls' micronutrient intakes (especially vitamins E and C) ($r = 0.50$, $p \leq 0.001$) and fibre intake ($r = 0.71$, $p \leq 0.001$) (404), providing evidence that poor fruit and vegetable intakes due to picky/fussy eating can potentially affect children's nutritional status. In a cohort of children followed from birth to 5.5 years of age (n=135), Jacobi, Agras and Hammer showed that picky eaters also ate a significantly lower variety of foods, especially vegetables ($p<0.001$) (403). In a recently published paper using data from the 2008 Feeding Infants and Toddlers Study (FITS) (n=2371, children aged 12 to 47.9 months old), van der Horst and colleagues reported that picker eaters were more likely to be neophobic ($p<0.001$), texture resistant ($p<0.001$), ate fewer vegetables from the "other vegetables" category (Brussel sprouts, asparagus, artichoke, beets, cabbage, celery, green beans, lettuce, mushrooms, okra, onions, pea pods, peppers, tomatoes, yellow beans, zucchini and yellow squash) ($p<0.01$) and less raw vegetables ($p<0.001$) compared to non-picky eaters (411).

Despite this, neophobia and picky/fussy eating can be reduced through early and repeated exposure to disliked or novel foods (64, 412), indicating the importance of early intervention. The role of exposure in determining outcomes in fruit and vegetable consumption in children is presented in Section 2.2.2.3. Given the association between food neophobia and picky/fussy eating with food intake, it is therefore important that they are considered when examining the determinants of fruit and vegetable consumption in young children.

2.3 CONCLUSION

Children's consumption of fruit and vegetables (FV) fall short of recommendations. Inadequate consumption of FV increases the risk of cardiovascular diseases, some cancers, chronic respiratory diseases, and diabetes. Furthermore, evidence from the Boyd Orr cohort indicates that adequate consumption of FV may have a protective effect against future risk of cardiovascular disease, stroke and some cancers.

In early childhood, exposure and child behaviour towards new foods play important roles in determining acceptance and consumption of fruit and vegetables. Children from mothers with a high sense of feeding self-efficacy consume more FV than children from mothers who are less efficacious at feeding. This relationship may be influenced by the state of mother's mental health and child's temperament, and warrants further investigation.

CHAPTER THREE: METHODOLOGY

This chapter describes the overall design and procedures of the study, including a comprehensive description of questionnaire items, data reduction and transformation processes, and variable definitions. The chapter ends with a detailed description of the data analysis method to aid understanding of the method and tests used in this study.

3.1 STUDY DESIGN

The subjects in this study were participants in the South Australia Infants Dietary Intake (SAIDI) study (146). SAIDI is a longitudinal study designed to prospectively describe maternal feeding practices, dietary intake and growth of young children aged 6 months to 24 months. Mother-child dyads were recruited at birth and assessed at 6 months (Time 1), 14 months (Time 2) and 24 months (Time 3) postnatal. This thesis is confined to data collected at Time 1 (T1) and Time 2 (T2). Table 3.1 shows the measures collected in the SAIDI study and the measures that are reported in this thesis (highlighted in bold and shaded). Figure 3.1 summarises the overall design of the SAIDI study, from recruitment to consent, including assessment time points relevant to this thesis.

Ethics approval for the study was granted by the Flinders Clinical Research Ethics Committee, Children, Women & Youth Health Ethics Committee (CWYHS), Central Northern Adelaide Health Service Ethics of Human Research Committee, Bellberry

Human Research Ethics Committee and Health SA Ethics Committee. Therefore, consent forms are site specific (eg: different site logos and contact details for ethics committees) to conform to the ethics requirements of the study sites.

Table 3.1 Overview of measures collected in the SAIDI study and measures reported in this thesis (highlighted in bold and shaded).

Measure	Time of assessment	
	T1	**T2**
Demographics		
Maternal age, parity, country of birth, education level Child gender, birth weight, birth length	**X**	
Anthropometry		
Child weight and length	**X**	**X**
Maternal weight and height	**X**	
Dietary intake		
24-hour dietary recall	**X**	**X**
2 days food diary	**X**	**X**
Questionnaire		
Breastfeeding, formula feeding, other fluids	X	X
Feeding solids, food refusal, fussiness	**X**	**X**
Child self-feeding skills	X	X
Child feeding practices[a]	X	X
Maternal feeding self-efficacy	**X**	**X**
Maternal psychological distress[b]	**X**	**X**
Maternal perception of child weight and health	X	X
Child temperament	**X**	**X**
General parenting and lifestyle	**X**	**X**
Household and family income	**X**	**X**

[a]items from the Child Feeding Practices Questionnaire (413)
[b]items from Kessler 10 (414)

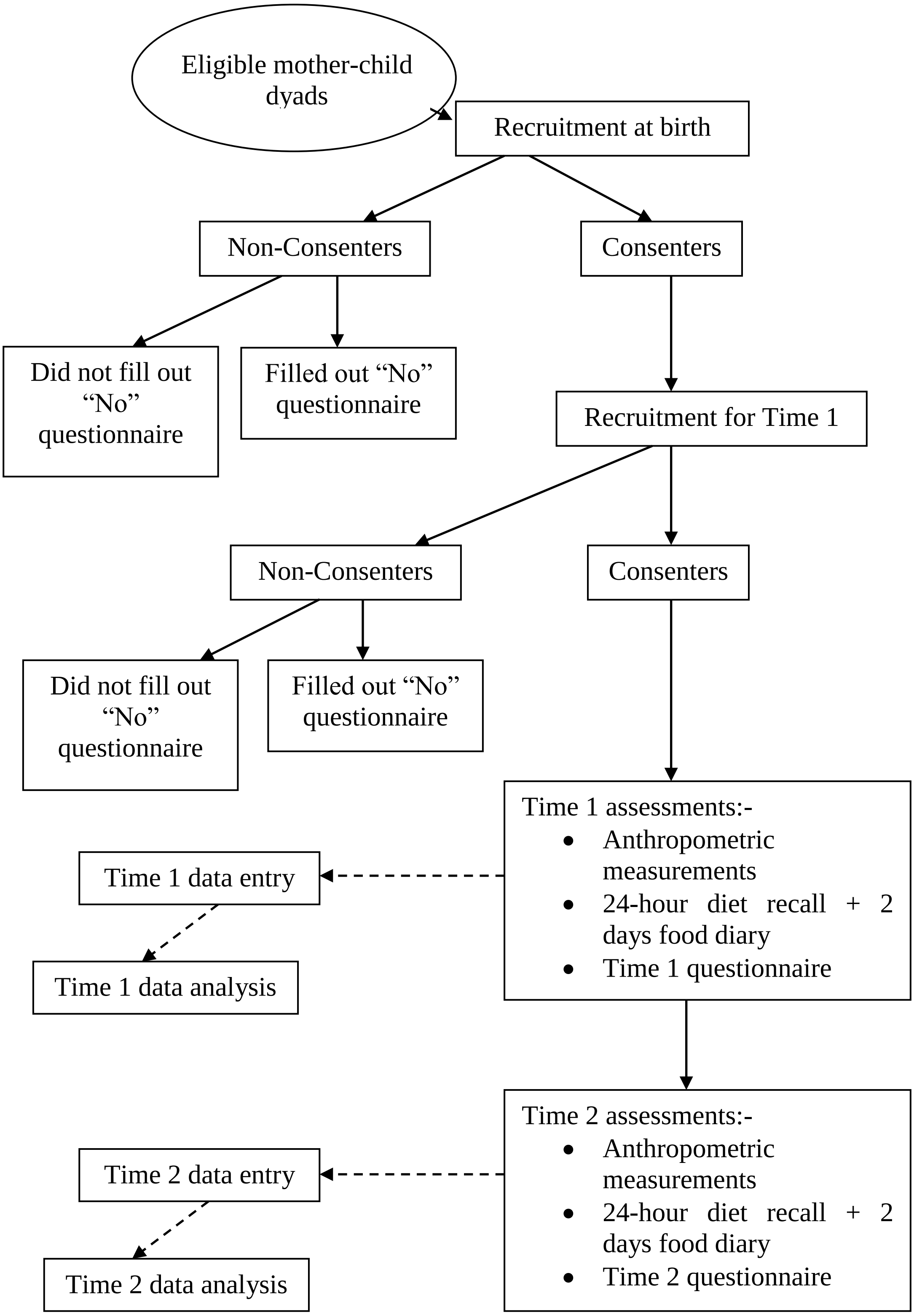


Figure 3.1 Summary of overall design of the SAIDI study that is relevant to this thesis.

3.2 STUDY POPULATION

This section outlines the exclusion criteria for the study. Exclusion criteria were set in the SAIDI study to examine dietary intake, growth and feeding practices in a cohort of healthy mother-child dyads and are therefore suited for the purpose of this thesis.

3.2.1 Maternal exclusion criteria

Mothers were ineligible to enrol in the study if they were:

- aged below 18 years of age at the time of birth of the study child
- unable to read and write in English or required the assistance of translators.

3.2.2 Child exclusion criteria

Infants were ineligible to enrol in this study if they were:

- born with congenital, physical or long-term illnesses that may affect feeding
- born with a birth weight below 2500g
- born before 37 weeks gestation.

3.3 STUDY PROCEDURE

This section describes the recruitment procedures of the study, including how eligible mother-child dyads were identified.

3.3.1 Eligibility screening

In metropolitan hospitals, eligible mothers were identified from consultation with ward nurses, from the nurses' hand-over notes and birth records which include information on maternal parity, age, requirement for a translator, general medical status (eg: diabetic, hypertension), and infant gender and medical status. Mothers were then approached by study staff while still in hospital for consent for further contact regarding the study. In Regional hospitals, eligible mothers were identified and recruited by the hospital staff (nurses, midwives) trained and employed by the SAIDI research team.

3.3.2 Recruitment

Eligible mother-child dyads were recruited post-natally between 27th September 2008 and 31st March 2009. Participants were recruited from three public hospitals and one private hospital in metropolitan Adelaide and seven public hospitals from regional South Australia.

Estimated number of eligible participants for the study was based on the estimated number of births from each hospital for the duration of the study (Table 3.2) which was based on birth records from each hospital for the same time period in previous years. The anticipated 25% response rate was based on previous experience from the NOURISH study (415) from which this study derived its recruitment and dietary assessment methodology (416). Contrary to SAIDI's longitudinal descriptive design, the NOURISH study is a randomised intervention trial on early feeding practices in children aged 4-24 months old. Recruitment and eligibility screening procedures in

SAIDI varied slightly from hospital to hospital to account for the multi-site variation in patient filing, booking and hospital staff shift systems.

Table 3.2 Estimated number of participants based on estimated births per sites of recruitment between 27th September, 2008 to 31st March, 2009 in the SAIDI study.

Study site:	Estimated births:	Estimated number of potential participants for the study*:
Metropolitan		
Women's and Children's Hospital	482	121
Flinders Medical Centre	1196	299
Ashford Hospital	738	185
Lyell McEwin Hospital	631	158
Regional		
Port Lincoln Hospital	144	36
Whyalla Hospital	150	38
Port Augusta Hospital	156	39
Gawler Hospital	148	37
Mount Barker Hospital	166	42
Murray Bridge Hospital	141	36
Mount Gambier Hospital	265	66

*based on 25% response rate from the NOURISH study (415).

3.3.3 Consent

A two-stage recruitment process was used to obtain consent from mothers. This is designed to obtain a consecutive sample for the study. The first consent (Stage 1) was given after the birth of the infant when study staff approached eligible mothers to introduce and describe the study before their discharge from hospital. Following the description given by study staff, mothers were asked if they were interested to participate in the study. The second consent (Stage 2) was given when study staff contacted mothers around 2 weeks prior to her child turning 6 months old.

3.3.3.1 Consent at recruitment (Stage 1)

Mothers consenting at Stage 1 signed a site-specific consent form agreeing to further contact by study staff in around 5 months' time. These mothers completed a short questionnaire providing mother's contact details, two alternate contacts of persons not living in the same household, socio-demographic data (eg: mother's date of birth, education level, marital status etc) , their feeding intentions (eg: breast feeding, formula feeding etc) and parenting support. This questionnaire took around 5 minutes to complete. Mothers were also provided with:-

1) A take-home pamphlet containing information on the study and contact details of study staff
2) A paper slip for them to notify staff of change of address or to withdraw from the study
3) A reply- paid envelope for the paper slip above

3.3.3.2 Non-consenters at Stage 1

Mothers declining to participate in the study were asked to complete a short one page "No" questionnaire on socio-demographics, feeding intention and parenting support. Completion of this questionnaire was optional. Mothers agreeing to complete this questionnaire signed a site-specific consent form stating that they did not wish to participate in the study but gave permission to complete the questionnaire. This questionnaire took around 1 minute to complete.

3.3.3.3 Consent for further study (Stage 2/Time 1)

Around 2 weeks prior to the child turning 6 months old, study staff mailed letters of invitation for participation in the study to mothers who had consented to further contact at Stage 1. The letter of invitation to enrol in the study included:

1) A covering letter explaining the invitation to participate in the study and instructions on what to complete and return to study staff
2) A detailed information pamphlet about the study and what was required of mothers for the study
3) A site-specific consent form to enrol in the study
4) A form for mothers to indicate their time and venue preference for the assessments of anthropometric measurement
5) A short "No" questionnaire for mothers declining to participate. Completion of this "No" questionnaire was optional.
6) A paper slip for them to notify staff of change of address or to withdraw from the study
7) A reply- paid envelope

3.3.3.4 Follow up procedure

Two weeks after sending the letter of invitation for further participation, study staff gave mothers who had not responded a call to enquire if they had received the letter. Mothers who indicated their consent over the phone when contacted were asked their preference for venue and time for the anthropometric assessments and immediately mailed the consent form (if misplaced or lost). They were asked to bring their completed consent form to the anthropometric assessment session (Section 3.4.1).

3.4 DATA COLLECTION AND TRANSFORMATION

This section details the data collection methods and includes descriptions of measurement items from questionnaires and details of data transformation in preparation for data analysis. Data were collected using standardised questionnaires, diet recall forms and food diaries that were de-identified when collected. Hard copies of the completed questionnaires, diet recall forms and food diaries were stored in a locked filing cabinet according to time intervals (T1, T2) and stage of completion. All questionnaires, dietary recalls and food diaries were checked for their level of completeness and investigated where possible (eg: ringing participants to clarify ambiguous and missing responses). For all entered data, discrepancies and missing data were checked against the raw data and corrected where appropriate.

3.4.1 Assessment at Time 1 (T1)

Mothers who consented to further participation at T1 were sent a letter containing the T1 Questionnaire (Appendix 2) to complete at home. Study staff also contacted mothers and made appointments for the measurement of child weight and length. Metropolitan mothers who attended the measurement appointments brought their completed T1 Questionnaire. Measured child weight and length were recorded at the back of the T1 Questionnaire and filed for data entry and analysis.

After the anthropometric measurements were taken, mothers were given standardised visual aids for serve size estimation, instructions on how to estimate breast milk intake, food diaries for them to record child food intake for 2 days and reply-paid envelopes for the food diaries. Mothers were told to wait for further instructions from study staff before recording child's food intake in the diaries. Mothers also indicated the times when it was not appropriate for study staff to contact them to conduct a 24-hour dietary recall.

The procedure for data collection from regional mothers was similar to metropolitan mothers with the exception that regional mothers were not required to attend measurement appointments. They were instructed to have their child weighed and measured at the nearest doctor's clinic or Child and Youth Health clinic. This was easily achieved as the measurement of the child weight and length coincided with the 6 months universal immunisation and general health check. Unlike metropolitan mothers, regional mothers were asked to report all anthropometric measurements at the back of the T1 Questionnaire before mailing the questionnaire back to study staff.

The visual aid for serve size estimation was included in the letter containing the T1 Questionnaire sent to regional mothers.

3.4.2 Assessment at Time 2 (T2)

The procedure for T2 assessments was similar to the T1 assessments for both metropolitan and regional mothers with the exception that consent was not required. T2 Questionnaires (Appendix 2) were mailed to mothers with similar items, but age-adjusted to ensure appropriateness. The T2 letter which included the T2 Questionnaire was mailed to mothers around 2 weeks prior to the child turning 13 months old.

3.4.3 Demographics

Data on maternal age, education level, marital status and country of birth were obtained at Stage 1. Maternal age was calculated from the difference between the date of child birth and maternal birth date. Mothers responded to the choices of 1= Year 10 or 11, 2= Completed Year 12, 3= Trade, college or equivalent, 4= University for the highest level of education. For data on marital status, mothers responded to the choices of 1= Single/Never married, 2= Married, 3= De facto and 4= Widowed. Maternal country of birth was recorded in categorical options of 1= Australia/NZ, 2= UK/Europe/US, 3= Asia, 4= Others. Country of birth was used as a proxy variable of cultural determinant. Due to the small number of mothers from diversified birth countries, this variable was coded into two categories (Australian-born, Others) for analysis. Mothers responded to the options of 1= $0-$385 per week, 2= $386-$673 per week, 3= $674-961 per week, 4= $962-$1346 per week, 5= $1347-$1923 per week and 6= more than $1923 per week to the question on combined gross household income in T1 Questionnaire (Appendix 2) for measurement of household income. Data on total number of children (parity) was obtained from the Stage 1 questionnaire. The study child was included in the total number of children variable in this study.

Data on child gender was collected at Stage 1 from the birth register in the hospital. Child age at T1 and T2 were calculated from the difference between date of completion of the assessment questionnaires and child date of birth. Mother and child's place of residence was also recorded at Stage 1 as either in metropolitan or regional South Australia. Table 3.3 summarises the socio-demographic variables reported.

Table 3.3 Summary of socio-demographic variables included in thesis.

Variable	Source	Definition	Original form	Final form
Maternal age	Stage 1 questionnaire	Mother's age at time of study child's birth	Age in years	Continuous – age in years
Maternal education	Stage 1 questionnaire	The highest level of education attained at the time of study child's birth	Categorical – 1=Year 10/11, 2= Year 12, 3=Trade, TAFE, college or equivalent, 4= University	Binary – 1=Did not complete post-school education, 2= Completed post-school education
Marital status	Stage 1 questionnaire	Mother's marital status at the time of study child's birth	Categorical – 1=Single/Never married, 2= Married, 3= De-facto, 4=Widowed	Binary – 1= Not partnered, 2= Partnered
Maternal country of birth	Stage 1 questionnaire	Mother's country of birth	Categorical – 1=Australia, 2= New Zealand, 3= UK/Europe/Us, 4= Asia, 5= Others	Binary – 1= Not Australian born, 2= Australian born
Family income	Time 1 and Time 2 questionnaires	Gross family income per week at time of assessment	Categorical – 1= $0-385, 2=$386-673, 3=$674-961, 4=$962-1346, 5= $1347-1923, 6= >$1923.	Categorical – retained original categories.
Total number of children (parity)	Stage 1 questionnaire	The number of children (including study child) mother had at time of study child's birth	Total number of children	Continuous - count
Child age	Birth register (for child date of birth), Time 1 questionnaire, Time 2 questionnaire	Child age at Time 1 and Time 2	Age in weeks	Continuous – age in months
Child gender	Birth register	Study child's born gender	Binary – 1= Male, 2= Female	Binary – retained original form.
Residence	Stage 1 questionnaire	Mother-child place of residence	Binary – 1=Metropolitan, 2=Regional	Binary – retained original form.

3.4.4 Child weight and length

Child weight was measured at T1 and T2 using Tanita Digital Baby Scales Model BD-590 to the nearest 0.01kg. Scales were tared to 0 and mothers were asked to remove all forms of clothing, including nappies from their child, before placing their child on the weighing scale.

Child length was measured at T1 and T2 using the Seca length mat to the nearest 0.5cm. The Seca length mat has a fixed headpiece and a movable board to measure length of children up to 2 years of age. Children were measured supine with no or minimal (nappies only) clothing on. Mothers were asked to place their child with the top of his/her head touching the headpiece and their backbone on the straight line on the length mat. Mothers held the sides of their child's head to ensure it was facing straight up while study staff gently pressed down on the child's knees to straighten the legs. The sliding board was moved and stopped when the base of the child's feet were touched firmly to the flat surface of the board and parallel (at 90^o) to the mat.

Weight and length data were entered into Excel 2010 (417) and converted into WHO z-scores using the LMS Growth software (418). Weight and length z-scores were then transferred into SPSS 19 (419) for analysis.

3.4.5 Child feeding practices

Breastfeeding status at each time point was determined from the question "Are you currently breastfeeding your child?" while child age when mother stopped breastfeeding was determined from responses to the question "How old was your child when you stopped breastfeeding?" Mothers were given the option to record their answers to the later question in days, weeks or months. Responses in days and months were converted into weeks (based on 7 days = 1 week and 12 months = 52 weeks).

Age of introduction of solids was determined from the item "At what age was your child first given solid or semi-solid food regularly?" *Regularly* was defined as 'more than twice a week for several continuous weeks'. Mothers were given the option of recording their responses in weeks or months. Responses in months were converted into weeks (based on 12 months = 52 weeks).

3.4.6 Child food intake

3.4.6.1 Collection

One 24-hour dietary recall and two days of food record (food diaries) were collected. Study staff contacted mothers one to two weeks after anthropometric measurements were taken and conducted a 24-hour dietary recall phone interview using the multiple-pass methodology (420).

In the first pass, mothers were asked to recall the times when their child had something to eat in the past 24 hours (from midnight to just before midnight the day before the interview). In the second pass, the interviewer prompted mothers to recall the type of food and drinks given to their child, including names and brands of food and drinks offered. In the third pass, mothers were asked to estimate the amount consumed by the child while using the visual aid provided. In the fourth pass, study staff asked mothers if their child was given supplements, details of the supplements (if consumed), amount of water consumed, and if child was given other snacks that mother may have forgotten (eg: teething rusks, dips, icing, a taste of something the adults were eating etc). Finally, mothers were asked a short series of questions pertaining to salt and sugar usage in preparing foods and drinks offered to their child. The 24-hour dietary recall ended with study staff reciting the dietary information gathered for final confirmation from mothers.

Following the 24-hour dietary recall, mothers were advised of the two days to keep the food diary. The two days were selected to ensure that each child had dietary data for 2 weekdays and 1 weekend day and that all days of the week are equally represented for the study cohort. Mothers were given both verbal (in the phone interview) and written (in the diary) instructions on how to record child foods and drinks in the diary, and to record to the similar level of detail required in the 24-hour dietary recall:-

1) provide the recipes for home-cooked foods
2) give brand and product name for shop-bought foods and drinks

3) describe to the best detail the ingredients in the dishes consumed when eating out or if food was prepared by someone else (such as in childcare, party and other social situations)
4) give the best estimates of amounts consumed (mothers encouraged to use the visual aids provided for the dietary recall as guide for estimation)
5) record the time when any foods and drinks were consumed
6) record consumption of supplements, salt and sugar
7) record duration of breastfeeding and amount of formula and/or cow's milk consumed (including how formula was prepared)
8) record the amount of water consumed

Mothers mailed their completed food diaries to study staff using reply-paid envelopes provided with the diaries. Study staff checked each diary received to ensure they were recorded in adequate detail for data entry. Mothers were contacted by study staff for clarification if there was inadequate detail or ambiguity in their food diaries.

3.4.6.2 Entry and management of food data

All food data were entered into FoodWorks 2009 version 6 with AUSNUT 2007 database (421) by trained study staff. Home recipes were entered as new recipes. Commercial infant food products not available in the AUSNUT 2007 database were entered as new foods. Data for these foods was sourced from food labels and company websites. Where information on ingredients and nutrient content were missing, a product from another company with the nearest description was selected.

Food data were exported from FoodWorks into an Access database and merged with an 8 digit AUSNUT food code which allowed identification of each unique food. All home recipes and food products not available in the AUSNUT 2007 database were given new 8 digit AUSNUT food code. Codes were allocated based on the predominant ingredient, for example a chicken and vegetable home-cooked puree with 30% chicken, 60% vegetable and 10% water was allocated a code within the vegetable food group. This database was imported to SPSS version 19 (419).

3.4.6.3 Amount, frequency and variety of fruit or vegetable (3 days)

From the SPSS food database, fruits and vegetables were identified based on their 8 digit AUSNUT food codes. Amounts of fruit and vegetable consumed were calculated by totalling the grams of fruit and vegetable consumed. Frequency is defined as the number of occasions fruit or vegetable was consumed while variety is defined as the number of different sub-groups of fruits or vegetable consumed by the child. In total, twenty sub-groups of fruit and twenty-eight sub-groups of vegetables were identified (Table 3.4). Daily intakes (amount, frequency and variety) were calculated as mean of three days.

Table 3.4 Sub-groups of fruits and vegetables

Fruit	Vegetable
Apple	Pumpkin
Pear	Potato
Banana	Sweet potato
Stone fruits	Carrot
Berries	Broccoli
Citrus fruits	Peas and beans
Grapes	Zucchini
Melons	Avocado
Mango	Cauliflower
Pawpaw	Sweet corn
Pineapple	Green leafy vegetables
Kiwi fruit	Cabbage
Dried fruits	Tomato
Rhubarb	Cucumber
Dried fruits	Beetroot
Fruit dish	Capsicum
Mixed fruits	Mushroom
Commercial infant fruit	Bean sprout
Commercial infant mixed fruits	Mixed vegetables
Commercial infant fruit dish	Root vegetables
	Garlic and onion
	Legume
	Legume dish
	Commercial infant vegetables
	Commercial infant vegetable dish
	Vegetable dish
	Vegetable soup
	Pickled vegetable

3.4.6.4 Consumption of fruit and vegetable

Binary variables were created for fruit and vegetable intakes to show consumption status (consumed/did not consume) at each time point. Additional variables for fruit and vegetable consumption (consumed/did not consume) were created based on the following conditions:

i) Exclusion of commercial infant food products from the food data

ii) Exclusion of potatoes from the vegetable food group

3.4.7 Maternal fruit and vegetable intakes

Maternal fruit intake was measured from an item in the T1 and T2 questionnaires: "How many serves of fruit do you usually eat each day?" The definition of one serve of fruit was 1 medium piece of fruit or 1 cup of diced pieces. Responses were recorded as 0 serve, 1 serve, 2 serves, 3 to 4 serves and 5 or more serves.

Maternal vegetable intake was measure from an item in the T1 and T2 questionnaires: "How many serves of vegetables do you usually eat each day?" The definition of one serve of vegetable was ½ cup of cooked vegetables or 1 cup of salad vegetables. Responses were recorded as 0 serve, 1 serve, 2 serves, 3-4 serves and 5 or more serves.

3.4.8 Maternal feeding self-efficacy

Maternal feeding self- efficacy was measured using items adopted and modified from the "Self-efficacy" questionnaire from the Nutrition Education Aimed at Toddlers (NEAT) project (422). There is currently no known validated maternal self-efficacy questionnaire in feeding solids to infants and toddlers, although validated self-efficacy questionnaires have been developed in the past for self-efficacy in breastfeeding (305, 423-425).

Five of a total of eight items from the NEAT "Self-efficacy" questionnaire were used at T1 while all 8 items were used at T2. Responses were recorded on a 5-point Likert scale of 1= Not confident at all to 5= Very Confident. Modification to the items at Time 1 included the use of the term "baby" over the term "child" and re-wording of the items "I give my child healthy meals" and "I can get my child to eat enough at meals" to "I give my baby healthy foods" and "I can get my baby to eat enough". Table 3.5 shows the items measuring maternal feeding self-efficacy used in this thesis.

Table 3.5 Items measuring maternal feeding self-efficacy

Items	Time measured*	
	Time 1	Time 2
I can get my child to sit through a meal.		X
I give my child healthy meals.[a]	X	X
I can get my child to eat enough at meals.[b]	X	X
I am able to serve meals at regular times everyday.		X
I can get my child to try vegetables	X	X
I give my child the right amounts of food.	X	X
I can feed my child a meal without making dessert a reward.		X
I can get my child to taste new foods.	X	X

[a]re-worded as "I give my baby healthy foods" at Time 1.
[b]re-worded as "I can get my baby to eat enough" at Time 1.
*Time 1: 4 to 9 months, Time 2: 11 to 18 months

3.4.9 Child exposure to new foods, feeding behaviour and parenting confidence

Items measuring child exposure to new foods, feeding behaviour and parenting confidence can be found in the Time 1 and Time 2 questionnaires. Two items were used to measure child exposure to novel foods. They were adopted from the questionnaire used in an earlier study by Chan, Magarey & Daniels (426). These items require mothers to record on 5-point scales how often they offered new foods to their child and how many times a new food is offered before deciding that their child does not like the food. For measurement of child feeding behaviour, two items on child willingness to eat new foods and ease in feeding child were used while one question adopted from the Wave 1 questionnaire (Parent 2 K Cohort, Question A9) used in the Longitudinal Study of Australian Children (LSAC) (427) on maternal perception of themselves as a parent was used as a measure of parenting confidence. For analysis, descending scales were re-coded to ensure higher scores indicate higher agreement to the item. This facilitates interpretation of results from the conceptual model. Table 3.6 shows the items used to measure child exposure to new foods, feeding behaviour and parenting confidence, the original response scales for each item, the modifications to the original response scales and their final forms.

Table 3.6 Items measuring child exposure to new foods, feeding behaviour and parenting confidence in the Time 1 and Time 2 questionnaires.

Items	Original response scale	Modification	Final form
Exposure to new foods			
"How often is your child offered food s/he had never eaten before?"	1= Very often, 2=Often, 3=Sometimes, 4= Almost never, 5=Never.	Recoded	1=Never, 2=Almost never, 3=Sometimes, 4=Often, 5=Very often.
"How many times do you offer a food to your child before deciding whether s/he likes the food?"	1= Once, 2= Two to five times, 3= Six to ten times, 4=Eleven to fifteen times, 5= Sixteen or more times	None	As per original scale.
Child feeding behaviour			
"How willing is your child to eat foods s/he had never eaten before?"	1=Very willing, 2=Willing, 3=Neutral, 4=Unwilling, 5= Very unwilling.	Recoded	1= Very unwilling, 2= Unwilling, 3=Neutral, 4= Willing, 5= Very willing.
"Compared to children of similar age, my child is very easy to feed"	1= Strongly agree, 2=Agree, 3= Disagree, 4= Strongly disagree.	Recoded	1=Strongly disagree, 2=Disagree, 3= Agree, 4=Strongly agree.
Parenting confidence			
"Overall, as a parent, do you feel you are….."	1= Not very good, 2=A person who has some trouble, 3=Average, 4= Better than average, 5= Very good.	None	As per original scale.

3.4.10 Maternal psychological distress

Maternal psychological distress was measured at T1 and T2 of the study using the Kessler 10 Psychological Distress Scale (K10) (414). This popular screening tool has been studied in populations (428) and validated (414) as a screening tool for non-specific psychological distress. Unlike other screening tools commonly used in maternal studies such as the Edinburg Postnatal Depression Scale (EPDS) (429) which predominantly screens for postnatal depression, the K10 covers 7 domains of psychological distress namely depression, anhedonia, anxiety, motor agitation, worthless guilt, fatigue and the thoughts of death (414). Whilst postnatal depression may contribute to the lowering of maternal feeding self-efficacy (430), it is not the only form of psychological distress that may affect self-efficacy (431, 432). The Kessler 10 is, therefore, more suited to the purpose of this study.

K10 consists of 10-items starting with the question of "*In the past 30 days, how often did you feel……*" . Each item uses a 5-point Likert scale response with the score of 1= None of the time, 2= A little of the time, 3= Some of the time, 4= Most of the time and 5= All of the time. The 10 items in the K10 can be found in Table 3.7.

Table 3.7 Items in the Kessler 10 in the Time 1 and Time 2 questionnaires.

In the past 30 days, how often did you feel…..
- tired out for no good reason?
- nervous?
- so nervous that nothing could calm you down?
- hopeless?
- restless or fidgety?
- so restless that you could not sit still?
- depressed?
- that everything was an effort?
- so sad that nothing could cheer you up?
- worthless?

3.4.11 Child temperament

The three items measuring child irritability at T1 originate from the Short Temperament Scale for Infants (STSI) (433). This scale was adapted for use in Australia, from the Carey's Revised Infant Temperament Questionnaire (for infants 4-8 months old) (434), by the Australian Temperament Project using population data for Australian infants (435). Responses to the three items measuring "child irritability" were recorded on a 6-point Likert scale with the rating of 1= Almost never, 2= Not often, 3= Variable usually does not, 4= Variable usually does, 5= Frequently and 6= Almost always.

At T2, eight items measuring child reactivity were adopted from the Carey Short Temperament Scale for Toddlers (for toddlers 1-3.5 years old) (STST) (436). This questionnaire was also revised by the Australian Temperament Project and studied in a population sample of Australian toddlers (437). Responses to these items were recorded on a 6-point Likert Scale with the same rating used in the STSI questionnaire. Table 3.8 shows the child temperament items used in the SAIDI T1 and T2 questionnaires.

Table 3.8 Items measuring child irritability and child reactivity in the T1 and T2 questionnaires.

Time 1 (T1)
Irritability
My baby is fretful on waking up and/or going to sleep (frowns, cries).
My baby amuses self for ½ hour or more in cot or playpen (looking at mobile, playing with toy etc).
My baby continues to cry in spite of several minutes of soothing.
My baby cries when left to play alone.
Time T2 (T2)
Reactivity
My child cries after a fall or bump.
My child response to frustration intensely (screams, yells).
My child plays actively (bangs, throws, runs) with toys indoors.
My child runs to get where s/he wants to go.
My child has moody 'off' days when s/he is irritable all day.
My child shows much bodily movements (stomps, writes, swings arms) when upset or crying
My child is moody for more than for a few minutes when corrected or disciplined.
My child frowns or complains when left to play by himself/herself.

3.5 DATA ANALYSIS

This section describes statistical methods used to analyse the data used in this study, including exploration of data distribution and the methodology for the structural equation modelling to explore the proposed conceptual model. Data analysis was conducted using SPSS version 19 (419) for exploration of data distribution, descriptive analysis, Cronbach's alpha test, Wilcoxon Signed Ranked Test, Spearman's Rho and McNemar's test while MPlus version 6.11 (438) was used for confirmatory factor analysis (CFA) of categorical variables and structural equation modelling (SEM).

3.5.1 Data distribution

The distribution of each variable is critical in this study as it determines the suitability of the statistical methods used for testing the measurement and structural equation models. Further discussion on measurement and structural equation modelling (SEM) is provided in section 3.6.4.

3.5.1.1 Normality

To assess normality of the data, five outputs from the Explore option in SPSS were considered. First, normality was visually checked via a histogram of the data overlaid with a normal curve. Data are normally distributed if the histogram resembles the normal curve with smaller frequencies for extreme values (439). Second, the mean value for 5% trimmed was compared with the mean value for the full study population. If the two means are the same values, normality is assumed. Third, results from the Kolmogorov-Smirnov statistic were checked for significance. P values above 0.05 indicate non-significance and normality is assumed. Fourth, distribution of observed values was inspected against the expected value from a normal distribution in the Normal Q-Q Plot. A straight line indicates normality. Last, the box plot generated from the Explore option was visually checked to ensure distribution of observed values was similar at both sides of the middle line (median value) in the box. If distribution is not equal, data may be skewed. In this study, if data did not meet any one of the assumptions from the five tests above, they were considered skewed.

3.5.1.2 Outliers

Boxplots from the Explore option in SPSS were also checked for outliers. Additional circles outside the “whiskers” (the lines protruding out of the box) are outliers. Outliers were also visually checked by using the Descriptive and Extreme Value tables from the Explore function in SPSS. Cases contributing to outliers were individually checked to verify the validity of the data against the raw data and corrected where appropriate. They were retained in the dataset.

3.5.1.3 Missing values

Missing values were checked by running the Descriptive option in SPSS. The validity of each missing value was checked against the raw data. Cases with missing values were excluded list wise when considering the variables in the CFA and SEM.

3.5.2 Descriptive analysis

Categorical variables, responses to questionnaire items (maternal education level, marital status, gross household income level, country of birth, child gender, residence, breastfeeding status, maternal feeding self-efficacy, psychological distress, child irritability, reactivity, how often offered new foods, frequency offering a new food before deciding child does not like it, ease of feeding child, child willingness to eat new food, parenting confidence) and frequency and variety of fruits and vegetables were reported as frequencies and percentages. Additionally, data were also reported as mean (SD) if normally distributed and median with inter-quartile range (IQR) if skewed. Figures and charts were generated to visually present results from the questionnaire items.

Chi-square tests were performed to examine differences in maternal education level, country of birth and child gender between participants and non-participants of the study, as well as differences in fruit and vegetable consumption (consume or did not consume) when commercial infant products and potatoes were excluded. Independent samples t-tests were conducted to examine the differences in normally distributed continuous variables (maternal age, birth weight, weight z-score and length z-score) between participants and non-participants.

McNemar's test was conducted to test the difference in consumption status (consume/did not consume) for total fruit and vegetable intakes and for each fruit and vegetable sub-group between T1 and T2 (repeated measures). Spearman rho was used to examine correlation between frequency and variety of FV intakes while Wilcoxon Signed Ranked Test was conducted to test the T1 and T2 differences for frequency and variety of FV intakes.

Significance was set at $p<0.05$. Effect sizes were calculated and reported in this thesis to describe the substantiality of observed differences and non-differences:- eta square for independent samples t-test, Phi coefficient for 2x2 chi square tables and Cramer's V for larger chi square tables. Using Cohen's criteria for effect size, phi coefficient of 0.10 is considered as small effect, 0.30 as medium effect and 0.50 as large effect (440). Interpretation of Cramer's V is dependent on the number of categories in the row and column variables of the chi square table. Interpretation of Cramer's V was based on the criteria outlined by Gravetter and Wallnau 2013, p.615. (441).

3.5.3 Internal consistency of measured variables

Cronbach's alpha tests were conducted to examine the internal consistencies of the items measuring maternal feeding self-efficacy, psychological distress and child temperament. Alpha coefficients (α) are reported with values from 0.70 to 0.80 considered as acceptable and above 0.80 as desirable (439).

3.5.4 Structural equation modelling

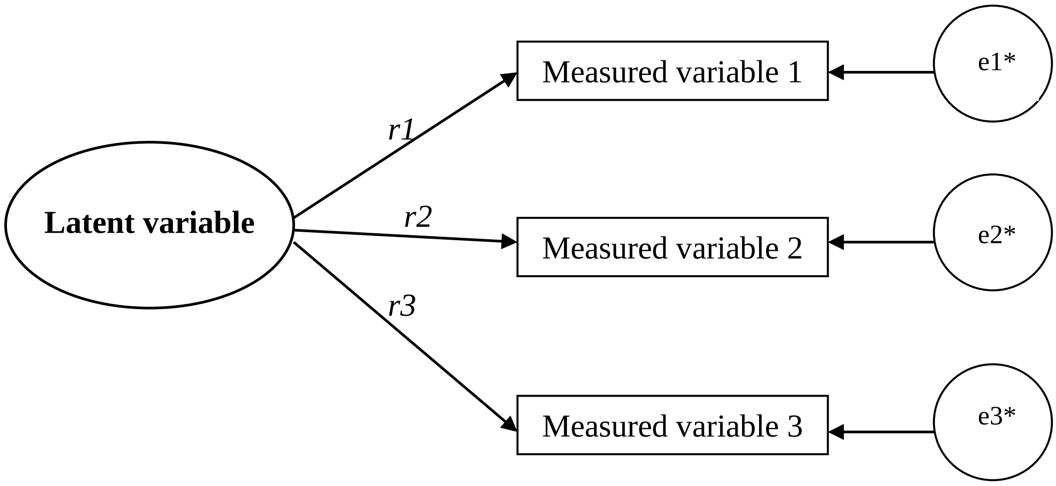
Structural equation modelling (SEM) is a technique that combines confirmatory factor analysis (CFA) and multiple regression (84) to allow examination of multi-directional relationships and causal dependencies that exist between variables of interest. When CFA is combined with exploratory factor analysis (EFA), it can also be used for exploratory purposes. However, the conceptual model tested in this thesis is theory driven. Therefore, SEM was used in a confirmatory manner. Any modifications to the model were based on theoretical sense rather than the use of modification indices, which are discussed further in section 3.5.4.5.

3.5.4.1 Important terminology in SEM

Discussions of SEM should begin with explanation of terminology used in reporting results. Observed variables in SEM are also referred to as measured variables and are graphically depicted using squares or rectangles while unobserved variables are also referred to as latent variables, and are depicted using circles or ovals (84). Exogenous variables (similar to independent variables) are variables that exert influence on other variables under study but are not influenced by other variables in the model. Endogenous variables (similar to dependent or outcome variables) are influenced by exogenous variables and other endogenous variables under study (84). Measurement error refers to the discrepancy between a measured value and its true value and is depicted as a small circle with an arrow pointing to the measured variable (see Figure 3.3). Measurement errors can be un-standardised or standardised. Only standardised measurement errors are reported in this thesis. Standard estimate or factor loading is the correlation coefficient (*r*) and shows the strength of the relationship between two variables under study.

3.5.4.2 Measurement models

The two components in SEM are the measurement model and structural model. In this thesis, SEM is used as a confirmatory technique which first requires the measurement models to be correctly fitted. To construct a measurement model, CFA is used to derive the latent variable from observed/measured variables (84). This technique is also referred to as 'latent variable modelling'. Measurement errors are accounted for in the construction of latent variables (84). Figure 3.2 shows an example of latent variable modelling using the CFA method that forms a measurement model for SEM.



*standardised measurement errors
r factor loadings

Figure 3.2 Example of latent variable modelling with three measured variables contributing to the measurement of one latent variable.

3.5.4.3 SEM with categorical data

Categorical and skewed data are not suited for SEM using Amos 19 (442) as it assumes normality, linearity and absence of outliers (443). It is a parametric technique that uses the Pearson method for correlation and estimation of variances (444). When skewed, categorical variables are forced into ‘traditional’ structural equation models, a distorted analysis follows (444) which produces biased results in terms of model fit, parameter estimates and their associated significance tests (443).

The use of bootstrapping (445) in SPSS Amos may account for some of the errors associated with the violation of parametric assumptions. Bootstrapping is a resampling method that treats the observed data as an estimate of the population (443). It can be used for estimating standard errors, sampling distribution and constructing hypothesis tests (445). It is usually used when parametric assumption is doubted or not possible but has been criticised as being overly optimistic in its estimation of variances (446, 447).

To address the limitations of SPSS Amos, Mplus was used to perform SEM with categorical data. SEM using Mplus takes into account that data may not be normally distributed. It uses a polychoric correlation matrix (444) rather than a covariance matrix as found in SPSS Amos. Put simply, SEM using Mplus assumes that for each categorical variable, there is an underlying continuous variable (polychoric correlation). It is this underlying continuous variable that is used in the analysis and not the observed variable. Therefore, this technique is also known as “underlying response variable approach” (448) and forms the basis for the latent variable modelling for categorical variables. Therefore, SEM using Mplus has the ability to estimate threshold measurements that account for the expected value of a latent variable (444) as the respondent transitions from one response to another within a categorical variable. A variable with N number of categories will have N-1 thresholds. Therefore, on a five-point rating scale (for example), the first threshold represents the expected value at which a respondent is most likely to transition from a value of zero to a value of one. The second threshold represents the expected value at which a respondent is most likely to transition from a value of one to two. In total, a five-point rating scale would have four thresholds. Therefore, thresholds connect each observed variable to a latent continuous response variable.

Graphical depiction of SEM uses a single headed arrow to show direction of a relationship and a double-headed arrow to show correlation between two variables. Figure 3.3 shows an example of a structural equation modelling with one exogenous measured variable, three endogenous measured variables and one endogenous latent variable.

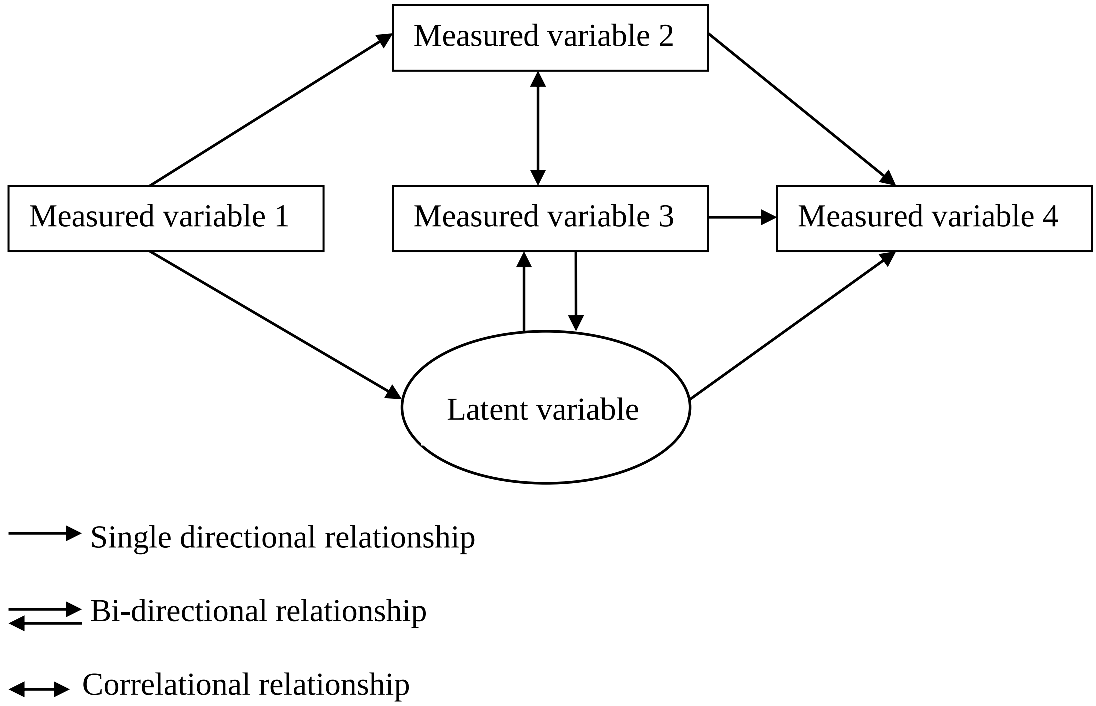


Figure 3.3 Example of structural equation modelling with four measured variables and one latent variable.

3.5.4.4 Method for model estimation

Mplus version 6 offers a number of model estimation methods such as maximum likelihood (ML), weighted least square (WLS), weighted least square mean adjusted (WLSM) and weighted least square mean and variance adjusted (WLSMV). Model estimation using ML assumes normality of distribution and is not a robust method for non-parametric estimations for SEM with categorical data (443). Unlike the ML method; WLS, WLSM and WLSMV methods use an asymptomatic covariance matrix for the estimation of standard estimates and standard errors (443). WLS, however, requires an assumption of bivariate normality of the underlying variable and like ML, requires a large sample size due to its computational demands (443). Both the WLSM and WLSMV address this problem and thus avoid the necessity for a large sample size, a characteristic ideal for this thesis with a sample size of 277 at Time 1. WLSMV, however, differs from WLSM in that the χ^2 is both mean and variance adjusted (443). Therefore, WLSMV was selected as the method for model estimation.

3.5.4.5 Model fit indices

Model fit indices provide a standard for comparing the observed model against the hypothetical and/or null model as a basis for rejecting or accepting the observed model. Depending on its type, model fit indices can be sensitive to sample size, model estimation method and model specification (449). There is currently no consensus on which model fit index is preferred although χ^2 (chi-square), Tucker-Lewis Index (TLI) and Comparative Fit Index (CFI) are popularly reported in studies using SEM (84).

The chi-square (χ^2) statistic is a conventional overall test of fit that assesses the extent of discrepancy between the sample and fitted covariance matrices (450). It is a dichotomous decision strategy (absolute fit index) where a model with a small χ^2 value is a better fitting model than one producing a larger χ^2 value. The degree of sensitivity of the χ^2 statistic depends on the distributional assumptions (450). Chi-square test generated from the ML method assumed multivariate normality of variables and is therefore unsuited for assessing model fit of a non-parametric model. The χ^2 values generated from the WLSMV method cannot be used as they are because the difference in χ^2 values for two nested models using the WLSMV chi-square values in not distributed as χ^2 (451). A two- step procedure was required to obtain the correct χ^2 difference test where the null model (H_0) is compared against a less restrictive alternative model (H_a) (451). To achieve this, the DIFFTEST of the ANALYSIS command and SAVEDATA options were used in Mplus. An example of the Mplus syntax for this is provided in Appendix 3. Another weakness of the χ^2 statistic is its dependence on sample size where even the smallest of discrepancies can lead to rejection of an otherwise acceptable model in large samples (452, 453). The effect of sample size in χ^2 statistic is even more pronounced when complex models were considered (452).

Two more examples of commonly used absolute fit indices are the Root Mean Square Error of Approximation (RMSEA) and the Weighted Root Mean Square Residual (WRMR). RMSEA is a population-based index that measures the discrepancy between the hypothesised model and the observed data while taking into account the number of free parameters in the model (454). The attractiveness of the RMSEA compared to the χ^2 statistic is its association with the non-central χ^2 distribution (455). However, Mplus output does not provide confidence intervals to assess precision of RMSEA values. Therefore, RMSEA values are reported without confidence intervals in this thesis. Similar to the RMSEA, the WRMR is an absolute fit index calculated from difference between predicted and observed values. However, WRMR differs from RMSEA in that WRMR reflects the difference between predicted and observed variances and co-variances in the model, based on weighted residuals. Therefore, the smaller the WRMR value (the smaller the difference), the better the model fit.

Absolute fit indices such as chi-square statistics, RMSEA and WRMR have been criticised as being sensitive to sample size and distributional misspecification, lending voice to an alternate group of fit indices that rely on proportionate improvement in fit by comparing a target model against a more restricted, nested baseline model (456). This group of fit indices are known as incremental fit indices and consists of the Normed Fit Index (NFI), Incremental Fit Index (IFI), Tucker-Lewis Index (TLI), Comparative Fit Index (CFI) and Relative Non-centrality Fit Index (RNI), to name a few. Amongst these, the TLI (also known as Non-normed Fit Index, NNFI) and CFI (also known as Bentler's Fit Index) have gained popularity of use since their introduction by Tucker & Lewis in 1973 (457) and Bentler in 1989 (458), respectively.

The TLI is derived by comparing a hypothesised model with a correctly defined null model. The higher the TLI value, the better the model fit with the value of one indicating perfect fit. TLI is particularly useful in testing nested models because it adjusts for model complexity while taking into account parsimony and goodness of fit (459).

The CFI compares the predicted covariance matrix against the observed co-variance matrix to determine the proportion of lack of fit which was addressed when moving from the null model to the hypothesised model. Like TLI, the CFI values ranged from zero to one with values closer to one indicating good fit. For example, a CFI value of 0.95 indicates that 95 per cent of the co-variation in the data can be explained by the hypothesised model.

All the model fit indices available from the MPlus version 6 (460) output, namely χ^2, TLI, CFI, RMSEA and WRMR are reported in this thesis. Models are considered well fitted if the ratio of χ^2 to degrees of freedom (df) is <2, TLI ≥ 0.95, CFI ≥ 0.95, RMSEA < 0.06 to 0.08 and WRMR <0.90 (84).

3.5.4.6 Modification indices

Model modifications to the hypothesised model can be made after examination of the standardised estimates and model fit indices (MI) to produce a better fitting or parsimonious model through various modification tests such as chi-square, Wald and Lagrange (84). As the models tested in this thesis are theory-driven (confirmatory), modifications made to the hypothesised models were based on theoretical sense and not because analyses from modification tests indicated addition or subtraction of a variable from the model would improve the fit of the model. The rationale for modifications made to the measurement models and hypothetical models are discussed in chapters 6 and 7.

3.5.4.7 Method for parameterisation

There are two methods for parameterisation available in Mplus version 6 (460); delta parameterisation and theta parameterisation. Delta parameterisation is the default option in Mplus because it has been found to perform better in many situations (451). In delta parameterisation, threshold values are used as parameters in the model estimation while theta parameterisation uses the residual variances for the underlying continuous latent variable as parameters in the model estimation. Delta parameterisation was used for the measurement models. However, for the structural equation models, theta parameterisation was used because the models imposed improper parameter constraints with delta parameterisation. Theta parameterisation is preferred when a categorical dependent variable is both influenced by and influences either another observed categorical dependent variable or a latent variable (451); which applies to the SEM model proposed in this thesis.

3.5.5 Summary of statistical tests

Statistical tests were selected after consideration of the thesis aims and data distribution. To summarise, table 3.9 shows the variables reported and their corresponding type of statistical analyses conducted. Effect sizes were obtained from SPSS outputs where possible or calculated (for Wilcoxon Signed Rank Test and Independent samples t-test).

Table 3.9 Summary of variables and their corresponding type of analysis.

Type of statistical analysis	Effect size[¶]	Variables involved
Frequency	-	Breastfeeding status, residence
Frequency and chi-square test (χ^2)	χ^2: Phi coefficient (ϕ)	Fruit consumption status (with and without commercial food products, at least once, all three days), Vegetable consumption status (with and without commercial food products, with and without potatoes, at least once, all three days)
Frequency and SEM[a]	-	Maternal level of education, marital status, country of birth, gross family income, child gender, how often offered new foods, frequency offering a new food before deciding child does not like it, ease of feeding child, child willingness to eat new food, parenting confidence.
Frequency and median (IQR[b])	-	Frequency and variety of fruit intake, frequency and variety of vegetable intake.
Frequency, median (IQR), CFA[c] and SEM[a]	-	Maternal feeding self-efficacy, psychological distress, child irritability, reactivity.
Mean (SD[d])	-	Child age, weight z-score, length z-score.
Mean (SD[d]) and SEM[a]	-	Maternal age, total number of children, age of introduction of solids.
Independent samples t-test (t)	$\eta^2 = t^2/t2 + (n1 + n2 -2)$	Maternal age, child weight z-score*, length z-score*: participants versus non-participants
Chi-square test (χ^2)	Phi coefficient (ϕ) (2x2 table); Cramer's V (V)	Maternal level of education, marital status, country of birth, gross family income*, child gender: participants versus non-participants
Wilcoxon Signed Rank Test (z) and Spearman's Rho (r_s)	Wilcoxon Signed Rank Test: $r = z/\ n^2$	Fruit and vegetable intakes (frequency, variety and amount)
McNemar's Test (χ^2)	Phi coefficient (ϕ)	Fruit and vegetable intakes (total): consumers versus non-consumers between Time 1 and Time 2

[¶]from SPSS Survival Manual (440), *r* or η^2 = effect size = effect size, n= number of cases, ; [a]Structural Equation Modelling; [b]Inter-quartile Range; [c]Confirmatory Factor Analysis; [d]Standard Deviation; *Time 2 only.

CHAPTER FOUR: THE STUDY'S COHORT

In this chapter, study response rates, demographic characteristics and feeding practices of the study cohort are described and discussed.

4.1 RESPONSE RATES

Figure 4.1 summarises participation rates from recruitment to T2 of this study. Of the 1119 eligible mother-child dyads that were approached, 796 mother-child dyads expressed interest in the SAIDI study and gave consent for study staff to contact them when their child was turning 6 months old. Three hundred and three (38.1% consent rate, 27.1% of eligible dyads) gave consent to participate in the study when contacted at this point. Of those who did not consent, 342 of them provided reasons (Table 4.1). The main reasons for declining participation were time and other commitments (n=145), and returning to work (n=55).

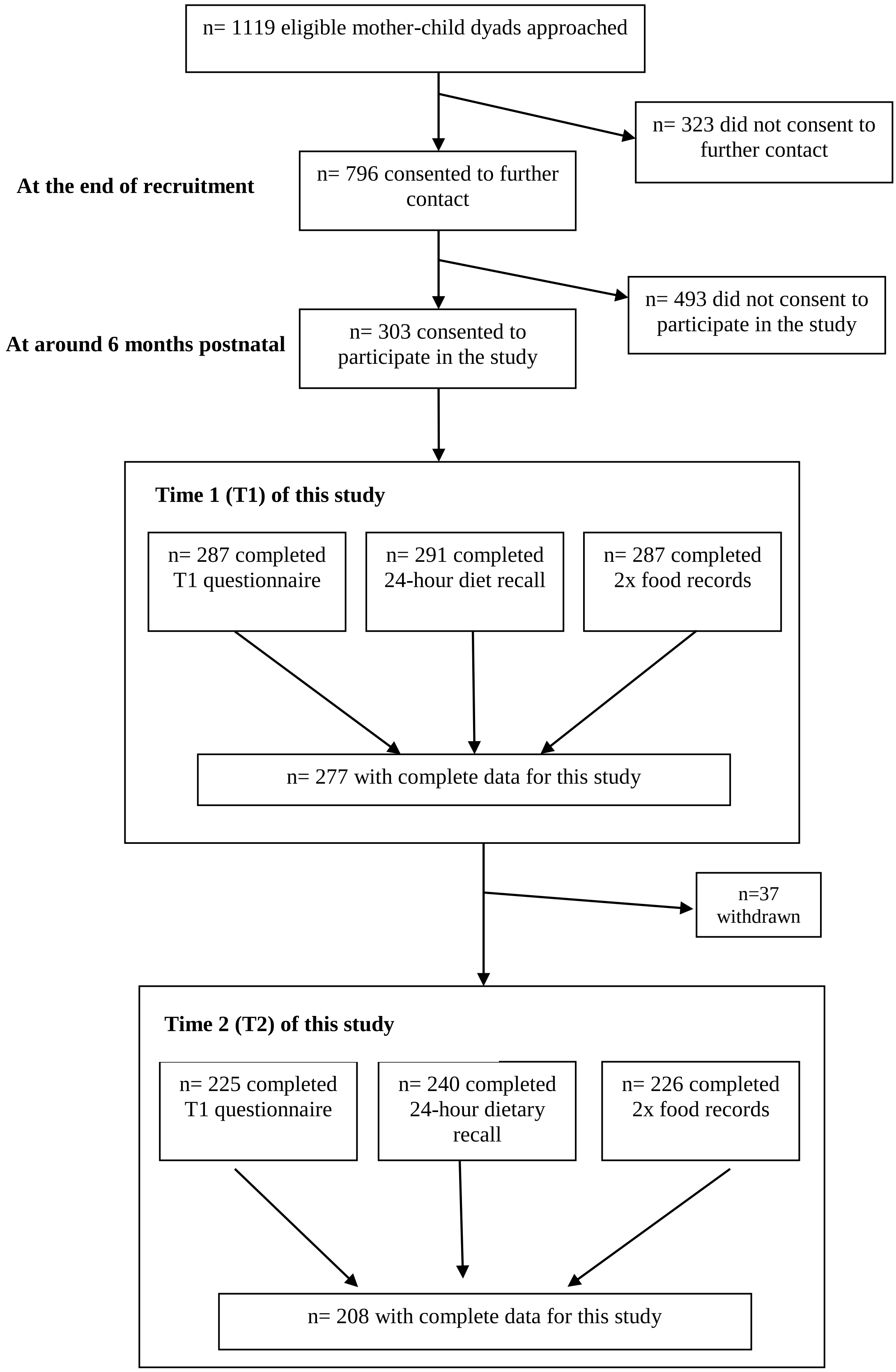


Figure 4.1 Flow diagram showing participation rates from recruitment to Time 2 of this study.

Table 4.1 Reasons for not participating in the study (n=342).

Reason	n(%)
Time and other family commitments	145(42.3)
Mother return to work	55(16.1)
Going away/Not available to attend assessments	35(10.2)
No transport to attend assessments	31(9.1)
No longer interested in study	31(9.1)
Family/Child's poor health	13(3.8)
Mother's own poor health	9(2.6)
Moving inter-state or to another country	8(2.3)
Do not need advice on feeding	6(1.8)
Participation in other early feeding studies	4(1.2)
No support from partner to participate in the study	2(0.6)
Legal issues concerning guardianship of child	2(0.6)
Poor English	1(0.3)

Thirty-seven participants withdrew from the study at T2; a retention rate of 86.6%. For the purpose of this thesis, only mothers who provided complete data for dietary intake (24-hours dietary recall and 2 x food records) and questionnaire items are included. A total of 32 participants were excluded from the study at T2 because of incomplete data leaving 208 participants at T2. Therefore, the final participation figures for this study were 277 and 208 mother-child dyads at T1 and T2 respectively, equating to 91.4% (T1) and 68.6% (T2) of those consenting to SAIDI study participation.

4.2 PARTICIPANT CHARACTERISTICS

4.2.1 Socio-demographic

Participant characteristics and differences between the characteristics of participants and non-participants at T1 of the study are detailed in Table 4.2. Of the 1119 eligible dyads approached, 105 of the 816 non-participants did not provide complete socio-demographic data. They are excluded from analysis. Therefore, the total number of non-participants with complete data is 711.

The mean (SD) age of participating mothers at the time of child's birth was 32 (5.2) year. A majority of mothers who consented had qualifications beyond Year 12 education (n=201, 72.6%), had a gross household income above $961 per week (n=194, 69.8%), were partnered (n=266, 96.0%), were born in Australia (n=245, 88.4%), had no more than 2 children at the time of the study (n= 204, 73.7%) and lived in metropolitan Adelaide (n=182, 65.7%). Mothers who participated in this study are also significantly older ($p<0.001$, $\eta^2= 0.08$) and higher educated ($p<0.001$, Cramer's V= 0.30) than mothers who declined to be in the study.

At T2, there was a significantly higher proportion ($p=0.02$) of mothers aged ≥ 25 years old (n=197, 94.7%) continuing in the study versus mothers who withdrew from the study (n=55, 79.6%). However, the effect size of this difference is small ($\eta^2=0.02$). No other socio-demographic differences were found at T2.

Table 4.2 The differences in socio-demographic characteristics between participants (n=277) and non-participants (n=711[§]) at Time 1 of the study.

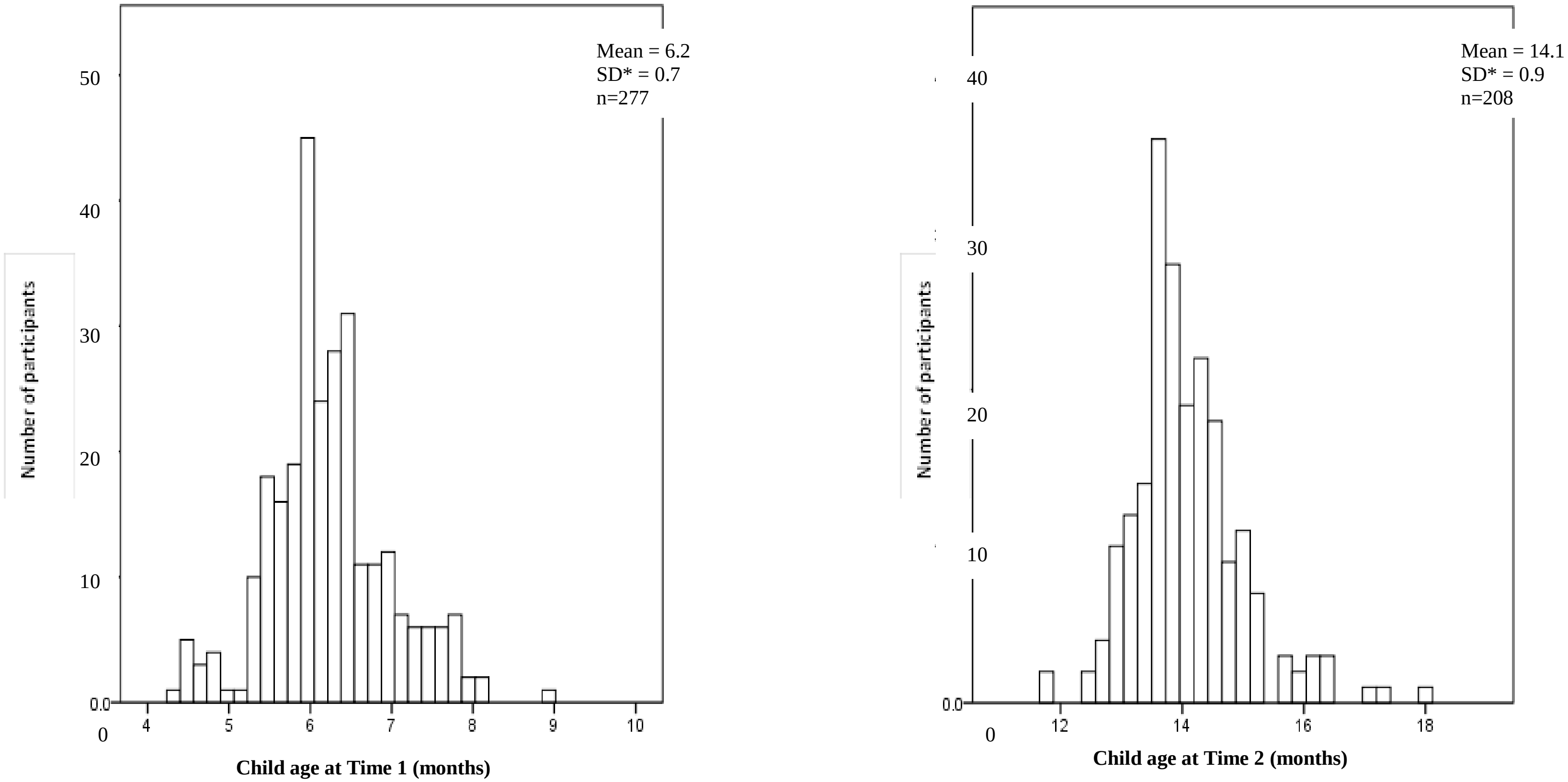
Characteristics	Participants	Non-participants[€]	p value[a]	Effect size[b]
	n (%)	n (%)		
Maternal characteristics				
Age (years)				
18-24	19 (6.9)	190 (26.7)		
25-30	83(30.0)	252 (35.4)		
31-35	98(35.3)	168 (23.6)		
36-40	63(22.7)	84 (11.8)		
>40	14 (5.1)	17 (2.4)		
[Mean ± SD]	[32.0 ± 5.2]	[28.4 ± 5.7]	<0.001	0.08
Education level				
< Year 10	2 (0.7)	39 (5.5)	<0.001	0.30
Year 10/11	31 (11.2)	218 (30.7)		
Year 12	43 (15.5)	157 (22.1)		
Trade/Apprenticeship	9 (3.3)	18 (2.5)		
TAFE	90 (32.5)	152 (21.4)		
University	102(36.8)	127 (17.8)		
Gross household income (per week)[c, d]				
$ 0-385	9 (3.2)	-	-	-
$ 386-673	23 (8.3)	-		
$ 674-961	44 (15.8)	-		
$ 962-1346	65 (23.4)	-		
$ 1347-1923	81 (29.1)	-		
> $ 1923 per week	48 (17.3)	-		
Marital status[¶]				
Partnered	266 (96.0)	604 (85.0)	<0.001	0.16
Not partnered	11 (4.0)	107 (15.0)		
Country of birth				
Australia	245 (88.4)	625 (87.9)	0.48	0.05
Others*	32 (11.6)	86 (12.1)		
Total number of children**				
1-2	204 (73.7)	491 (69.0)		
3-4	69 (24.9)	189 (26.6)		
>4	4 (1.4)	31 (4.4)		
[Mean ± SD]	[2.0± 0.9]	[2.2±1.1]	0.01	0.01
Region of residence				
Metropolitan	182 (65.7)	509 (71.6)	0.04	-0.06
Regional	95 (34.3)	202 (28.4)		

Table 4.2 continued.

Characteristics	Participants	Non-participants[€]	p value[a]	Effect size[b]
	n (%)	n (%)		
Child characteristics				
Gender				
Male	127 (45.8)	330 (46.4)	0.77	-0.01
Female	150 (54.2)	381 (53.6)		
Gestation age (weeks)				
37-40	238 (85.9)	641 (90.2)		
>40	39 (14.1)	70 (9.8)		
[Mean ± SD]	[39.3 ±1.2]	[39.1±1.1]	0.97	<0.001
Birth weight (kg)				
2.5-3.0	30 (10.8)	109 (15.3)		
>3.0-3.5	101 (36.5)	296 (41.6)		
>3.5-4.0	97 (35.0)	220 (30.9)		
>4.0-4.5	40 (14.4)	79 (11.1)		
>4.5	9 (3.2)	7 (1.0)		
[Mean ± SD]	[3.57 ±0.46]	[3.45 ± 0.44]	<0.001	0.01

[§] number of non-participants providing complete socio-demographic data
[€] refers to eligible mother-child dyads that did not participate in the study
[a] p value derived from independent samples t-test (for continuous data) and chi square test (for categorical data)
[b] effect size: eta square (η^2) calculated for independent samples t-test, Phi coefficient for 2x2 chi square table and Cramer's V for larger chi square tables
[c] no data collected from non-participants
[d] contains missing data
[¶]Partnered: married/defacto; Not partnered: single/divorced/separated/widowed
* includes participants born in UK, Europe, US, China, Japan, Southeast Asian countries and Africa
** study child included.

The mean (SD) age of children at T1 was 6.2 (0.8) months and 14.1 (0.9) months at T2. Figure 4.2 shows the distribution of age of children (by months) at T1 and T2. Age ranged from 4.7 to 9 months at T1 and from 11.8 to 18 months at T2. At T1, nineteen children (6.9%) were aged between 7 to 9 months while only three were aged 4.7 months (1.1%). At T2, fourteen children (6.7%) were aged between 16 to 18 months while only four children (2.0%) were aged 11.8 months. Mean (SD) z-scores for children's weight and length at T1 were 0.1 (1.1) and 0.2 (1.4) respectively while mean (SD) z-scores for children weight and length at T2 were 0.4 (0.9) and 0.2 (1.2) respectively.



*SD = standard deviation

Figure 4.2 Distribution of child age at Time 1 (n=277) and Time 2 (n=208).

4.2.2 Feeding practices

At T1, 72% (n=199) of the children were still being breastfed. This proportion decreased to 26% (n=55) at T2. Mean (SD) for breastfeeding duration reported by mothers at T2 was 21.1 (9.8) weeks. The mean age at which children were introduced to solids was 21.0 (3.8) weeks with 238 (86%) between 17 and 26 weeks, 31 (11.2%) before 17 weeks and 8 (2.8%) after 26 weeks.

4.2.3 Child exposure to novel foods, feeding behaviour and parenting confidence

Table 4.3 below shows the number and proportion of maternal responses to the variables measuring how often mothers offered new foods, how many times mothers offered a new food before deciding child dislike it, child how willing to eat new foods, how easy to feed child compared with other children of same age and parenting confidence. Most mothers reported that they offered new foods to their children often to very often (T1: 69.3%, T2: 70.7%), have children who were willing to very willing to eat new foods (T1: 78.3%, T2: 83.1%), perceived their children to be easy to very easy to feed (T1: 84.1%, T2: 85.1%) and felt that they were better than average to very good parents (T1: 73.6%, T2: 70.2%). At T1, most mothers in this study offered a new food two to five times before deciding their children disliked the food (63.2%). The frequency of repeated exposures of a novel food increased at T2 with most mothers offering a new food at least six times before deciding that their children did not like the food (91.3%).

Table 4.3 Number and proportion of responses to variables measuring child exposure to novel foods, feeding behaviour and parenting confidence at Time 1 (n=277) and Time 2 (n=208).

Measure:	n (%):	
	Time 1	Time 2
How often offer new foods:		
Never	2 (0.7)	0 (0.0)
Almost never	3 (1.1)	1 (0.5)
Sometimes	80 (28.9)	60 (28.8)
Often	127 (45.8)	111 (53.4)
Very often	65 (23.5)	36 (17.3)
How many times offer a new food before deciding child does not like it:		
Once	12 (4.3)	4 (2.0)
2-5 times	175 (63.2)	14 (6.7)
6-10 times	67 (24.2)	104 (50.0)
11-15 times	13 (4.7)	61 (29.3)
≥16 times	10 (3.6)	25 (12.0)
Child how willing to feed new foods:		
Very unwilling	1 (0.4)	1 (0.5)
Unwilling	7 (2.5)	7 (3.4)
Neutral	52 (18.8)	27 (13.0)
Willing	89 (32.1)	100 (48.1)
Very willing	128 (46.2)	73 (35.0)
Child easy to feed compared to other child of same age:		
Strongly disagree	3 (1.1)	3 (1.4)
Disagree	41(14.8)	28 (13.5)
Agree	135 (48.8)	91 (43.8)
Strongly agree	98 (35.3)	86 (41.3)
"Overall, as a parent, do you feel you are….."		
Not very good	0 (0.0)	0 (0.0)
A person who has some trouble	3 (1.1)	5 (2.4)
Average	70 (25.3)	57 (27.4)
Better than average	106 (38.3)	80 (38.5)
Very good	98 (35.3)	66 (31.7)

4.4 DISCUSSION

Comparisons of the socio-demographic characteristics of the study cohort against the state and national populations (Table 4.3) revealed that the mothers in this study were slightly older, more highly educated and Australian born. The proportion of mothers in this study born in countries where English is not the first language is very low (n=11 ,0.04%), compared with the state and national proportions of households where two or more languages are spoken (14.1% and 20.4% respectively) (461). The greater proportion of mothers with post-school education, speak English as their first language and are Australian born can be attributed to the study's requirements that mothers must be able to speak and write fluently in English in order to complete all of the study's assessment criteria.

There were slightly more female children enrolled in this study (n=148, 53.2%) than males (n=126, 45.3%), which is contrary to the slightly higher male to female ratio (1.1:1.0) of babies born in South Australia and Australia in the similar time period (462). Children's mean (SD) birth weight was 3.57 (0.46) kg, a slightly higher mean compared with the mean birth weight of children from the state and national populations (463). The exclusion of children with birth weight under 2500g in this study explains this difference. Further demographic comparisons of this study's cohort against state and national populations can be found in Table 4.4. State and national statistics were obtained from census statistics available through the Australian Bureau of Statistics (ABS) between year 2008 to 2009 (study period) (461, 463-467) while South Australian child weight statistic was obtained from the South Australian perinatal statistics reported in the same period of time (462).

Table 4.4 Comparisons of socio-demographic characteristics of study participants against state and national populations

Characteristic	Study cohort	South Australia	Australia
Maternal age	Mean age= 32 years	Median child-bearing age = 30.3 years[a]	Median child-bearing age = 30.7 years[b]
Maternal education level (Post-high school qualifications)	72.7%	24.4% [c]	24.1% [c]
Mother's country of birth (Australian born)	87.1%	74.9% of census population[d], 84.1% of mothers [g]	76% of the census population [b], 72.8% mothers [g]
Mother's marital status (Married/Partnered)	75.2%	51% of census population [c]	68% of mothers[e]
Gross household income	>$961 per week (n=194, 69.8%)	Median = $905 per week[b]	Median = $1040 per week[b]
Total number of children*	70.1% have 1-2 children	Fertility rate of 1.92 children per woman[a]	Fertility rate of 1.97 children per woman[f]
Region of residence (Metropolitan residence)	64.4%	72.7% [c]	68.4% [b]
Child gender	46% males and 53% females (0.9:1.0)	52% males and 48% females (1.1:1.0)[g]	51.4% males and 48.5% females (1.1:1.0)[g]
Mean child birth weight	3.57kg	3.34kg[g]	3.37kg[e]

sources: [a]ABS catalogue 1345.4 (464); [b]ABS catalogue1301.0 (465); [c]ABS Quickstats 2011(461); [d]ABS catalogue 2030.4 (466); [e]ABS catalogue 4102.0 (463); [f]ABS catalogue 3301.0 (467), [g]Li Z et al 2011(462)
*includes study child

The proportions of children still being breastfed at T1 and T2 of this study are higher compared with the proportion of children still being breastfed at 6 months and 13-18 months in the 2010 Australian National Infant Feeding survey (60.1% and 18.2% respectively) and in other studies and national surveys (468-473). However, caution is required in interpreting this as there are younger children included in this study at T1 (4.7 to 9 months) and T2 (11.8 to 18 months) that may have contributed to the differences.

In Australia, mothers are recommended to breastfeed *"..until 12 months of age and beyond, for as long as the mother and child desire."* (106, 474). Sustained breastfeeding beyond 12 months is more common in developing countries such as sub-Saharan Africa, Asia and South America where around 40% to 63% of children who were breastfed as infants were still breastfeeding at 2 years of age (475). However, breastfeeding beyond 12 months is not as commonly practiced in developed countries such as Australia due to the social stigma attached to breastfeeding an older child (475, 476).

Exploration of social attitudes of health workers and opinions of breastfeeding mothers in developed countries concluded that social stigmatisation increased dramatically with the increase of child age (477) and that mothers needed to be extremely determined and confident in weathering the challenges of breastfeeding in the face of social marginalisation in order to successfully continue to breastfeed an older child (478). Despite growing evidence showing health benefits to both the mother and child when breastfeeding is continued beyond 6 months (475), there is limited evidence to support health benefits of sustained breastfeeding in developed countries; most likely because of the shorter durations of breastfeeding reported (468-473) limiting the ability of researchers to determine the long-term health effects of sustained breastfeeding in developed nations.

Globally, there are some variations in the guidelines on complementary feeding ranging from introduction of solids at 4 to 6 months (479), at 6 months of age (480) to at around 6 months of age (481, 482). In Australia, past and current guidelines consistently recommend that solid foods should be introduced at around 6 months of age (474, 482). A majority of mothers in this study (86%) introduced solids to their children between 17 and 26 weeks (4 to 6 months) with 11.2% introduced solids earlier than 4 months and 2.8% after 6 months of age. Children in this study were also of similar age when solids were introduced (mean age= 21 weeks or 4.9 months) as the cohort in the 2010 Australian National Infant Feeding survey (median age = 4.7 months) (472). Younger mothers, mothers speaking languages other than English and being less educated are known risk factors associated with introduction of solids before 4 months of age (472, 483-485). Therefore, the high proportion of mothers introducing solids between 4 to 6 months observed in this study is expected given that a majority of mothers in this study were older, English speaking and highly educated

Most mothers in this study reported that they are confident parents and had positive views regarding their children's feeding behaviours. This may be due to two reasons: over- reporting of positive behaviours and perceptions due to the voluntary and self-reporting nature of this study, and systematic bias in the responses provided due to the recruitment criteria where only healthy mother-child dyads were recruited into this study. Positivity or social desirable response bias is common in studies relying on self-report measures, especially in questions containing socially sensitive items (eg: self-report of confidence as a parent) (486). For instance, in a study comparing parental and child self-reports of child temperament in children aged 4 to 11 years, Lagutta and colleagues concluded that parents significantly underestimated their children's worry and anxiety, and significantly overestimated their children's feelings of optimism (487). Clearly, positivity bias cannot be overlooked in the interpretation of self-report data from parents.

The analysis from the repeated exposure variable ("how frequent offer a new food before deciding child does not like it") reveals some interesting results. Despite the established role of repeated exposures in promoting food acceptance in children (35), a majority of the mothers in this study only offered a novel food between two to five times at T1 before deciding their children do not like it. Moreover, nine mothers reported that they only offered novel food once before deciding their children did not like the food. These results, however, are consistent with evidence from the literature where mothers were generally found to offer novel foods a limited amount of times (around five times) before deciding their children do not like the food (35).

At T2, however, most mothers in this study reported that they offered a new food at least six times before deciding their children do not like it. The reason for this change is unclear. It may be due to the change in the quality of mother-child interaction or the change in parenting style associated with parenting an older child or reporting bias.

4.5 CONCLUSION

Around a third of mothers approached for the study consented to participate and of these 86.6% remained in this study at T2. The mothers in this study are older, mostly Australian born and characterised by high levels of education. This limits the generalisability of findings in this study. Other socio-economic indicators such as level of household income and total number of children were comparable to state and national census data. A majority of mothers in this study stopped breastfeeding before 12 months and most children were introduced to solids between 17 to 26 weeks of age. Most mothers reported that they are confident parents and have positive perceptions of their children's feeding behaviour. Despite the homogeneity of findings due to recruitment bias, there are many strengths to the sample including the contemporaneous data collection method which reduces recall bias, captures the current socioeconomic situations and feeding practices of the participants, and the low attrition rate between T1 and T2.

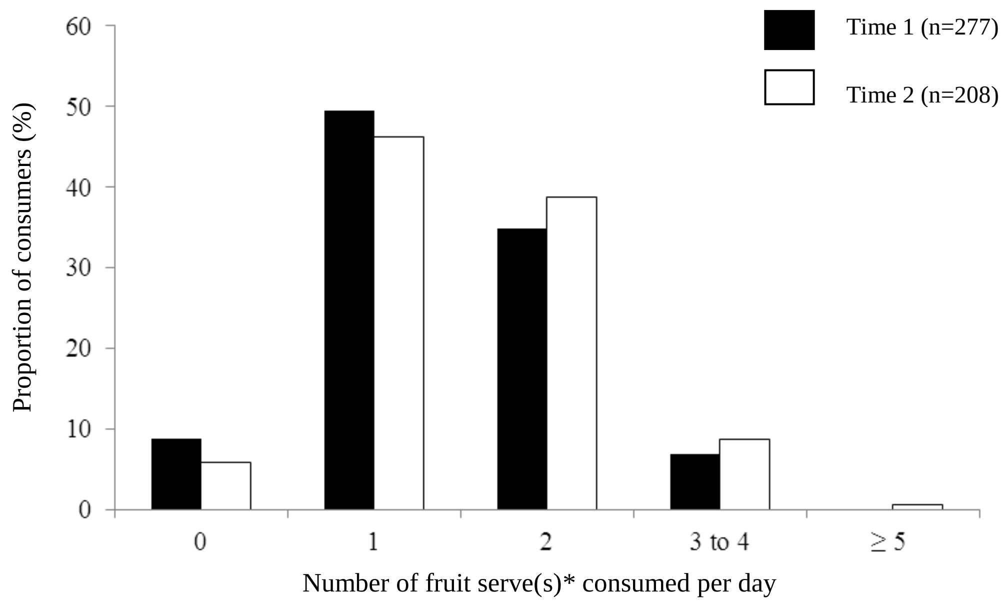
CHAPTER FIVE: FRUIT AND VEGETABLE INTAKES

This chapter describes maternal and child fruit and vegetable intakes and the trend of child intakes between Time 1 and Time 2. Child intakes are discussed in reference to guidelines and published literature.

5.1 FRUIT INTAKE

5.1.1 Maternal intake

Figure 5.1 shows the proportion of fruit consumers according to the category of serves of fruit consumed at T1 and T2. Almost half the mothers reported consuming 1 serve of fruit per day at T1 (49.5%, n=137) and T2 (46.2%, n=96). Around 42% (n=116) at T1 and 48% (n=99) at T2 consumed ≥2 serves of fruits/day. There were also 24 (8.7%) mothers who reported not consuming any fruit at T1. This number decreased to 12 at T2 (5.8%).



***1 serve of fruit = 150g fresh fruit or 125ml 100% fruit juice or 30g dried fruit (114).**

Figure 5.1 Maternal consumption of fruit.

5.1.2 Child intake

5.1.2.1 Proportion of fruit consumers, grams and serves consumed

Table 5.1 reports the proportion of fruit consumers and the amount of fruit consumed at T1 and T2. A majority of children consumed fruit at least once in the three days of dietary assessment at T1 (n=240, 86.6%). This proportion increased to 88.9% (n=185) at T2 but the increase was not statistically significant (χ^2= 1.2, p =0.27, ϕ= 0.08). In the three days of intake, 181 (65.3%) at T1 and 115 (55.3%) at T2 consumed fruit every day. This decrease was not significant (χ^2 = 2.9, p=0.10, ϕ = 0.12). Thus, the proportion of fruit consumers (consumed at least once and consumed all 3 days) tracked between T1 and T2.

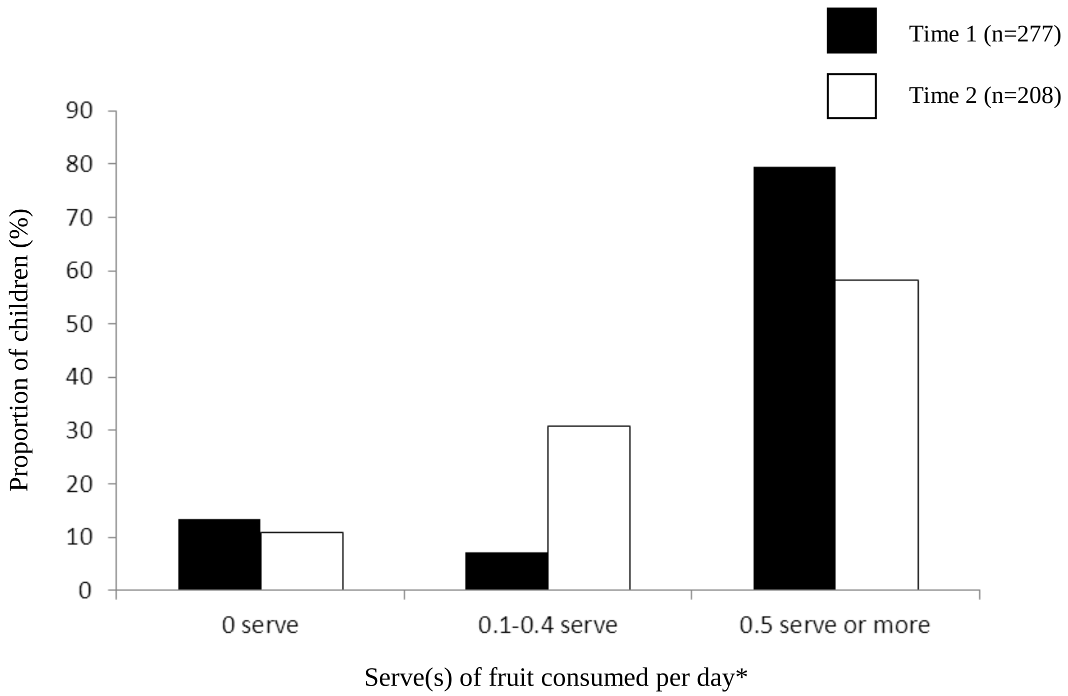
Between T1 and T2, the amount of fruit consumed per day increased (Table 5.1). This increase although significant ($z=2.27$, $p<0.05$), has a small effect size ($r=0.16$). When commercial infant fruit products (commercial fruit, commercial mixed fruit and commercial infant fruit dishes) were excluded from the fruit group, the number of children consuming fruit at least once in the 3 days significantly decreased ($\chi^2=29.3$, $p<0.001$, $\phi= 0.34$) at T1 and at T2 ($\chi^2 =9.0$, $p<0.01$, $\phi= 0.22$). The total amount of fruit consumed also decreased (Table 5.1). Additionally, consumers of infant fruit products consumed significantly more fruit than non-consumers of infant fruit products at T1 ($z=9.96$, $p<0.001$, $r=0.60$, $n=54$) and T2 ($z=1.84$, $p<0.05$, $r=0.13$, $n=6$).

Table 5.1 Proportion of fruit consumers, grams and serves[b] of fruit consumed at Time 1 (n=277) and Time 2 (n=208) from three days of intake.

Fruit intake	n(%)[a]		Amount consumed per day (g)		Serve[b] per day	
	Time 1	Time 2	Time 1 Median (IQR[†])	Time 2 Median (IQR[†])	Time 1 Median (IQR[†])	Time 2 Median (IQR[†])
Total	240 (86.6)	185 (88.9)	56 (16:140)	104 (38:163)	2.8 (0.8:7.0)	0.7 (0.3:1.1)
Without commercial infant fruit products	186 (67.1)	179 (86.1)	41 (13:96)	81 (21:153)	2.1 (0.6:4.8)	0.5 (0.1:1.0)

[a] consumed fruit at least once; [b]1 serve of fruit = 20g for T1 and 150g for T2 (9); [†]inter-quartile range.

Figure 5.2 shows the proportion of children by serves of fruit consumed per day (as mean of three days) at T1 and T2. At T1 and T2, a majority of children consumed at least 0.5 serve of fruit per day.



*as mean of 3 days, 1 serve of fruit = 20g for T1 and 150g for T2 (9).

Figure 5.2 Proportion of children by serve of fruit consumed.

5.1.2.2 Type of fruits consumed

Table 5.2 shows the number of consumers of each type of fruit at T1 and T2. The three most popular fruits at T1 were apple, banana and commercially prepared mixed fruits marketed for infants. Banana and apple continue to be popular at T2. Proportions consuming other fresh fruits such as grapes and melons increased between T1 and T2 while proportions consuming commercial infant fruit mixtures and single fruit purees decreased. At T2, a greater proportion of children consumed dried fruits, mostly as sultanas (88%, n=51).

Table 5.2 Proportion of fruit consumers by type of fruit/fruit group at Time 1(n=240) and Time 2(n=185).

Fruit/fruit sub-group	n(%)	
	Time 1	Time 2
Banana	101(42.2)	142(76.8)
Apple	108(45.0)	60(32.4)
Pear	82(34.2)	43(23.2)
Commercial infant mixed fruits[€]	83(34.6)	30(16.2)
Commercial infant fruit[¶]	58(24.2)	7 (3.8)
Stone fruits[ж]	20(8.3)	46(24.9)
Berries	14(5.8)	47(25.4)
Mixed fruits[†]	13(5.4)	10(5.4)
Commercial infant fruit dishes[‡]	8 (3.3)	25(13.5)
Melons	6 (2.5)	60(32.4)[a]
Citrus fruits	5 (2.1)	16(8.6)
Kiwi fruit	3 (1.3)	18(9.7)
Mango	3 (1.3)	9(4.9)
Grapes	2 (0.8)	68(36.8)
Rhubarb	2 (0.8)	4(2.1)
Paw paw	1 (0.4)	0 (0.0)
Dried fruits	1 (0.4)	58(31.4)[b]
Homemade fruit dishes[§]	3 (1.3)	0 (0.0)

[a] n= 46 (76.6%) consumed watermelon and n= 14 (23.3%) consumed rockmelon.
[b] n=51 (87.9%) consumed sultana.
[€]Commercially prepared food products for infants and/or toddlers consist of mixtures of fruits only, eg: pureed pear and apple.
[¶]Commercially prepared food products for infants and/or toddlers consist of single fruit; eg: pureed apple.
[ж] Consists of apricot, peach, cherry, prune, plum, nectarine.
[†]Homemade mixtures of more than 1 fresh fruit, eg: fruit salad, homemade apple and pear puree.
[‡]Commercially prepared dishes for infants and/or toddlers where fruit is the main ingredient, eg: apple and blueberry muesli; pumpkin, apple and sweet corn (where apple makes up 65% of the ingredient).
[§]Homemade dishes where fruit is the main ingredient

5.1.2.3 Frequency and variety of fruit intake

Table 5.3 summarises the frequency and variety of fruit intake across three days at T1 and T2. In the three days of assessment, fruit was consumed for a median (IQR) of 4 (2:6) occasions at T1 and 5 (2:9) occasions at T2, that is median (IQR) of 1.3 (0.3:2.3) occasions per day at T1 and 1.7 (0.7:2.9) occasions per day at T2.

Median (IQR) variety of intake over three days was 2(1:3) at T1 and 3 (1:4) at T2 (out of 18 sub-groups). At T1, most children consumed between 1 to 2 sub-groups of fruit (n=144, 60.0%) while at T2, most children consumed three or more sub-groups of fruit (n=130, 70.3%) across three days of intake.

Table 5.3 Frequency and variety of fruit intake amongst fruit consumers at T1 (n=240) and T2 (n=185) across the three days of intake.

Fruit intake	n (%)		Median (IQR*)	
	T1	T2	T1	T2
Frequency[a]			4 (2:6)	5 (2:9)
1	39(16.3)	10(5.4)		
2-5	108(45.0)	77(41.6)		
6-10	77(32.1)	69(37.3)		
≥11	16(6.6)	29(15.7)		
Variety[b]			2 (1:3)	3 (1:4)
1	74(30.8)	20(10.8)		
2	70(29.2)	35(19.0)		
3	49(20.4)	55(29.7)		
≥4	47(19.6)	75(40.5)		

*inter-quartile range
[a]number of occasions fruit was consumed
[b]number of different sub-groups of fruit consumed. See Table 5.2 for the 18 sub-groups.

The distribution of frequency of fruit consumption against variety of fruit consumption has a non-linear and monotonic relationship at both time points as shown in Figures 5.3 and 5.4. This allows for Spearman rho correlation which shows that frequency and variety of fruit consumption were strongly correlated at T1 (r_s= 0.87, p<0.001) and T2 (r_s=0.88, p<0.001).

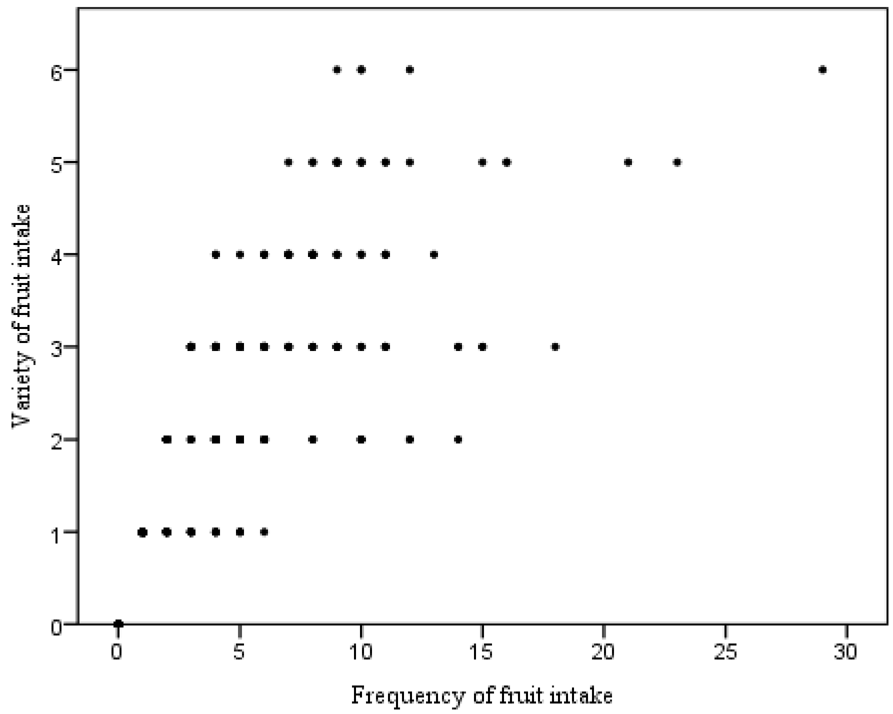


Figure 5.3 Distribution of frequency of fruit intake against variety of fruit intake from 3 days of intake at Time 1 (n=277).

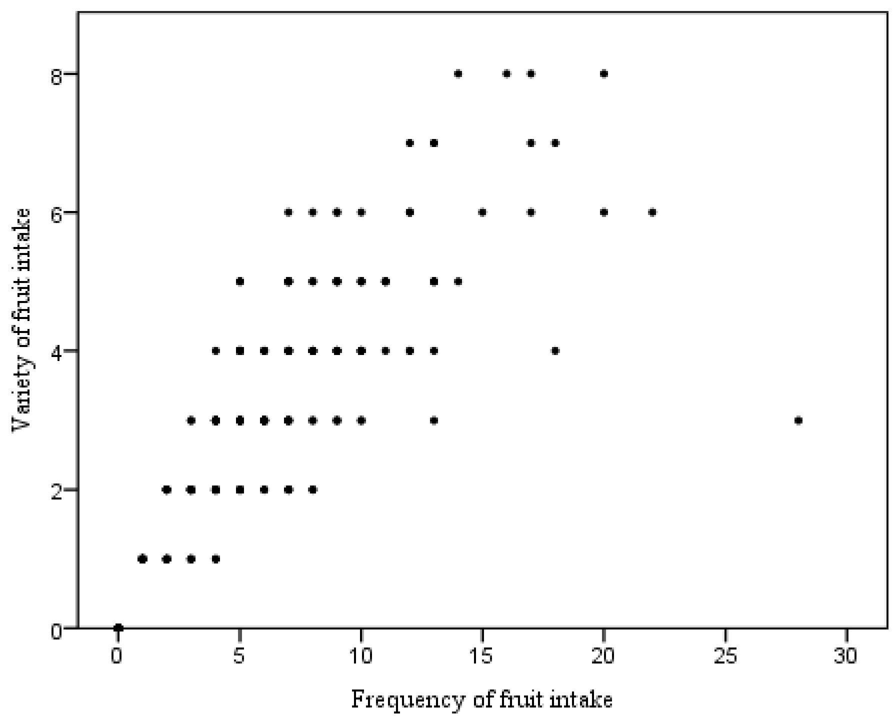


Figure 5.4 Distribution of frequency of fruit intake against variety of fruit intake from 3 days of intake at Time 2 (n=208).

Table 5.4 shows the difference between the frequency and variety of fruit consumption between T1 and T2 across three days of intake. A majority of children consumed fruit more frequently and with greater variety at T2 compared with T1. Wilcoxon signed rank test showed a significant increase in the frequency ($z=3.0$, $p<0.01$) and variety ($z=4.2$, $p<0.001$) of intake between T1 and T2, with the median (IQR) difference of 1 (-2:4) times for frequency of intake and 1 (-1:2) for variety of intake. However, the effect sizes for these differences are small to moderate ($r=0.21$ for fruit frequency and $r=0.30$ for fruit variety).

Table 5.4 Difference in the frequency and variety of fruit consumption between T1 and T2 (n=208) across three days of intake.

	n(%)	Median (IQR†)
Frequency		1 (-2:4)
Consumed less	72(38.9)	
No difference	18(9.7)	
Consumed more	118(63.8)	
Variety		1 (-1:2)
Consumed less	54(29.2)	
No difference	38(20.5)	
Consumed more	116(62.7)	

†inter-quartile range, negative value indicates lesser consumption.

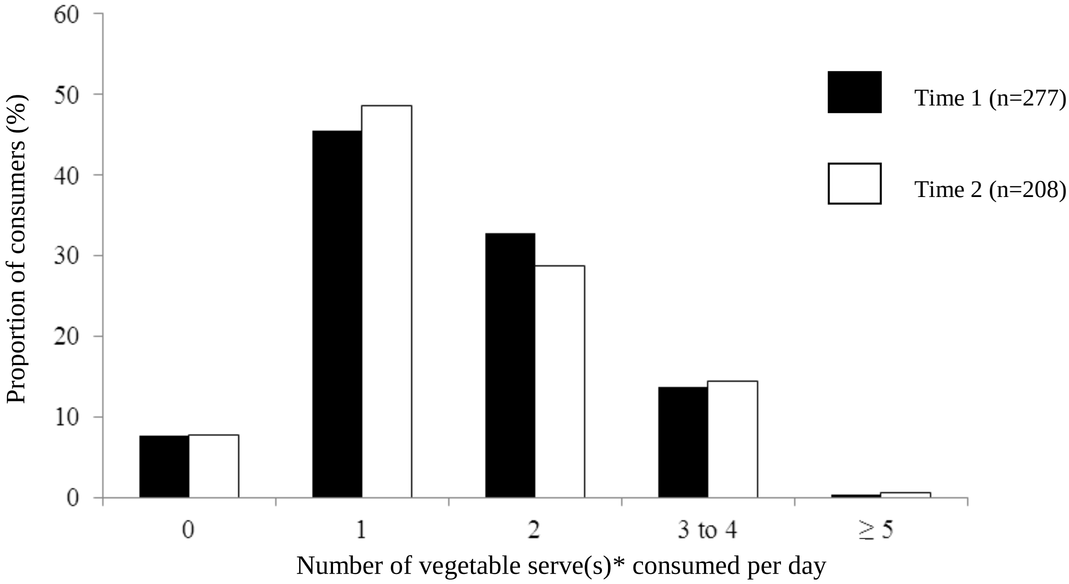
5.1.2.4 Association between frequency, variety and amount eaten

Both variety and frequency of fruit consumption were strongly correlated with total amount of fruit eaten at T1 ($r_s= 0.69$, $p<0.001$ for variety and $r_s= 0.81$, $p<0.001$ for frequency) and T2 ($r_s= 0.75$, $p<0.001$ for variety and $r_s= 0.85$, $p<0.001$ for frequency).

5.2 VEGETABLE INTAKE

5.2.1 Maternal intake

Figure 5.5 shows the proportion of participants consuming vegetables according to the category of vegetable consumption in the T1 and T2 questionnaires. The number of daily serves of vegetables consumed by mothers was consistent between T1 and T2 with only a minority of mothers consuming 5 or more serves of vegetables per day at T1 (n=21, 7.6%) and T2 (n=16, 7.7%). One mother reported not consuming any vegetable at either time point. A majority of mothers reported consuming one to four serves of vegetables per day at T1 (n=255, 92.0%) and T2 (n=188, 90.4%).



*1 serve of vegetable = 75g of cooked or raw vegetables (114).

Figure 5.5 Maternal consumption of vegetable.

5.2.2 Child intake

5.2.2.1 Proportion of vegetable consumers, grams and serves consumed

Table 5.5 presents the proportion of vegetable consumers and the amount of vegetables consumed at T1 and T2. At T1, two hundred and fifty-four (91.7%) children consumed vegetable at least once in the three days of dietary assessment. The proportion was similar at T2 (90.3%, χ^2= 1.5, p =0.22, ϕ= 0.09). A majority of participants ate vegetables on all three assessed days at T1 (n=209, 75.5%) and T2 (n=150, 72.1%). This decrease was not significant (χ^2= 2.1, p =0.12, ϕ= 0.10), indicating tracking of vegetable consumers between T1 and T2.

Although the amount of vegetables consumed per day significantly increased (z= 2.27, p<0.05) between T1 and T2 (Table 5.5), the effect size is small (r=0.16). When commercial infant vegetable products were excluded, there was no change in the number of vegetable consumers at T1. However, the amount of vegetables consumed decreased to median (IQR) of 51 (21:110)g per day (Table 5.5). Consumers of commercial infant vegetable products also consumed significantly more vegetables than non-consumers of commercial infant vegetable products (z=6.71, p<0.001, r=0.40). The number of consumers decreased by two with the exclusion of commercial infant vegetable products at T2 and the amount of vegetables consumed decreased to a median (IQR) of 68 (16:109)g per day (Table 5.5). Furthermore, the amount of vegetables consumed between consumers and non-consumers of commercial infant vegetable products significantly differed (z=0.372, p<0.001, r=0.26).

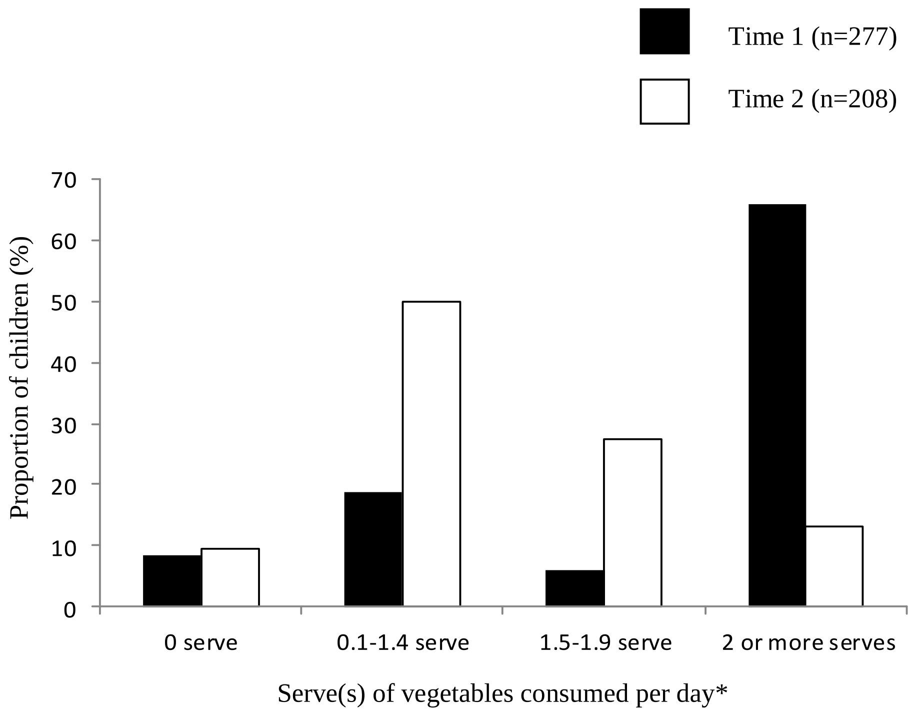
When potatoes were excluded from the vegetable food group, the number of children consuming vegetables decreased non-significantly at T1 (χ^2= 1.3, p=0.24, ϕ= 0.08) and T2 (χ^2= 2.3, p=0.13, ϕ= 0.10). The amount of vegetables consumed also decreased to a median (IQR) of 36(23:143)g per day at T1 and 56 (11:101)g per day at T2 (Table 5.5). Furthermore, comparison of the amount of vegetables consumed between consumers and non-consumers of potatoes resulted in significant differences at T1 (z=2.80, p<0.01, r=0.17) and T2 (z=4.96, p<0.001, r=0.35).

Table 5.5 Proportion of vegetable consumers, grams and serves of vegetables consumed at Time 1 (n=277) and Time 2 (n=208).

Vegetable intake	n(%)[a]		Amount consumed per day (g)		Serve[b] per day consumed	
	Time 1	Time 2	Time 1 Median (IQR[†])	Time 2 Median (IQR[†])	Time 1 Median (IQR[†])	Time 2 Median (IQR[†])
Total	254 (91.7)	188 (90.3)	69 (27:151)	74 (17:113)	3.4 (1.3:7.5)	1.0 (0.2:1.5)
Without commercial infant vegetable products	254 (91.7)	186 (89.4)	51 (21:110)	68 (16:109)	2.6 (1.0:5.5)	0.9 (0.2:1.4)
Without potatoes	245 (88.5)	176 (84.6)	36 (23:143)	56 (11:101)	1.8 (1.2:7.2)	0.7 (0.1:1.3)

[a]consumed at least once; [b]1 serve of vegetable = 20g for T1 and 75g for T2 (9); [†]inter-quartile range.

Figure 5.6 illustrates the proportion of children by serve of vegetables consumed per day (as a mean of 3 days). At T1, a majority of children (n=200, 72.2%) consumed at least 1.5 serves of vegetable per day, with only 27 children (13.0%) consuming at least 2 serves of vegetables per day at T2.



*as mean of 3 days; [b]1 serve of vegetable = 20g for T1 and 75g for T2 (9).

Figure 5.6 Proportion of children by serve of vegetable consumed.

5.2.2.2 Type of vegetables consumed

Table 5.6 shows the number of consumers for each type of vegetable/vegetable sub-group at T1 and T2. At T1, 22 of 28 defined sub-groups were consumed by at least one child. The three most popular vegetables at T1 were pumpkin, carrot and potato. These vegetables continued to dominate children's vegetable intake at T2.

There was a decrease from T1 to T2 for 12 of the 28 sub-groups in the proportion of consumers. The most notable decrease was for commercial vegetable dishes and mixed vegetables, homemade vegetable dishes, pumpkin and sweet potato. There were increases of more than 10% in the proportion of consumers between T1 and T2 for 11 of the vegetable sub-groups with the greatest increases for tomatoes (26.1%), peas and beans (22.1%) and potato (20.1%). However, almost half (n=22) of tomato consumers at T2 consumed tomato paste or tomato puree (usually used in combination with other ingredients in a dish), leaving thirty children consuming fresh tomatoes at T2.

Table 5.6 Consumers of vegetable at Time 1 (n=254) and Time 2 (n=188).

Vegetable/Vegetable sub-group	n(%)	
	Time 1	Time 2
Potato[£]	107(42.1)	117(62.2)
Carrot	155(61.0)	112(59.6)
Pumpkin	143(56.3)	67 (35.6)
Sweet potato	100(39.4)	27 (14.1)
Broccoli	59(23.2)	67 (35.6)
Mixed vegetables	67(26.4)	24 (12.8)
Commercial infant vegetable dishes[€]	60(23.6)	17 (9.0)
Commercial infant mixed vegetables[¶]	39(15.4)	3 (1.6)
Peas and beans	44(17.3)	74 (39.4)
Zucchini	33(13.0)	29 (15.4)
Avocado	45(17.7)	23 (12.2)
Cauliflower	38(15.0)	28 (14.9)
Sweet corn	20 (7.9)	31 (16.5)
Homemade vegetable dishes	75 (29.5)	14 (7.5)
Green leafy vegetables[Ж]	16 (6.3)	31 (16.5)
Other root vegetables[†]	8 (3.1)	3 (1.6)
Garlic and onion	10 (3.9)	34 (18.1)
Homemade legume dishes[‡]	4 (1.6)	2 (1.1)
Cabbage	5 (2.0)	6 (3.2)
Legumes[§]	3 (1.2)	25 (13.3)
Tomatoes[ß]	4 (1.6)	52 (27.7)
Cucumber	2 (0.8)	35 (18.6)
Beetroot	0 (0.0)	5 (2.7)
Capsicum	0 (0.0)	16 (8.5)
Mushroom	0 (0.0)	10 (5.3)
Vegetable soup[¥]	0 (0.0)	7 (3.7)
Bean sprout	0 (0.0)	1 (0.5)
Pickled vegetables[Ξ]	0 (0.0)	3 (1.6)

[£]excludes hot chips, potato chips, potato crisps and French fries.
[€]commercially prepared dishes for infants and/or toddlers where vegetable is the main ingredient, eg: beef and vegetable casserole.
¶commercially prepared food products for infants and/or toddlers consist of mixed vegetables only, eg: broccoli and pea mash.
[Ж]consists of lettuce, spinach, asparagus, Brussels sprouts, celery and Asian greens.
[†]consists of parsnip, swede and squash.
[‡]homemade dishes where legumes (eg: baked beans, lentils, kidney beans) are the main ingredient.
[§]consists of baked beans and kidney beans
[ß]includes tomato puree and tomato paste but excludes tomato ketchups/sauces.
[¥]soups where vegetables (besides water/stock) are the main ingredients; eg: minestrone soup, pumpkin soup.
[Ξ]pickled and/or preserved vegetables, eg: gherkin, sauerkraut, pickled olives.

5.2.2.3 Frequency and variety of vegetable intake

Table 5.7 summarises the frequency and variety of vegetable consumption across the three days of intake at T1 and T2. Over the three assessed days, vegetables were consumed on a median (IQR) of 6 (3:11) occasions at T1 and 5 (2:9) ocassions at T2, that is a median (IQR) of 2 (1:3.5) times per day at T1 and 1.7 (0.7:3) times per day at T2. Median (IQR) variety of vegetable intake for three days were 3 (2:5) and 4 (1:6) sub-groups of vegetables at T1 and T2 respectively.

Table 5.7 Frequency and variety of vegetable intake amongst vegetable consumers at T1 (n=254) and T2 (n=188) across the three days of intake.

Vegetable intake	n(%)		Median (IQR*)	
	Time 1	Time 2	Time 1	Time 2
Frequency[a]			6 (3:11)	5 (2:9)
1-5	106(41.7)	88(46.8)		
6-10	79(31.1)	60(31.9)		
11-20	57(22.5)	3719.7)		
≥21	12(4.7)	3(1.6)		
Variety[b]			3(2:5)	4(1:6)
1	31(12.2)	28(14.9)		
2-5	163(64.2)	101(53.7)		
6-10	58(22.8)	58(30.9)		
≥11	2(0.8)	1 (0.5)		

*inter-quartile range
[a]number of occasions vegetable was consumed
[b]number of different sub-groups of vegetables consumed

The distribution of frequency of vegetable consumption against variety of vegetable consumption has a non-linear and monotonic relationship at both time points as shown in Figures 5.7 and 5.8. This allows for Spearman rho correlation which showed that frequency and variety of vegetable consumption were strongly correlated at T1 (r_s= 0.82, p<0.001) and T2 (r_s=0.94, p<0.001).

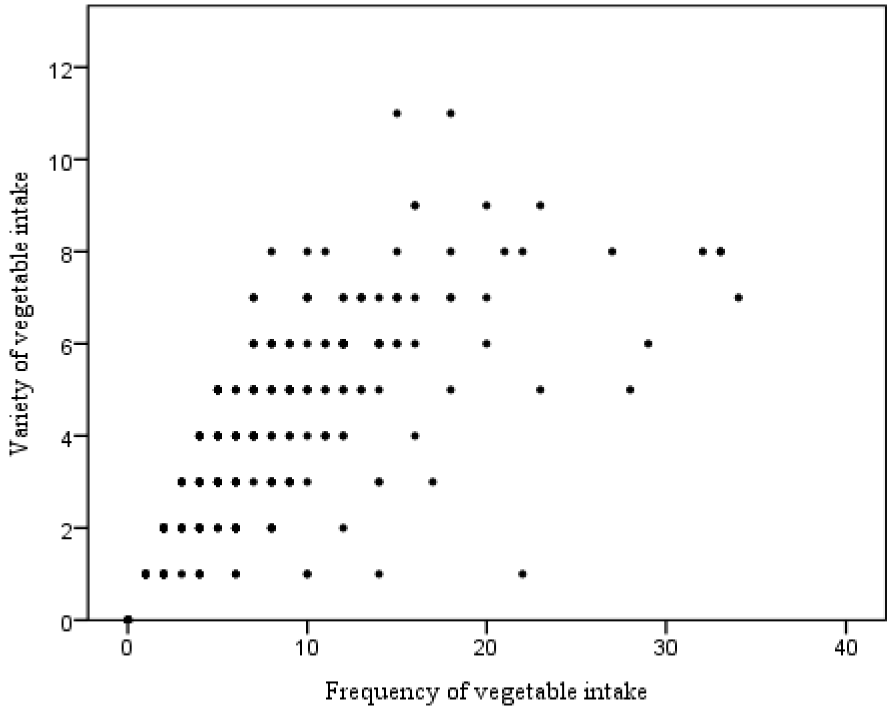


Figure 5.7 Distribution of frequency of vegetable consumption against vegetable variety from 3 days of intake at Time 1 (n=277).

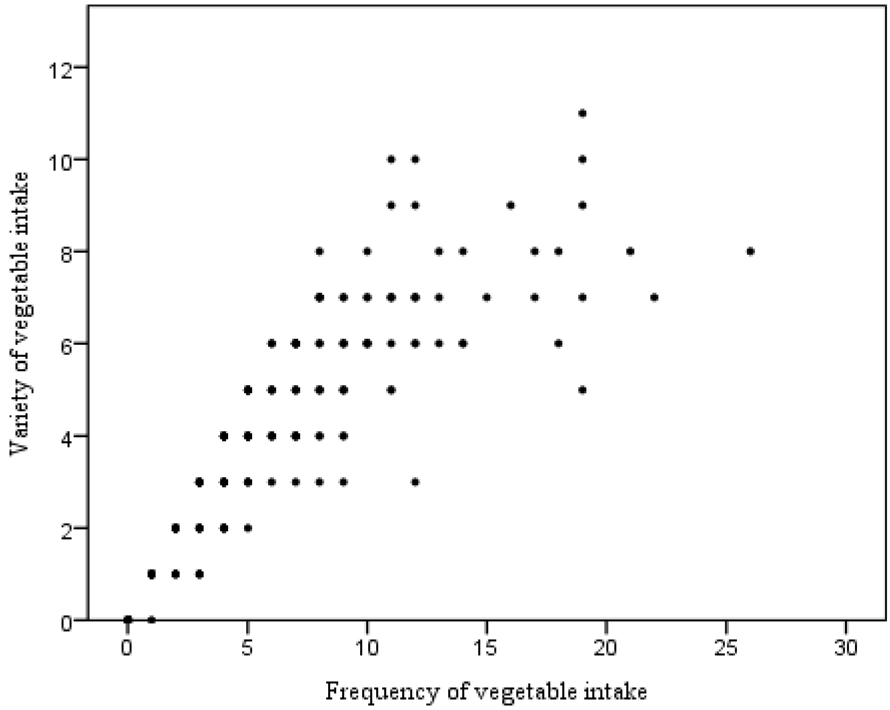


Figure 5.8 Distribution of frequency of vegetable consumption against vegetable variety from 3 days of intake at Time 2 (n=208).

Table 5.8 summarises the difference in the frequency and variety of vegetable consumption between T1 and T2. A majority of children consumed vegetable less frequently at T2 (n=121, 58.2%) (Wilcoxon signed rank Z = -3.4, p<0.01 between T1 and T2, effect size r=20) and many also consumed less variety (n=94, 45.2%) although non-significant (Z = -0.9, p>0.05, r=0.09).

Table 5.8 Difference in the frequency and variety of vegetable consumption between T1 and T2 (n=208) across three days of intake.

	n(%)	Median (IQR†)
Frequency		-1.5(-6.0:2.8)
Consumed less	121(58.2)	
No difference	15(7.2)	
Consumed more	72(34.6)	
Variety		0.0 (-2.0:2.0)
Consumed less	94(45.2)	
No difference	24(11.5)	
Consumed more	89(42.8)	

†inter-quartile range, negative value indicates lesser consumption

5.2.2.4 Association between frequency, variety and amount eaten

Frequency of vegetable intake was strongly correlated with total amount eaten at both time points (r_s= 0.72, p<0.001 at T1 and r_s= 0.69, p<0.001 at T2). Similar results were found for variety and total amount eaten (r_s= 0.57, p<0.001 at T1 and r_s= 0.64, p<0.001 at T2).

5.3 DISCUSSION

5.3.1 Maternal fruit and vegetable consumption

Adequate consumption of fruit and vegetables provides a diversified diet that is protective of a range of chronic diseases (1). The previous and current AGHE recommend consumption of at least 2 serves of fruit and 5 serves of vegetables a day for women (10, 488). Analysis of the maternal responses on fruit and vegetable consumption in the T1 and T2 questionnaires showed that the proportions of mothers meeting the guidelines for fruit (42% at T1 and 48% at T2) and vegetable (7.6% at T1 and 7.7% at T2) were lower than those reported from the 2007-2008 National Health Survey (NHS) (56.4% for fruit and 10.1% for vegetable) and 2011-2012 Australian Health Survey (53.1% for fruit and 9.4% for vegetable) for women aged 18 years and over (489, 490).

Nevertheless, higher proportion of mothers in this study meet the recommendation for 2 serves of fruit daily than the women (aged 19-40 years) in the 1995 National Nutrition Survey (NNS) (32% for age 19-30 years and 31% for age 31-40 years) (15). Proportion of mothers meeting vegetable serves are however, lower than those reported from the NNS survey for women of similar age (24% for age 19-30 years and 21% for age 31-40 years) (15).

Caution is required when making comparisons between data due to differences in dietary data collection methods, age categories, time period of survey/study and sampling method (not nationally representative). Dietary data from the ABS national health survey came from recall information collected from Computer Assisted Interview (CAI) (491) while data from the NNS were obtained from 1 x 24-hour dietary recalls on 8,891 adults aged 19 to 64 years (15). Although 1 x 24-hour recall is limited in its ability to capture day-to-day variation, it is a commonly used method in group assessments that has undergone validity studies on various populations (492-495). The use of questionnaires where answers are limited to predefined categories and the self-reporting nature of this study raise a few questions regarding the validity of this method to measure FV intake in mothers. For example, it is unclear how participants would interpret 'usual intake' without guidelines accompanying the questions asked in the study. Although serve sizes were defined, the absence of a visual guide and verbal prompts from a trained interviewer on what makes up a serve of fruit and vegetable may have also led to reporting bias.

Despite the differences discussed above, the high proportions of inadequate fruit and vegetable intakes found in the mothers in this study are broadly consistent with global consumption patterns. For example, in the USA, analysis of the 2003-2004 National Health and Nutrition Examination Survey (NHANES) using two non-consecutive days of 24-hour dietary recall reported that only 12.3% and 18.6% of women aged 19 years and over met their individualized recommendations for daily fruit and vegetable consumption respectively (496). In addition, poor FV consumption is expected to continue. Recent trend analysis of fruit and vegetable intake amongst Australians by the ABS reported that the proportions of Australian women meeting the recommendation for fruit and vegetable intakes decreased over time between 2001 and 2012 with 53.3% and 9.4% Australian women meeting guidelines for fruit and vegetable respectively in 2012 (497).

5.3.2 Child fruit and vegetable consumption

A majority of children consumed fruit and vegetable at least once and every day in the three days of assessment at both T1 and T2. Frequency and variety of fruit and vegetable intakes were also highly correlated with amounts eaten, but despite the increase in the amount of vegetables consumed between T1 and T2, only 13% children were able to meet the serve/day recommendation for vegetables at T2. This is because at T2, children are recommended to consume a minimum of 2 serves/day of vegetables (1 serve =75g) while at T1, they were only recommended to consume a minimum of 1.5 serves/day (1 serve = 20g) (9). Despite the five-fold increase in the amount recommended, there was only an increase of a mere 5.5g/day (comparison of medians) of vegetables eaten which explains why children were not meeting the dietary recommendation for vegetable at T2. In contrast, the increase in daily serve size recommendations for fruit between T1 and T2 did not affect children meeting the serve recommendations for fruit (9).

A minority of children did not consume any fruit (13.4% at T1 and 11.1% at T2) or vegetable (8.3% at T1 and 9.7% at T2) in the 3 days of study. While this does not indicate that they never consumed any fruit or vegetable, they are most likely not to consume very much and most unlikely to meet recommended intake. Due to the limitation of only 3 days of intake, it is not possible to determine if children consume fruit and vegetables every day. However, it is reasonable to conclude that children who met the recommendations in the three days of intake would be most likely to meet the recommendations for daily fruit and vegetable intakes on most days.

Comparisons against two early feeding studies conducted in similar time periods as this study and with cohorts of children under 2 years of age showed that the proportion of children consuming fruit and vegetables in this study were higher than those found in the 2008 US FITS study (16) but lower than those found in the Melbourne InFANT program (17) (Table 5.9).

Table 5.9 Comparisons of proportion of fruit and vegetable consumers

Study:	Diet assessment method:	Age (months)	% fruit consumers	% vegetable consumers
This study	1 x 24-hour diet recall,	6.3[¶§]	86.6	91.7
	2 x food records	14.3[¶†]	88.9	90.4
Melbourne InFANT[a]	3 x 24-hour diet recalls	9[¶]	94.9	94.9
		18[¶]	98.3	94.9
2008 US FITS[b]	1 x 24-hour diet recall	6-8.9	64.5[¶]	62.8[¶]
		12-14.9	74.3[¶]	72.4[¶]
		15-17.9	74.7[¶]	70.8[¶]

[a]Lioret S *et al* 2013 (17); [b]Siega-Riz AM et al 2010 (16) ; [¶]mean; [§]age ranged between 4 to 9 months; [†]age ranged between 12 to 18 months.

The notable higher proportions of fruit and vegetable consumers between the Australian cohorts (this study and the Melbourne InFANT program) and the US FITS cohort mirrored findings from fruit and vegetable studies for older children and adults in both countries (13, 15, 498, 499), indicating that population differences between countries in fruit and vegetable consumption begins as early as in the weaning period. Methodological differences in how dietary data were collected and differences in age range may also have contributed to the observed differences between studies. This study and the Melbourne InFANT study collected dietary data from 3 days of intake while the US FITS study relied solely on a single 24-hour dietary recall (500). This may have contributed to an underestimation of consumers.

The proportion of fruit and vegetable consumers in this study tracked between T1 and T2. The significant but small increase in the amounts consumed between T1 and T2 can be attributed to children transitioning from a predominantly milk diet at T1 to a diet at T2 dominated by food. The Melbourne InFANT program also reported tracking in fruit and vegetable intakes (percentage consuming and amount eaten per day), although the amount of vegetables consumed significantly decreased from median (IQR) of 84.3 (37.4:134.0)g/day at 9 months to 69.9 (30.5:124.6) g/day at 18 months ($p<0.05$) (17).

Despite differences in the proportion of fruit and vegetable consumers, the type of fruit and vegetables consumed by children in this study is comparable to those reported in the 2002 and 2008 US FITS study (16). Banana, apple and pear are popular “first fruits” consumed by infants at the weaning period. At T2, banana and apple continue to be popular while more children were consuming grapes, melons and dried fruits. Although banana and apple were also popular in children aged 12-17.9 months in the US FITS study, there were more consumers of processed or canned fruits (eg: 16.8% at 12 to 14.9 months and 12.4% at 15 to 17.9 months consuming canned applesauce) in the US cohort (16).

Popular vegetables were generally root, starchy and sweet vegetables such as potato, carrot, sweet potato and pumpkin. The popularity at T1 is possibly due to their sweetness and texture which facilitate acceptability and ease of mashing/puree. The starchiness and energy density of these vegetables may provide a pleasant feeling of satiety which teaches children to prefer their tastes, texture and smell (24). At T2, potato, carrot and pumpkin continue to be popular and more children were consuming peas and beans.

When potato was excluded from the vegetable food group, the number of vegetable consumers decreased at T1 and T2. Potato remains the most popular vegetable consumed in older children with findings from the 2007 NCNPAS showing that the proportion of children meeting the recommendations for vegetable decreased when potato was excluded to the extent that no children were able to meet the vegetable recommendations in the 14-16 years age group (13). Similarly, potato contributed prominently to adult vegetable intake along with poor consumption of other vegetables such as legumes, brassica and leafy vegetables (15). This suggests that the types of vegetables infants are consuming at the weaning period reflects adult intakes and provides useful information for early interventions targeting parent-child dyads.

The general difference between the US FITS cohort and the cohort of this study is the reliance of the American cohort on commercial infant food products for the consumption of fruit and vegetables while the children in this study were more likely to consume home-prepared, fresh forms. Despite this, the number of fruit consumers and amount of fruit consumed by children in this study decreased significantly at T1 and T2 when commercial infant fruit products were excluded from the fruit group. This shows the significant contribution of commercial infant food products to the consumption of fruit in the first 14 months of life.

Globally, North Americans are currently the world's number one purchasers of infant food products (501), followed by China (502). Although supermarket sales accounted for the largest proportion of demand in the US, online shopping for infant food products is fast gaining popularity in this region (502). In Australia, demand for 'pharmacy home-brands' and organic baby foods are on the rise and with the infant food industry projected to reach USD 38.7 billion in value by 2015 (502), it is logical to postulate that infant food products will continue to contribute significantly to fruit consumption of infants at the weaning period.

Manufactured to provide a convenient alternative to busy, working families, infant food products are generally considered to be nutritionally safe. However, they are manufactured to be uniform in presentation, taste and texture. The packaging of infant food products into jars, cans and opaque pouches minimises infant interaction with food. This limits child exposure to the taste, texture, smell and look of the food. Providing opportunities for experiencing the sensory properties of food is important to increase child familiarity and acceptance of foods (383). Whether reliance on infant food fruit products affects consumption of fresh fruit in later childhood is not yet well established, but emerging evidence from the ALSPAC study in the UK suggests that early and frequent exposure to fresh, home-cooked fruits and vegetables was linked to better outcomes for intake in older children (frequency, amount and variety consumed) while no such relationship was observed in children frequently exposed to commercially prepared fruits and vegetables (402). Specifically, this longitudinal prospective study where 7866 mother-child dyads were recruited 6-7 months postpartum from 1991-1992 found a linear correlation between frequency of home cooked fruits and vegetables offered to infants at 6 months with the amount of fruits and vegetables consumed by children at age 7 years (ß=0.14 for vegetable and ß=0.09 for fruit, $p<0.001$) (402).

Furthermore, a study on the longitudinal modelling of dietary patterns of children from 6 months to 2 years of age also reported that frequent consumption of infant food products at the weaning period is associated with a less healthy diet at 2 years (503). This provides further support that heavy reliance on infant food products may have long term implications on the formation of children's long-term food preferences and dietary quality. Therefore, the longitudinal relationship between consumption of infant food products and dietary and weight outcomes warrants further investigation.

Fruit frequency and variety increased significantly between T1 and T2. However, vegetable frequency significantly decreased between the two time points while there was no significant difference in variety consumed (around 1 sub-group per day). While lower frequency of vegetable intake between T1 and T2 may be explained by the lower frequency of feedings in older children as they move towards a more established eating pattern, the poor variety of vegetables consumed indicates a potential problem in children's diet. Nutritionally, a wide dietary variety can potentially provide nutritional adequacy, especially adequacy of micronutrients (504, 505) and indicates overall dietary quality (506). Behaviourally, dietary variety is important to help infants acquire preferences for new foods (265, 266). Infants have innate inclination for sweet and salty tastes (38) and infant habituation to these tastes may lead to poor acceptance of bland tasting foods such as vegetables (24). There is evidence to support this from both experimental studies and community based interventions in children aged five years and above (65).

5.4 CONCLUSION

Maternal FV intakes were far from ideal with less than half of the mothers in this study meeting recommendations for fruit intake and less than 10% meeting the recommendations for vegetable intake. A similar disparity between fruit and vegetable intake was observed for children at T2 where the majority of children were able to meet the serve/day recommendations for fruit in the three days of intake, but only 13% meet the serve/day recommendations for vegetables at T2. This shows that compared with fruit intake, vegetable intake is a more critical problem in maternal and child diets and should be prioritised for interventions.

The findings presented in this study add to the limited literature on fruit and vegetable consumption in infants and toddlers. In particular, this study reported on the frequency and variety of fruit and vegetable intakes which were often not reported in earlier studies on young children's diet. As discussed in Section 2.1.5.2, variety plays an important role in increasing fruit and vegetable intakes and acceptance at weaning while repeated exposure (frequency) shapes children's preference for fruit and vegetables (Section 2.2.2.3). Future studies on young children's diet can benefit from measuring and reporting variety and frequency of fruit and vegetable consumption as they provide meaningful data for early intervention.

The types of fruits and vegetables consumed by children were mostly sweet and starchy. They appeal to children’s innate preference for sweet tastes and limit children’s exposure to blander and/or bitter tastes as found in many green, leafy vegetables and legumes. Furthermore, infant food products contributed significantly to children’s fruit and vegetable consumption at T1. Reliance on commercial infant food products may have a long-term impact on child dietary quality and warrants further investigation in longitudinal studies.

Variety of fruit and vegetable intakes remain low at around 1 sub-group of fruit or vegetable per day, despite the high frequency of intake at both T1 and T2. Furthermore, the proportion of consumers of fruit and vegetable tracked between T1 and T2. This provides evidence that poor consumption of fruits and vegetables begins at the weaning period and continues into early toddlerhood and that interventions can benefit from targeting the mother-child dyad prior or at the time solids are being introduced.

CHAPTER SIX: MEASUREMENT MODELS

This chapter reports, compares and discusses median ratings, internal consistency and results from the confirmatory factor analysis (CFA) of measured items for maternal feeding self-efficacy, psychological distress and child temperament (irritability at T1 and reactivity at T2) in the construction of latent variables and measurement models for the purpose of structural equation modelling reported and discussed in Chapter 7. Results from the CFA of maternal feeding self-efficacy, psychological distress and child irritability were reported in Koh *et al* (2014) (19).

6.1 MEDIAN AND RELIABILITY

Median and interquartile range of ratings of individual measured items and reliability (measured as internal consistency using Cronbach's alpha) of the unobserved latent variables of maternal feeding self-efficacy, psychological distress and child temperament for T1 and T2 are presented in Table 6.1. Overall, median ratings for all items measuring maternal feeding self-efficacy at T1 and T2 were high, indicating high levels of feeding self-efficacy in this cohort of women. Initial reliability testing for all relevant items measuring maternal feeding self-efficacy at T1 (5 items) and T2 (8 items) resulted in alpha coefficients (α) of 0.99 and 0.70 respectively. At T2, the items 'can get child to sit through a meal', 'able to serve meals at regular times every day' and 'can feed child a meal without making dessert a reward' have poor item-total correlations of 0.28, 0.25 and 0.19. Exclusion of these items improved the α coefficient of the remaining 5 items to 0.82.

Table 6.1 Median (interquartile range) of individual items and reliability for maternal feeding self-efficacy, psychological distress and child temperament (irritability/reactivity) at Time 1 (n=277) and Time 2 (n= 208).

Latent variables/ Measured items[a]	Median (IQR)[b]		α[c]	
	Time 1	Time 2	Time 1	Time 2
Maternal feeding self-efficacy[d]			0.99	0.82
Give child healthy food	5 (5:5)	5(4:5)		
Can get child to eat enough	5 (4:5)	5(4:5)		
Can get child to try vegetables	5 (5:5)	5(4:5)		
Give child right amount of food	4 (4:5)	4(4:5)		
Can get child to taste new food	5 (4:5)	5(4:5)		
Can get child to sit through a meal*	-	5(4:5)		
Able to serve meals at regular times every day*	-	5(4:5)		
Can feed child a meal without making dessert a reward*	-	5(5:5)		
Maternal psychological distress[e]			0.84	0.85
Feel hopeless	1(1:2)	1(1:1)		
Feel depressed	1(1:2)	1(1:2)		
Feel so sad nothing could cheer you up	1(1:1)	1(1:1)		
Often feel tired for no good reason	2(2:3)	2(1:3)		
Feel everything was an effort	2(1:2)	2(1:2)		
Feel nervous	1 (1:2)	1(1:2)		
Feel so nervous that nothing could calm you down	1(1:1)	1(1:1)		
Feel restless or fidgety	1(1:2)	1(1:1)		
Feel so restless that you could not sit still	1(1:1)	1(1:1)		
Feel worthless	1(1:1)	1(1:1)		
Child irritability[f]			0.63	-
Fretful on waking up	2(2:3)	-		
Continues to cry despite soothing	2(1:3)	-		
Cries when left alone to play	2(2:3)	-		
Amuses self for ½ hour in cot/playpen*	5(4:5)	-		
Child reactivity[f]			-	0.60
Moody 'off' days when irritable all day	-	2(2:3)		
Response to frustration intensely	-	4(2:5)		
Shows much bodily movements when upset or crying	-	4(3:5)		
Moody for more than a few minutes when corrected or disciplined	-	2(1:3)		
Cries after a fall or bump*	-	4(4:5)		
Plays actively with toys indoors*	-	5(5:5)		
Runs to get to where s/he wants to go*	-	4(1:5)		
Frowns or complains when left to play by him/herself*	-	2(1:3)		

[a]Latent variables in bold
[b]Median rating with inter-quartile range (IQR)
[c]Cronbach's alpha coefficient for internal consistency: α >0.70 (acceptable), α >0.8 (good consistency) (440).
[d] Items from 'Self-efficacy' questionnaire from the Nutrition Aimed at Toddlers study (NEAT) (422). All items rated in 5-point Likert scale with 1= Not confident at all to 5=Very confident
[e]Kessler 10 (414). All items rated in 5-point Likert scale with 1=None of the time to 5= All of the time
[f] Items for 'irritability' from Short Temperament Scale for Infants (STSI) (507). Items for 'reactivity' from Short Temperament Scale for Toddlers (STST) (436). All items rated in 6-point Likert scale with 1=Almost never to 6= Almost always
*Items removed from reliability test due to poor item-total correlation

Maternal self-reported psychological stress measured using K10 indicated little to no distress (all median ratings <3 out of possible 5). If the individual responses for each K10 item are treated as scores and summed, the median (IQR) total score at T1 is 14 (11:16) and 13 (11:15) at T2. Cronbach's alpha test on all 10 items in the K10 show good item-total correlations (α=0.84 at T1 and 0.85 at T2).

Mothers reported minimal child irritability and reactivity at T1 and T2 respectively. However, items measuring child irritability and child reactivity have poor internal consistencies (α <0.70) even after items with low item-total correlation, r <0.3 (440) were removed. The items removed are: 'amuses self for ½ hour in cot or playpen' (r= 0.11) for child irritability; 'cries after a fall or bump' (r =0.13), 'plays actively with toys indoors' (r =0.12), 'runs to get to where s/he wants to go' (r =0.21), and 'frowns or complains when left to play by him/herself' (r =0.11) for child reactivity.

Alpha coefficients provide a measurement of internal consistency of the items in a scale but are insufficient to give information on how well the items measure what they purportedly measure. For this, validity tests are required. Section 6.2 below reports results from confirmatory analyses in the construction of measurement models and in doing so, provides outcomes for construct validity of maternal feeding self-efficacy, K10 and child irritability (T1) and reactivity (T2).

6.2 CONSTRUCTION OF MEASUREMENT MODELS

6.2.1 Maternal feeding self-efficacy

Confirmatory factor analysis (CFA) on all five items measuring maternal feeding self-efficacy at T1 resulted in a well-fitting model (χ^2/df= 0.52, RMSEA = 0.01, CFI = 1.0, TLI=1.0, WRMR = 0.21) as shown in Figure 6.1. The two items making the greatest contribution to the variation (R^2) seen in maternal feeding self-efficacy were 'can get child to eat enough' and 'can get child to try vegetables'. All of the measured items loaded strongly (r>0.5) to the latent variable maternal feeding self-efficacy at T1.

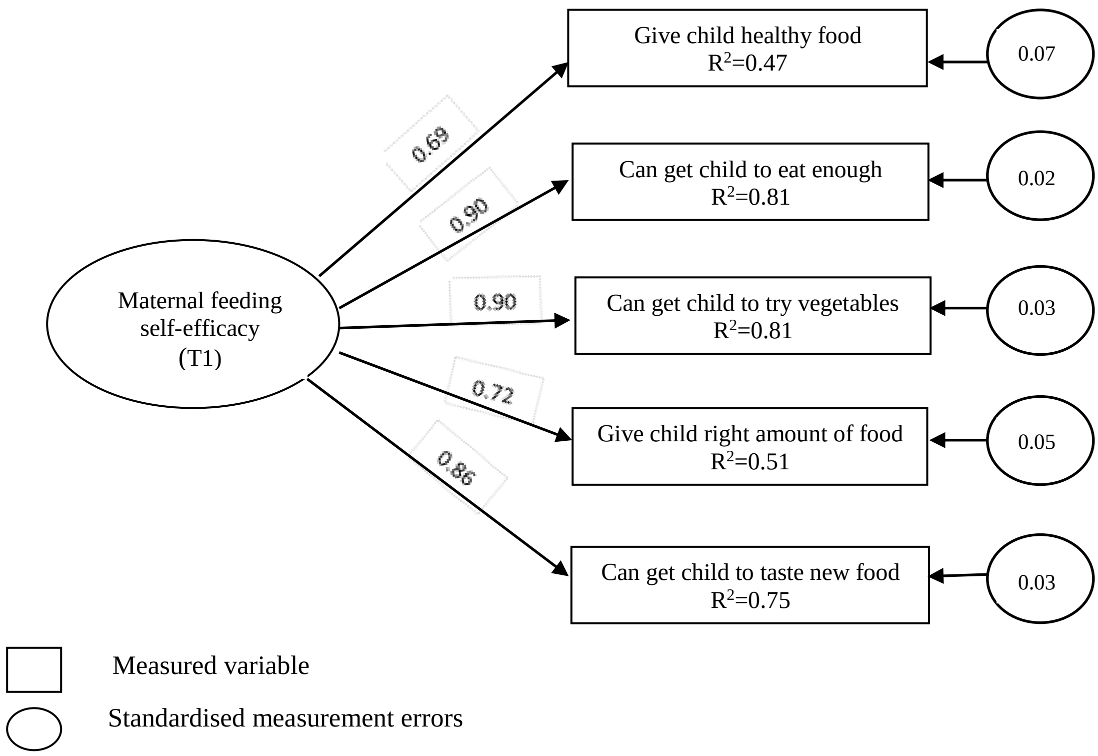


Figure 6.1 Measurement model for maternal feeding self-efficacy at Time 1 (n=277).

As shown in Figure 6.2, CFA on all eight items measuring maternal feeding self-efficacy at T2 resulted in a reasonably fitted model (χ^2/df= 2.0, RMSEA = 0.07, CFI = 0.98, TLI=0.97, WRMR = 0.69). As per the results from T1, the two items that made the greatest contribution to the variation (R^2) were ‘can get child to eat enough’ and ‘can get child to try vegetables’. All items loaded strongly (*r*> 0.5) to the latent variable maternal feeding self-efficacy except for the variable ‘can feed child a meal without making dessert a reward’. Following the results from Cronbach’s alpha test on all 8 items (Section 6.1) where three items (‘can get child to sit through meals’, ‘able to serve meals at regular times’, ‘can feed a meal without making dessert a reward’) were found to be poorly correlated, a separate CFA on a two-factor model (factor 1 containing the 3 items that were poorly correlated and factor 2 containing the other 5 items) was conducted. The two-factor model resulted in a poorly fitted model (χ^2/df= 3.5, RMSEA = 0.12, CFI=0.77, TLI = 0.76, WRMR = 0.90).

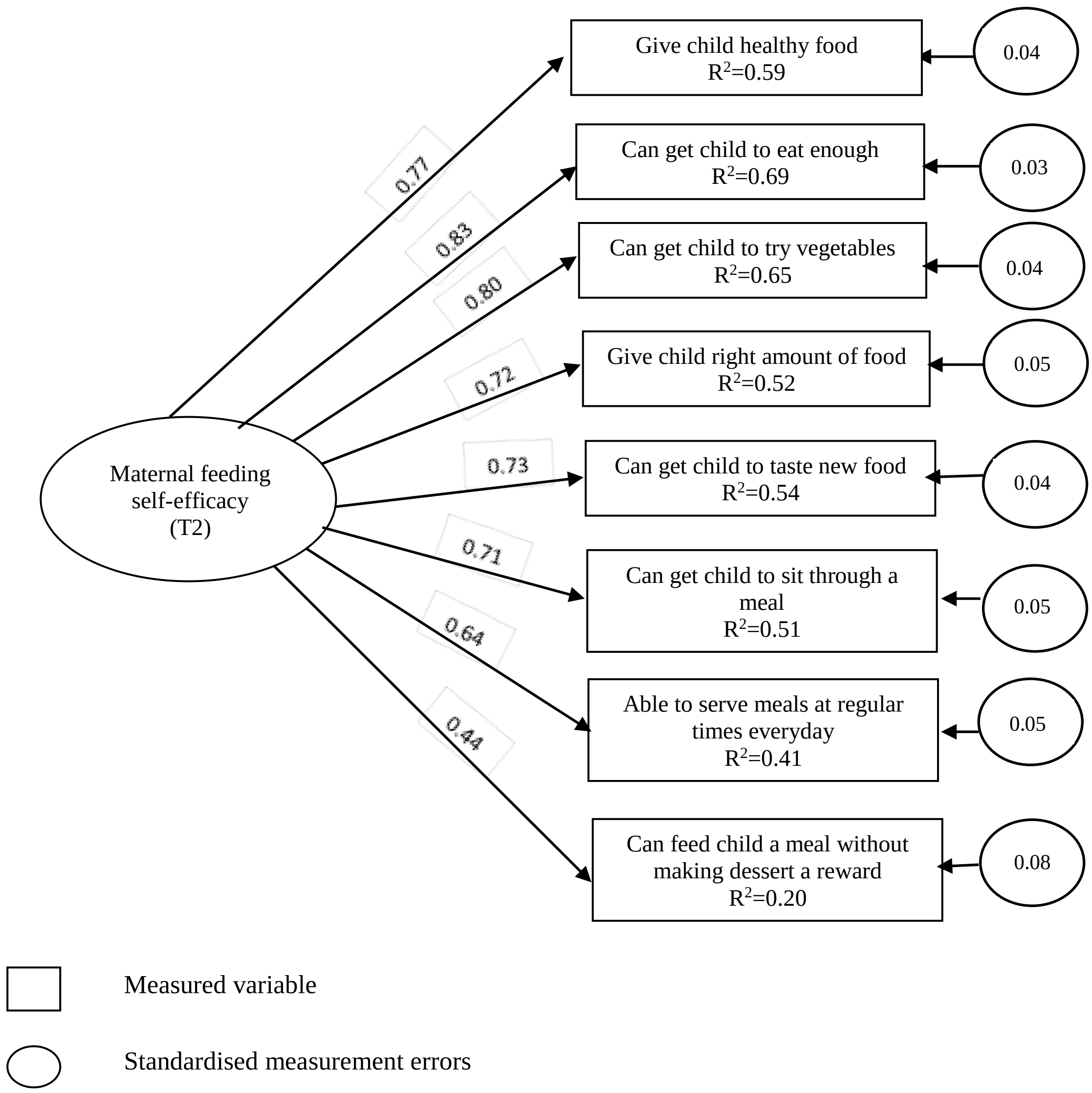


Figure 6.2 Measurement model for maternal feeding self-efficacy at Time 2 (n=208).

6.2.2 Maternal psychological distress

As shown in Table 6.2 below, CFA for all 10 items in the K10 resulted in poorly fitted models at both T1 and T2.

Table 6.2 Model fit indices, standardised factor loadings and squared multiple correlations for ten items in the Kessler 10 at Time 1 (n=277) and Time 2 (n=208).

	Standardised factor loading		**R^{2}¶**	
	Time 1	**Time 2**	**Time 1**	**Time 2**
Time 1 model fit indices*:				
χ^2/df = 2.2, RMSEA = 0.11, CFI = 0.94, TLI = 0.93, WRMR = 1.1				
Time 2 model fit indices*:				
χ^2/df= 2.1, RMSEA = 0.11, CFI= 0.93, TLI = 0.92, WRMR = 1.1				
Feel hopeless	0.67	0.70	0.82	0.84
Feel depressed	0.74	0.82	0.86	0.91
Feel so sad nothing could cheer you up	0.86	0.83	0.93	0.91
Often feel tired for no good reason	0.40	0.32	0.63	0.56
Feel everything was an effort	0.50	0.48	0.69	0.69
Feel nervous	0.52	0.40	0.72	0.63
Feel so nervous that nothing could calm you down	0.80	0.75	0.90	0.87
Feel restless or fidgety	0.56	0.37	0.75	0.61
Feel so restless that you could to sit still	0.69	0.37	0.83	0.61
Feel worthless	0.65	0.60	0.81	0.78

¶Squared multiple correlation (R2) indicates reliability of measured item; for example:R^2= 0.82 for the item 'feel hopeless' at Time 1 means 82% variance of the latent variable 'maternal psychological distress' is explained by this item.

*Models are considered well fitted if the ratio of χ^2/df is <2, Tucker-Lewis Index (TLI) ≥ 0.95, Comparative Fit Index (CFI) ≥ 0.95, Root Mean Square Error of Approximation (RMSEA) < 0.06 to 0.08 and Weighted Root Mean Square Residual (WRMR) <0.90 (84).

According to Kessler *et al* (2002) (508), the ten items in K10 measure five different dimensions of psychological distress; namely depressed mood, motor agitation, fatigue, worthless guilt and anxiety. Table 6.3 shows the items from the K10 that correspond with five dimensions. Table 6.3 also indicates items corresponding to the K6, the shortened version of the K10 (508).

Table 6.3 Items from the Kessler 10 and Kessler 6 and their corresponding dimensions(508).

Dimension	Item from Kessler 10
Depressed mood	Feel depressed, feel so sad nothing could cheer you up*, feel hopeless*
Motor agitation	Feel restless or fidgety*, feel so restless you could not sit still
Fatigue	Often feel tired for no good reason, feel everything was an effort*
Worthless guilt	Feel worthless*
Anxiety	Feel nervous*, feel so nervous that nothing could calm you down

*items in the Kessler 6 (K6).

Following poor one factor model fit for the K10, CFAs were conducted for the 6 items from the K10 that forms the K6 to examine if good model fits could achieved for the K6. However, CFA tests also resulted in poor model fits at T1 (χ^2/df =2.3, RMSEA =0.11, CFI= 0.92, TLI= 0.91 and WRMR = 1.1) and T2 (χ^2/df =2.2, RMSEA =0.11, CFI= 0.90, TLI= 0.89 and WRMR = 1.0).

Adhering strictly to the theoretical dimensions proposed by Kessler and colleagues (Table 6.3), multiple confirmatory factor analyses (eg: 2 factor model or 3 factor model) were not conducted on the items in the K10 as each factor (dimension) is measured via one or two items only (except for ‘depressed mood’). Therefore, modification indices (MI) were considered alongside theoretical sense of the models when modifications were made to the models to achieve good fitting measurement models for T1 and T2.

According to the MIs obtained from CFA of all ten items in the K10, a better model fit can be achieved if “feel restless or fidgety” is regressed on “feel so restless you could not sit still” (MI= 35.1 for T1 and 58.2 for T2) and if “feel so restless you could not sit still" is regressed on "feel so nervous nothing could calm you down" (MI=46.1 for T1 and 48.7 for T2). This indicates that the two items measuring 'motor agitation' are covariates for the item "so nervous nothing could calm you down". These two items were removed from the K10 measurement model. Removal of these two items slightly improved the model fit indices with both CFI and TLI achieving 0.97 and 0.96 respectively for both time points. However, other model fit indices remained poor (χ^2/df = 2.1, RMSEA = 0.10, WRMR = 0.97 at T1 and χ^2/df = 2.0, RMSEA = 0.09 WRMR= 0.90 at T2).

MIs for the models at T1 and T2 (without the two items measuring 'motor agitation') were checked again to identify items that may be inappropriately fitted into the models. Table 6.4 shows the summary from the modification tests.

Table 6.4 Modification indices for K10 measurement models without items measuring motor agitation at Time 1(n=277) and Time 2 (n=208).

	Modification Index	
	Time 1	**Time 2**
Feel worthless → Feel so nervous nothing could calm you down	15.9	14.1
Feel so nervous that nothing could calm you down → Often feel tired for no good reason	38.2	22.2
Feel so nervous that nothing could calm you down → Feel nervous	40.0	19.8
Feel depressed ↔ Feel so sad nothing could cheer you up	15.2	-
Often feel tired for no good reason ↔ Feel everything was an effort	-	25.3

→ indicates regression
↔ indicates correlation

These results show that 'feel worthless' and 'feel so nervous nothing could calm you down' were covariates for 'often feel tired for no good reason' and 'feel nervous'. Therefore, they were removed from the measurement models at T1 and T2.

As suggested by the results from the modification tests, ‘feel depressed’ and ‘feel so sad nothing could cheer you up’ were correlated at T1 while ‘often feel tired for no good reason’ and ‘feel everything was an effort’ were correlated at T2. As shown in Figures 6.3 and 6.4 below, the results following these modifications to the models at T1 and T2 resulted in good fitting measurement models (χ^2/df = 1.9, RMSEA = 0.06, CFI= 0.99, TLI= 0.99 and WRMR= 0.52 at T1 and χ^2/df = 1.2, RMSEA = 0.04, CFI= 0.99, TLI= 0.99 and WRMR= 0.38 at T2). Cronbach’s alpha tests repeated on the remaining 6 items following the CFA results showed good internal consistencies at T1 (α=0.81) and T2 (α= 0.83).

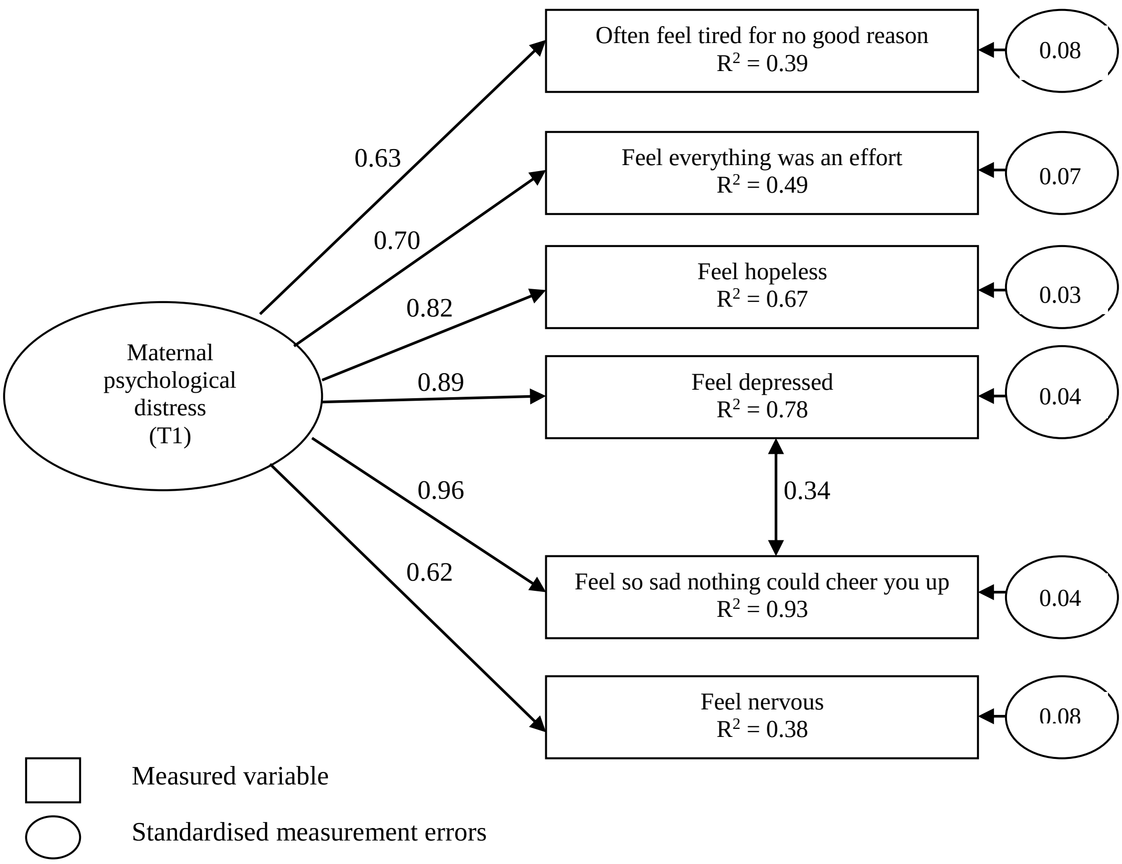


Figure 6.3 Measurement model for maternal psychological distress at Time 1 (n=277).

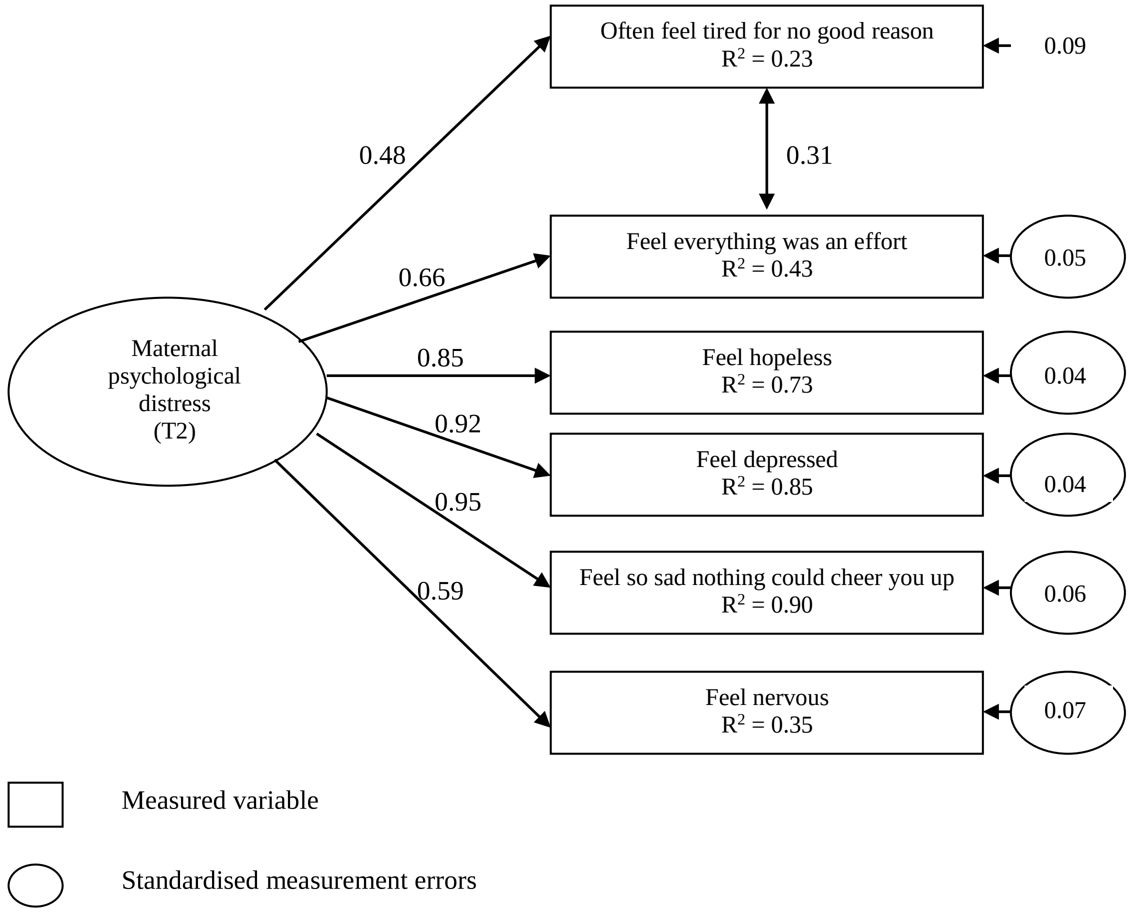


Figure 6.4 Measurement model for maternal psychological distress at Time 2 (n=208).

6.2.3 Child temperament

As shown in Table 6.5, CFA on the four items measuring child irritability at T1 and 8 items measuring child reactivity at T2 resulted in poorly fitted models. Therefore, items with low item-total correlation (r<0.3) identified through Cronbach's alpha test in Section 6.1 were removed. CFA was repeated on the remaining 3 items for child irritability and 4 items for child reactivity. As shown in Figures 6.5 and 6.6, the resulting models achieved excellent fit (χ^2/df = 0.1, RMSEA = 0.01, CFI= 0.99, TLI= 0.99 and WRMR= 0.01 for child irritability and χ^2/df = 0.49, RMSEA = 0.01, CFI= 0.99, TLI= 0.99 and WRMR= 0.15 for child reactivity).

Table 6.5 Model fit indices, standardised factor loading and squared multiple correlations for items measuring child irritability at T1 (n=277) and child reactivity at T2 (n=208).

	Standardised factor loading	$R^{2¶}$
Child irritability[a]		
Model fit indices*: χ^2/df is=27.0, TLI=0.55, CFI=0.85, RMSEA=0.31, WRMR=1.1		
-Fretful on waking up	0.63	0.40
-Continues to cry despite soothing	0.59	0.35
-Cries when left alone to play	0.77	0.60
-Amuses self for ½ hour in cot/playpen	0.37	0.04
Child Reactivity[b]		
Model fit indices*: χ^2/df is=3.8, TLI=0.59, CFI=0.71, RMSEA=0.12, WRMR=0.97		
-Moody "off" days when irritable all day	0.57	0.33
-Response to frustration intensely	0.45	0.21
-Shows much bodily movements when upset or crying	0.59	0.35
-Moody for more than a few minutes when corrected or disciplined	0.57	0.33
-Cries after a fall or bump	0.22	0.05
-Plays actively with toys indoors	0.14	0.02
-Runs to get to where s/he wants to go	0.16	0.03
-Frowns of complains when left to play by him/herself	0.24	0.06

¶Squared multiple correlation (R^2) indicates reliability of measured item; for example: R^2= 0.82 for the item 'feel hopeless' at Time 1 means 82% variance of the latent variable 'maternal psychological distress' is explained by this item.
*Models are considered well fitted if the ratio of χ^2/df is <2, TLI ≥ 0.95, CFI ≥ 0.95, RMSEA < 0.06 to 0.08 and WRMR <0.90 (84).
[a]Items from Short Temperament Scale for Infants (STSI) (507).
[b]Items from Short Temperament Scale for Toddlers (STST) (436).

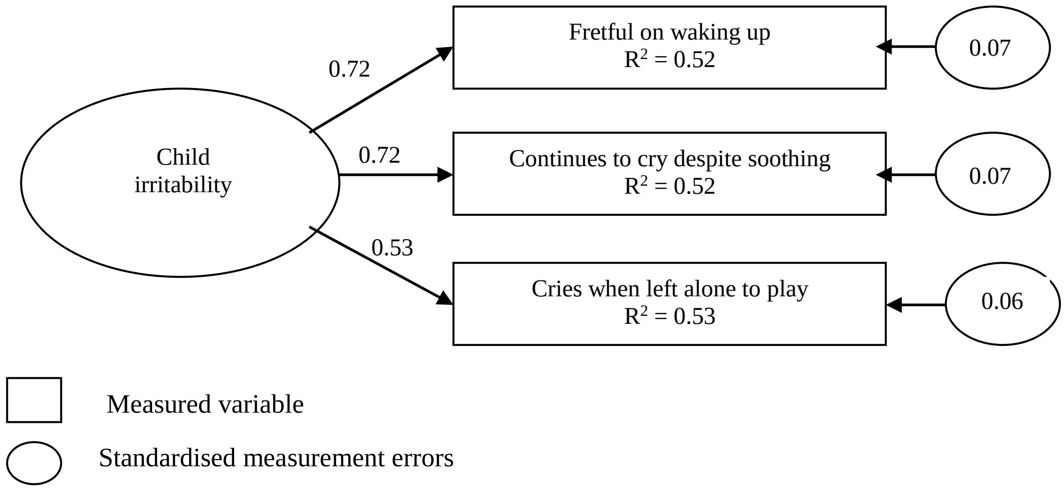


Figure 6.5 Measurement model for child irritability at Time 1 (n=277).

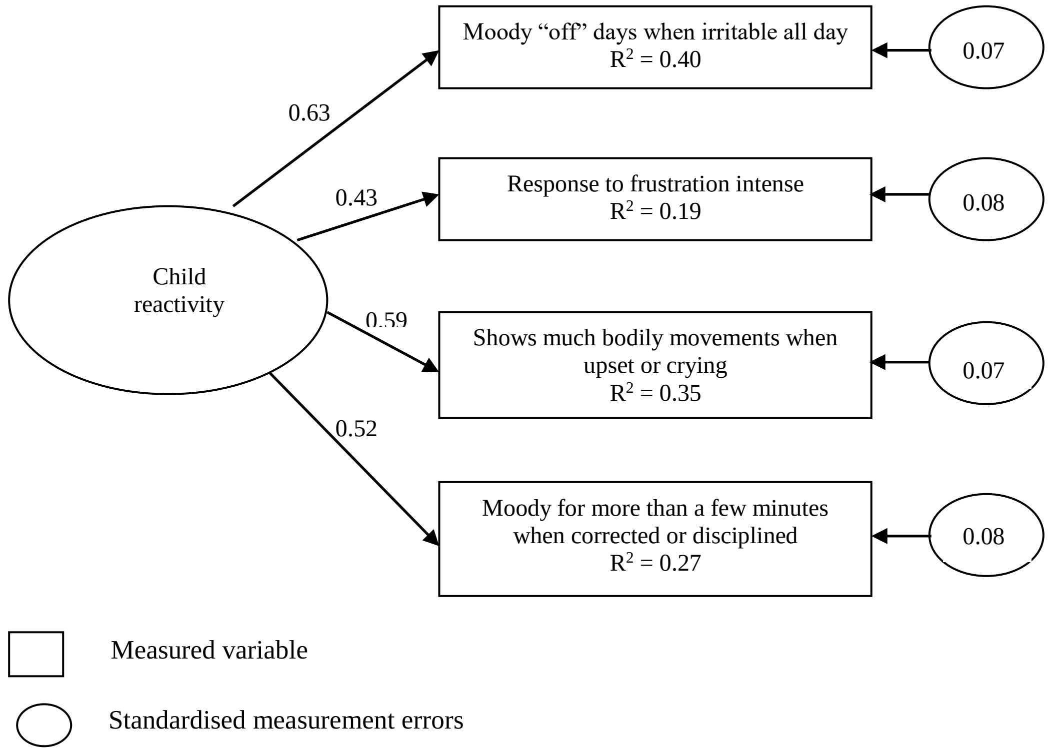


Figure 6.6 Measurement model for child reactivity at Time 2 (n=208).

Two alternate two-factor models for child reactivity consisting of all 8 measured items were also considered and tested. The first model with two correlated latent factors (Figure 6.7) achieved poor fit (χ^2/df = 3.8, RMSEA = 0.12, CFI= 0.72, TLI= 0.58 and WRMR= 0.96).

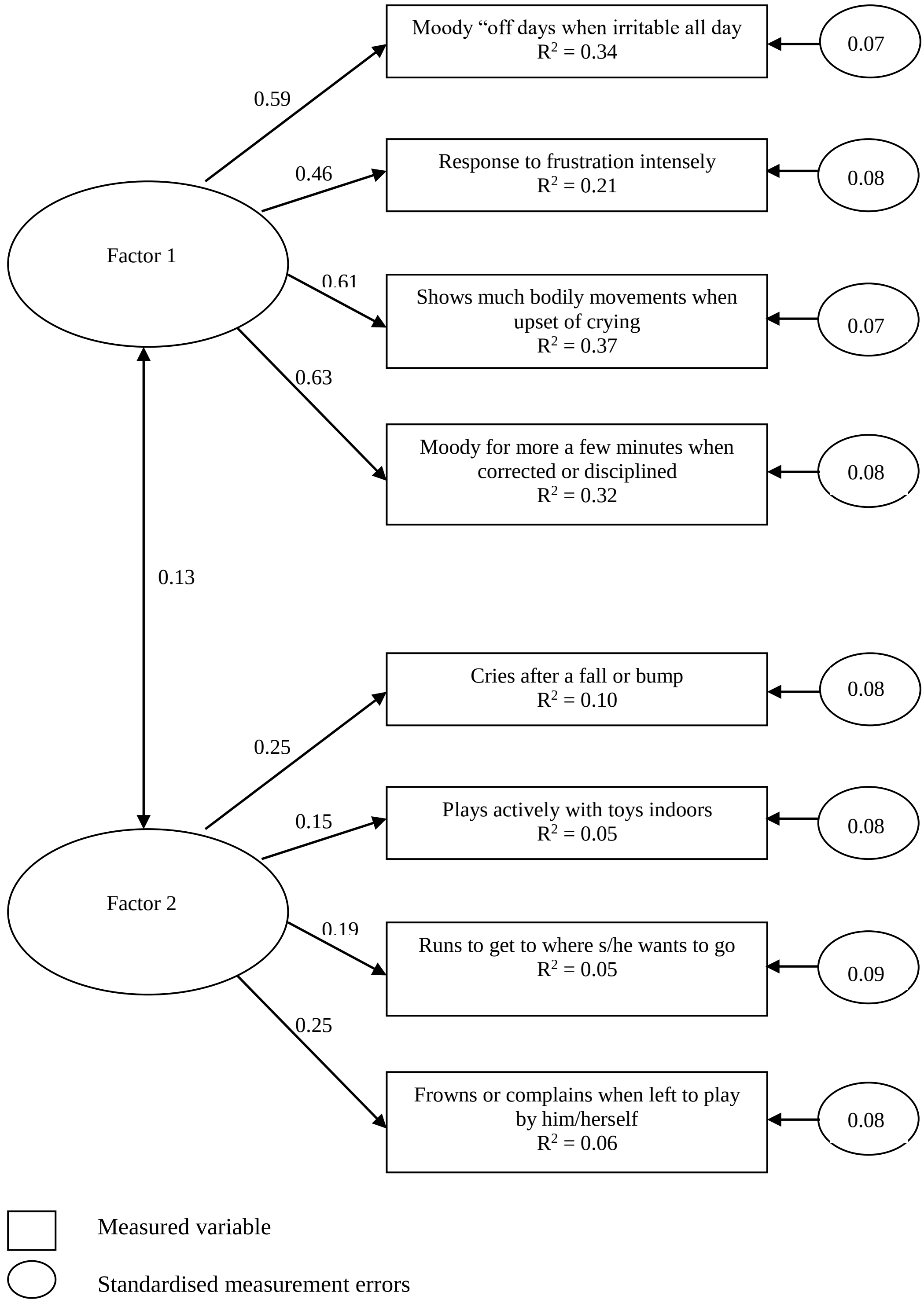


Figure 6.7 Measurement model with two correlated latent factors for child reactivity at Time 2 (n=208).

The second two factor model (Figure 6.8) which consisted of a two-level CFA achieved even poorer fit (χ^2/df = 17.9, RMSEA = 0.32, CFI= 0.56, TLI= 0.44 and WRMR= 0.99) than the measurement model presented in Figure 6.7.

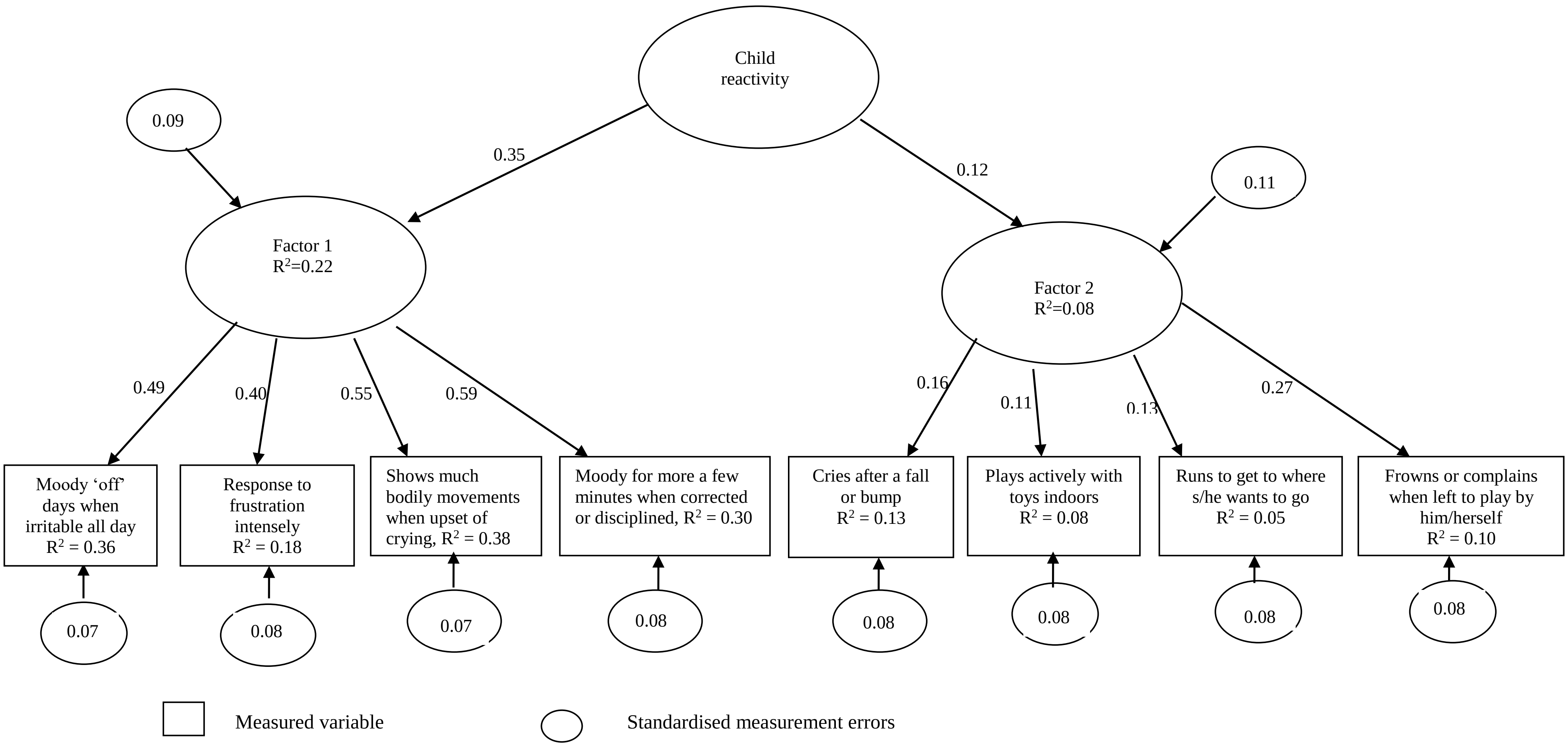


Figure 6.8 Two level confirmatory factor analysis of eight items measuring child reactivity at Time 2 (n=208).

6.3 DISCUSSION

Mothers in this study reported high levels of feeding self-efficacy and low levels of psychological distress. High levels of maternal feeding self-efficacy for each measured items (mean scores > 4 out of 5) were also recorded in the NEAT (53 parent-toddler dyads, children mean age 19.3 months) (422) and InFANT cohorts (n=60 one-year-olds, n= 90 five-year-olds) with the InFANT study reporting decreased maternal self-efficacy in limiting use of discretionary foods in the older cohort of children (5 year olds) compared with the youngest cohort (1 year olds) (decrease of median score from 4.5 to 4 out of possible maximum score of 5, $p<0.005$) (63). The low levels of distress found in mothers in this study may be a consequence of systematic bias due to the selection criteria, literacy and voluntary nature of this study that favours highly educated and healthy mothers.

At T2, three items ('can get child to sit through meals', 'able to serve meals at regular times every day', 'can feed child a meal without making dessert a reward') have poor item-total correlations, indicating that these items may belong to a different construct than the other five items used in the maternal feeding self-efficacy questionnaire. Interestingly, these are the only three items at T2 that measured self-efficacy concerning meal structure and managing child's mealtime behaviour. However, CFA on the five items (T1) and eight items (T2) resulted in good fitting models while CFA on a two-factor model at T2 resulted in a poorly fitted model. Although items making up the same constructs from factor analysis are usually internally consistent, this is not always the case. Furthermore, Cronbach's alpha is not a perfect indication of consistency as it does not discriminate between consistency and redundancy of items (509). This may indicate that the self-efficacy questionnaire used in T2, although validly measured the latent construct of 'maternal feeding self-efficacy', has poor reliability, hence limiting its repeatability in other cohorts.

To date, this is the first published study (19) to have conducted a construct validity testing on the items used to measure maternal feeding self-efficacy from the NEAT study (422). The discrepancy found between the reliability and validity of the questionnaire at T2 has important implications for future research intending to adopt the NEAT self-efficacy questionnaire for children ≥ 12 months old. Depending on the culture and cohort under study, re-wording or removal of the items with poor item-total correlations may be needed. For example, what is considered a 'meal' (eg: do snacks qualify as a 'meal' and if so, does the type of snack eaten matter?) and what constitutes '*regular* meal times'. Redundancy may also occur for 'can get child to eat enough' and 'give child right amount of food' as mothers may consider these two items of similar meaning.

Conversely, Cronbach's alpha and CFA on the K10 revealed good internal consistency (α >0.8) at T1 and T2 but poorly fitted measurement models at both time points. The good internal consistency found for the K10 is not surprising given that many studies have consistently reported α values above 0.8 for this tool (510-513). However, the construct validity of the K10 is less studied and remains controversial. Only a few studies have examined the latent modelling of the items in K10. Table 6.6 presents a summary of these studies which report inconsistent results. Moreover, studies using data from clinical samples failed to show construct validity of the K10; raising questions regarding its suitability in clinical settings.

The lack of construct validity studies on the K10 may be explained by the fact that both the K10 and K6 are usually used as screening tools to identify non-specific mental illness by summing the 5-point Likert scale ratings for each item to derive a total score. Depending on whether the scales were scored from 0 to 4 or 1 to 5, the maximum total score for the K10 is 40 or 50, which indicates severe distress.

Cut-off scores for diagnosis of mental illness are calculated from Area Under Curve (AUC) values by adjusting for the desired sensitivity and specificity of the test. Studies examining AUCs for K10 reported AUC values of 0.66 to 0.94 (510-516). AUC provides an indication of the K10's diagnostic ability to discriminate between case and non-case with values between 0.50 to 0.70 indicative of low accuracy, 0.70 to 0.90 indicative of acceptable accuracy and 0.90 and above indicative of high accuracy (516). AUC tests on K10 showed low to acceptable accuracy with lowest accuracy for diagnosis of depression in pregnant women (AUC = 0.66) (516) and the highest accuracy for diagnosis of depression and anxiety disorders in men who had completed high school education (AUC =0.93) (515). These results show that the accuracy of K10 is reliant on the gender, physiological condition and demographic factors of the study cohort.

Table 6.6 Summary of studies on the latent modelling of items in the Kessler 10.

Study	Sample population	Analysis method¶	Outcome*
Kessler *et al* 2002 (508)	>200,000 respondents (>18 years old); US National Health Interview Survey and the 1997 Australian National Survey of Mental Health and Well-being (NSMHWB).	EFA, PAF	PAF on 45 questions/ psychological dimensions loaded strongly on one factor with 106 out of 135 items in the questions had a factor loading of at least 0.4 on the one factor. EFA on the 106 items that passed the PAF test resulted in a good fitting two factor model (χ^2/df=9.2, p<0.001) for the mail survey. PAF on 32 questions loaded strongly on one factor with 93 out of 138 items fitted well into a two factor model (χ^2/df=6.5, p<0.001).
Brooks *et al* 2006 (517)	1407 respondents; Northern Rivers Mental Health Study (NoRMHS), Sydney, Australia; cross-validation with 10,641 respondents from the 1997 NSMHWB.	PAF, CFA	CFA on all ten items produced poor fitting model (χ^2/df = 14.5, RMSEA = 0.09, CFI= 0.82, GFI = 0.82, AGFI= 0.71). Modelling on a two level model resulted in a poor fitting model (χ^2/df = 10.2, RMSEA = 0.03, GFI = 0.96, AGFI= 0.92). PAF produced a better fitting 4 factor model (Nervous, Fatigue, Agitation & Negative Effect) which was confirmed through CFA re-examination (χ^2/df = 2.3, RMSEA = 0.03, GFI = 0.96, AGFI= 0.92).
Fassaert *et al* 2009 (518)	321 ethnic Dutch, 191 Moroccan and 213 Turkish participants; Amsterdam Health Monitor survey 2004.	EFA	Good fitted one factor model which explained 70% of the variance in psychological distress and factors loadings ranging from 0.67 to 0.89. CFI = 0.97 and RMSEA= 0.09.
Arnaud et al 2010 (513)	71 patients suffering from alcohol-related disorders who was admitted to the emergency department of the Centre Hospitalier Universitaire Gabriel Montpied in Clermont-Ferrand, France between 1st February to 1st March 2008.	PAF	Three factor solution (p<0.001) with factor 1 explaining 45.5% variance, factor 2 explaining 19.3% and factor 3 explaining 10.9% variance. All three factors explained 75.8% of total variance. Factor loadings ranged from 0.66 to 0.92.
Berle *et al* 2010 (519)	183 patients commencing treatment at the Nepean Anxiety Disorders Clinic, Penrith, NSW, Australia.	CFA	Poor fitting models for CFA on the Kessler *et al* 2002 model (508) (χ^2/df = 6.7, RMSEA = 0.20, CFI= 0.81, TLI= 0.75, GFI = 0.79). CFA on the Brooks *et al* 2006 (517) model resulted in a better fitting 4-factor model (χ^2/df = 1.8, RMSEA = 0.09, CFI= 0.98, TLI= 0.97, GFI = 0.95).

Table 6.6 continued.

Study	Sample population	Analysis method[¶]	Outcome
Sunderland *et al* 2012 (520)	Clinical sample: 957 patients referred for treatment in Sydney Metropolitan Anxiety Disorder between April 2001 to May 2007. Community sample: 8841 respondents from the 2007 Australian National Survey of Mental Health and Wellbeing	CFA	CFA on 4 proposed models for K10 for both clinical and community samples resulted in poor fitting models for one factor model (χ^2/df = 168, RMSEA = 0.14, CFI= 0.92, TLI= 0.90 for community sample and (χ^2/df = 78.4, RMSEA = 0.16, CFI= 0.95, TLI= 0.93 for clinical sample). Best fit was achieved for a one factor model with correlated errors for the community sample (χ^2/df = 20.8, RMSEA = 0.05, CFI= 0.99, TLI= 0.99) and a two factor model for the clinical sample (χ^2/df = 41.2, RMSEA = 0.12, CFI= 0.97, TLI= 0.96).
McNamara *et al* 2014 (521)	1589 Indigenous Australians and 227063 non-indigenous Australians from the Sax Institute 45 and Up study.	CFA	CFA on the 4 models proposed by Sunderland et al 2012 revealed best fitting model for a one factor model with correlated errors for both indigenous (χ^2/df = 7.6, RMSEA = 0.07, CFI= 0.97, TLI= 0.96) and non-indigenous respondents (χ^2/df = 966.8, RMSEA = 0.07, CFI= 0.91, TLI= 0.87).
Chan & Fung 2014 (522)	2325 children aged 12 to 19 years.	CFA	Poor fit for a one factor model (χ^2/df = 814.3, CFI=0.93, TLI=0.9, RMSEA=0.04).

[¶]PAF – Principal Axis Factoring, EFA – Exploratory Factor Analysis, CFA – Confirmatory Factor Analysis.

*Models are well fitted if χ^2/df <2, TLI ≥ 0.95, CFI ≥ 0.95, RMSEA < 0.06 to 0.08, GFI ≥ 0.95 and AGFI ≥ 0.95 (84). χ^2/df is not recommended for large sample size (449).

Depending on the sample population and setting of measurement, the K10 demonstrated moderate to acceptable sensitivity and specificity for detecting depressive and anxiety disorders ranging from 0.65 to 0.92 and 0.62 to 0.81 respectively (510-516). Therefore, cut points for diagnosis of mental illness differ between populations and can range from 21.5 for screening of depression in pregnant women to 38.5 for screening of panic disorder in pregnant women (516). The median total scores for the K10 found in this study (14 at T1 and 13 at T2) are well below these cut points but caution is required in their interpretation.

Despite the preference of researchers and clinicians to use the total sum of K10 to screen for mental illness, Kessler and colleagues themselves have warned against such simplistic interpretation of results (508). For epidemiological studies, items need to be weighted from values generated from normative samples while in clinical settings, cut-points need to be developed from data obtained from clinical norms (508). Unfortunately in Australia, clinical scoring and cut-points are based on epidemiological data (414, 523) with only one clinical study conducted on Australian drug users (510). Therefore, without reliable and valid data from a reference population for the cohort in this study, the use of the sum of K10 scores may not be the best measure for the screening of psychological distress. In the absence of cohort-specific normative data, validity studies provide useful information on the quality of the K10 to measure what it claims to measure.

This study is the first to present a one-factor 6-item latent model for the K10 that differed from the six items used in the K6. The CFA presented adhered strictly to the theoretical dimensions as proposed by its creators (508), hence maintaining the confirmatory nature of the analysis. The six items identified in this study correspond to three psychological dimensions of 'depressed mood', 'fatigue' and 'anxiety'. However, these results are not transferrable to other studies. Further reliability, validation and test-retest studies on larger cohorts are needed to provide stronger evidence for its performance against the K10 and K6. Despite the weaknesses of the K10 discussed, the K10 remains a popular tool in health screenings and epidemiological studies because it can be quickly self- or interviewer-administered.

Cronbach's alpha for child irritability at T1 (5 items) and child reactivity at T2 (8 items) were under 0.70. The items used in this study came from STSI and STST which are the abridged versions of the 95 items in the Revised Infant Temperament Questionnaire (RITQ) (524) and the 115 items in the Toddler Temperament Scale (TTS) (436). STSI and STST were used in the Australian Temperament Project (ATP) (525) to measure temperament of children aged 0-3 years old. Analysis from the ATP on a cohort of 4 to 8 month old Australian infants (n=2443) reported an alpha coefficient of 0.64 with test-retest reliability of 0.77 for five items measuring child irritability (526). Factor analysis of the 5 items also showed that the items only predicted 5.9% of the variance for the sub-scale 'child irritability' (526). Analysis of Australian toddlers aged 1 to 3 years old from the same project resulted in an alpha coefficient of 0.61 for all eight items measuring child reactivity (for the younger group aged 12 to 23 months old, n=135) (437, 527).

In the SAIDI cohort studied, best model fits were achieved for a one factor model (3 items) for child irritability at T1 and a one factor model (4 items) for child reactivity at T2. Attempts at validating 2 two-factor models resulted in poorly fitted models for child reactivity.

Despite various validation attempts for the RITQ, there are no published studies analysing the individual items that make up the RITQ sub-scales (or dimensions). To date, this study represents the first attempt at analysing the factor structure of the individual dimensions (and not the factor structure of the entire questionnaire) in a confirmatory manner following its use in the ATP. However, interpretation is limited as not all items from the STSI and STST questionnaires used in the ATP were adopted into the SAIDI questionnaire.

Past validation studies analysed the clustering of dimension scores; unquestioningly accepting the sub-scales (dimensions) given (528, 529). Total scores from each dimension were then compared against normative data to categorise children into 'easy', 'difficult' and 'slow to warm up' temperaments. Studies that have conducted factor analyses of the individual items were exploratory and were primarily concerned with shortening the RITQ and TTS for use in larger cohorts. For example, the STSI and STST from the factor analyses on the ATP cohort consisted of only 30 items each which correspond to only five of the original nine dimensions of child temperament found in the RITQ and TTS (530). An earlier factor analysis by Bohlin and colleagues on 791 Swedish infants aged 11 to 41 weeks resulted in a seven factor questionnaire (531) while Rothbart and Mauro reported a six factor solution from data obtained from the ATP and 463 American infants aged 3 to 12 months old (532). A more recent analysis by Sasaki and colleagues on 1099 Japanese mothers resulted in a RITQ questionnaire consisting of 57 items corresponding to seven dimensions of child temperament (533).

It is clear from the literature that the factor structures of the RITQ and TTS differs between cohorts and culture. Cultural differences may lead to interpretational differences of the RITQ and TTS items due to differences in parenting approaches and cultural practices (534). Mothers' expectations and beliefs concerning their children's temperament (534, 535), environmental influences (536) and genetic factors (536) can all play a role in determining how mothers perceive their child temperament. Despite these weaknesses, mothers can be reliable observers with the added advantage of being able to observe their children in various situations that cannot be replicated in a laboratory setting (536).

Although the CFAs for child irritability and reactivity conducted on the SAIDI cohort are limited in their interpretational value, they provide initial evidence for further examination of the individual items that are supposed to measure each dimensions proposed in the STSI and STST. Due to the global popularity of the use of RITQ and TTS (and their various abridged forms) for measurement of child temperament, population specific studies confirming the factor structure of each item measuring each dimensions of temperament should be considered. There is also strength and practicality in validating the structure of individual dimensions as it provides future researchers the option of adopting specific items measuring a dimension (eg: irritability, persistence, approach) of interest rather than adopting the entire STSI and STST questionnaires.

6.4 CONCLUSION

Mothers in this study reported high levels of feeding self-efficacy and low levels of psychological distress. The measurement tool for maternal feeding self-efficacy at T1 (5 items) and T2 (8 items) have good internal consistency and the CFA models for all its items fitted well. The K10 demonstrated good internal consistency at both time points but poor model fit for all 10 items. Adjustments through consideration of modification indices and the psychological dimensions of the K10 resulted in good fitting models for 6 items at T1 and T2. The measurement tool for child irritability (4 items) and child reactivity (8 items) have poor internal consistency but the items measuring them fitted well into one factor models after removal of items with low item-total correlation values. This study is the first to validate the factor structure for the maternal feeding self-efficacy questionnaire used in the NEAT study and provides evidence for further research into the factor structures of the individual items making up the K10, child irritability dimension and child reactivity dimension from the STSI and STST questionnaires.

CHAPTER SEVEN: STRUCTURAL EQUATION MODELS

This chapter reports the results of the structural equation modelling of the conceptual model proposed in this thesis. Results from the conceptual model at Time 1 were published (19) (Appendix 1) and referenced where appropriate. Results for the conceptual model at Time 2 were presented at the 2014 International Obesity Conference (537) (Appendix 1). This chapter ends with a discussion and conclusions of the results found from the models.

7.1 THE MODEL AT T1

Tables 7.1 and 7.2 list the factor loadings (ß), standardised errors (SE) and p values found for the conceptual model for child vegetable variety and fruit variety respectively. Effect size (R^2) is also reported for endogenous variables.

The conceptual model achieved good fits for both the variety of child vegetable intake and fruit intake (χ^2/df<2, RMSEA <0.06, CFI >0.96, TLI>0.95, WRMR<0.90 respectively). The model explained 13% and 14% in the variances for child fruit and vegetable varieties, but only the model for the variety of child vegetable intake showed significant relationships. To summarise, Figure 7.1 depicts the significant relationships found in the conceptual model for child vegetable variety.

Parenting confidence (ß= 0.36, p<0.01), frequency of offering a new food before deciding child does not like it (ß= 0.40, p<0.01), how often offer new foods (ß= 0.26,

$p<0.05$) and child willingness to eat new foods (ß= 0.70, $p<0.01$) were significantly related to maternal feeding self-efficacy. Furthermore, the relationships between the variables ‘frequency of offering a new food before deciding child does not like it’ and ‘how often offer new foods’ with maternal self-efficacy were found to be bi-directional.

Maternal feeding self-efficacy (ß= 0.61, $p<0.05$) and total number of children (ß= -0.50, $p<0.01$) are directly related to the variety of child vegetable intake while maternal psychological distress was found to be a significant predictor for maternal vegetable intake (ß= -0.31, $p<0.01$), parenting confidence (ß= -0.42, $p<0.01$), maternal frequency of offering a new food before deciding child does not like it (ß= -0.26, $p<0.05$) and how often mothers offer new foods (ß= -0.14, $p<0.001$).

Table 7.1 Factor loadings (ß), standardised errors (SE), p values and effect sizes (R^2) for the conceptual model for child vegetable variety at Time 1 (n=277).

	Variable*	ß	SE	p	R^2
Exogenous variables:					
Maternal education					-
	→ how often offer new foods	0.04	0.07	0.57	
	→ frequency offering a new food before deciding child does not like it	0.12	0.07	0.08	
	→ child age of introduction of solids	0.86	0.48	0.08	
	→ child how willing to eat new foods	0.21	0.16	0.11	
	→ child how easy to feed compared to other child of same age	0.03	0.03	0.42	
	→ parenting confidence	0.03	0.05	0.55	
	→ maternal psychological distress	-0.08	0.14	0.57	
	→ child irritability	-0.09	0.06	0.12	
	→ maternal vegetable intake	0.07	0.06	0.22	
	→ maternal feeding self-efficacy	0.12	0.14	0.37	
	→ child variety of vegetable intake	0.18	0.12	0.13	
Maternal age					-
	→ how often offer new foods	0.01	0.02	0.74	
	→ frequency offering a new food before deciding child does not like it	-0.01	0.02	0.87	
	→ age of introduction of solids	0.04	0.07	0.63	
	→ child how willing to eat new foods	0.07	0.11	0.38	
	→ child how easy to feed compared to other child of same age	0.02	0.36	0.77	
	→ parenting confidence	0.01	0.02	0.81	
	→ maternal psychological distress	-0.09	0.05	0.06	
	→ child irritability	-0.01	0.02	0.31	
	→ maternal vegetable intake	0.04	0.02	0.05	
	→ maternal feeding self-efficacy	0.02	0.04	0.62	
	→ child variety of vegetable intake	0.04	0.03	0.27	

Table 7.1 continued.

	Variable*	ß	SE	p	R^2
Exogenous variables:					
Maternal country of birth§					-
	→ how often offer new foods	0.01	0.13	0.44	
	→ frequency offering a new food before deciding child does not like it	0.11	0.06	0.16	
	→ age of introduction of solids	0.02	0.19	0.64	
	→ child how willing to eat new foods	-0.21	0.11	0.33	
	→ child how easy to feed compared to other child of same age	-0.01	0.08	0.67	
	→ parenting confidence	0.13	0.02	0.12	
	→ maternal psychological distress	-0.10	0.23	0.33	
	→ child irritability	0.11	0.34	0.14	
	→ maternal vegetable intake	-0.32	0.11	0.22	
	→ maternal feeding self-efficacy	0.04	0.10	0.56	
	→ child variety of vegetable intake	0.13	0.18	0.37	
Total number of children					-
	→ child variety of vegetable intake	-0.50	0.19	<0.01	
	→ how often offer new foods	-0.04	0.13	0.78	
	→ frequency offering a new food before deciding child does not like it	-0.11	0.13	0.41	
	→ age of introduction of solids	-0.19	0.34	0.11	
	→ child how willing to eat new foods	0.10	0.03	0.36	
	→ child how easy to feed compared to other child of same age	-0.16	0.11	0.55	
	→ parenting confidence	-0.02	0.09	0.83	
	→ maternal psychological distress	0.18	0.25	0.46	
	→ child irritability	0.07	0.10	0.50	
	→ maternal vegetable intake	-0.02	0.16	0.77	
	→ maternal feeding self-efficacy	-0.05	0.23	0.82	

Table 7.1 continued.

	Variable*	ß	SE	p	R^2
Exogenous variables:					
Child gender[€]					-
	→ how often offer new foods	0.23	0.19	0.21	
	→ frequency offering a new food before deciding child does not like it	0.20	0.18	0.26	
	→ age of introduction of solids	-0.86	1.35	0.52	
	→ child how willing to eat new foods	0.25	0.17	0.15	
	→ child how easy to feed compared to other child of same age	-0.25	0.20	0.22	
	→ parenting confidence	0.10	0.16	0.52	
	→ maternal psychological distress	-0.02	0.15	0.67	
	→ child irritability	-0.17	0.10	0.31	
	→ maternal vegetable intake	0.01	0.22	0.77	
	→ maternal feeding self-efficacy	0.23	0.05	0.31	
	→ child variety of vegetable intake	0.10	0.23	0.16	
Total family income					-
	→ how often offer new foods	0.22	0.19	0.30	
	→ frequency offering a new food before deciding child does not like it	0.07	0.11	0.45	
	→ age of introduction of solids	-0.37	0.46	0.42	
	→ parenting confidence	-0.12	0.09	0.17	
	→ maternal vegetable intake	0.08	0.11	0.33	
	→ child how willing to eat new foods	-0.03	0.10	0.76	
	→ child how easy to feed compared to child of same age	-0.01	0.11	0.92	
	→ maternal feeding self-efficacy	-0.13	0.19	0.48	
Endogenous variables:					
Parenting confidence					0.16
	→maternal feeding self-efficacy	0.36	0.26	<0.01	
	→ how often offer new foods	0.23	0.10	0.43	
	→ frequency offering a new food before deciding child does not like it	0.11	0.34	0.12	
	→ age of introduction of solids	0.09	0.24	0.24	
	→ child variety of vegetable intake	0.12	0.10	0.21	

Table 7.1 continued.

	Variable*	ß	SE	p	R^2
Endogenous variables:					
Maternal vegetable intake					0.14
	→ how often offer new foods	0.11	0.10	0.14	
	→ frequency offering a new food before deciding child does not like it	0.14	0.08	0.06	
	→ child age of introduction of solids	0.02	0.13	0.33	
	→ parenting confidence	0.21	0.19	0.28	
	→ maternal feeding self-efficacy	0.24	0.21	0.26	
	→ child variety of vegetable intake	0.05	0.15	0.74	
How often offer new foods					0.10
	→ maternal feeding self-efficacy	0.26	0.30	<0.05	
	→ child how willing to eat new foods	0.29	0.12	0.55	
	→ child how easy to feed compared to other child of same age	0.13	0.07	0.12	
	→ child variety of vegetable intake	0.26	0.20	0.20	
Frequency offering a new food before deciding child does not like it					0.04
	→ maternal feeding self-efficacy	0.40	0.29	<0.01	
	→ child how willing to eat new foods	0.33	0.12	0.49	
	→ child how easy to feed compared to other child of same age	0.12	0.19	0.25	
	→ child variety of vegetable intake	0.24	0.19	0.22	
Child age of introduction of solids					0.02
	→ child how willing to eat new foods	-0.20	0.28	0.10	
	→ child how easy to feed compared to other child of same age	0.05	0.06	0.47	
	→ maternal feeding self-efficacy	0.03	0.11	0.29	
	→ child variety of vegetable intake	0.05	0.05	0.32	

Table 7.1 continued.

	Variable*	ß	SE	p	R^2
Endogenous variables:					
Child how willing to eat new foods					0.06
	→ maternal feeding self-efficacy	0.70	0.37	<0.01	
	→ how often offer new foods	0.11	0.23	0.47	
	→ frequency offering a new food before deciding child does not like it	0.21	0.09	0.13	
	→ child age of introduction of solids	0.31	0.14	0.37	
	→ child variety of vegetable intake	0.20	0.37	0.59	
Maternal feeding self-efficacy					0.71
	→ how often offer new foods	0.64	0.06	<0.001	
	→ frequency offering a new food before deciding child does not like it	0.52	0.06	<0.01	
	→ child variety of vegetable intake	0.61	0.17	<0.05	
	→ child age of introduction of solids	0.09	0.29	0.33	
	→ child how willing to eat new foods	0.06	0.08	0.48	
	→ child how easy to feed compared to other child of same age	0.17	0.11	0.11	
Child how easy to feed compared to other child of same age					0.01
	→ how often offer new foods	0.11	0.11	0.10	
	→ frequency offering a new food before deciding child does not like it	-0.05	0.01	0.62	
	→ child variety of vegetable intake	0.14	0.10	0.10	
	→ maternal feeding self-efficacy	0.31	0.26	0.09	
	→ child age of introduction of solids	0.22	0.13	0.12	

Table 7.1 continued.

Variable*		ß	SE	p	R^2
Endogenous variables:					0.03
Maternal psychological distress					
	→ how often offer new foods	-0.14	0.04	<0.001	
	→ frequency offering a new food before deciding child does not like it	-0.26	0.04	<0.05	
	→ parenting confidence	-0.42	0.06	<0.01	
	→ maternal vegetable intake	-0.31	0.04	<0.01	
	→ child age of introduction of solids	-0.07	0.15	0.67	
	→ child how willing to eat new foods	-0.13	0.09	0.12	
	→ child how easy to feed compared to other child of same age	-0.01	0.04	0.92	
	→ maternal feeding self-efficacy	-0.08	0.09	0.34	
Child irritability					0.03
	→ how often offer new foods	-0.10	0.10	0.31	
	→ frequency offering a new food before deciding child does not like it	-0.23	0.09	0.66	
	→ child age of introduction of solids	-0.37	0.46	0.42	
	→ child how willing to eat new foods	-0.03	0.10	0.76	
	→ child how easy to feed compared to other child of same age	-0.01	0.11	0.92	
	→ parenting confidence	-0.12	0.09	0.17	
	→ maternal vegetable intake	-0.06	0.11	0.44	
	→ maternal feeding self-efficacy	-0.14	0.19	0.48	
Outcome variable:					
Variety of child vegetable intake					0.14

→ direction of relationship

*higher score/ranking/numeral indicates higher agreement to the variable

§ 1 – Not Australian born, 2- Australian born

€ 1- Male, 2- Female

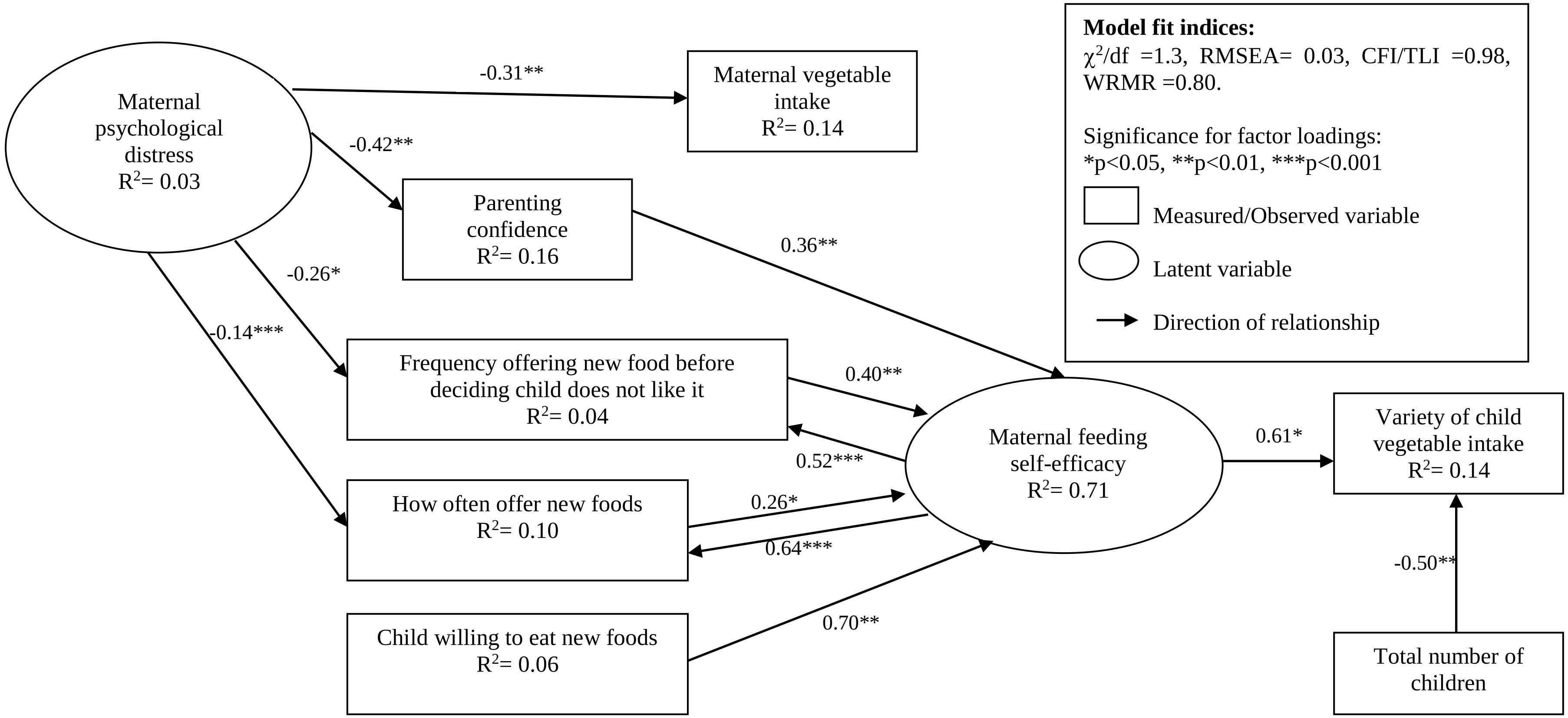


Figure 7.1 Significant relationships in the conceptual model for variety of child vegetable intake at Time 1 (n=277) (19).

Table 7.2 Factor loadings (ß), standardised errors (SE), p values and effect sizes (R^2) for the conceptual model for child fruit variety at Time 1 (n=277).

Variable*		ß	SE	p	R^2
Exogenous variables:					
Maternal education					-
	→ how often offer new foods	0.04	0.07	0.58	
	→ frequency offering a new food before deciding child does not like it	0.12	0.07	0.08	
	→ child age of introduction of solids	0.10	0.05	0.16	
	→ child how willing to eat new foods	0.07	0.12	0.33	
	→ child how easy to feed compared to other child of same age	0.01	0.01	0.89	
	→ parenting confidence	0.05	0.12	0.52	
	→ maternal psychological distress	-0.03	0.29	0.91	
	→ child irritability	-0.01	0.11	0.81	
	→ maternal fruit intake	0.10	0.06	0.08	
	→ maternal feeding self-efficacy	0.23	0.14	0.12	
	→ child variety of fruit intake	-0.01	0.04	0.80	
Maternal age					-
	→ how often offer new foods	0.01	0.02	0.72	
	→ frequency offering a new food before deciding child does not like it	0.01	0.02	0.99	
	→ age of introduction of solids	0.14	0.09	0.06	
	→ child how willing to eat new foods	0.11	0.05	0.11	
	→ child how easy to feed compared to other child of same age	0.29	0.11	0.39	
	→ parenting confidence	0.02	0.11	0.77	
	→ maternal psychological distress	-0.08	0.06	0.15	
	→child irritability	-0.01	0.10	0.63	
	→ maternal fruit intake	0.04	0.02	0.10	
	→ maternal feeding self-efficacy	0.02	0.04	0.64	
	→ child variety of fruit intake	0.03	0.01	0.10	

Table 7.2 continued.

	Variable*	ß	SE	p	R^2
Exogenous variables:					
Maternal country of birth[§]					-
	→ how often offer new foods	0.03	0.21	0.68	
	→ frequency offering a new food before deciding child does not like it	0.14	0.03	0.07	
	→ age of introduction of solids	0.11	0.09	0.13	
	→ child how willing to eat new foods	0.07	0.01	0.31	
	→ child how easy to feed compared to other child of same age	0.10	0.06	0.22	
	→ parenting confidence	0.01	0.01	0.99	
	→ maternal psychological distress	0.02	0.11	0.69	
	→ child irritability	-0.01	0.03	0.74	
	→ maternal fruit intake	0.13	0.06	0.07	
	→ maternal feeding self-efficacy	0.05	0.12	0.41	
	→ child variety of fruit intake	0.01	0.30	0.49	
Total number of children					-
	→ child variety of fruit intake	-0.14	0.07	0.06	
	→ how often offer new foods	-0.04	0.13	0.77	
	→ frequency offering a new food before deciding child does not like it	-0.11	0.03	0.12	
	→ age of introduction of solids	-0.02	0.31	0.22	
	→ child how willing to eat new foods	0.12	0.01	0.09	
	→ child how easy to feed compared to other child of same age	0.09	0.15	0.11	
	→ parenting confidence	0.11	0.06	0.21	
	→ maternal psychological distress	0.04	0.33	0.90	
	→child irritability	0.01	0.09	0.78	
	→ maternal fruit intake	0.01	0.01	0.99	
	→ maternal feeding self-efficacy	-0.17	0.25	0.49	

Table 7.2 continued.

	Variable*	ß	SE	p	R^2
Exogenous variables:					
Child gender[€]					-
	→ how often offer new foods	0.25	0.19	0.19	
	→ frequency offering a new food before deciding child does not like it	0.17	0.17	0.32	
	→ age of introduction of solids	-0.03	0.11	0.77	
	→ child how willing to eat new foods	0.27	0.19	0.15	
	→ child how easy to feed compared to other child of same age	0.26	0.21	0.21	
	→ parenting confidence	0.08	0.10	0.23	
	→ maternal psychological distress	-0.01	0.23	0.11	
	→ child irritability	-0.05	0.11	0.63	
	→ maternal fruit intake	0.12	0.01	0.55	
	→ maternal feeding self-efficacy	-0.38	0.38	0.32	
	→ child variety of fruit intake	0.13	0.02	0.16	
Total family income					-
	→ how often offer new foods	0.06	0.13	0.44	
	→ frequency offering a new food before deciding child does not like it	0.12	0.01	0.69	
	→ age of introduction of solids	0.01	0.01	0.98	
	→ parenting confidence	0.20	0.07	0.09	
	→ maternal fruit intake	0.06	0.02	0.32	
	→ child how willing to eat new foods	0.03	0.14	0.14	
	→ child how easy to feed compared to child of same age	0.09	0.01	0.11	
	→ maternal feeding self-efficacy	0.11	0.23	0.12	
Endogenous variables:					
Parenting confidence					0.25
	→maternal feeding self-efficacy	0.98	0.91	0.28	
	→ how often offer new foods	0.13	0.11	0.56	
	→ frequency offering a new food before deciding child does not like it	0.07	0.01	0.88	
	→ age of introduction of solids	-0.23	0.14	0.67	
	→ child variety of fruit intake	0.09	0.15	0.45	

Table 7.2 continued.

	Variable*	ß	SE	p	R^2
Endogenous variables:					
Maternal fruit intake					0.08
	→ how often offer new foods	0.01	0.03	0.89	
	→ frequency offering a new food before deciding child does not like it	0.15	0.06	0.12	
	→ child age of introduction of solids	-0.12	0.01	0.07	
	→ parenting confidence	0.03	0.02	0.79	
	→ maternal feeding self-efficacy	0.22	0.21	0.29	
	→ child variety of fruit intake	0.10	0.06	0.08	
How often offer new foods					0.10
	→ maternal feeding self-efficacy	0.57	0.31	0.07	
	→ child how willing to eat new foods	0.11	0.02	0.11	
	→ child how easy to feed compared to other child of same age	0.10	0.11	0.26	
	→ child variety of fruit intake	0.13	0.07	0.07	
Frequency offering a new food before deciding child does not like it					0.10
	→ maternal feeding self-efficacy	0.03	0.34	0.05	
	→ child how willing to eat new foods	0.23	0.11	0.21	
	→ child how easy to feed compared to other child of same age	0.09	0.05	0.09	
	→ child variety of fruit intake	0.01	0.08	0.97	
Child age of introduction of solids					0.02
	→ child how willing to eat new foods	-0.07	0.01	0.10	
	→ child how easy to feed compared to other child of same age	-0.02	0.03	0.47	
	→ maternal feeding self-efficacy	-0.10	0.10	0.25	
	→ child variety of fruit intake	0.03	0.01	0.05	

Table 7.2 continued.

	Variable*	ß	SE	p	R^2
Endogenous variables:					
Child how willing to eat new foods					0.34
	→ maternal feeding self-efficacy	0.24	0.44	0.06	
	→ how often offer new foods	-0.06	0.04	0.32	
	→ frequency offering a new food before deciding child does not like it	-0.01	0.01	0.88	
	→ child age of introduction of solids	-0.16	0.12	0.11	
	→ child variety of fruit intake	0.03	0.13	0.82	
Maternal feeding self-efficacy					0.66
	→ how often offer new foods	0.27	0.06	0.05	
	→ frequency offering a new food before deciding child does not like it	0.23	0.06	0.06	
	→ child variety of fruit intake	0.12	0.06	0.07	
	→ child age of introduction of solids	-0.11	0.03	0.12	
	→ child how willing to eat new foods	0.11	0.10	0.24	
	→ child how easy to feed compared to other child of same age	0.13	0.11	0.21	
Child how easy to feed compared to other child of same age					0.32
	→ how often offer new foods	0.12	0.08	0.10	
	→ frequency offering a new food before deciding child does not like it	-0.03	0.03	0.78	
	→ child variety of fruit intake	0.01	0.09	0.97	
	→ maternal feeding self-efficacy	0.52	0.27	0.05	
	→ child age of introduction of solids	-0.02	0.03	0.47	

Table 7.2 continued.

Variable*		ß	SE	p	R^2
Endogenous variables:					
Maternal psychological distress					0.04
	→ how often offer new foods	-0.05	0.03	0.18	
	→ frequency offering a new food before deciding child does not like it	-0.10	0.05	0.06	
	→ parenting confidence	-0.23	0.21	0.29	
	→ maternal fruit intake	-0.05	0.03	0.17	
	→ child age of introduction of solids	-0.11	0.07	0.09	
	→ child how willing to eat new foods	-0.01	0.11	0.68	
	→ child how easy to feed compared to other child of same age	-0.01	0.04	0.82	
	→ maternal feeding self-efficacy	-0.04	0.08	0.11	
Child irritability					0.23
	→ how often offer new foods	-0.11	0.07	0.11	
	→ frequency offering a new food before deciding child does not like it	-0.03	0.01	0.88	
	→ child age of introduction of solids	-0.02	0.11	0.56	
	→ child how willing to eat new foods	-0.07	0.11	0.49	
	→ child how easy to feed compared to other child of same age	-0.02	0.12	0.90	
	→ parenting confidence	-0.48	0.43	0.26	
	→ maternal vegetable intake	-0.01	0.13	0.88	
	→ maternal feeding self-efficacy	-0.10	0.23	0.66	
Outcome variable:					
Variety of child fruit intake					0.13

→ direction of relationship

*higher score/ranking/numeral indicates higher agreement to the variable

§ 1 – Not Australian born, 2- Australian born

€ 1- Male, 2- Female

7.2 THE MODEL AT T2

Tables 7.3 and 7.4 list the results from the SEM of the conceptual model at Time 2. The conceptual model achieved good fits for both the variety of child vegetable intake and fruit intake (χ^2/df<2, RMSEA <0.06, CFI >0.96, TLI>0.95, WRMR<0.90 respectively). The model explained 9% and 25% in the variances for child fruit and vegetable varieties, but the model for the variety of child fruit intake showed only one significant relationship where maternal fruit intake predicted the variety of child fruit intake (β= 0.31, $p<0.05$). To summarise, Figure 7.2 depicts the significant relationships found in the conceptual model for child vegetable variety.

Maternal psychological distress (β=-0.52, $p<0.05$), parenting confidence (β= 0.46, $p<0.001$), child willingness to eat new foods (β= 0.55, $p<0.001$) and maternal vegetable intake (β=0.41, $p<0.01$) significantly predicted maternal feeding self-efficacy. Maternal feeding self-efficacy was indirectly related to the variety in child vegetable variety through the variable 'how often offer new foods' (β=0.65, $p<0.01$) while maternal vegetable intake directly predicted the variety in child vegetable intake (β= 0.88, $p<0.01$). Consistent with the result from T1, total number of children (β= -1.0, $p<0.001$) directly predicted child vegetable variety.

Table 7.3 Factor loadings (ß), standardised errors (SE), p values and effect sizes (R^2) for the conceptual model for child vegetable variety at Time 2 (n=208).

Variable*		ß	SE	p	R^2
Exogenous variables:					
Maternal education					-
	→ how often offer new foods	0.03	0.07	0.64	
	→ frequency offering a new food before deciding child does not like it	0.10	0.06	0.09	
	→ child age of introduction of solids	0.01	0.07	0.99	
	→ child how willing to eat new foods	0.03	0.02	0.69	
	→ child how easy to feed compared to other child of same age	0.01	0.12	0.78	
	→ parenting confidence	0.05	0.22	0.81	
	→ maternal psychological distress	-0.02	0.22	0.90	
	→ child reactivity	-0.19	0.10	0.12	
	→ maternal vegetable intake	0.12	0.07	0.07	
	→ maternal feeding self-efficacy	0.01	0.10	0.97	
	→ child variety of vegetable intake	0.11	0.15	0.46	
Maternal age					-
	→ how often offer new foods	0.01	0.02	0.87	
	→ frequency offering a new food before deciding child does not like it	0.02	0.02	0.24	
	→ age of introduction of solids	0.09	0.03	0.56	
	→ child how willing to eat new foods	0.01	0.01	0.89	
	→ child how easy to feed compared to other child of same age	0.05	0.11	0.36	
	→ parenting confidence	0.03	0.10	0.74	
	→ maternal psychological distress	-0.02	0.09	0.67	
	→child reactivity	-0.09	0.02	0.10	
	→ maternal vegetable intake	0.05	0.02	0.09	
	→ maternal feeding self-efficacy	0.1	0.03	0.54	
	→ child variety of vegetable intake	0.02	0.04	0.72	

Table 7.3 continued.

	Variable*	ß	SE	p	R^2
Exogenous variables:					
Maternal country of birth[§]					-
	→ how often offer new foods	0.01	0.11	0.79	
	→ frequency offering a new food before deciding child does not like it	0.10	0.03	0.11	
	→ age of introduction of solids	0.01	0.06	0.69	
	→ child how willing to eat new foods	0.03	0.02	0.77	
	→ child how easy to feed compared to other child of same age	0.07	0.01	0.32	
	→ parenting confidence	0.01	0.10	0.81	
	→ maternal psychological distress	-0.13	0.12	0.10	
	→ child reactivity	-0.01	0.03	0.89	
	→ maternal vegetable intake	-0.05	0.01	0.46	
	→ maternal feeding self-efficacy	0.16	0.05	0.09	
	→ child variety of vegetable intake	0.11	0.23	0.35	
Total number of children					-
	→ child variety of vegetable intake	-1.00	0.26	<0.001	
	→ how often offer new foods	0.01	0.10	0.94	
	→ frequency offering a new food before deciding child does not like it	-0.09	0.11	0.43	
	→ age of introduction of solids	-0.11	0.05	0.32	
	→ child how willing to eat new foods	0.02	0.02	0.88	
	→ child how easy to feed compared to other child of same age	0.10	0.07	0.36	
	→ parenting confidence	0.35	0.30	0.25	
	→ maternal psychological distress	0.06	0.32	0.75	
	→child reactivity	0.25	0.18	0.26	
	→ maternal vegetable intake	0.01	0.01	0.99	
	→ maternal feeding self-efficacy	0.20	0.12	0.39	

Table 7.3 continued.

	Variable*	ß	SE	p	R^2
Exogenous variables:					
Child gender€					-
	→ how often offer new foods	0.22	0.18	0.21	
	→ frequency offering a new food before deciding child does not like it	0.06	0.18	0.73	
	→ age of introduction of solids	-0.13	0.10	0.36	
	→ child how willing to eat new foods	0.02	0.01	0.86	
	→ child how easy to feed compared to other child of same age	-0.13	0.18	0.47	
	→ parenting confidence	0.16	0.43	0.71	
	→ maternal psychological distress	0.01	0.01	0.99	
	→ child reactivity	-0.34	0.25	0.25	
	→ maternal vegetable intake	0.03	0.05	0.56	
	→ maternal feeding self-efficacy	-0.05	0.23	0.76	
	→ child variety of vegetable intake	0.13	0.10	0.12	
Total family income					-
	→ how often offer new foods	0.06	0.02	0.56	
	→ frequency offering a new food before deciding child does not like it	0.01	0.07	0.77	
	→ age of introduction of solids	0.06	0.10	0.45	
	→ parenting confidence	0.08	0.01	0.32	
	→ maternal vegetable intake	0.01	0.12	0.86	
	→ child how willing to eat new foods	0.02	0.01	0.89	
	→ child how easy to feed compared to child of same age	0.07	0.10	0.45	
	→ maternal feeding self-efficacy	0.16	0.10	0.08	
Endogenous variables:					
Parenting confidence					0.29
	→ maternal feeding self-efficacy	0.46	0.18	<0.001	
	→ how often offer new foods	0.12	0.10	0.23	
	→ frequency offering a new food before deciding child does not like it	0.05	0.01	0.76	
	→ age of introduction of solids	0.02	0.01	0.89	
	→ child variety of vegetable intake	0.11	0.01	0.19	

Table 7.3 continued.

	Variable*	ß	SE	p	R^2
Endogenous variables:					
Maternal vegetable intake					0.10
	→ maternal feeding self-efficacy	0.41	0.14	<0.01	
	→ child variety of vegetable intake	0.88	0.23	<0.001	
	→ how often offer new foods	0.10	0.03	0.56	
	→ frequency offering a new food before deciding child does not like it	0.03	0.01	0.75	
	→ child age of introduction of solids	0.01	0.12	0.79	
	→ parenting confidence	0.07	0.15	0.56	
How often offer new foods					0.11
	→ maternal feeding self-efficacy	0.65	0.32	<0.01	
	→ child variety of vegetable intake	0.86	0.29	<0.01	
	→ child how willing to eat new foods	0.23	0.19	0.12	
	→ child how easy to feed compared to other child of same age	0.06	0.01	0.49	
Frequency offering a new food before deciding child does not like it					0.05
	→ maternal feeding self-efficacy	0.15	0.16	0.18	
	→ child how willing to eat new foods	0.05	0.09	0.45	
	→ child how easy to feed compared to other child of same age	0.01	0.07	0.78	
	→ child variety of vegetable intake	0.31	0.18	0.09	
Child age of introduction of solids					0.01
	→ child how willing to eat new foods	-0.01	0.03	0.77	
	→ child how easy to feed compared to other child of same age	0.01	0.02	0.65	
	→ maternal feeding self-efficacy	0.03	0.12	0.33	
	→ child variety of vegetable intake	0.05	0.06	0.34	

Table 7.3 continued.

	Variable*	ß	SE	p	R^2
Endogenous variables:					
Child how willing to eat new foods					0.08
	→ maternal feeding self-efficacy	0.55	0.19	<0.001	
	→ how often offer new foods	-0.11	0.05	0.23	
	→ frequency offering a new food before deciding child does not like it	-0.02	0.02	0.59	
	→ child age of introduction of solids	-0.20	0.13	0.07	
	→ child variety of vegetable intake	0.45	0.26	0.09	
Maternal feeding self-efficacy					0.54
	→ how often offer new foods	0.69	0.10	<0.001	
	→ frequency offering a new food before deciding child does not like it	0.03	0.08	0.79	
	→ child variety of vegetable intake	0.30	0.18	0.23	
	→ child age of introduction of solids	0.11	0.07	0.32	
	→ child how willing to eat new foods	0.07	0.10	0.66	
	→ child how easy to feed compared to other child of same age	0.36	0.11	0.07	
Child how easy to feed compared to other child of same age					0.11
	→ how often offer new foods	-0.06	0.10	0.55	
	→ frequency offering a new food before deciding child does not like it	-0.16	0.25	0.48	
	→ child variety of vegetable intake	0.16	0.23	0.06	
	→ maternal feeding self-efficacy	0.14	0.14	0.15	
	→ child age of introduction of solids	-0.11	0.01	0.09	

Table 7.3 continued.

	Variable*	ß	SE	p	R^2
Endogenous variables:					
Maternal psychological distress					0.05
	→ maternal self-efficacy	-0.52	0.08	<0.05	
	→ how often offer new foods	0.12	0.06	0.23	
	→ frequency offering a new food before deciding child does not like it	-0.16	0.06	0.12	
	→ parenting confidence	-0.25	0.12	0.08	
	→ maternal vegetable intake	-0.18	0.06	0.11	
	→ child age of introduction of solids	-0.03	0.10	0.68	
	→ child how willing to eat new foods	-0.06	0.02	0.56	
	→ child how easy to feed compared to other child of same age	-0.04	0.05	0.67	
Child reactivity					0.24
	→ how often offer new foods	-0.10	0.09	0.59	
	→ frequency offering a new food before deciding child does not like it	-0.03	0.05	0.76	
	→ child age of introduction of solids	-0.03	0.02	0.79	
	→ child how willing to eat new foods	-0.22	0.16	0.10	
	→ child how easy to feed compared to other child of same age	-0.08	0.13	0.47	
	→ parenting confidence	-0.11	0.01	0.15	
	→ maternal vegetable intake	-0.01	0.05	0.88	
	→ maternal feeding self-efficacy	-0.26	0.21	0.05	
Outcome variable:					
Variety of child vegetable intake					0.25

→ direction of relationship
*higher score/ranking/numeral indicates higher agreement to the variable
§ 1 – Not Australian born, 2- Australian born
€ 1- Male, 2- Female

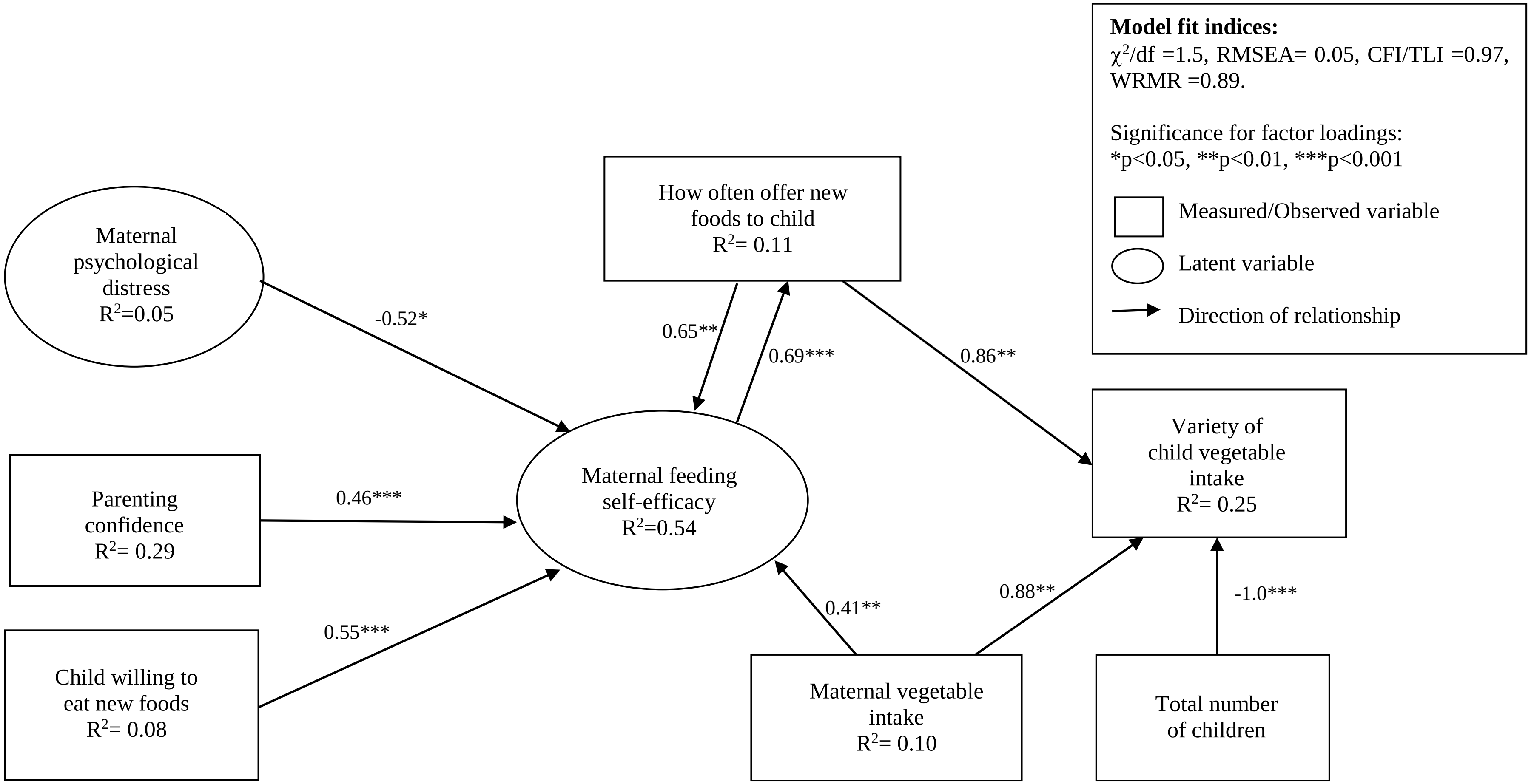


Figure 7.2 Significant relationships in the conceptual model for variety of child vegetable intake at Time 2 (n=208).

Table 7.4 Factor loadings (ß), standardised errors (SE), p values and effect sizes (R^2) for the conceptual model for child fruit variety at Time 2 (n=208).

Variable*		ß	SE	p	R^2
Exogenous variables:					
Maternal education					-
	→ how often offer new foods	0.06	0.01	0.48	
	→ frequency offering a new food before deciding child does not like it	0.01	0.02	0.89	
	→ child age of introduction of solids	0.11	0.16	0.25	
	→ child how willing to eat new foods	0.03	0.01	0.76	
	→ child how easy to feed compared to other child of same age	0.09	0.10	0.44	
	→ parenting confidence	0.15	0.10	0.07	
	→ maternal psychological distress	-0.04	0.22	0.88	
	→ child reactivity	-0.17	0.11	0.13	
	→ maternal fruit intake	0.10	0.05	0.36	
	→ maternal feeding self-efficacy	0.05	0.10	0.67	
	→ child variety of fruit intake	0.09	0.11	0.40	
Maternal age					-
	→ how often offer new foods	0.01	0.02	0.81	
	→ frequency offering a new food before deciding child does not like it	0.02	0.02	0.28	
	→ age of introduction of solids	0.03	0.05	0.66	
	→ child how willing to eat new foods	0.01	0.01	0.99	
	→ child how easy to feed compared to other child of same age	0.03	0.02	0.65	
	→ parenting confidence	0.04	0.10	0.69	
	→ maternal psychological distress	0.05	0.01	0.38	
	→child reactivity	-0.07	0.02	0.09	
	→ maternal fruit intake	0.04	0.02	0.08	
	→ maternal feeding self-efficacy	0.01	0.03	0.95	
	→ child variety of fruit intake	0.04	0.03	0.17	

Table 7.4 continued.

	Variable*	ß	SE	p	R^2
Exogenous variables:					
Maternal country of birth§					-
	→ how often offer new foods	0.05	0.01	0.86	
	→ frequency offering a new food before deciding child does not like it	0.01	0.01	0.99	
	→ age of introduction of solids	0.07	0.05	0.76	
	→ child how willing to eat new foods	0.02	0.02	0.69	
	→ child how easy to feed compared to other child of same age	0.01	0.01	0.89	
	→ parenting confidence	0.10	0.02	0.23	
	→ maternal psychological distress	0.16	0.12	0.23	
	→ child reactivity	-0.02	0.05	0.77	
	→ maternal fruit intake	0.15	0.01	0.10	
	→ maternal feeding self-efficacy	0.09	0.12	0.49	
	→ child variety of fruit intake	0.10	0.01	0.35	
Total number of children					-
	→ child variety of fruit intake	-0.22	0.19	0.11	
	→ how often offer new foods	-0.01	0.10	0.91	
	→ frequency offering a new food before deciding child does not like it	-0.09	0.11	0.42	
	→ age of introduction of solids	-0.03	0.02	0.45	
	→ child how willing to eat new foods	0.11	0.06	0.29	
	→ child how easy to feed compared to other child of same age	0.03	0.01	0.56	
	→ parenting confidence	0.36	0.30	0.23	
	→ maternal psychological distress	0.06	0.32	0.85	
	→child reactivity	0.20	0.19	0.29	
	→ maternal fruit intake	0.03	0.02	0.69	
	→ maternal feeding self-efficacy	-0.20	0.17	0.22	

Table 7.4 continued.

	Variable*	ß	SE	p	R^2
Exogenous variables:					
Child gender€					-
	→ how often offer new foods	0.23	0.17	0.17	
	→ frequency offering a new food before deciding child does not like it	0.06	0.18	0.74	
	→ age of introduction of solids	-0.14	0.24	0.58	
	→ child how willing to eat new foods	0.27	0.18	0.13	
	→ child how easy to feed compared to other child of same age	-0.11	0.19	0.57	
	→ parenting confidence	0.14	0.44	0.76	
	→ maternal psychological distress	0.01	0.01	0.38	
	→ child reactivity	-0.30	0.26	0.25	
	→ maternal fruit intake	0.04	0.03	0.56	
	→ maternal feeding self-efficacy	0.11	0.09	0.39	
	→ child variety of fruit intake	0.08	0.03	0.19	
Total family income					-
	→ how often offer new foods	0.03	0.03	0.69	
	→ frequency offering a new food before deciding child does not like it	0.01	0.01	0.56	
	→ age of introduction of solids	0.09	0.02	0.49	
	→ parenting confidence	0.18	0.11	0.09	
	→ maternal fruit intake	0.03	0.01	0.79	
	→ child how willing to eat new foods	0.05	0.01	0.88	
	→ child how easy to feed compared to child of same age	0.04	0.02	0.36	
	→ maternal feeding self-efficacy	0.18	0.15	0.11	
Endogenous variables:					
Parenting confidence					0.27
	→ maternal feeding self-efficacy	0.67	0.20	0.07	
	→ how often offer new foods	0.22	0.13	0.26	
	→ frequency offering a new food before deciding child does not like it	0.11	0.02	0.55	
	→ age of introduction of solids	0.02	0.02	0.84	
	→ child variety of fruit intake	0.31	0.11	0.10	

Table 7.4 continued.

	Variable*	ß	SE	p	R^2
Endogenous variables:					
Maternal fruit intake					0.07
	→ child variety of fruit intake	0.31	0.14	<0.05	
	→ how often offer new foods	0.07	0.01	0.49	
	→ frequency offering a new food before deciding child does not like it	0.06	0.05	0.33	
	→ child age of introduction of solids	0.01	0.03	0.65	
	→ parenting confidence	0.17	0.15	0.16	
	→ maternal feeding self-efficacy	0.18	0.14	0.20	
How often offer new foods					0.01
	→ maternal feeding self-efficacy	0.75	0.29	0.06	
	→ child how willing to eat new foods	0.11	0.03	0.29	
	→ child how easy to feed compared to other child of same age	0.02	0.02	0.91	
	→ child variety of fruit intake	0.06	0.18	0.72	
Frequency offering a new food before deciding child does not like it					0.02
	→ maternal feeding self-efficacy	0.38	0.19	0.06	
	→ child how willing to eat new foods	0.15	0.10	0.23	
	→ child how easy to feed compared to other child of same age	0.06	0.07	0.49	
	→ child variety of fruit intake	0.04	0.14	0.80	
Child age of introduction of solids					0.02
	→ child how willing to eat new foods	-0.01	0.03	0.73	
	→ child how easy to feed compared to other child of same age	0.02	0.02	0.53	
	→ maternal feeding self-efficacy	0.07	0.05	0.36	
	→ child variety of fruit intake	0.01	0.04	0.98	

Table 7.4 continued.

	Variable*	ß	SE	p	R^2
Endogenous variables:					
Child how willing to eat new foods					0.03
	→ maternal feeding self-efficacy	0.51	0.23	0.06	
	→ how often offer new foods	-0.18	0.10	0.39	
	→ frequency offering a new food before deciding child does not like it	-0.07	0.05	0.78	
	→ child age of introduction of solids	-0.25	0.12	0.11	
	→ child variety of fruit intake	0.33	0.18	0.06	
Maternal feeding self-efficacy					0.51
	→ how often offer new foods	0.40	0.10	0.06	
	→ frequency offering a new food before deciding child does not like it	-0.09	0.09	0.29	
	→ child variety of fruit intake	0.08	0.14	0.57	
	→ child age of introduction of solids	0.02	0.03	0.79	
	→ child how willing to eat new foods	0.17	0.06	0.15	
	→ child how easy to feed compared to other child of same age	0.28	0.12	0.07	
Child how easy to feed compared to other child of same age					0.03
	→ how often offer new foods	0.06	0.02	0.49	
	→ frequency offering a new food before deciding child does not like it	0.14	0.07	0.21	
	→ child variety of fruit intake	0.26	0.19	0.17	
	→ maternal feeding self-efficacy	0.13	0.16	0.41	
	→ child age of introduction of solids	0.02	0.05	0.50	

Table 7.4 continued.

Variable*		ß	SE	p	R^2
Endogenous variables:					
Maternal psychological distress					0.04
	→ how often offer new foods	-0.04	0.05	0.43	
	→ frequency offering a new food before deciding child does not like it	-0.11	0.06	0.08	
	→ parenting confidence	-0.29	0.13	0.06	
	→ maternal fruit intake	-0.09	0.06	0.09	
	→ child age of introduction of solids	-0.05	0.01	0.66	
	→ child how willing to eat new foods	-0.06	0.01	0.49	
	→ child how easy to feed compared to other child of same age	-0.03	0.05	0.62	
	→ maternal feeding self-efficacy	-0.13	0.09	0.14	
Child reactivity					0.21
	→ how often offer new foods	-0.14	0.07	0.30	
	→ frequency offering a new food before deciding child does not like it	-0.21	0.15	0.11	
	→ child age of introduction of solids	-0.06	0.02	0.70	
	→ child how willing to eat new foods	-0.14	0.11	0.23	
	→ child how easy to feed compared to other child of same age	-0.10	0.13	0.44	
	→ parenting confidence	-0.38	0.28	0.77	
	→ maternal fruit intake	-0.11	0.09	0.69	
	→ maternal feeding self-efficacy	0.43	0.22	0.06	
Outcome variable:					
Variety of child fruit intake					0.09

→ direction of relationship

*higher score/ranking/numeral indicates higher agreement to the variable

§ 1 – Not Australian born, 2- Australian born

€ 1- Male, 2- Female

7.3 DISCUSSION

This study shows how maternal feeding self-efficacy is directly and indirectly related to vegetable variety consumed by children aged 4 to 18 months. At T1, maternal self-efficacy directly related to child vegetable variety ($\beta=0.61$, $p<0.05$) while at T2, it is indirectly related to child vegetable variety via its association with how often mothers offered novel foods to their children ($\beta=0.69$, $p<0.001$). This supports the findings from past studies that maternal feeding self-efficacy is a significant predictor of child fruit and vegetable consumption (63, 302, 303).

Parenting confidence, how often mothers offered novel foods and child willingness to eat new foods consistently predicted maternal feeding self-efficacy at both time points. At T1, child willingness to eat new foods ($\beta=0.70$, $p<0.01$) is the strongest predictor of maternal feeding self-efficacy, followed by child's frequency of exposure to new foods ($\beta= 0.40$, $p<0.01$), parenting confidence ($\beta=0.36$, $p<0.01$) and lastly, by how often mothers offer new foods to their children ($\beta=0.26$, $p<0.05$). This is consistent with the literature on child feeding at the weaning period where food neophobia and repeated exposure to a new food are considered as the two most important determinants of child food acceptance (35).

Food neophobia is arguably the strongest psychological barrier to the acquisition of variety in children's diet (538). Mothers with food neophobic children were shown to use more restriction (539), pressuring (80) and controlling (540) feeding practices which may impact negatively on children's fruit and vegetable intakes (80, 540). The findings from this thesis expands on the current knowledge base to show that maternal feeding self-efficacy can potentially be the missing link to explain the relationship between child food neophobic behaviour and maternal feeding practices. Children's rejection or reluctance to eat new foods may have modified mothers' sense of feeding competency which then leads to mothers resorting to feeding practices that are known to be detrimental towards children's dietary (80, 541) and weight outcomes (70, 542).

For instance, in an American study published in 2012, Tan and Holub studied 85 mothers of 3-to 12-year old children about food neophobia and maternal feeding practices (539). They found that mothers with highly neophobic children and who are food neophobic themselves used more restrictive child feeding practices ($r = 0.36$, $p<0.01$ and $r = 0.24$, $p<0.05$) respectively) (539). In an Italian study published in the same year ($n=127$ mother-child dyads), preschoolers' neophobia was found to be significantly correlated to both their mothers' food neophobia ($r = 0.22$, $p<0.05$) and pickiness ($r = 0.21$, $p<0.05$) (543). Picky children had mothers who ate unfamiliar foods and offered unfamiliar foods less frequently than mothers of less picky children (median = 2.7 ± 0.8 versus 3.04 ± 0.7, $p<0.05$ and median = 2.93 ± 0.75 versus 3.19 ± 0.63, $p<0.05$ respectively) (543). Moreover, mothers' food neophobia was shown to be related to their personality characteristics (539). Clearly, the development of child eating behaviours involve a complex interplay of genetics and environment which may be explained through maternal feeding self-efficacy.

A key strategy to modify children's neophobic food behaviour is to increase children's familiarity towards novel foods through the role of food exposure (24). There are two variables included in the SEM models that measured exposure:-

frequency of offering a new food before deciding child does not like it, and how often new foods were offered. Although both measure exposure, they are conceptually different; the former measuring repeated exposure to a new food while the later measuring the number of opportunities children had to taste a variety of new foods. Both repeated exposure and variety of exposure to new foods have been shown to be predictive of child food acceptance (35).

Interestingly, in this thesis, repeated exposure to a new food is found to be related to maternal feeding self-efficacy only at T1 while how often mothers offered new foods to their children was related to maternal feeding self-efficacy at both time points. From the literature, repeated exposure of a new food is more effective in younger children than in older children with established food preference (274). This may explain why repeated exposure is a significant predictor in the model at T1 and not at T2.

Findings in this thesis show that the frequency of being exposed to a variety of new foods can directly (T2) and indirectly (T1) predict children's vegetable variety. Although variety is a known predictor of children's fruit and vegetable intakes in older children (269-272), evidence for the role of variety in early exposure on children's diet is mostly limited to experimental studies (265-268). A most recent study by Maier-Noth *et al* examined the role of vegetable variety at weaning in predicting children's vegetable preference and intake at 15 months, 3 and 6 years using data obtained from an experimental cohort study (275). They reported children who had high vegetable variety at the start of weaning ate more new vegetables and liked them more at each time points (275). The results from this thesis complements the findings from the Maier-Noth *et al* study by showing how higher levels of maternal feeding self-efficacy predicted more frequent child exposure to a new food and to a variety of new foods, and that these relationships are reciprocal.

At both time points, maternal psychological distress and parenting confidence played significant roles in predicting child vegetable variety, especially at T1 where maternal psychological distress was found to negatively predict all significant maternal factors (parenting confidence, repeated exposure, variety of exposure, vegetable intake). This is expected considering mothers who are more distressed are more self-preoccupied and therefore unable or unwilling to respond to their children's needs (326). Mothers who are distressed may also report negative behaviours due to the role of negative affectivity (544-546). Therefore, caution is required in interpreting the results. Importantly, the results from this thesis show that mothers who were less distressed have higher sense of parenting confidence and were more likely to offer a new food more frequently and with greater variety which then predicted greater sense of feeding self-efficacy and subsequently variety in child vegetable intake. This highlights the importance of addressing maternal psychological health as a modifiable determinant of child vegetable intake and possibly other child health outcomes. Therefore, health professionals should be trained to identify symptoms of distress in mothers and to provide support to mothers who are distressed as a strategy to increase child vegetable intakes.

Although the literature suggests that maternal intake is a consistent predictor of children's intake (359), this is only observed at T2. The absence in the link between maternal vegetable intake and children's vegetable intake at T1 may be due to the young age of children and the fact that children at T1 had just started eating solids and therefore, do not have an established diet. The relationship between maternal and child food intake was also found in the literature to be generally weaker in young children and stronger in older children (23). In this thesis, maternal vegetable intake is found to be the second strongest predictor of child vegetable variety at T2 ($\beta=0.88$, $p<0.05$). Maternal fruit intake was also found to be a significant predictor of child fruit variety at T2 ($\beta=0.31$, $p<0.05$), though the structural model for fruit intake was not well fitted at both time points. This shows that mothers can influence children's fruit and vegetable intakes through their own fruit and vegetable intakes and that interventions that target increasing fruit and vegetable intakes in mothers can potentially benefit children's intakes as well.

The variable that directly and consistently predicted children's variety in vegetable intake was mother's parity. Interestingly, this variable is also found in the literature to be associated with poor child diet quality (547-549). Mother's parity may influence children's diet through the influence of siblings on child's diet and/or through differential feeding practices in response to the needs of multiple children.

The influence of siblings has been largely ignored by health researchers (550). Yet, the quality of sibling relationship is recognised as a significant predictor for adolescent outcomes such as delinquency (551) and peer competence (552, 553). A longitudinal study conducted in the Netherlands on 415 sibling pairs (aged 13-16 years) by de Leeuw and colleagues used Structural Equation Modelling to investigate similarities and reciprocal influences in eating behaviours in adolescent siblings, and found that sibling eating behaviours were significantly correlated and moderated by the quality of sibling relationship (554).

Subsequently, a cross-sectional American study on 326 sibling dyads (aged 12-19 years) examined the link between sibling relationship and weight-related health behaviours and concluded that sibling intimacy was related to healthy attitudes (γ=0.11, $p<0.05$) and greater exercise activities (γ=0.19, $p<0.01$) and that these relationships were moderated by the gender of the sibling dyads (550). A more recent analysis on data obtained from the U.S. Eating and Activity in Teens (EAT) and Families and Eating and Activity Among Teens (F-EAT) studies (n=58 sibling pairs) showed that fast food consumption (0.65, 95% CI= 0.17,0.88), frequency of eating breakfast (0.45, 95% CI= 0.11,0.69) and sedentary behaviour (0.65, 95%CI= 0.04, 0.94) were significantly correlated between siblings (555). Currently, there is no published study that has examined the relationship between feeding behaviours and dietary intakes between young sibling dyads. This is clearly a gap in the literature that needs to be addressed in future studies.

Besides the influence of siblings, mothers may use differential feeding practices in respond to child behaviour and this may affect child feeding outcomes. A U.K study on 80 parents with at least two sibling children by Farrow *et al* showed that parents used greater restrictive feeding practices with fussier siblings (r=0.53), and greater pressure to eat on siblings who were slower to eat (r=0.52), fussier (r=0.48), emotionally under-eat (r=0.35), less responsive to food (r=-0.39), enjoyed less food (r=-0.61) and more responsive to internal satiety cues (r=0.61) (all $p\leq0.01$) (556). Parents may also use different feeding practices in respond to child temperament.

Greater maternal feeding restriction on siblings who were distractible (r=0.33, $p<0.05$) was observed by Horn and colleagues in their study on 55 parents and child-sibling pairs (557). Parents also reported a greater sense of feeding responsibility for children with negative mood (r=030, $p<0.05$) (557). It is therefore clear that parents may change their feeding practices when parenting multiple children. Future studies would benefit from exploring this change or difference in relation to children's diet.

Parents may also use differential feeding practices due to differential weight concern for the weight status of their children (558). They may also alter their feeding practices in response to perceived differences in appetitive traits and food preferences between their children (559). Mothers generally spend less time thinking about their later pregnancies than their first (560). They are more ambivalent but feel more confident in parenting (560). This relaxes their parenting expectations (560) which may affect the quality of children's diet. Maternal parity may also moderate parenting determinants associated with having to juggle the needs of more than one child, such as maternal stress (561), perception of support (562) and marital quality (561, 562).

The relationship between parity and child vegetable variety found in this thesis may also be explained by social trends. Global data from the World Bank show that the higher the level of a woman's educational attainment, the fewer children she is likely to bear which then relates to delayed marriage (older mothers) and more resources per child and better child health and survival rates (563). This trend is also observed in developed countries like Australia and is attributed to increased liberalism and participation in the workforce which led to an upsurge of lifestyle options for women

(564). Moreover maternal education is a known predictor of feeding practices (565, 566). Clearly, the role of mother's parity in predicting child feeding and intakes is multi-faceted. Therefore, future studies aiming to investigate the role of mother's parity in predicting child intakes should consider a more tailored model which include child eating behaviours (eg: fussiness, appetite regulation, responsiveness to food), temperament, maternal concern for child weight, maternal feeding practices (eg: pressure to eat, restriction), quality of sibling relationship and socio-demographic determinants.

The SEM models at both time points explained >50% of the variation in maternal feeding self-efficacy, indicating that the conceptual models predicted most the variation in maternal feeding self-efficacy. However, cautious interpretation is required on the predictive power of the models as the R^2 values for maternal feeding self-efficacy can be influenced by the number of exogenous variables linked to it (567). The more variables linked to maternal self-efficacy, the higher the R^2 value, even if the variables are only slightly related to maternal feeding self-efficacy (567). Therefore, the models presented cannot be used to elucidate causality.

Despite the significant relationships found, the SEM models only predicted 14% and 25% in the variation in child vegetable variety at T1 and T2 respectively. This indicates that there are important determinants of child vegetable variety that were excluded in the models. Maternal feeding variables in the models are limited to feeding practices related to early food exposure and age of introduction of solids while child feeding behaviour was represented by two variable measuring child neophobia and fussiness. Inclusion of maternal and child feeding variables that measure more dimensions of feeding such as restrictive feeding, pressure to eat, child responsiveness to food and satiety cues could further strengthen the models.

No significant relationships were observed in the models for child variety of fruit intake at both time points. Unlike vegetables, fruit appeals to child’s innate preference for sweetness which makes its consumption more voluntary and less dependent on conscious effort (378). For instance, a cross-sectional study on 1739 parent-child dyads of children aged 4 to 12 years in the Netherlands showed that habit was found to be the most important correlate in predicting child fruit intakes in boys ($\beta = 0.19$, $p<0.001$) and girls ($\beta = 0.13$, $p<0.001$) (378). In this study, when added into a model containing psychosocial variables such as self-efficacy, habit explained an additional 13% variance in fruit intake but only explained an additional 3% variance in vegetable intake; indicating that vegetable consumption is less habitual and that consumption of fruits and vegetables is influenced by different predictors and should therefore be examined separately (378).

The current SEM models are not transferrable to older children with established eating habits as the variables in the models are concerned with investigating variety in fruit and vegetable consumed in the early feeding period. In older children, other determinants such as availability and accessibility of fruit and vegetables, food preferences, knowledge and school factors are shown to be strong predictors of child fruit and vegetable intakes (359).

Despite the weaknesses discussed above, the SEM models presented include a comprehensive consideration of distal and proximal determinants related to early feeding and show direct and indirect relationships; a strength not found in studies reporting unidirectional models. The assessment of the models at two time points show temporal differences in the direction and strength of the relationships. This adds to the understanding in the differences in the role of maternal feeding self-efficacy, child feeding behaviour and exposure in predicting child vegetable variety at two different stages in early child feeding.

7.4 CONCLUSION

Maternal feeding self-efficacy is an important predictor of child vegetable variety at T1 and T2 and is predicted by child food exposure, child willingness to eat novel foods and parenting confidence. The relationship between maternal feeding self-efficacy and child exposure to new foods is reciprocal. Maternal psychological distress plays an important role at the weaning period (T1) and is related to parenting confidence, child exposure to new foods and maternal vegetable intake at T1. Mother's parity is a significant and direct predictor of child vegetable variety at both time points. At T2, maternal vegetable intake predicted child vegetable variety but this relationship was not observed at T1.

Future studies can improve on the models tested in this thesis by including a more in-depth analysis of maternal feeding practices (eg: restriction, pressure to eat, control) and child feeding behaviours (eg: responsiveness, appetite regulation, interest in food). A separate conceptual model should be considered to explore determinants of fruit intake in young children as the current models were unable to show any significant relationship between the variables tested for child fruit variety.

CHAPTER EIGHT: CONCLUSION

This chapter provides an overall conclusion to the findings of this thesis. A summary of key findings, the strengths and limitations of the study, implications and specific suggestions for future research are also included.

8.1 KEY FINDINGS

As stated in Chapter 1, this thesis has three main aims. A summary of the key findings related to these aims can be found in the table below.

Table 8.1 Summary of key findings of this thesis.

Aim:	Findings[¶]:
To examine fruit and vegetable intakes in a cohort of South Australian children aged 4 to 9 months (T1) and 11 to 18 months (T2).	In the 3 days of study:- Fruit: T1: 86.6% (n=240) consumed; intake = 56g/day; frequency = 1.3/day; variety = 0.6/day; commercially prepared infant foods contributed significantly to the amount eaten. T2: 88.9% (n=185) consumed; intake = 104g/day; frequency = 1.7/day; variety= 1/day. Vegetable: T1: 91.7% (n=254) consumed; intake = 69g/day; frequency = 2/day; variety = 1/day; amount eaten decreased significantly when potatoes excluded. T2: 90.3% (n=188) consumed; intake = 74g/day; frequency = 1.7/day; variety= 1.3/day; amount eaten decreased significantly when potatoes excluded. Proportion of consumers tracked between T1 and T2 for fruit and vegetables. Frequency and variety correlated with amount of fruit and vegetable eaten.
To examine the relationship between maternal feeding self-efficacy, maternal feeding practices, child exposure to novel foods, child feeding behaviour, socio-demographic factors and child fruit and vegetable variety in a cohort of South Australian children aged 4 to 9 months (T1) and 11 to 18 months (T2).	Child vegetable variety:- Maternal feeding self-efficacy: directly (T1) and indirectly(T2); predicted by parenting confidence (T1 & T2), maternal psychological distress (T2), child exposure to novel foods (T1 & T2), child feeding behaviour (T1 & T2), maternal vegetable intake (T2). Parity directly predicted child vegetable variety (T1 & T2). No significant relationships observed for child fruit variety.

Table 8.1 continued.

Aim:	Findings[¶]:
To examine the construct validity and reliability of items used in the South Australian Infant Dietary Intake (SAIDI) study to measure maternal feeding self-efficacy, maternal psychological distress and child temperament in a cohort of South Australian children aged 4 to 9 months (T1) and 11 to 18 months (T2).	Maternal feeding self-efficacy: good fit (T1 & T2); α = 0.99 (T1); α = 0.70 (T2). Maternal psychological distress: poor fit (10- & 6-items); α = 0.84 (T1); α = 0.85 (T2). Child irritability (T1): good fit for 3 out of 4 items; α = 0.63. Child reactivity (T2): good fit for 4 out of 8 items; α = 0.60.

[¶]Intake, frequency and variety expressed in median.

8.2 STRENGTHS AND LIMITATIONS

Data from this thesis comes from the SAIDI study. The SAIDI study is a prospective cohort study and is therefore characterised by the strengths and limitations common to a study of this design. Cohort studies are important for the investigation of temporal relationships and allow examination of multiple determinants and outcomes within the same study. Although prospective cohort studies have the temporal framework to potentially assess causality (568), they do not always explain why those associations exist and therefore do not strictly elucidate causality. This is because in a prospective cohort study, determinants are pre-selected before outcomes and any associations observed between the both is limited to the determinants available for study. Unmeasured confounding is also a possibility. Therefore, findings from studies of other designs (eg: experimental, randomised controlled trials, qualitative, cross sectional, case-control) are required to complement data from cohort studies.

In the context of this thesis, even with the use of SEM; a statistical method favoured by social scientists in path analysis and causality studies, causality cannot be concluded. SEM is an inference method that takes theoretical assumptions and empirical data and derives logical consequences based on these inputs (569). Failure to fit the data casts doubt on the theoretical assumptions while a good fit makes causal assumptions more plausible (569). There is always the possibility that a better fit can be found through another model for the same data or that the same model is not replicable using data from another cohort. Moreover, the analyses performed in this thesis are cross-sectional. Findings from the SEM presented snapshots of associations between the variables under study at T1 and T2. It is not possible to ascertain whether exposure led to outcome or vice versa since both were measured simultaneously.

The longitudinal design of prospective cohort studies can be a long-term costly endeavour which warrants careful planning on the cost-effectiveness of the study. In many cases, a variety of measures are collected with many potential research questions in mind. This may create unnecessary burden on the respondents which may affect retention rate of the study, which then leads to a trade-off between depth and breadth of the data collected. In the case of SAIDI, some of the measurements collected would benefit from greater depth. For example, the use of two non-validated questions with ordinal choices to ascertain maternal daily fruit and vegetable intakes in the SAIDI questionnaires as opposed to collection of food diary or 24-hour dietary recall to more accurately measure mother's food intake stemmed from the need to reduce respondent burden and to manage cost in the study. Certain items from the Infant and Toddler Temperament Scales were also excluded to increase brevity of the questionnaires. Although best effort was placed in ensuring measures that were valid and reliable for young children were included, there was a lack of quality validated measures pertaining to food behaviour in infants and toddlers due to the scarcity of evidence in this area of study.

In SAIDI, the retention rate between T1 and T2 was 86.6% but the high retention rate can be attributed to the recruitment method used where mothers were recruited from a cohort of mothers who had earlier provided some baseline data and expressed interest in the study at the time of their children's birth. Although this may have helped with the retention rate between T1 and T2, it may have contributed to systematic bias. The voluntary nature of this study and high literacy requirements further limit the generalisability of the findings. This is evident in the high proportion of older and highly educated Australian-born mothers in the study which was not representative of the general Australian population (Chapter Four). A high level of effort was also employed to encourage mothers to complete their questionnaires and food diaries, and to honour their appointments through reminder phone calls and use of home-visits to ease the burden on participants who were interested to be in the study but were unable to travel to attend assessments. This may have also helped with the retention rate in this study.

Sample size is an important factor, considering the number of measures included in this study. The sample size in this study is adequate for the construction of measurement models and for the categorical SEM using the WLSMV model estimation method. Should the model be tested using ML estimation method, such as in the case of SPSS AMOS, a larger sample size is required due to its computational demands.

Another limitation of this study is the self-reporting nature of the questionnaires and child dietary intakes used to measure many of the variables included in the SEM model. Infant feeding raises profound issues of moral responsibility where the mother is often seen as the primary caregiver with responsibilities to maximise growth and child health outcomes (570). This may have led to over-estimation of positive responses as mothers may have reported what is desirable over what is actual practice. Therefore, data in this study need to be complemented with findings from assessment of maternal and child feeding behaviours by trained observers before a more accurate conclusion can be reached.

Children's diet was measured on three days using a combination of 1x 24-hour diet recall and 2x food records. Currently, there is no published evidence on the validation of this combination of dietary assessment methods in infants and toddlers. However, a review by Burrows *et al* on 15 cross-sectional studies examining validity of dietary assessment methods against the doubly-labelled water method in children from birth to age 18 years (n=664) concluded that over-reporting was often associated with 24-hour multiple pass recall (7% to 11%, n=4 studies) while under-reporting by food records varied from 19% to 41% (n= 5 studies) (571). The authors suggested that the best estimate for children aged 6 months to 4 years is weighed food records (571). The use of both the 24-hour diet recall and food record methods in this study is an attempt to address the weaknesses of both methods while reducing respondent burden.

Despite the limitations mentioned above, this study is unique in examining fruit and vegetable intakes and predictors of early feeding at the age when solids were just being introduced to infants. This provided a rare opportunity to study the genesis of children's fruit and vegetable intakes and contributes to the limited literature surrounding this area of study. Moreover, the contemporaneous data collection method reduces recall bias as mothers were asked to record current practices.

The SEM model studied is a comprehensive model that includes socio-demographic, affective, behavioural and cognitive factors. The use of the SEM method showed the multi-directional relationships between the variables in study; an achievement not possible through unidirectional models such as regression analyses.

Although the use of self-reported measures is often quoted as the Achilles Heel of observational studies (568), mothers can be important informants as they observe their children in their naturalistic home environments and are in a unique position to sample children's behaviour more frequently, across greater variety of situations and over more extended periods of time (572). Moreover, the examination of children's intakes and the conceptual model at two time points provided an understanding on temporal differences at the period when there are important changes in children's diet as they move from a milk-dominant to a solid-dominant diet. In summary, the study reported in this thesis provided useful evidence and new ideas for future research in early child feeding.

8.3 IMPLICATIONS & SUGGESTIONS FOR FUTURE RESEARCH

Specific suggestions for future research are included in the discussion sections in Chapters 6 and 7. To avoid repetition, this section presents suggestions for future research stemmed from the overall findings of this thesis, especially how it translate to interventions, community and public health practice.

Future studies can benefit from assessing longitudinal associations between the proximal and distal determinants at T1 in this study and children's fruit and vegetable intakes at later time points. This is not possible in the current study due to data and timeline limitation. Mplus takes a multivariate approach in growth and multi-level modelling which requires each variable in the SEM model to be measured at four occasions (451). Variables reported in this thesis were measured on two occasions (T1 and T2).

As presented in Chapter 5, meeting recommendations for vegetable consumption is harder to achieve than for fruit consumption in both mothers and children. The older the child, the less likely that s/he will be able to meet fruit and vegetable recommendations (Section 2.1.3.2), indicating that interventions should target young children with continuity into later adolescence. Moreover, dietary studies on children show that children generally tend to consume adequate fruit but not vegetables (Section 2.1.3.2). Reviews on the impact of fruit and vegetable intervention on school children reported that interventions resulted in lower effect on children's vegetable intake as opposed to their fruit intake (573, 574). Clearly, increasing children's vegetable consumption should be prioritised for intervention.

Importantly, the findings from this thesis suggest that child fruit and vegetable intakes are predicted by different socio-behavioural determinants. Therefore, interventions need to be tailored to target specific determinants related to child vegetable intake before significant change in intake can be observed.

A recent review by Cox *et al* as part of a report in a strategic investment plan for the Australian Vegetable Industry concluded that intervention targeting children at the weaning age should consider repeated exposure as a key strategy towards increasing children's vegetable intake (575). However, the findings in this thesis show that whilst exposure is important, mother's confidence in the feeding task plays an important role as well.

Increasing maternal self-efficacy as a key strategy is not new in early feeding interventions but past studies were focused on breastfeeding. These interventions produced favourable outcomes (291, 576). Clearly, strategies used in breastfeeding intervention studies to increase maternal self-efficacy can be adopted to improve children's vegetable intake at the weaning age. These include targeted maternal education concerning weaning, realistic goal setting and how to manage difficult child feeding behaviours; peer and professional support and the use of media and social marketing (577, 578) to promote vegetable intake in infants and toddlers. For instance, the Melbourne InFANT Program which targeted 542 parents of pre-schoolers in its intervention reported positive associations between maternal self-efficacy (promoting health foods, $\beta = 6.33$, $p<0.05$; limiting unhealthy foods, $\beta = 3.0$, $p<0.05$) and child diet quality post-intervention (579). Therefore, early feeding interventions such as NOURISH (147) and The Melbourne InFANT Program (145) that utilise community and mother groups to provide targeted education, and peer and professional support, can potentially impact favourably on children's vegetable consumption.

However, these programs only targeted primiparous mothers while the findings from this thesis suggests that multiparous mothers may benefit from the intervention as well. Clearly, the household environment plays an important role alongside mother's sense of competency in feeding and there is evidence to show that mothers do parent each child differently (580) and this may affect children's dietary outcomes (581). A whole-family approach will not only benefit the child's vegetable intake, but also the mother's intake which may have positive effect on the quality of the overall household diet.

Furthermore, the role of maternal psychological distress, parenting confidence, child eating behaviour and early exposure on maternal feeding self-efficacy and subsequently on children's fruit and vegetable intakes highlighted the need for multi-disciplinary collaboration. Therefore, future studies would benefit from the input from professionals from various disciplines related to early feeding to tailor interventions to increase maternal feeding-self efficacy while addressing challenges that mothers may face in parenting multiple children.

8.4 THESIS CONCLUDING STATEMENT

"Train up a child the way he should go; even when he is old, he will not depart from it." – Proverbs 22:6, The Bible.

The parenting choices parents make at the beginning of every child's life have far reaching consequences. The study reported in this thesis provides empirical evidence that mothers' influence on children's fruit and vegetable intakes begins at the weaning period and that a mother who is confident in her ability to feed her child is most likely able to feed her child adequate vegetables. How mothers feed, how they choose to feed and the family environment play important roles in determining child feeding success and no dietary intervention on young children is complete without addressing these crucial determinants of early feeding.

REFERENCES

1. World Health Organisation. WHO Technical Report Series 916: Diet, Nutrition and the Prevention of Chronic Diseases. In: Joint WHO/FAO Expert Consultation. Geneva 2003. p. 56.
2. Food and Agriculture Organization of the United Nations (FAO). Colour is the key 2003 [Available from: http://www.fao.org/english/newsroom/focus/2003/fruitveg3.htm.
3. Dauchet L., Amouyel P., Hercberg S., Dallongeville J. Fruit and vegetable consumption and risk of coronary heart diseas: a meta-analysis of cohort studies. Journal of Nutrition. 2006;136:2588-93.
4. Hu D., Huang J., Wang Y., Zhang D., Qu Y. Fruits and vegetables consumption and risk of stroke: a meta-analysis of prospective cohort studies. Stroke. 2014;45(1613-1619).
5. Seyedrezazadeh E., Moghaddam M.P., Ansarin K., Vafa M.R., Sharma S., Kolahdooz F. Fruit and vegetable intake and risk of wheezing and asthma: a systematic review and meta-analysis. Nutrition Reviews. 2014;72(7):411-28.
6. Carter P., Gray L.J., Troughton J., Khunti K., Davies M.J. Fruit and vegetable intake and incidence of type 2 diabetes mellitus: systematic review and meta-analysis. British Medical Journal. 2010;341:c4229.
7. Wang P., Fang J., Gao Z., Zhang C., Xie S. Higher intake of fruits, vegetables or their fiber reduces the risk of type 2 diabetes: a meta-analysis. Journal of Diabetes Invstigation. 2016;7(1):56-69.
8. World Cancer Research Fund and American Institute for Cancer Research. Food, Nutrition, Physical Activity, and the Prevention of Cancer: a Global Perspective. Washington DC: American Institute for Cancer Research; 2007.
9. National Health and Medical Research Council. Eat for Health: Educator Guide. Canberra: NHMRC; 2013. p. 44.
10. National Health and Medical Research Council. Eat For Health: Australian Dietary Guidelines, Summary. In: Department of Health and Ageing, editor. Canberra: National Health and Medical Research Council; 2013.
11. National Cancer Institute. Usual Dietary Intakes: Food Intakes, U.S. Population, 2007-20102015 12 December 2015. Available from: http://epi.grants.cancer.gov/diet/usualintakes/pop/2007-2010.
12. Food Standards Agency. National Diet and Nutrition Survey: Results from Years 1,2,3 and 4 (combined) of the rolling programme (2008/2009- 2012-2012). London 2014.
13. Commonwealth Scientific Industrial Research Organisation (CSIRO). 2007 Australian National Children's Nutrition and Physical Activity Survey:Main Findings. 2007.
14. Krebs-Smith S.M., Guenther P.M., Subar A.F., Kirkpatrick S.I., Dodd K.W. Americans do not meet federal dietary recommendations. The Journal of Nutrition. 2010;140(10):1832-8.
15. Magarey A.M, McKean S., Daniels L. Evaluation of fruit and vegetable intakes of Australian adults: the National Nutrition Survey 1995. Australian and New Zealand Journal of Public Health. 2006;30(1):32-7.

16. Siega-Riz A.M., Derming D.M., Reidy K.C., Fox M.K., Condon E., Briefel R.R. Food Consumption Patterns of Infants and Toddlers: Where Are We Now? Journal of the American Dietetic Association. 2010;110(12):S38-S51.
17. Lioret S., McNaughton S.A, Spence A.C, Crawford D., Campbell K.C. Tracking of dietary intakes in early childhood: the Melbourne InFANT Program. European Journal of Clinical Nutrition. 2013;67:275-81.
18. Foterek K., Hilbig A., Alexy U. Associations between commercial complementary food consumption and fruit and vegetable intake in children. Results from the DONALD study. Appetite. 2015;85:84-90.
19. Koh G.A., Scott J. A., Woodman R.j., Kim S.W., Daniels L.A., Magarey A.M. Maternal feeding self-efficacy and fruit and vegetable intakes in infants: Results from the SAIDI study. Appetite. 2014;81:44-51.
20. Kelder S.H., Perry C.L., Klepp K.I., Lytle L.L. Longitudinal tracking of adolescent smoking, physical activity, and food choice behaviors. American Journal of Public Health. 1994;84(7):1121-6.
21. Resnicow K., Smith M., Baranowski T., Baranowski J., Vaughan R., Davis M. 2-year tracking of children's fruit and vegetable intake. Journal of American Dietetic Association. 1998;98:785-9.
22. Lytle L.A., Seifert S., Greenstein J., McGovern P. How do children's eating patterns and food choice change over time? American Journal of Health Promotion. 2000;14:222-8.
23. Birch L.L. Development of food preferences. Annual Review of Nutrition. 1999;19:41-62.
24. Wardle J., Cooke L. Genetic and environmental determinants of children's food preferences. British Journal of Nutrition. 2008;99(1):S15-S21.
25. Harris G. Development of taste and food preferences in children. Current Opinion in Clinical Nutrition and Metabolic Care. 2008;11:315-9.
26. Skinner J.D., Caruth B.R., Bounds W., Ziegler P., Reidy K. Do food related experiences in the first years of life predict dietary variety in school-aged children? Journal of Nutrition Education and Behavior. 2002;34:310-5.
27. Bjelland M., Brantsaeter A.L., Haugen M., Meltzer H.M., Nystad W., Andersen L.F. Changes and tracking of fruit, vegetables and sugar-sweetened beverages intake from 18 months to 7 years in the Norwegian mother and child cohort study. BMC Public Health. 2013;13:793.
28. Northstone K., Emmet P. Multivariate analysis of diet in children at four and seven years of age and association with socio-demographic characteristics. European Journal of Clinical Nutrition. 2005;59(6):751-60.
29. Northstone K., Emmett P.M. Are dietary pattterns stable throughout early and mid-childhood? A birth cohort study. British Journal of Nutrition. 2008;100:1069-76.
30. Wang Y., Bentley M.E., Zhai F., Popkin B.M. Tracking of dietary intake patterns of Chinese from childhood to adolescence over a six-year follow-up period. Journal of Nutrition. 2002;132:430-8.
31. Mikkila V., Rasanen L., Raitakari O.T., Pietinen P., Viikari J. Consistent dietary patterns identified from childhood to adulthood: the Cardiovascular Risk in Young Finns Study. British Journal of Nutrition. 2005;93:923-31.
32. Mikkila V., Rasanen L., Raitakari O.T., Pietinen P., Vikari J. Longitudinal changes in diet from childhood into adulthood with respect to risk of cardiovascular disease: The Cardiovascular Risk in Young Finns Study. European Journal of Clinical Nutrition. 2004;58(7):1038-45.

33. Birch L.L. Development of food acceptance patterns in the first years of life. Proceedings of the Nutrition Society. 1998;57:617-24.
34. Drewnowski A. Taste preferences and food intake. Annual Review of Nutrition. 1997;17:237-53.
35. Nicklaus S. Children's acceptance of new foods at weaning. Role of practices of weaning and of food sensory properties. Appetite. 2011;57:812-5.
36. Schwartz C., Scholtens P.A.M., Lalanne A., Weenen H., Nicklaus S. Development of healthy eating habits early in life. Review of the recent evidence and selected guidelines. Appetite. 2011;57:57.
37. Harris G. The psychology behind growth faltering. European Journal of Clinical Nutrition. 2010;64:S14-S6.
38. Ventura A.K., Worobey J. Early influences on the development of food preferences. Current Biology. 2013;23(9):R401-8.
39. Coulthard H., Harris G., Emmett P. Delayed introduction of lumpy foods to children during the complementary feeding period affects child's food acceptace and feeding at 7 years of age. Maternal & Child Nutrition. 2009;5(1):75-85.
40. Harris G., Coulthard H. Early eating beahviours and food acceptance revisited: breastfeeding and introduction of complementary foods as predictive of food acceptance. Current Obesity Reports. 2016;5:113-20.
41. BlissettJ. Relationships between parenting style, feeding style and feeidng practices and fruit and vegetable consumption in early childhood. Appetite. 2011;57(3):826-31.
42. Cooke L.J., Wardle J., Gibson E.L., Sapochnik M., Sheiham A., Lawson M. Demographic, familial and trait predictors of fruit and vegetable consumption by pre-school children. Public Health Nutrition. 2004;7(2):295-302.
43. Azar S.T., Reitz E.B., Goslin M.C. Mothering: Thinking is part of the job description: Application of cognitive views to understanding maladaptive parenting and doing intervention and prevention work. Journal of Applied Developmental Pyschology. 2008;29:295-304.
44. Bandura A. Social cognitive theory of self-regulation. Organizational Behavior and Human Decision Processes. 1991;50(2):248-87.
45. Janz N.K., Becker M.H. The Health Belief Model: A Decade Later. Health Education & Behavior. 1984;11(1):1-47.
46. Ajzen I. The theory of planned behavior. Organizational Behavior and Human Decision Processes. 1991;50:179-211.
47. Abusabha R., Actherberg C. Review of self-efficacy and locus of control for nutrition and health related behaviour. Journal of American Dietetic Association. 1997;97(10):1122-32.
48. Klein-Hessling J., Lohaus A., Ball J. Psychological predictors of health-related behaviour in children. Psychology, Health & Medicine. 2005;10(1):31-43.
49. Cullen K.W., Smalling A.L.S., Thompson D., Watson K.B., Reed D., Konzelmann K. Creating Health Home Environments: results of a study with participants in the Expanded Food and Nutrition Education Program. Journal of Nutrition Education and Behavior. 2009;41(6):380-8.
50. Cerin E., Barnett A., Baranowski T. Testing theories of dietary behavior change in youth using the mediating variable model with intervention programs. Journal of Nutrition Education & Behavior. 2009;41(5):309-18.
51. Rimal R.N. Closing the knowledge-behavior gap in health promotion: the mediating role of self-efficacy. Health Communication. 2000;12(3):219-37.

52. Granner M.L., Sargent R.G., Calderon K.S., Hussey J.R., Evans A.E., Watkins K.W. Factors of fruit and vegetable intake by race, gender, and age among young adolescents. Journal of Nutrition Education and Behavior. 2004;36(4):173-80.
53. Reynolds K.D., Hinton A.W., Shewchuk R.M., Hickey C.A. Social cognitive model of fruit and vegetable consumption in elementary school children. Journal of Nutrition Education. 1999;31(1):23-30.
54. De Bourdeaudhuij I., Te Velde S., Brug J., Due P., Wind M., Sandvik C., et al. Personal, social and environmental predictors of daily fruit and vegetable intake in 11-year-old children in nine European countries. European Journal of Clinical Nutrition. 2008;62(7):834-41.
55. Bandura A. Self-efficacy: Toward a unifying theory of behavioral change. Psychological Review. 1977;84(2):191-215.
56. Sniehotta F.F., Scholz U., Schwarzer R. Bridging the intention-behaviour gap: Planning, self-efficacy, and action control in the adoption and maintenance of physical exercise. Psychology & Health. 2005;20(2):143-60.
57. DuCharme K.A., Brawley L.R. Predicting the intentions and behavior of exercise initiates using two forms of self-efficacy. Journal of Behavioral Medicine. 1995;18(5):479-97.
58. Sirois F.M. Procrastination and intentions to perform health behaviors: the role of self-efficacy and the consideration of future consequences. Personality and Individual Differences. 2004;37(1):115-28.
59. Schwarzer R. Modeling health behavior change: how to predict and modify the adoption and maintenance of health behaviors. Applied Psychology. 2008;57(1):1-29.
60. Judge T.A., Erez A., Bono J.E. Are measures of self-esteem, neuroticism, locus of control, and generalized self-efficacy indicatiors of a common core construct? Journal of Personality and Social Pyschology. 2002;83(3):693-710.
61. Farrow C., Blissett J. The development of maternal self-esteem. Infant Mental Health. 2007;28(5):517-35.
62. Dodt R.C.M., Joventino E.S., Aquino P.S., Almeida P.C., Ximenes L.B. An experimental study of an educational intervention to promote maternal self-efficacy in breastfeeding. The Revista Latino-Americana de Enfermagem. 2015;23(4):725-32.
63. Campbell K., Hesketh K., Silverii A., Abbott G. Maternal self-efficacy regarding children's eating and sedentary behaviours in the early years: association with children's food intake and sedentray behaviours. Internation Journal of Pediatric Obesity. 2010;5(6):501-8.
64. Dovey T.M., Staples P.A., Gibson E.L., Halford J.C.G. Food neophobia and 'picky/fussy' eating in children: A review. Appetite. 2008;50(2):181-93.
65. Cooke L. The importance of exposure for healthy eating in childhood: a review. Journal of Human Nutrition and Dietetics. 2007;20(4):294-301.
66. Cooke L, Wardle J., Gibson E.L., Sapochnik M., Sheiham A., Lawson M. Demograpic, familial and trait predictors of fruit and vegetable consumption by pre-school children. Public Health Nutrition. 2003;7(2):295-302.
67. Gregory J.E., Paxton S.J., Brozovic A.M. Maternal feeding practices child eating behaviour and body mass index in preschool-aged children: a prospective analysis. International Journal of Behavioral Nutrition and Physical Activity. 2010;7:55.

68. Webber L., Cooke L., Hill C., Wardle J. Associations between children's appetitive traits and maternal feeding practices. Journal of the American Dietetics Association. 2010;110(11):1718-22.
69. Powell F.C., Farrow C.V., Meyer C. Food avoidance in children. The influence of maternal feeding practices and behaviours. Appetite. 2011;57(3):683-92.
70. Rodgers R.F., Paxton S.J., Massey R., Campbell K.J., Wertheim E.H., Skouteris H., et al. Maternal feeding practices predict weight gain and obesogenic eating behaviors in young children: a prospective study. International Journal of Behavioral Nutrition and Physical Activity. 2013;10:24.
71. Davison K.K., Birch L.L. Childhood overweight: a contextual model and recommendations for future research. Obesity Reviews. 2001;2:159-71.
72. Birch L.L., Davison K.K. Family environmental factors influencing the developing behavioral controls of food intake and childhood overweight. Pediatr Clin North Am. 2001;48(4):893-907.
73. Ventura A.K., Birch L.L. Does parenting affect children's eating and weight status? International Journal of Behavioral Nutrition and Physical Activity. 2008;5:15.
74. Shloim N., Edelson L.R., Martin N., Hetherington M.M. Parenting styles, feeding styles, feeding practices and weight status in 4-12 year-old children: a systematic review of the literature. Frontiers in Pyschology. 2015;6:1849.
75. Hughes S.O., Power T.G., O'Connor T.M., Fisher J.O., Chen T.A. Maternal feeding styles and food parenting practices as prdictors of longitudinal changes in weight status in hispanic preschoolers from low-income families. Journal of Obesity. 2016;2016:Article ID 7201082.
76. Nowicka P., Sorjonen K., Pietrobelli A., Flodmark C.E, Faith M.S. Parental feeding practices and associations with child weight status. Swedish validation of the Child Feeding Questionnaire finds parents of 4-year-olds less restrictive. Appetite. 2014;81(1):232-41.
77. Martin-Biggers J., Worobey J., Byrd-Bredbenner C. Parental feeding practices are associated with weight and eating styles of preschoolers. The FASEB Journal. 2015;29(1):S395.1.
78. Webber L., Cooke L., Hill C., Wardle J. Child adiposity and maternal feeding practices: a longitudinal analysis. American Journal of Clinical Nutrition. 2010;92(6):1423-8.
79. Jansen P.W., Tharner A., van der Ende J., Wake M., Raat H., Hofman A., et al. Feeding practices and child weight: is the association bidirectional in preschool children? American Journal of Clinical Nutrition. 2014;doi: 10.3945/ajcn.114.088922.
80. Gregory J.E., Paxton S.J., Brozovic A.M. Maternal feeding practices predict fruit and vegetable consumption in young children. Results of a 12-month longitudinal study. Appetite. 2011;57:167-72.
81. de Lauzon-Guillain B., Jones L.J., Oliveira A., Moschonis G., Betoko A., Lopes C., et al. The influence of early feeding practices on fruit and vegetable intake among preschool children in 4 European birth cohorts. American Journal of Clinical Nutrition. 2013;98:804-12.
82. Shim J.E., Kim J., Lee Y. Fruit and vegetable intakes of preschool children are associated with feeding practices facilitating internalization of extrinsic motivation. Journal of Nutrition Education and Behavior. 2016;48(5):311-7.

83. Papaioannou M.A., Cross M.B., Power T.G., Liu Y., Qu H., Shewchuk R.M., et al. Feeding style differences in food parenting practices associated with fruit and vegetable intake in children from low-income families. Journal of Nutrition Education and Behavior. 2013;45(6):643-51.
84. Schreiber J.B., Stage F.K., King J., Nora A., Barlow E.A. Reporting structural equation modeling and confirmatory factor analysis results: a review. The Journal of Educational Research. 2006;99(6):323-37.
85. World Health Organisation. Measuring intake of fruit and vegetables: Background paper for the joint WHO/FAO Workshop on fruit and vegetables for health, 1-3 September, Kobe, Japan. In: Organisation WH, editor. Geneva2005.
86. National Health Service. 5 A DAY: What's this all about? UK [10 July 2014]. Available from: http://www.nhs.uk/Livewell/5ADAY/Documents/(activities-health)-5-a-day-whats-it-all-about[1].pdf.
87. Paik H.Y. Dietary Reference Intakes for Koreans (KDRIs). Asia Pacific Journal of Clinical Nutrition. 2008;17(S2):416-9.
88. United States Department of Agriculture. Choose MyPlate [Available from: http://www.choosemyplate.gov/food-groups/vegetables.html.
89. National Health Service. The Eatwell Plate [Available from: http://www.nhs.uk/Livewell/Goodfood/Pages/eatwell-plate.aspx.
90. European Food Information Council. Food-Based Dietary Guidelines in Europe [Available from: http://www.eufic.org/article/en/expid/food-based-dietary-guidelines-in-europe/.
91. Keyou G. The transition of Chinese dietary guidelines and the food guide pagoda. Asia Pacific Journal of Clinical Nutrition. 2011;20(3):439-46.
92. Marshall T.A., Levy S.M., Broffitt B., Waren J.J, Eichenberger-Gilmore J.M., Burns T.L., et al. Dental caries and beverage consumption in young children. Pediatrics. 2003;112(3):e184-e91.
93. Vargas C.M., Dye B.A., Kolasny C.R., Buckman D.W., McNeel T.S., Tinanoff T., et al. Early childhood caries and intake of 100 percent fruit juice: Date from NHANES, 1999-2004. Journal of the American Dental Association. 2014;145(12):1254-61.
94. Evans E.W., Hayes C., Palmer C.A., Bermudez O.I, Cohen S.S, Must A. Dietary intake and severe childhood caries in low-income, young children. Journal of the Academy of Nutrition and Dietetics. 2013;113(8):1957-061.
95. AbdelAziz W.E., Dowidar K.M., El Tantawi M.M. Association of Healthy Eating, Juice Consumption, and Bacterial Counts with Early Childhood Caries. Journal of Pediatric Dentistry. 2015;37(5):462-7.
96. Du M., Luo Y., Zeng X., Alkhatib N., Bedi R. Caries in preschool children and its rosk factors in 2 provinces in China. Quintessence International. 2007;38(2):143-5.
97. Lim S., Sohn W., Burt B.A., Sandretto A.M., Kolker J.L., Marshall T.A., et al. Cariogenicity of soft drinks, milk and fruit juice in low-income african-american children: a longitudinal study. Journal of American Dental Association. 2008;139(7):959-67.
98. Nunn M.E., Braunstein N.S., Krall Kaye E.A., Dietrich T., Garcia R.I., Henshaw M.M. Healthy Eating Index is a predictor of early childhood caries. Journal of Dental Research. 2009;88(4):361-6.
99. Hallet K.B., O'Rourke P.K. Early childhood caries and infant feeding practices. Community Dental Healh. 2002;19(4):237-42.

100. Chaffee B.W., Feldens C.A., Rodrigues P.H., Vitolo M.R. Feeding practices in infancy associated with caries incidence in early childhood. Community Dentistry and Oral Epidemiology. 2015;43(4):338-48.
101. Palmer C.A., Kent R., Loo C.Y., Hughes C.V., Stutius E., Pradhan N., et al. Diet and caries-associated bacteria in severe early childhood caries. Journal of Dental Research. 2010;89(11):1224-9.
102. Dennison B.A., Rockwell H.L., Baker S.L. Excess fruit juice consumption by preschool-aged children is associated with short stature and obesity. Pediatrics. 1997;99(1):15-22.
103. O'Connor T.M., Yang S-J., Nicklas T.A. Beverage intake among preschool children and its effect on weight status. Pediatrics. 2006;118(c1010-c1018).
104. Newby P.K., Peterson K.E., Berkey C.S., Lepert J., Willet W.C., Colditz G.A. Beverage consumption is not associated with changes in weight and body mass among low-income preschool children in North Dakota. Journal of American Dietetic Association. 2004;104(104):1086-94.
105. Sonneville K.R., Long M.W., Rifas-Shiman S.L., Kleinman K., Gillman M.W., Taveras E.M. Juice and water intake in infancy and later beverage intake and adiposity: could juice be a gateway drink? Obesity. 2015;23(1):170-6.
106. National Health and Medical Research Council. Eat For Health: Infant Feeding Guidelines - Information for health workers. In: Council NHaMR, editor. Canberra: Commonwealth of Australia; 2012.
107. American Academy of Pediatrics. The use and misuse of fruit juice in pediatrics. Pediatrics. 2001;107(5):1210-3.
108. U.S. Department of Agriculture, U.S. Department of Health and Human Services. Dietary Guidelines for Americans 2010. Washington DC: U.S. Government Printing Office; 2010.
109. National Health Service. 5-A-DAY portion sizes UK2013 [Available from: http://www.nhs.uk/Livewell/5ADAY/Pages/Portionsizes.aspx.
110. National Cancer Institute. 5 A Day Fact Sheet Rockville, Maryland, US1991 [Available from: http://www3.cancer.gov/extra/pcer/pcerpage/5factpage/.
111. U.S. Department of Agriculture. Dietary Guidelines for Americans 2005 Washington, DC: U.S. Department of Health and Human Services,
U.S. Department of Agriculture; 2005 [Available from: http://www.health.gov/dietaryguidelines/dga2005/document/pdf/dga2005.pdf.
112. U.S. Department of Health and Human Services. 2015-2020 Dietary Guidelines for Americans2015; 8th edition. Available from: http://health.gov/dietaryguidelines/2015/guidelines.
113. Health Canada. Canada's Food Guide: Vegetables and fruit 2011 [Available from: http://www.hc-sc.gc.ca/fn-an/food-guide-aliment/choose-choix/fruit/index-eng.php.
114. National Health and Medical Research Council. Eat For Health: Educator Guide. In: Ageing DoHa, editor. Canberra: National Health and Medical Research Council; 2013.
115. Yngve A., Wolf A., Poortvliet E., Elmada I., Brug J., Ehrenblad B., et al. Fruit and vegetable intake in a sample of 11-year old children in 9 European countries: The Pro Children Cross-sectional survey. Annals of Nutrition and Metabolism. 2005;49(4):236-45.
116. The National Health Service. 5 A DAY and your family15 March 2015. Available from: www.nhs.uk/Livewell/5ADAY/Pages/Family.aspx.

117. U.S. Department of Agriculture. Choose My Plate30 March 2016. Available from: www.choosemyplate.gov.au.
118. National Health and Medical Research Council. A modelling system to inform the revision of the Australian Guide to Healthy Eating. In: Council NHaMR, editor. Canberra2011.
119. National Health and Medical Research Council. Australian Dietary Guidelines. Canberra: National Health and Medical Research Council; 2013.
120. World Health Organisation. Global Environment Monitoring System (GEMS/Food) 2012. 2015.
121. Australian Bureau of Statistics (ABS). Australian Health Survey: Nutrition First Results - Foods and Nutrients, 2011-12. Catalogue no: 4364.0.55.007. In: (ABS) ABoS, editor. Canberra2014.
122. European Food Safety Authority. The EFSA Comprehensive European Food Consumption Database2013 12 December 2015. Available from: http://www.efsa.europa.eu/en/datexfooddb/datexfooddbspecificdata.htm.
123. Australian Institute of Health and Welfare. Australia's food & nutrition 2012. In: Welfare AIoHa, editor. Canberra2012.
124. Centers for Disease Control and Prevention (CDC). Adults meeting fruit and vegetable intake recommendations - United States, 20132015 15 August 2015. Available from: www.cdc.gov/mmwr/preview/mmwrhtml/mm6426a1.htm.
125. Public Health England. New National Diet and Nutrition Survey shows UK population is eating too much sugar, saturated fat and salt2014 12 May 2015. Available from: https://www,gov.uk/government/news/new-national-diet-and-nutrition-survey-shows-uk-population-is-eating-too-much-sugar-saturated-fat-and-salt.
126. Blanck H.M., Gillespie C., Kimmons J., Seymour J.D., Serdula M.K. Trends in fruit and vegetable consumption among U.S. men and women, 1994-2005. Preventing Chronic Disease. 2008;5(2):1-10.
127. Kim S.A., Moore L.V., Galuska D., Wright A.P., Harris D., Grummer-Strawn L.M., et al. Vital Signs: Fruit and Vegetable Intake Among Children - United States, 2003-2010. Morbidity and Mortality Weekly Report. 2014;63(31):671-6.
128. Clinical Trials Research Unit Synovate. A National Survey of Children and Young People's Physical Activity and Dietary Behaviours in New Zealand: 2008/2009 - Key Findings2010 15 January 2014. Available from: http://www.health.govt.nz/.
129. Larson N.I., Neumark-Sztainer D., Hannan P.J., Story M. Trends in adolescent fruit and vegetable consumption, 199-2004: project EAT. American Journal of Preventive Medicine. 2007;32(2):147-50.
130. Australian Bureau of Statistics (ABS). 4364.0.55.012 Australian Health Survey: Consumption of Food Groups from the Australian Dietary Guidelines, 2011-12. Canberra: Commonwealth of Australia; 2016.
131. Dennison B.A., Rockwell H.L., Baker S.L. Fruit and vegetable intake in young children. Journal of American College of Nutrition. 1998;17(4):371-8.
132. Theodore R., Thompson J., Wall C., Becroft D., Robinson E., Clark P., et al. Dietary patterns of New Zealand European preschool children. New Zealand Medical Journal. 2006;119(1235):U1998.
133. Alexy U., Sichert-Hellert W., Kersting M., Manz F. The foods most consumed by German children and adolescents: results of the DONALD study.

Dortmund Nutritional and Anthropometric Longitudinally Design. Annals of Nutrition and Metabolism. 2001;45(3):128-34.
134. Fox M.K., Condon E., Briefel R.R., Reidy K.C., Deming D.M. Food consumption patterns of young preschoolers: are they starting off on the right path? Journal of American Dietetic Association. 2010;110(12):s52-s9.
135. Magarey A.M., Daniels A.M., Boulton T.J., Cockington R.A. Predicting obesity on early adulthood from childhood and parental obesity. Internation Journal of Obesity. 2003;27:505-13.
136. Power C., Parsons T. Nutrition and other influences in childhood as predictors of adult obesity. Proceedings of the Nutrition Society. 2002;59:267-72.
137. Kleges R.C., Stein R.J., Eck L.H., Isbell T.R., Kleges L.M. Parental influence on food selection in young children and its relationships to childhood obesity. American Journal of Clinical Nutrition. 1991;53(4):859-64.
138. Byrne R., Magarey A.M., Daniels L. Food and beverage intake in Australian children aged 12-16 months participating in the NOURISH and SAIDI studies. Australian and New Zealand Journal of Public Health. 2014;38(4):326-31.
139. Department of Health, Food Standards Agency. Diet and nutrition survey of infants and young children 20112011 18 March 2014. Available from: https://www.gov.uk/government/publications/diet-and-nutrition-survey-of-infants-and-young-children-2011.
140. Siega-Riz A.M., Deming D.M., Reidy K.C., Fox M.K., Condon E., Briefel R.R. Food Consumption Patterns of Infants and Toddlers: Where are We Now? Journal of American Dietetic Association. 2010;110:S38-S51.
141. Hart C.N., Raynor H.A., Jelalian E., Drotar D. The association of maternal food intake and infants' and toddlers' food intake. Child: Care and Development. 2010;36(3):396-403.
142. Pan Yu, Denney L., Zheng Y., Vinnes-Pares G., Reidy K.C., Eldridge A.L., et al. Food groups consumed by infants and toddlers in urban areas of China. Food and Nutrition Research. 2016;60:30289.
143. Fox M.K., Pac S., Devaney B., Jankowski L. Feeding infants and toddlers study: What foods are infants and toddlers eating? Journal of American Dietetic Association. 2004;104(1):s22-s30.
144. National Health Service. Healthy Start10 April 2015. Available from: https://www.healthystart.nhs.uk.
145. Campbell K., Hesketh K., Crawford D., Salmon J., Ball K., McCallum Z. The Infant Feeding Activity and Nutrition trial (InFANT) an early intervention to prevent childhood obesity: cluster-randomized controlled trial. BMC Public Health. 2007;8:103.
146. Magarey A.M., Perry R.A., Daniels L. Overview of the NOURISH and SAIDI studies: investigation of the dietary intake of infants and children and trial of an innovative approach to obesity prevention. Public Health Bulletin South Australia. 2010;7(3):19-23.
147. Daniels L.A, Magarey A.M, Battistutta D., Nicholson J.M., Farrell A., Davidson G., et al. The NOURISH randomised control trial: Positive feeding practices and food preferences in early childhood - a primary prevention program for childhood obesity. BMC Public Health. 2009;9:387.
148. Kroke A., Manz F., Kersting M., Remer T., Sichert-Hellert W., Alexy U., et al. The DONALD study. History, current status and future perspectives. European Journal of Nutrition. 2004;43(1):45-54.

149. Chen C., Denney L., Zheng Y., Vinyes-Pares G., Reidy K., Wang H., et al. Nutrient intakes of infants and toddlers from maternal and child care centres in urban areas of China, based on one 24-hour dietary recall. BMC Nutrition. 2015;1:23.
150. Voortman T., Kiefte-de Jong J.C., Geelen A., Villamor E., Moll H.A., de Jongste J.C., et al. The development of diet quality score for preschool children and its validation and determinants in the generation R study. The Journal of Nutrition. 2015;145(2):306-14.
151. Smithers L.G., Golley R.K., Brazionis L., Lynch J.W. Characterizing whole diets of young children from developed countries and the association between diet and health: a systematic review. Nutrition Reviews. 2011;69(8):449-67.
152. Bell L.K., Golley R.K., Daniels L., Magarey A.M. Dietary patterns of Australian children aged 14 and 24 months, and associations with socio-demographic factors and adiposity. European Journal of Clinical Nutrition. 2013;67:638-45.
153. Tylansky F.A., Holliday K., Danish R., Womack C., Norwood J., Carbone L. Fruit and vegetable intake are an independent predictor of bone size in early pubertal children. American Journal of Clinical Nutrition. 2004;79:311-7.
154. Moynihan P., Peterson P.E. Diet, nutrition and the prevention of dental diseases. Public Health Nutrition. 2004;1:201-26.
155. Rolls B.J., Ello-Martin J.A., Tohill B.C. What can intervention studies tell us about the relationship between fruit and vegetable consumption and weight management? Nutrition Reviews. 2004;62(1):1-17.
156. Ledoux T.A., Hingle M.D., Baranowski T. Relationship of fruit and vegetable intake with adiposity: a systematic review. Obesity Reviews. 2011;12(5):e143-e50.
157. Moreira P., Santos S., Padrao P., Cordeiro T., Bessa M., Valente H., et al. Food patterns accordting to sociodemographic, physical activity, sleeping and obesity in Portugese children. International Journal of Environmental Research and Public Health. 2010;7:1121-38.
158. Food and Agriculture Organization of the United Nations (FAO). Increasing fruit and vegetable consumption becomes a global priority 2003 [Available from: http://www.fao.org/english/newsroom/focus/2003/fruitveg1.htm.
159. GBD 2013 Mortality and Causes of Death Collaborators. Global, regional, and national age-sex specific all-casue and cause-specific mortality for 240 causes of death, 1990-2013: a systematic analysis for the Global Burden of Disease Study 2013. The Lancet. 2015;385(9963):117-71.
160. World Health Organisation. Global status report on noncommunicable diseases 2010. In: Organisation WH, editor. Italy2011.
161. World Health Organisation (WHO). Global status report on noncommunicable diseases 2014. In: Organisation WH, editor. Switzerland2014.
162. Australian Institute of Health and Welfare. Australian Burden of Disease Study: Impact and causes of illness and deaths in Australia 2011. Australian Burden of Disease Study Series no. 3. BOD 4. In: AIHW, editor. Canberra2016.
163. Begg S., Vos T., Barker B., Stevenson C., Stanley L., Lopez A.D. The burden of disease and injury in Australia 2003. In: AIHW, editor. Canberra2007.
164. Ness A.R., Maynard M., Frankel S., Smith G.D., Frobisher C., Leary S.D., et al. Diet in childhood and adult cardiovascular and all cause mortality: the Boyd Orr cohort. Heart. 2005;91(7):894-8.
165. Lock K., Pomerleau J., Causer L., Altmann D.R., McKee M. The global burden of disease attributable to low consumption of fruit and vegetable:

implications for the global strategy on diet. Bulletin of the World Health Organization. 2005;83:100-8.
166. Key T.J. Fruit and vegetables and cancer risk. British Journal of Cancer. 2011;104:6-11.
167. World Cancer Research Fund and American Institute for Cancer Research. Food, nutrition, and the prevention of cancer: a global perspective. In: Cancer AIf, editor. New York1997.
168. International Agency for Research on Cancer. Fruit and vegetables. In: IARC, editor. Lyon2003.
169. United Kingdom Department of Health. Nutritional aspects of the development of cancer. Report of the working group on diet and cancer of the Committe on Medical Aspects of the Food and Nutrition Policy. Committee on Medical Aspects of the Food and Nutrition Policy. Norwich, UK: The Stationery Office; 1998.
170. Cancer Council Australia. Position Statement: Fruit, vegetables and cancer prevention. In: Australia CC, editor. 2007.
171. Bofetta P., Cuoto E., Wichmann J., Ferrari P., Trichopoulos D., Bueno De Mesquita H.B., et al. Fruit and vegetable intake and overall cancer risk in the European Prospective Investigation into Cancer and Nutrition (EPIC). Journal of the National Cancer Institution. 2010;102:529-37.
172. Bradbury K.E., Appleby P.N., Key T.J. Fruit, vegetable and fiber intake in relation to cancer risk: findings from the European Prospective Investifation into Cancer and Nutrition (EPIC). American Journal of Clinical Nutrition. 2014;100:394S-8S.
173. van Duijnhoven F.J., Bueno De Mesquita H.B., Ferarri P., Jenab M., Boshuizen H.C., Ros M.M., et al. Fruit, vegetable and colorectal cancer risk: European Prospective Investigation into Cancer and Nutrition. American Journal of Clinical Nutrition. 2009;89(5):1441-52.
174. Aune D., Chan D.S.M., Lau R., Veira R., Greenwood D.C., Kampman E., et al. Dietary fibre, whole grains, and risk of colorectal cancer: systematic review and dose-response meta-analysis of prospective studies. British Medical Journal. 2011;343:d6617.
175. Willet W.C. Fruits, vegetables, and cancer prevention: turmoil in the produce section. Journal of the National Cancer Institution. 2010;102(8):510-1.
176. Zhang X., Wu K., Giovannucci E.L., Ma J., Colditz G.A., Fuchs C.S., et al. Early life body fatness and risk of colorectal cancer in U.S. women and men - results from two large cohort studies. Cancer, Epidemiology, Biomarkers and Prevention. 2015;24(4):690-7.
177. Wang X., Ouyang Y., Liu J., Zhu M., Zhao G., Bao W., et al. Fruit and vegetable consumption and mortality from all causes, cardiovascular disease and cancer: systematic review and dose-response meta-analysis of prospective cohort studies. BMJ. 2014;349:g4490.
178. He F.J., Nowson C.A., MacGregor G.A. Increased consumption of fruit and vegetables is related to a reduced risk or coronary heart disease: a meta-analysis of cohort studies. Journal of Human Hypertension. 2007;21:717-28.
179. Joshipura K.J., Ascario A., Manson J.E, Stampfer M.J., Rimm E.B., Speizer F.E., et al. Fruit and vegetable intake in relation to risk of ischemic stroke. Journal of the American Medical Association. 1999;282(13):1233-9.

180. Hu F.B., Stampfer M.J., Manson J.E, Rimm E.B., Colditz G.A., Rosner B.A., et al. Dietary fat intake and the risk of coronary heart disease in women. New England Journal of Medicine. 1997;337(21):1491-9.
181. Rimm E.B., Stampfer M.J., Ascherio A., Giovannucci E., Colditz G.A., Willet W.C. Vitamin E consumption and risk of coronary heart disease in men. New England Journal of Medicine. 1993;328:1450-6.
182. Jialal I., Singh U. Is vitamin C an anti-inflammatory agent? American Journal of Clinical Nutrition. 2006;83(3):525-6.
183. Tavani A., La Vecchia C. Beta-carotene and risk of coronary heart disease: a review of observational and interventions studies. Biomedicine & Pharmacotherapy. 1999;53(9):409-16.
184. Lee I-M, Cook N.R., Caziano J.M., Gordon D., Ridker P.M., Manson J.E, et al. Vitamin E in the primary prevention of cardiovascular disease and cancer. The Women's Health Study: A randomized controlled trial. Journal of the American Medical Association. 2005;294:56-65.
185. Jha P., Flather M., Lonn E., Farkouh M., Yusuf S. The antioxidant vitamins and cardiovascular disease: a critical review of epidemiologic and clinical trial data. Annals of Internal Medicine. 1995;123(11):860-72.
186. Bazzano L.A. Dietary intake of fruit and vegetables and risk of diabetes mellitus and cardiovascular diseases. Background paper for the Joint FAO/WHO workshop on fruit and vegetables for health, 1-3 September 2004, Kobe, Japan.: World Health Organisation; 2005 [Available from: http://www.who.int/dietphysicalactivity/publications/f&v_cvd_diabetes.pdf.
187. Lampe J.W. Health effects of vegetables and fruit: assessing mechanisms of action in human experimental studies. American Journal of Clinical Nutrition. 1999;70(3):475S-90S.
188. Homocysteine Studies Collaboration. Homocysteine and risk of ischemic heart disease and stroke: a meta-analysis. Journal of the American Medical Association. 2002;16:2015-22.
189. The Heart Outcomes Prevention Evalution (HOPE) 2 Investigators. Homocysteine lowering with folic acid and B vitamins in vascular disease. New England Journal of Medicine. 2006;354:1567-77.
190. Messina M.J. Legumes and soybeans: overview of their nutritional profiles and health effects. American Journal of Clinical Nutrition. 1999;70(3):439S-50S.
191. Nagata C. Factors to consider in the association betwen soy isoflavones intake and breast cancer risk. Journal of Epidemiology and Community Health. 2010;2:83-9.
192. Fung T.T., Rexrode K.M., Mantzoros C.S., Manson J.E., Willet W.C., Hu F.B. Mediterranean diet and incidence of and mortality from coronary heart disease and stroke in women. Circulation. 2009;119:1093-100.
193. Fung T.T., Chiuve S.E., McCullough M.L., Rexrode K.M., Logroscino G., Hu F.B. Adherence to a DASH-style diet and risk of coronary heart disease and stroke in women. Archives of Internal Medicine. 2008;168(7):713-20.
194. Australian Institute of Health and Welfare. Chronic respiratory diseases in Australia. In: AIHW, editor. Canberra2005.
195. Berthon B.S., Wood L.G. Nutrition and respiratory health - feature review. Nutrients. 2015;7:1618-43.

196. Hirayama F., Lee A.H., Binns C.W. Dietary factors for chronic obstructive pulmonary disease: epidemiological evidence. Expert review of respiratory medicine. 2008;2(5):645-53.
197. Boeing H., Bechthold A., Bub A., Ellinger S., Haller D., Korke A., et al. Critical review: vegetables and fruit in the prevention of chronic diseases. European Journal of Nutrition. 2012;51:637-63.
198. Tabak C., Arts I, Smit H.A., Heederik D., Kromhout D. Chronic obstructive pulmonary disease and intake of catechins, flavonols and flavones. American Journal of Respiratory and Critical Care Medicine. 2001;164:61-4.
199. Butler L.M., Koh W-P., Lee H-P., Yu M.C., London S.J. Dietary fibre and reduced cough with phlegm: a cohort study in Singapore. American Journal of Respiratory and Critical Care Medicine. 2004;170(3):279-87.
200. Watson L., Margetts B., Howarth P., Dorward M., Thompson R., Little P. The association between diet and chronic obstructive pulmonary disease in subject selected from general practice. European Respiratory Journal. 2002;20(2):313-8.
201. Tabak C., Feskens E.J., Heederik D., Kromhout D., Menotti A., Blackburn H.W. Fruit and fish consumption: a possible explanation for population differences in COPD mortality (The Seven Countries Study). European Journal of Clinical Nutrition. 1998;52(11):819-25.
202. Butland B.K., Fehily A.M., Elwood P.C. Diet, lung function and lung function decline in a cohort of 2512 middle aged men
Thorax. 2000;55:102-8.
203. La Vecchia C., Decarli A., Pagano R. Vegetable consumption and risk of chronic disease. Epidemiology. 1998;9(2):208-10.
204. Kelly Y., Sacker A., Marmot M. Nutrition and respiratory health in adults: findings from the health survey for Scotland. European Respiratory Journal. 2003;21:664-71.
205. Celik F., Topcu F. Nutritional risk factors for the development of chronic obstructive pulmonary disease (COPD) in male smokers. Clinical Nutrition. 2006;25:955-61.
206. Varasso R., Fung T.T., Barr R.G., Hu F.B., Willet W.C., Camargo C.A. Prospective study of dietary patterns and chronic obstructive pulmonary disease among US women. American Journal of Clinical Nutrition. 2007;86(2):488-95.
207. Varasso R., Fung T.T., Hu F.B., Willet W.C., Camargo C.A. Prospective study of dietary patterns and chronic obstructive pulmonary disease among US men. Thorax. 2007;62(9):786-91.
208. Keranis E., Makris D., Rodopoulou P., Martinou H., Papamakarios G., Daniil Z., et al. Impact of dietary shift to higher-antioxidant foods in COPD: a randomised trial. European Respiratory Journal. 2010;36:774-80.
209. Baldrick F.R., Elborn J.S., Woodside J.V., Treacy K., Bradley J.M., Patterson C.C., et al. Effect of fruit and vegetable intake on oxidative stress and inflammation in COPD: a randomised controlled trial. European Respiratory Journal. 2012;39:1377-84.
210. Lv N., Xiao L., Ma J. Dietary pattern and asthma: a systematic review and meta-analysis. Journal of Asthma and Allergy. 2014;7:105-21.
211. Van Duyn M.A.S., Pivonka E. Overview of the health benefits of fruit and vegetable consumption for the dietetics professional: selected literature. Journal of American Dietetic Association. 2000;100:1511-21.
212. Tanaka T., Takahashi R. Flavanoids and asthma. Nutrients. 2013;5:2128-43.

213. Smith L.J., Kalhan R., Wise R.A., Sugar E.A., Lima J.J., Irvin C.G., et al. Effect of a soy supplement on lung function and clinical outcomes in patients with poorly controlled asthma: a randomized clinical trial. Journal of the American Medical Association. 2015;313(20):2033-43.
214. Romieu I., Trenga C. Diet and obstructive lung diseases. Epidemiologic Reviews. 2001;23(2):268-87.
215. Thien F.C.K., Woods R., De Luca S., Abramson M.J. Dietary marine fatty acids (fish oil) for asthma in adults and children (Cochrane Review). Chichester, UK: John Wiley & Sons Ltd; 2002 (updated 2010).
216. Diabetes Australia. Type 2 diabetes [Available from: https://www.diabetesaustralia.com.au/type-2-diabetes.
217. World Health Organisation. Global report on diabetes. Geneva, Switzerland2016.
218. Australian Institute of Health and Welfare. How many Australians have diabetes? [Available from: http://www.aihw.gov.au/how-common-is-diabetes/.
219. D'Adamo E., Caprio S. Type 2 diabetes in youth: epidemiology and pathophysiology. Diabetes Care. 2011;34(2):S161-S5.
220. Reinehr T. Type 2 diabetes mellitus in children and adolescents. Would Journal of Diabetes. 2013;4(6):270-81.
221. Hamer M., Chiya Y. Intake of fruit, vegetables, and antioxidants and risk of type 2 diabetes: a systematic review and meta-analysis. Journal of Hypertension. 2007;25(12):2361-9.
222. Li M., Fan Y., Zhang X., Hou W., Tang Z. Fruit and vegetable intake and risk of type 2 diabetes mellitus: meta-analysis of prospective cohort studies. BMJ Open. 2014;4:e005497.
223. Wu Y., Zhang D., Jiang X., Jiang W. Fruit and vegetable consumption and risk of type 2 diabetes mellitus: a dose-response meta-analysis of prospective cohort studies. Nutrition, Metabolism & Cadriovascular Diseases. 2015;25:140-7.
224. Weickert M.O., Pfeiffer A.F.H. Metabolic effects of dietary fiber consumption and prevention of diabetes. The Journal of Nutrition. 2008;138(3):439-42.
225. Tarwadi K., Agte V. Potential of commonly consumed green leafy vegetables for their antioxidant capacity and its linkage with the micronutrient profile. International Journal of Food Science and Nutrition. 2003;54:417-25.
226. Liu S., Ajani U., Chae C., Hennekens C., Buring J.E., Manson J.E. Long-term beta-carotene supplementation and risk of type 2 diabetes mellitus: a randomized controlled trial. Journal of the American Medical Association. 1999;282(2):1073-5.
227. Ceriello A., Motz E. Is oxidative stress the pathogenic mechanism underlying insulin resistance, diabetes, and cardiovascular disease? The common soil hypothesis revisited. Arteriosclerosis, Thrombosis and Vascular Biology. 2004;24:816-23.
228. Dong J., Xun P., He K., Qin L. Magnesium intake and risk of type 2 diabetes. Diabetes Care. 2011;34:2116-22.
229. Larsson S.C., Wolk A. Magnesium intake and risk of type 2 diabetes: a meta-analysis. Journal of Internal Medicine. 2007;262:208-14.
230. Barbagallo M., Dominguez L.J. Magnesium and type 2 diabetes. Would Journal of Diabetes. 2015;6(10):1152-7.
231. Oguma Y., Sesso H.D., Paffenbarger R.S., Lee I.M. Weight change and risk of developing type 2 diabetes. Obesity Research. 2005;13(5):945-51.

232. World Health Organisation. Obesity and overweight 2016 [Available from: http://www.who.int/mediacentre/factsheets/fs311/en/.
233. World Health Organisation. Report of the Commission on Ending Childhood Obesity. Geneva, Switzerland2016.
234. Australian Bureau of Statistics (ABS). National Health Survey: First Results, 2014-15. Catalogue no. 4364.0.55.001 Canberra2015 [Available from: http://www.abs.gov.au/ausstats/abs@.nsf/mf/4364.0.55.001.
235. Newby P.K. Plant foods and plant-based diets: protective against childhood obesity? American Journal of Clinical Nutrition. 2009;89:1572S-87S.
236. Tohill B.C., Seymour J., Serdula M., Kettel-Khan L., Rolls B.J. What epidemiologic studies tell us about the relationship between fruit and vegetable consumption and body weight. Nutrition Reviews. 2004;62(10):365-74.
237. Mytton O.T., Nhoaham K., Eyles H., Scarborough P., Mhurchu C.N. Systematic review and meta-analysis of the effect of increased vegetable and fruit consumption on body weight and energy intake. BMC Public Health. 2014;14:886.
238. Kaiser K.A., Brown A.W., Brown M.M.B., Shikany J.M., Mattes R.D., Allison D.B. Increased fruit and vegetable intake has no discernible effect on wieght loss: a systematic review and meta-analysis. American Journal of Clinical Nutrition. 2014;100:567-76.
239. Schwingshackl L., Hoffmann G., Kalle-Ujlmann T., Arregui M., Buijsse B., Heiner B. Fruit and vegetable consumption and changes in anthropometric variables in adult populations: a systematic review and meta-analysis of prospective cohort studies. PLoS ONE. 2015;10(10):e0140846.
240. Turner-MGrievy G.M., Barnard N.D., Scialli A.R. A two-year randomized weight loss trial comparing a vegan diet to a more moderate low-fat diet. Obesity. 2007;15(9):2276-81.
241. Berkow S.E., Barnard N. Vegetarian diets and weight status. Nutrition Reviews. 2006;64(4):175-88.
242. Buckland G., Bach A., Serra-Majem L. Obesity and the Mediterranean diet: a systematic review of observational and intervention studies. Obesity Reviews. 2008;9(6):582-93.
243. Australian Institute of Health and Welfare. Risk factors contributing to chronic disease. In: AIHW, editor. Canberra2012.
244. Pollard J., Greenwood D., Kirk S., Cade J. Lifestyle factors affecting fruit and vegetable consumption in the UK Women's Cohort Study. Appetite. 2001;37(1):71-9.
245. Thompson R.L., Margetts B.M., Speller V.M., McVey D. The Health Education Authority's health and lifestyle survey 1993: who are the low fruit and vegetable consumers? Journal of Epidemiology & Community Health. 1999;53:294-9.
246. De Irala-Estevez J., Groth M., Johansson L., Oltersdorf U., Prattala R., Martinez-Gonzalez M.A. A systematic review of socio-economic differences in food habits in Europe: consumption of fruit and vegetables. European Journal of Clinical Nutrition. 2000;54:706-14.
247. Maynard M., Gunnell D., Emmet P., Frankel S., Davey Smith G. Fruit, vegetables and antioxidants in childhood and risk of adult cancer: the Boyd Orr cohort. Journal of Epidemiology & Community Health. 2003;57(3):218-25.

248. Martin R.M., Holly J.M.P., Middleton N., Smith G.D., Gunnell D. Childhood diet and insulin-like growth factors in adulthood: 65-year follow-up of the Boyd Orr cohort. European Journal of Clinical Nutrition. 2007;61:1281-92.
249. Fruits & Veggies: More Matters. What are phytonutrients? [Available from: http://www.fruitsandveggiesmorematters.org/what-are-phytochemicals.
250. Slavin J.L., Llyod B. Heath benefits of fruits and vegetables. Advances in Nutrition. 2012;3:506-16.
251. Kourlaba G., Panagiotakos D.B. Dietary Quality Indices and Human Health: a review. Maturitas. 2009;62:1-8.
252. Reedy J., Mitrou P.N., Krebs-Smith S.M., Wirfalt E., Flood A., Kipnis V., et al. Index-based dietary patterns and risk of colorectal cancer. American Journal of Epidemiology. 2008;168(1):38-48.
253. Fung T.T., McCullough M.L., Newby P.K., Manson J.E., Meigs J.B., Rifai N., et al. Diet-quality scores and plasma concentrations of markers of inflammation and endothelial dysfunction. American Journal of Clinical Nutrition. 2005;82:163-73.
254. Bhupathiraju S.N., Tucker K.L. Greater variety in fruit and vegetable intake is associated with lower inflammation in Puerto Rican adults. American Journal of Clinical Nutrition. 2011;93:37-46.
255. Tucker K.L., Mattei J., Noel S.E., Collado B.M., Mendez J., Nelson J., et al. The Boston Puerto Rican Health Study: a longitudinal cohort study on health disparities in Puerto Rican adults: challenges and opportunities. BMC Public Health. 2010;10:107.
256. Wilson P.W., D'Agostino R.B., Levy D., Belanger A.M., Silbershatz H., Kannel W.B. Prediction of coronary heart disease using risk factor categories. Circulation. 1998;97:1837-47.
257. Griep L.M.O., Verschuren W.M.M., Kromhout D., Ocke M.C., Geleijnse J.M. Variety in fruit and vegetabe consumption and 10-year incidence of CHD and stroke. Public Health Nutrition. 2012;15(12):2280-6.
258. Bhupathiraju S.N., Wedick N.M., Manson J.E., Rexrode K.M., Willet W.C., Rimm E.B., et al. Quantity and variety in fruit and vegetable intake and risk of coronary heart disease. American Journal of Clinical Nutrition. 2013;98:1514-23.
259. Buchner F.L., Bueno De Mesquita H.B., Ros M.M., Overvad K., Dahm C.C., Hansen L., et al. Variety in fruit and vegetable consumptuon and the risk of lung cancer in the European Prospective Investigation into Cancer and Nutrition. Cancer Epidemiology, Biomarkers & Prevention. 2010;19(9):2278-86.
260. Buchner F.L., Bueno-de-Mesquita H.B., Ros M.M., Kampman E., Evegad L., Overvad K., et al. Variety in vegetable and fruit consumption and risk of bladder cancer in the European Prospective Investigation into Cancer and Nutrition. International Journal of Cancer. 2011;128:2871-979.
261. Jeurnink S.M., Buchner F.L., Bueno De Mesquita H.B., Siersema P.D., Boshuizen H.C., Numans M.E., et al. Variety in vegetable and fruit consumption and the risk of gastric and esophageal cancer in the European Prospective Investigation into Cancer and Nutrition. International Journal of Cancer. 2012;131:E963-E73.
262. Leenders M., Siersema P.D., Overvad K., Tjonneland A., Olsen A., Boutron-Ruault M.C., et al. Subtypes of fruit and vegetables, variety in consumption and risk of colon and rectal cancer in the European Prospective Investigation into Cancer and Nutrition. International Journal of Cancer. 2015;137:2705-14.

263. Cooper A.J., Sharp S.J., Lentjes M.A.H., Luben R.N., Khaw K.T., Wareham N.J., et al. A prospective study into the association between quantity and variety of fruit and vegetable intake and incident type 2 diabetes. Diabetes Care. 2012;35:1293-300.
264. Ye X., Bhupathiraju S.N., Tucker K.L. Variety in fruit and vegetable intake and cognitive function in middle-aged and older Puerto Rican adults. British Journal of Nutrition. 2013;109:503-10.
265. Gerrish C.J., Mennella J.A. Flavor variety enhances food acceptance in formula fed infants. American Society for Clinical Nutrition. 2001;73(6):1080-5.
266. Mennella J.A., Nicklaus S., Jagolino A.L., Yourshaw L.M. Variety is the spice of life: strategies for promotion fruit and vegetable acceptance during infancy. Physiology & Behavior. 2008;94(1):29-38.
267. Coulthard H., Harris G., Fogel A. Exposure to vegetable variety in infants weaned at different ages. Appetite. 2014;78:89-94.
268. Maier A., Chabanet C., Schaal B., Issanchou S., Leahwood P. Effects of repeated exposure on acceptance of intially disliked vegetables in 7-month old infants. Food Quality and Preference. 2007;18:1023-32.
269. Roe L.S., Meengs J.S., Birch L.L., Rolls B.J. Serving a variety of vegetables and fruit as a snack increased intake in preschool children. American Journal of Clinical Nutrition. 2013;98:693-9.
270. Adams M.A., Pelletier R.L., Zive M.M., Sallis J.F. Salad bars and fruit and vegetable consumption in elementary schools: a plate waste study. Journal of American Dietetic Association. 2005;105:1789-92.
271. de Wild V.W.T., de Graaf C., Boshuizen H.C., Jager G. Influence of choice on vegetable intake in children: an in-home study. Appetite. 2015;91:1-6.
272. Just D.R., Lund J., Price J. The role of variety in increasing the consumption of fruits and vegetables among children. Agriculture and Resource Econmics Review. 2012;41(1):72-81.
273. Remick A.K., Polivy J., Pliner P. Internal and external moderators of the effect of variety on food intake. Psychological Bulletin. 2009;135:434-51.
274. Nicklaus S., Boggio V., Chabanet C., Issanchou S. A prospective study of food variety seeking in childhood, adolescent and early adult life. Appetite. 2005;44(289-297).
275. Maier-Noth A., Schaal B., Leathwood P., Issanchou S. The lasting influences of early food-related variety experience: a longitudinal study of vegetable acceptance from 5 months to 6 years in two populations. PLoS ONE. 2016;11(3):e0151356.
276. Hirschy A.J., Morris J.R. individual differences in attributional style: the relational influence of self-efficacy, self-esteem, and sex role identity. Personality and Individual Differences. 2002;32:183-96.
277. Miller N.E., Dollard J. Social learning and imitation. New Haven, CT, US: Yale University Press; 1941.
278. Bandura A. Perceived self-efficacy in cognitive development and functioning. Educational Psychologist. 1993;28(2):117-48.
279. Dennis C. Theoretical underpinnings of breastfeeding confidence: a self-efficacy framework. Journal of Human Lactation. 1999;15(3):195-201.
280. Ajzen I., Fishbein M. Understanding attitudes and predicting social behavior. Cliffs E., editor. NJ, US: Prentice-Hall; 1980.

281. Rogers R.W. Cognitive and physiological processes in fear appeals and attitude change: A revised theory of protection motivation. Cacioppo J.T., Petty R.E., editors. NY, US: Guilford Press; 1983.
282. Sutton S. Stage models of health behaviour. Conner M., Norman P., editors. Maidenhead, England: Open University Press; 2005.
283. Guillaumie L., Godin G., Vezina-Im L. Psychosocial determinants of fruit and vegetable intake in adult population: a systematic review. International Journal of Behavioral Nutrition and Physical Activity. 2010;7:12.
284. Baranowski T., Weber Cullen K., Baranowski J. Psychosocial correlates of dietary intake: advancing dietary intervention. Annual Review of Nutrition. 1999;19:17-40.
285. Rogers R.P., Brug J., van Assema P., Dagnelie P.C. Explaining fruit and vegetable consumption: the theory of planned beahiour and misconcption of personal intake levels. Appetite. 2004;42(2):157-66.
286. Kothe E.J., Mullan B.A., Butow P. Promoting fruit and vegetable consumption. Testing an intervention based on theory of planned behaviour. Appetite. 2012;58(3):997-1004.
287. Gratton L., Povey R., Clark-Carter D. Promoting children's fruit and vegetable consumption: Interventions using the Theory of Planned Behaviour as a framework. British Journal of Health Psychology. 2007;12(4):639-50.
288. Blyth R., Creedy D.K., Dennis C.L., Moyle W., Pratt J., De Vries S.M., et al. Breastfeeding duration in an Australian population: the influence of modifiable antenatal factors. Journal of Human Lactation. 2004;20(1):30-8.
289. Ip W.Y, Gao L.L, Choi K.C., Chau J.P.C., Xiao Y. The short form of the breastfeeding self-efficacy scale as a prognostic factor of exclusive breastfeeding among mandarin-speaking chinese mothers. Journal of Human Lactation. 2016;32(4):711-20.
290. Ansari S., Abedi P., Hasanpoor S., Bani S. The effect of interventional program on breastfeeding self-efficacy and duration of exclusive breastfeeding in pregnant women in Ahvaz, Iran. International Scholarly Research Notes. 2014;2014:510793.
291. Nichols J., Schutte N.S., Brown R.F., Dennis C.L., Price I. The impact of self-efficacy intervention on short-term breast-feeding outcomes. Health Education & Behavior. 2009;36(2):250-9.
292. Blyth R., Creedy D.K., Dennis C.L., Moyle W., Pratt J., De Vries S.M. Effect of maternal confidence on breastfeeding duration: an application of breastfeeding self-efficacy theory. Birth. 2002;29(4):278-84.
293. Turner C.T., Papinczak T.A. An analysis of personal and social factors influencing intiation and duration of breastfeeding in a large Queensland maternity hospital. Breastfeeding Review. 2000;8(1):25-33.
294. Baghurst P., Pincombe J., Peat B., Henderson A., Reddin E., Antoniou G. Breastfeeding self-efficacy and other determinants of the duration of breastfeeding in a cohort of first-time mothers in Adelaide, Australia. Midwifery. 2007;23(4):382-91.
295. Noel-Weiss J., Rupp A., Cragg B., Bassett V., Woodend A.K. Randomized controlled trial to determine effects of prenatal breastfeeding workshop on maternal breastfeeding self-efficacy and breastfeeding duration. Journal of Obstetric, Gynecologic & Neonatal Nursing. 2006;35(5).

296. Otsuka K., Dennis C.L., Tatsuoka H., Jimba M. The relationship between breastfeeding self-efficacy and perceived insufficient milk among Japanese mothers. Journal of Obstetric, Gynecologic & Neonatal Nursing. 2008;37(5):546-55.
297. McCarter-Spaulding D.E., Kearney M.H. Parenting self-efficacy and perception of insufficient breast milk. Journal of Obstetric, Gynecologic & Neonatal Nursing. 2001;30(5):515-22.
298. Meedya S., Fahy K., Kable A. Factors that positively influence breastfeeding duration to 6 months: a literature review. Women and Birth. 2010;23:135-45.
299. Dennis C.L. Identifying predictors if breastfeeding self-efficacy in the immediate postpartum period. Research in Nursing & Health. 2006;29:256-68.
300. United States Department of Agriculture, National Institute of Food and Agriculture. Expanded Food and Nutrition Education Program (EFNEP) [Available from: https://nifa.usda.gov/program/expanded-food-and-nutrition-education-program-efnep.
301. Golan M., Wiezman A. Familial approach to the treatment of childhood obesity: conceptual model. Journal of Nutrition Education. 2001;33(2):102-7.
302. Kratt P., Reynolds K., Shewchuk R. The role of availability as a moderator of family fruit and vegetable consumption. Health Education & Behavior. 2000;27:471-82.
303. Cullen K.W., Baranowski T., Rittenberry L., Cosart C., Owens E., Hebert D., et al. Socioenvironmental influences on children's fruit, juice and vegetable consumption as reported by parents:realiability and validity of measures. Public Health Nutrition. 2000;3(3):345-56.
304. West F., Sanders M.R. The Lifestyle Behavior Checklist: A measure of weight-related problem behavior in obese children. Internation Journal of Obesity. 2009;7(4):266-73.
305. Dennis CL, Faux S. Development and psychometric testing of the Breastfeeding Self-Efficacy Scale. Research in Nursing and Health. 1999;22(5):399-409.
306. Dennis C.L. The breastfeeding self-efficacy scale: psychometric assessment of the short form. Journal of Obstetric, Gynecologic & Neonatal Nursing. 2003;32(6):734-44.
307. Molina Torres M., Davila Torres R.R., Parilla Rodriguez A.M., Dennis C.L. Translation and validation of the Breastfeeding Self-Efficacy Scale into Spanish: data from a Puerto Rican population. Journal of Human Lactation. 2003;19:35-42.
308. Dai X., Dennis C.L. Translation and validation of the Breastfeeding Self-Efficacy Scale into Chinese. Journal of Midwifery & Women's Health. 2003;48(5):350-6.
309. Alus-Tokat M., Okumus H., Dennis C.L. Translation and psychometric assessment of the Breastfeeding Self-Efficacy Scale-Short Form among pregnant and postnatal women in Turkey. Midwifery. 2010;26:101-8.
310. Gregory A., Penrose K., Morrison C., Dennis C.L., MacArthur C. Psychometric properties of the Breastfeeding Self-Efficacy Scale-Short Form min an ethnically diverse U.K. sample. Public Health Nursing. 2008;25(3):278-84.
311. McCarter-Spaulding D.E., Dennis C.L. Psychometric testing of the Breastfeeding Self-Efficacy Scale-Short Form in a sample of black women in the United States. Research in Nursing & Health. 2010;33(2):111-9.

312. Ip W.Y., Yeung L.S., Choi K.C., Chair S.Y., Dennis C.L. Translation and validation of the Hong Kong Chinese version of the Breastfeeding Self-Efficacy Scale-Short Form. Research in Nursing & Health. 2012;35(5):450-9.
313. Wutke K., Dennis C.L. The reliability and validity of the Polish version of the Breastfeeding Self-Efficacy Scale-Short Form: translation and psychometric assessment. International Journal of Nursing Studies. 2007;44(8):1439-46.
314. Zubaran C., Foresti K., Schumacher M., Thorell M.R., Amoretti A., Muller L., et al. The Portugese version of the Breastfeeding Self-Efficacy Scale-Short Form. Journal of Human Lactation. 2010;26(3):297-303.
315. Dix T., Meunier L.N. Depressive symptoms and parenting competence: an analysis of 13 regulatory processes. Developmental Review. 2009;29:45-68.
316. Lovejoy M.C., Graczyk P.A., O'Hare E., Neuman G. Maternal depression and parenting behavior: a meta-analytic review. Clinical Psychology Review. 2000;20(5):561-92.
317. Cost K.T., Plamondon A., Unternaehrer E., Meaney M., Steiner M., Fleming A.S. The more things change, the more things stay the same: maternal attitudes 3 to 18 months postpartum. Acta Paediatrica. 2016;105:e320-e7.
318. Wang L., Anderson J.L., Dalton W.T., Wu T., Liu X., Zheng S., et al. Maternal depressive symptoms and the risk of overweight in their children. Maternal & Child Health Journal. 2013;17:940-8.
319. Surkan P.J., Kawachi I., Ryan L.M., Berkman L.F., Vieira L.M.C., Peterson K.E. Maternal depressive symptoms, parenting self-efficacy and child growth. Research and Practice. 2007;98:125-32.
320. Surkan P.J., Kennedy C.E., Hurley K.M., Black M.M. Maternal depression and early childhood growth in developing countries: a systematic review and meta-analysis. Bulletin of the World Health Organization. 2011;287:607-15D.
321. Surkan P.J., Ettinger A.K., Hock R.S., Ahmed S., Strobino D.M., Minkovitz C.S. Early maternal depressive symptoms and child growth trajectories: a longitudinal analysis of a nationally representative US birth cohort. BMC Pediatrics. 2014;14:185.
322. Surkan P.J., Kawachi I., Peterson K.E. Childhood overweight and maternal depressive symptoms. Journal of Epidemiology & Community Health. 2008;62(e11).
323. Cummings E.M., Davies P.T. Maternal depression and child development. Journal of Child Psychology and Psychiatry. 1994;35:73-112.
324. Downey G., Coyne J.C. Children opf depressed parents: an integrative review. Psychological Bulletin. 1990;108:50-76.
325. Canadian Paediatric Society. Maternal depression and child development. Paediatric Child Health. 2004;9(8):575-83.
326. Gondoli D.M., Silverberg S.B. Maternal emotional distress and diminished responsiveness: the mediating role of parenting efficacy and parental perspective taking. Developmental Psychology. 1997;33(5):861-8.
327. Field T., Healy B., Goldstein S., Guthertz M. Behavior-state matching and synchrony in mother-infant interactions of nondepressed versus depressed dyads. Developmental Pyschology. 1990;26:7-14.
328. Leung D.W., Slep A.M.S. Predicting inept discipline: the role of parental depressive symptoms, anger, and attributions. Journal of Consulting and Clinical Psychology. 2006;74:524-34.

329. Mitchell S., Brennan L., Hayes L., Miles C.L. Maternal psychosocial predictors of controlling parental feeding styles and practices. Appetite. 2009;53:384-9.
330. Hurley K.M., Black M.M., Papas M.A., Caufield L.E. Maternal symptoms of stress, depression and anxiety are related to nonresponsive feeding styles in a statewide sample of WIC participants. Journal of Nutrition. 2008;138:799-805.
331. Morrissey T.W. Maternal depressive symptoms and weight-related parenting behaviors. Maternal & Child Health Journal. 2014;18:1328-35.
332. Jackson A.P., Huang C.C. Parenting stress and behavior among single mothers of preschoolers: the mediating role of self-efficacy. Journal of Social Service Research. 2000;26(4):29-42.
333. Teti D.M., O'Connell M.A., Reiner C.D. Parenting sensitivity, parental depression and child health: the mediational role of parental self-efficacy. Infant and Child Development. 1996;5(4):237-50.
334. Horwitz S.M., Briggs-Gowan M.J., Storfer-Isser A., Carter A.S. Persistence of maternal depressive symptoms throughout the early years of childhood. Journal of Women's Health. 2009;18(5):637-45.
335. Giallo R., Cooklin A., Nicholson J.M. Risk factors associated with trajectories of mothers' depressive symptoms across the early parenting period: an Australian population-based longitudinal study. Archives of Women's Mental Health. 2014;17:115-25.
336. Kohlhoff J., Barnett B. Parenting self-efficacy: links with maternal depression, infant behaviour and adult attachment. Early Human Development. 2013;89:249-56.
337. Dennis C.L., McQueen K. The relationship between infant-feeding outcomes and postpartum depression: a qualitative systematic review. Pediatrics. 2016;123:e736-e51.
338. Hurley K.M., Black M.M., Merry B.C., Caulfied L.E. Maternal mental health and infant dietary patterns in a statewide sample of Maryland WIC participants. Maternal and Child Nutrition. 2015;11:229-39.
339. Ystrom E., Niegel S., Vollrath M.E. The maternal negative affectivity on dietary patterns of 18-month-old children in the Norwegian Mother and Child Cohort Study. Maternal and Child Nutrition. 2009;5:234-42.
340. Rahman A., Iqbal Z., Bunn J., Lovel H., Harrington R. Impact of maternal depression on infant nutritional status and illness. Archives of General Psychiatry. 2004;61:946-52.
341. Audelo J., Kogut K., Harley K.G., Rosas L.G., Stein L., Eskenazi B. Maternal depression and childhood overweight in the CHAMACOS Study of Mexican-American children. Maternal and Child Health Journal. 2016;20:1405-14.
342. Mech P., Hooley M., Skouteris H., Williams J. Parent-related mechanisms underlying the social gradient of childhood overweight and obesity: a systematic review. Child: care, health and development. 2016;42(5):603-24.
343. Rothbart M.K., Bates J.E. Temperament. In: Eisenberg, editor. Handbook of child psychology: social, emotional, and personality development. New York: Wiley & Sons; 2006. p. 99-166.
344. Donovan W.L., Leavitt L.A. Maternal self-efficacy and infant attachment: integrating physiology, perceptions and behavior. Child Development. 1989;60:460-72.

345. Porter C.L., Hsu H. First-time mother's perceptions of efficacy during the transition to motherhood: links to infant temperament. Journal of Family Psychology. 2003;17:54-64.
346. Anzman-Frasca S., Stifter C.A., Paul I.A., Birch L.L. Infant temperament and maternal parentings elf-efficacy predict child weight outcomes. Infant Behavior and Development. 2013;36:494-7.
347. Solmeyer A.R., Feinberg M.E. Mother and father adjustment during early parenthood: the roles of infant temperament and coparenting relationship quality. Infant Behavior and Development. 2011;34:504-14.
348. Goodman S.H., Rouse M.H., Connell A.M., Broth M.R., Hall C.M., Heyward D. Maternal depression and child psychopatholoy: a meta-analytic review. Clinical Child Family Psychology Review. 2011;14:1-27.
349. McMeekin S., Jansen E., Mallan K., Nicholson J., Magarey A.M, Daniels L. Associations between infant temperament and early feeding practices. A cross-sectional study of Australian mother-infant dyads from the NOURISH randomised controlled trial. Appetite. 2013:239-45.
350. Vollrath M.E., Stene-Larsen K., Tonstad S., Rothbart M.K., Hampson S.E. Associations between temperament at age 1.5 years and obesogenic diet at ages 3 and 7 years. Journal of Development and Behavioral Pediatrics. 2012;33(9):721-7.
351. Vollrath M.E., Tonstad S., Rothbart M.K., Hampson S.E. Infant temperament is associated with potentially obesogenic diet at 18 months. International Journal of Pediatric Obesity. 2011;6:e408-e14.
352. Vereecken C., Rovner A., Maes L. Associations of parenting styles, parental feeding practices and child characteristics with young children's fruit and vegetable consumption. Appetite. 2010;55:589-96.
353. Haycraft E., Farrow C., Meyer C., Powell F., Blissett J. Relationships between temperament and eating behaviours in young children. Appetite. 2011;56(3):689-92.
354. Haycraft E., Blissett J. Predictors or paternal and maternal controlling feeding practices with 2- to 5- year old children. Journal of Nutrition Education and Behavior. 2012;44.
355. Moding K.J., Birch L.L., Stifter C.A. Infant temperament and feeding history predict infants' responses to novel foods. Appetite. 2014;83:218-25.
356. Pliner P., Leowen E.R. Temperament and food neophobia in children and their mothers. Appetite. 1997;28:239-54.
357. Bergmeier H., Skouteris H., Horwood S., Hooley M., Richardson B. Associations between child temperament, maternal feeding practices and child body mass index during the preschool years: a systematic review of the literature. Obesity Reviews. 2014;15:9-18.
358. Braungart-Rieker J.M., Moore E.S., Planalp E.M., Lefever J.B. Psychosocial pathways to childhood obesity: a pilot study involving a high risk preschool sample. Eating Behaviors. 2014;15:528-31.
359. Rasmussen M., Krolner R., Klepp K.I., Lytle L.A., Brug J., Bere E., et al. Determinants of fruit and vegetable consumption among children and adolescents: a review of the literature. Part I: quantitative studies. International Journal of Behavioral Nutrition and Physical Activity. 2006;3:22.
360. Hendrie G.A, Conveney J., Cox D. Exploring nutrition knowledge and the demographic variation in knowledge levels in an Australian community sample. Public Health Nutrition. 2008;11(12):1365-71.

361. Larsen M.H. Nutritional advice from George Orwell. Exploring the social mechanisms behind the overconsumption of unhealthy foods by people with low socio-economic status. Appetite. 2015;91:150-6.
362. Campbell K., Crawford D., Jackson M., Cashel K., Worsley A., Gibbons K., et al. Family food environments of 5-6 year old children: does socioeconomic status make a difference? Asia Pacific Journal of Clinical Nutrition. 2002;11(3):553-61.
363. Gilbert P.A., Khokhar S. Changing dietary habits of ethnic groups in Europe and implications for health. Nutrition Reviews. 2008;66(4):203-15.
364. Rodenburg G., Oenema A., Kremers S.P., van de Mheen D. Parental and child fruit consumption in the context of parenting, parental education and ethnic background. Appetite. 2012;58(1):364-72.
365. Neuhouser M.L., Thompson B., Coronado G.D., Solomon C.C. Higher fat intake and lower fruit and vegetables intakes are associated with greater acculturation among mexicans living in Washington State. Journal of American Dietetic Association. 2004;104(1):51-7.
366. Dave J.M., Evans A.E., Saunders R.P., Watkins K.W., Pfeiffer K.A. Associations among food security, acculturation, demographic factors, and fruit and vegetable intake at home in Hispanic children. Journal of American Dietetic Association. 2009;109(4):697-701.
367. Holmboe-Ottesen G., Wandel M. Changes in dietary habits after migration and consequences for health: a focus on South Asians in Europe. Food and Nutrition Research. 2012;56:18891.
368. Satia J.A., Patterson R.E., Kristal A.R., Hislop T.G., Yasui Y., Taylor V.M. Development of dietary acculturation scales among Chinese Americans and Chinese Canadians. Journal of American Dietetic Association. 2001;101:548-53.
369. Rosenmoller D.L., Gasevic D., Seidell J., Lear S.A. Determinants of changes in dietary patterns among Chinese immigrants: a cross-sectional analysis. International Journal of Behavioral Nutrition and Physical Activity. 2011;8:42.
370. Wahlqvist M.L. Asian migration to Australia: food and health consequences. Asia Pacific Journal of Clinical Nutrition. 2002;11(3):S562-S8.
371. Noia J.D., Byrd-Bredbenner C. Determinants of fruit and vegetable intake in low-income children and adolescents. Nutrition Reviews. 2014;72(9):575-90.
372. Bere E., Brug J., Klepp K-I. Why do boys eat less fruit and vegetables than girls? Public Health Nutrition. 2008;11(3):321-5.
373. Cooke L.J., Wardle J. Age and gender differences in children's food preferences. British Journal of Nutrition. 2005;93(5):741-6.
374. Harris H., Mallan K.M., Nambiar S., Daniels L.A. The relationship between controlling feeding practices and boys' and girls' eating in the absence of hunger. Eating Behaviors. 2014;15:519-22.
375. Fisher J.O., Mitchell D.C., Smiciklas-Wright H., Birch L.L. Parental influences on young girls' fruit and vegetabl, micronutrient and fat intakes. Journal of the American Dietetics Association. 2002;102(1):58-64.
376. Bere E., Klepp K.I. Correlates of fruit and vegetable intake among Norwegian schoolchildren: parental and self-reports. Public Health Nutrition. 2004;7(8):991-8.
377. Coulthard H., Blissett J. Fruit and vegetable consumption in children and their mothers: moderating effects of child sensory sensitivity. Appetite. 2009;52(2):410-5.

378. Reinaerts E., de Nooijer J., Candel M., de Vries N. Explaining school children's fruit and vegetable consumption: The contributions of availability, accesibility, exposure, parental consumption and habit in addition to psychosocial factors. Appetite. 2007;48(2):248-58.
379. Birch L.L, Marlin D.W. I don't like it; I never tried it: Effects of exposure on two-year-old children's food preferences. Appetite. 1982;23:353-60.
380. Sullivan S.A., Birch L.L. Infant dietary experience and acceptance of solid foods. Pediatrics. 1994;93:271-7.
381. Birch L.L, Gunder L., Grimm-Thomas K., Laing D.G. Infants' consumption of a new food enhances acceptance of similar foods. Appetite. 1998;30(3):283-95.
382. Williams K.E., Paul C., Pizzo B., Riegel K. Practice does make perfect: a longitudinal look at repeated taste exposure. Appetite. 2008;51(3):739-42.
383. Heath P., Houston-Price C., Kennedy O.B. Increasing food familiarity without the tears. A role for visual exposure? Appetite. 2011;57:832-8.
384. Dazaley P., Houston-Price C. Exposure to foods' non-taste sensory properties. A nursery intervention to increase childrens' willingness to try fruit and vegetables. Appetite. 2015;84(1):1-6.
385. Cooke L.J., Chambers L.C., Anez E.V., Croker H.A., Boniface D., Yeomans M.R., et al. Eating for pleasure of profit: the effect of incentives on children's enjoyment of vegetables. Psychological Science. 2011;22(2):190-6.
386. Wardle J., Cooke L. J., Gibson E.L., Sapochnik M., Sheiham A., Lawson M. Increasing children's acceptance of vegetables: A randomized trial of parent-led exposure. Appetite. 2003;40(2):155-62.
387. Fildes A., van Jaarsveld C.H.M., Wardle J., Cooke L. Parent-administered exposure to increase children's vegetable acceptance: a randomized controlled trial. Journal of the Academy of Nutrition and Dietetics. 2014;114(6):881-8.
388. Remington A., Anez E., Croker H., Wardle J., Cooke L. Increasing food acceptance in the home setting: a randomized controlled trial of parent-administered taste exposure with incentives. American Journal of Clinical Nutrition. 2012;95:72-7.
389. Anez E., Remington A., Wardle J., Cooke L. The impact of instrumental feeding on children's responses to taste exposure. Journal of Human Nutrition and Dietetics. 2013;26(5):415-20.
390. Birch L.L, Birch D., Marlin D.W., Kramer L. Effects of instrumental consumption on children's food preference. Appetite. 1982;3(2):125-34.
391. Newman J., Taylor A. Effect of a means end contingency on young children's food preferences. Journal of Experimental Child Psychology. 1992;53(2):200-16.
392. Cooke L., Chambers L.C., Anez E.V., Wardle J. Facilitating or undermining? The effect of reward on food acceptance. A narrative review. Appetite. 2011;57(2):493-7.
393. Barends C., de Vries J.H.M., Mojet J., de Graaf C. Effects of starting weaning exclusively with vegetables on vegetable intake at the age of 12 and 23 months. Appetite. 2014;81:193-9.
394. Hetherington M.M., Schwartz C., Madrelle J., Croden F., Nekitsing C., Vereijken C.M.J.L., et al. A step-by-step introduction to vegetables at the beginning of complementary feeding. The effects of early and repeated exposure. Appetite. 2015:280-90.
395. Menella J.A., Nicklaus S., Jagolino A.L., Yourshaw L.M. Variety is the spice of life: strategies for promoting fruit and vegetable acceptance during infancy. Physiology & Behavior. 2008;94(1):29-38.

396. Beauchamp G.K., Menella J.A. Sensitive periods in the development of human flavor perception and preference. Annales Nestle. 1998;56:20-32.
397. Menella J.A., Beauchamp G.K. Understanding the origin of flavor preferences. Chemical senses. 2005;30(1):i242-i3.
398. Menella J.A., Lukasewycz L.D., Castor S.M., Beauchamp G.K. The timing and duration of a sensitive period in human flavor learning: a randomized trial. American Journal of Clinical Nutrition. 2011;93(5):1019-24.
399. Lange C., Visalli M., Jacob S., Chabanet C., Schlich P., Nicklaus S. Maternal feeding practices during the first year and their impact on infants' acceptance of complementary food. Food Quality and Preference. 2013(29):89-98.
400. Blossfeld I., Collins A., Boland S., Baixauli R., Kiely M., Delahunty C. Relationships between acceptance of sour taste and fruit intakes in 18-month-old infants. British Journal of Nutrition. 2007;98:1084-91.
401. Gibson E.L., Wardle J. Energy density predicts preferences for fruit and vegetables in 4-year-old children. Appetite. 2003;41:97-8.
402. Coulthard H., Harris G., Emmett P. Long-term consequences of early fruit and vegetable feeding practices in the United Kingdom. Public Health Nutrition. 2010;13(12):2044-51.
403. Jacobi C., Agras W.S., Bryson S., Hammer L.D. Behavioral validation, precursors, and concomitants of picky eating in childhood. Journal of the Amrican Academy of the Child & Adolescent Psychiatry. 2003;42(1):76-84.
404. Galloway A.T., Fiorito L.M., Francis L.A., Birch L.L. Parental pressure, dietary patterns and weight status among girls who are "picky/fussy" eaters. Journal of American Dietetic Association. 2005;105:541-8.
405. Raudenbush B., Schroth F., Reilley S., Frank R.A. Food neophobia, odor evaluation and exploratory sniffing behavior. Appetite. 1998;31(2):171-83.
406. Cooke L., Carnell S., Wardle J. Food neophobia and mealtime food consumption in 4-5 year old children. International Journal of Behavioral Nutrition and Physical Activity. 2006;6:3-14.
407. Perry R.A., Mallan K.M., Koo J., Mauch C.E., Daniels L.A., Magarey A.M. Food neophobia and its association with diet quality and weight in children aged 24 months: a cross sectional study. International Journal of Behavioral Nutrition and Physical Activity. 2015;12:13.
408. Lafraire J., Rioux C., Giboreau A., Picard D. Food rejections in children: cognitive and social/environmental factors involved in food neophobia and picky/fussy eating behavior. Appetite. 2016;96:347-57.
409. Mascola A.J., Bryson S.W., Agras W.S. Picky eating during childhood: a longitudinal study to age 11 years. Eating Behaviors. 2010;11(4):253-7.
410. Dubois L., Farmer A., Girard M., Peterson K., Tatone-Takuda F. Problem eating beahviors related to social factors and body weight in preschool children: a longitudinal study. International Journal of Behavioral Nutrition and Physical Activity. 2007;4:9.
411. van der Horst K., Deming D.M., Lesniauskas R., Carr B.T., Reidy K. Picky eating: associations with child eating characteristics and food intake. Appetite. 2016;103:286-93.
412. Pliner P., Pelchat M., Grabski M. Reduction in neophobia in humans by expsoure to novel foods. Appetite. 1993;20(2):111-23.
413. Baughcum AE, Powers SW, Johnson SB, Chamberlin LA, Deeks CM, Jain A, et al. Maternal Feeding Practices and Beliefs and Their Relationships to

Overweight in Early Childhood. Developmental and Behavioral Pediatrics. 2001;22(6):391-408.
414. Andrews G, Slade T. Interpreting scores on the Kessler Psychological Distress Scale (K10). Anz N Z J Public Health. 2001;25:494-7.
415. Daniels L.A, Wilson J.L., Mallan K.M., Mihrshahi S., Perry R.A., Nicholson J.M., et al. Recruiting and engaging new mothers in nutrition research studies: lessons from the Australian NOURISH randomised controlled trial. International Journal of Behavioral Nutrition and Physical Activity. 2012;9:129.
416. Daniels LA, Magarey A, Battistutta D, Nicholson JM, Farell A, Davidson G, et al. The NOURISH Randomised control trial: Positive feeding practices and food preferences in early childhood- a primary prevention program for childhood obesity. BMC Public Health. 2009;9:387.
417. Microsoft Office. Excel 2010. In: Corporation M, editor. Redmond, WA2010.
418. UK Child Growth Foundation. LMS Growth [Available from: http://homepage.mac.com/tjcole/FileSharing1.html.
419. IBM. IBM SPSS Statistics 19.0.0. In: Corporation I, editor. Chicago2010.
420. Jonnalagadda SS, Mitchell DC, Smiciklas-Wright. Accuracy of energy intake data estimated by a multiple-pass, 24-hour dietary recall tecnique. J Am Diet Assoc. 2000;100:303-11.
421. Xyris Software. FoodWorks 2009 version 6. Australia2009.
422. Horodynski MA, Stommel M. Nutrition Education Aimed At Toddlers: An Intervention Study. Pediatric Nursing. 2005;31(5):364-72.
423. Wells KJ, Thompson NJ, Kloeblen-Tarver AS. Development and Psychometric Testing of the Prenatal Breast-feeding Self-efficacy scale. American Journal of Health Behavior. 2006;30(2):177-87.
424. Creedy DK, Dennis CL, Blyth R, Moyle W, Pratt J, De Vries SM. Psychometric characteristics of the breastfedding self-efficacy scale: Data from an Australian sample. Research in Nursing and Health. 2003;26(2):143-52.
425. Dennis CL. The Breastfeeding Self-Efficacy Scale: Psychometric Assessment of the Short Form. Journal of Obstetric, Gynecologic, & Neonatal Nursing. 2003;32(6):734-44.
426. Chan L., Magarey A.M., Daniels L.A. Maternal feeding practices and feeding behaviors of Australian children aged 12-36 months. Maternal & Child Health Journal. 2011;15(8):1363-71.
427. Department of Social Services, Australian Institute of Family Studies, Australian Bureau of Statistics. Growing Up In Australia: The Longitudinal Study of Australian Children: Commonwealth of Australia; 2017 [Available from: http://www.growingupinaustralia.gov.au/studyqns/wave1qns/P2SC4.pdf.
428. Slade T., Grove R., Burgess P. Kessler Psychological Distress Scale: normative data from the 2007 Australian National Survey of Mental Health and Wellbeing. Aus N Z J Psychiatry. 2011;45:308-16.
429. Cox J, Holden J, Sagovsky R. Detection of postnatal depression: Development of the 10-item Edinburg Postnatal Depression Scale. Br J Psychiatry. 1987;150:782-6.
430. Dennis CL, McQueen K. The Relationship Between Infant-Feeding Outcomes and Postpartum Depression: A Qualitative Systematic Review. Pediatrics. 2009;123(4):e736-e51.

431. Donovan WL, Leavitt LA, Walsh RO. Maternal Self-Efficacy: Illusory Control and Its Effect on Susceptibility to Learned Helplessness. Child Development. 1990;61(5):1638-47.
432. Dennis CL. Theoritical Underpinnings of breast-feeding confidence: a self-efficacy framework. J Hum Lactation. 1999;15:195-201.
433. The Australian Temperament Project. The Short Temperament Scale for Infants. 1987.
434. Carey WB, McDevitt SC, Associates. Carey Temperament Scales: Revised Infant Temperament Questionnaire (RITQ) for infants 4-11 months. Texas: Pearson Education, Inc.; 2008.
435. Oberklaid F, Sanson AV, Prior M. The development of the Australian normative data for infant temperament.
. Aust Paediatr J. 1986;22(3):185-7.
436. Fullard W., McDevitt S.C., Carey W.B. Assessing temperament in one to three year old children. Journal of Pediatric Psychology. 1982;9(2):205-17.
437. Sewell J., Oberklaid F., Prior M., Sanson A., Kyrios M. Temperament in Australian toddlers. Journal of Pediatrics and Child Health. 1988;24(6):343-5.
438. Muthen LK, Muthen BO. MPlus version 6.11. Los Angeles, CA: Muthen & Muthen; 2011.
439. Pallant J. SPSS Survival Manual. 3 ed. NSW, Australia: Allen & Unwin; 2007.
440. Pallant J. SPSS Survival Manual. 5 ed. NSW, Australia: Allen & Unwin; 2013.
441. Gravetter F.J., Wallnau L.B. Statistics for the behavioral sciences. 9 ed. Belmont, CA: Wadsworth; 2013.
442. IBM. IBM SPSS Amos 19. In: IBM, editor. Chicago2010.
443. Finney S.J., DiStefano C. Structural Equation Modeling. Hancock G.R., Mueller R.O., editors. Charlotte, NC: Information Age Publishing; 2006.
444. Muthen B. Latent variable structural equation modeling with categorical data. Journal of Econometrics. 1983;22:43-65.
445. Efron B., Tibshirani R.J. An introduction to the bootstrap. NY: Chapman & Hall; 1993.
446. Abadie A., Imbens G.W. On the failure of the bootstrap for matching estimators. Econometrica. 2008;76(6):1537-57.
447. Langlet E.R., Faucher D., Lesage E. An application of the bootstrap variance estimation method to the Canadian Participation and Activity Limitation Survey. 2003.
448. Joreskog K.G., Moustaki I. Factor analysis of ordinal variables: a comparison of three approaches. Multivariate Behavioral Research. 2001;36(3):347-87.
449. Fan X., Thompson B., Wang L. Effects of sample size, estimation methods, and model specification on structural equation modelling fit indexes. Structural Equation Modeling: A multidisciplinary Journal. 1999;6(1):56-83.
450. Hu L-T., Bentler P.M. Fit indices in covariance structure modeling: sensitivity to underparameterized model misspecification. Psychological Methods. 1998;3(4):424-53.
451. Muthen L.K., Muthen B.O. Mplus Statistical Analysis with latent variables: User's Guide. 6 ed. Los Angeles, CA: Muthen & Muthen; 1998-2010.

452. Bearden W.O., Sharma S., Teel J.E. Sample size effects on chi-square and other statistics used in evaluating causal models. Journal of Marketing Research. 1982;19(4):425-30.
453. Loehlin J.C. Latent variables: An introduction to factor, path, and structural analysis. 3rd ed. Mahwah, NJ, US: Lawrence Erlbaum Associates Inc.; 1998.
454. Byrne B.M. Structural equation modeling with LISREL, PRELIS and SIMPLIS: Basic concepts, applications, and programming. Mahwah, NJ, US: Lawrence Erlbaum Associates; 1989.
455. Hancock G.R., Freeman M.J. Power and sample size for the root mean square error of approximation test of not close fit in structural equation modeling. Education and Psychological Measurement. 2001;61(5):741-58.
456. Hu L-T., Bentler P.M. Cutoff criteria for fit indexes in covariance structure analysis: conventional criteria versus new alternatives. Structural Equation Modeling. 1999;6(1):1-55.
457. Tucker L.R., Lewis C. A reliability coefficient for maximum likelihood factor analysis. Psychometrika. 1973;38:1-10.
458. Bentler P.M. Comparative fit indexes in structural models. Psychological Bulletin. 1990;107:238-46.
459. Marsh H.W., Balla J.R., Hau K.T. An evaluation of incremental fit indices: A clarification of mathematical and empirical properties. Advanced structural equation modeling: issues and techniques. Mahwah, NJ, US: Lawrence Erlbaum Associates; 1996. p. 315-53.
460. Muthen L.K., Muthen B.O. MPlus version 6.11. In: Muthen & Muthen, editor. Los Angeles, CA2011.
461. Australian Bureau of Statistics (ABS). 2011 Census Quickstats 2011, 1 Oct 2013. Available from: www.censusdata.abs.gov.au.
462. Li Z, McNally L, Hilder L, Sullivan E.A. Australia's mothers and babies, 2009. Perinatal statistics series no.25. Cat no. PER 52. In: Unit ANPEaS, editor. Sydney: Australian Institute of Health and Welfare; 2011.
463. Australian Bureau of Statistics (ABS). Australian Social Trends, March 2009. Canberra: Commonwealth of Australia; 2009.
464. Australian Bureau of Statistics (ABS). Recent Increases in South Australia's fertility. Canberra: Commenwealth of Australia; 2009.
465. Australian Bureau of Statistics (ABS). 2008 Year Book Australia. Canberra: Commonwealth of Australia; 2008.
466. Australian Bureau of Statistics (ABS). Adelaide: A Social Atlas - 2006 Census of Population and Housing. Canberra: Commonwealth of Australia; 2006.
467. Australian Bureau of Statistics (ABS). Births, Australia 2008. Canberra: Commonwealth of Australia; 2008.
468. Amir L. H., Donath S.M. Socioeconomic status and rates of breastfeeding in Australia: evidence from three recent national health surveys. Medical Journal of Australia. 2008;189(5):254-6.
469. Scott J. A., Binns C.W., Oddy W.H., Graham K.I. Predictors of breastfeeding duration: evidence from a cohort study. Pediatrics. 2006;117(4):e646-e55.
470. Pontin D., Emmett P., Steer C., Emond A., ALSPAC team. Patterns of breastfeeding in a UK longitudinal cohort study. Maternal & Child Nutrition. 2007;3(1):2-9.
471. Centers for Disease Control and Prevention (CDC). Breastfeeding Report Card - United States, 2012. In: Services DoHaH, editor. Atlanta2012.

472. Australian Institute of Health and Welfare. 2010 Australian National Infant Feeding Survey: indicator results. Canberra: AIHW; 2011.
473. Briefel R.R., Reidy K., Karwe V., Devaney B. Feeding Infants and Toddlers Study: Improvements Needed in Meeting Infant Feeding Recommendations. Journal of American Dietetic Association. 2004;104:S31-S7.
474. National Health and Medical Research Council. Dietary Guidelines for Adolescents and Children in Australia incorporating The Infant Feeding Guidelines for Health Workers. In: Council NHaMR, editor. Canberra, Australia: Commonwealth of Australia; 2003.
475. Mortensen K., Tawia S. Sustained breastfeeding. Breastfeeding Review. 2013;21(1):22-34.
476. Faircloth C.R. 'If they want to risk the health and well-being of their child, that's up to them': Long-term breastfeeding, risk and maternal identity. Health, Risk & Society. 2010;12(4):357-67.
477. Cockerham-Colas L., Geer L., Benker K., Joseph M.A. Exploring and influencing the knowledge and attitudes of health professionals towards extended breastfeeding. Breastfeeding Medicine. 2012;7:143-50.
478. Hills-Bonczyk S.G., Tromiczak K.R., Avery M.D, Potter S., Savik K., Duckett L.J. Women's experiences with breastfeeding longer than 12 months. Birth. 1994;21:206-12.
479. American Academy of Pediatrics Committee on Nutrition. Pediatric Nutrition Handbook. 6 ed. R.E. K, editor. IL: Elk Grove Village; 2008.
480. World Health Organisation. Complementary Feeding: Report of the global consultation-Summary of Guiding Principles for Complementary Feeding of the Breastfed Child. In: Department of Child and Adolescent Health and Development, Department for Nutrition and Health Development, editors. Geneva2002.
481. The British Dietetic Association (BDA). Complementary Feeding: Introduction of solid food to an infants diet - Policy Statement. BDA; April, 2013.
482. National Health and Medical Research Council. Eat For Health: Infant Feeding Guidelines, Information for health workers-Summary. In: Department of Health and Ageing, editor. Canberra2013.
483. Scott J.A, Binns C.W., Graham K.I., Oddy W.H. Predictors of the early introduction of solid foods in infants: results of a cohort study. BMC Pediatrics. 2009;9(60).
484. Ladomenou F., Kafatos A., Galanakis E. Risk factors related to intention to breastfeed, early weaning and suboptimal duration of breastfeeding. Acta Paediatrica. 2007;196(10):1441-4.
485. Flacking R., Nygvist K.H., Ewald U. Effects of socioeconomic status on breastfeeding duration in mothers of preterm and term infants. European Journal of Public Healh. 2007;17(6):579-84.
486. van de Mortel T.F. Faking it: social desirability response in self-report research. Australian Journal of Advanced Nursing. 2008;25(4):40-8.
487. Lagattuta K.H., Sayfan L., Bamford C. Do you know how I feel? Parents underestimate worry and overestimate optimism compared to child self-report. Journal of Experimental Child Psychology. 2012;113(2):211-32.
488. Department of Health and Ageing. The Australian Guide to Healthy Eating. In: Department of Health and Ageing, editor. Canberra: Commonwealth of Australia; 1998.

489. Australian Bureau of Statistics (ABS). National Health Survey, 2007-2008. In: ABS, editor. Canberra2008.
490. Australian Bureau of Statistics (ABS). Australian Health Survey: Updated Results, 2011-2012 (Catalogue No. 4364.0.55.003). Table 11: Daily Intake of fruit and vegetables by age and sex - Australia. In: (ABS) ABoS, editor. Canberra2015.
491. Australian Bureau of Statistics (ABS). National Health Survey 2007-2008: User's Guide. In: (ABS) ABoS, editor. 2008.
492. Karvetti R.L., Knuts L.R. Validity of the 24-hour dietary recall. Journal of American Dietetic Association. 1985;85(11):1437-42.
493. Dwyer J.T., Coleman K.A. Insights into dietary recall from a longitudinal study: accuracy over four decades. American Journal of Clinical Nutrition. 1997;65(4):1153S-8S.
494. Conway J.M., Ingwersen L.A., Moshfegh A.J. Accuracy of dietary recall using the USDA five-step multiple-pass method in men: an observational validation study. Journal of American Dietetic Association. 2004;104(4):595-603.
495. Beer-Borst S., Amado R. Validation of self-administered 24-hour recall questionnaire used in large-scale dietary survey. European Journal of Nutrition. 1995;34(183-189).
496. Kimmons J., Gillespie C., Seymour J., Serdula M., Blanck H.M. Fruit and vegetable intake among adolescents and adults in the United States: percentage meeting individualized recommendations. The Medscape Journal of Medicine. 2009;11(1):26.
497. Australian Bureau of Statistics (ABS). Profiles of Health, Australia, 2011-13: Daily Intake of fruit and vegetables. In: ABS, editor. Canberra2013.
498. Guenther P.M., Dodd K.W., Reedy J., Krebs-Smith S.M. Most Americans eat much less than recommended amounts of fruits and vegetables. Journal of American Dietetic Association. 2006;106:1371-9.
499. Magarey A.M., Daniels L.A, Smith A. Fruit and vegetable intakes of Australians aged 2-18 years: anb evaluation of the 1995 National Nutrition Survey data. Australian and New Zealand Journal of Public Health. 2001;25(2):155-61.
500. Ziegler P.J., Briefel R.R., Clusen N., Devaney B. Feeding Infants and Toddler Study (FITS): development of the FITS survey in comparison to other dietary survey methods. Journal of American Dietetic Association. 2006;106(1):S12-S27.
501. BBC Research. Global Markets for Baby Foods 2012 [Available from: www.bbcresearch.com/market-research/food-and-beverage/baby-foods-infant-formula-global-markets-fod046a.html.
502. Brown A. Optimistic forecasts for baby food and infant formula 2012 [Available from: www.ausfoodnews.com.au/2012/07/11/optimistic-forecasts-for-baby-food-and-infant-formula.html.
503. Brazionis L., Golley R.K., Mittinty M.N, Smithers L.G., Emmet P.., Northstone K., et al. Characterization of transition diets spanning infancy and toddlerhood: a novel, multiple-time-point application of principal component analysis. American Journal of Clinical Nutrition. 2012;95:1200-8.
504. Steyn N.P., Nel J.H., Nantel J., Kennedy G., Labadarious D. Food variety and dietary diversity scores in children: are they good indicators of dietary adequacy? Public Health Nutrition. 2006;9(5):644-50.

505. Kennedy G.L., Pedro M.R., Seghieri C., Nantel G., Brouwer I. Dietary Diversity Score is a useful indicator of micronutrient intake in non-breastfeeding Filipino children. The Journal of Nutrition. 2007;137(2):472-7.
506. Ruel M.T. Operationalizing dietary diversity: a review of measurement issues and research priorities. Journal of Nutrition. 2003;133(11):3911S-26S.
507. The Australian Temperament Project. The Short Temperament Scale for Infants. 1987.
508. Kessler R.C., Andrews G., Colpe R.J., Hiripi E., Mroczek D.K., Normand S-L. T., et al. Short screening scales to monitor population prevalences and trends in non-specific psychological distress. Psychological Medicine. 2002;32:959-76.
509. McCrae R.R., Kurtz J.E., Yamagata S., Terracciano A. Internal consistency, retest reliability and their implications for personality scale validity. Personality and social psychology review. 2011;15(1):28-50.
510. Hides L, Lubman D.I., Devlin H., Cotton S., Aitken C., Gibbie T., et al. Reliability and validity of the Kessler 10 and Patient Health Questionnaire among injecting drug users. Aus N Z J Psychiatry. 2007;41:166-8.
511. Spies G., Kader K., Kidd M., Smit J., Myer L., Stein D.J., et al. Validity of the K-10 in detecting DSM-IV-defined depression and anxiety disorders among HIV-infected individuals. AIDS Care. 2009;21(9):1163-8.
512. Donker T., Comijs H., Cujjpers P., Terliun B., Nolen W., Zitman F., et al. The validity of the Dutch K10 and extended K10 screening scales for depressive and anxiety disorders. Psychiatry Research. 2010;176:45-50.
513. Arnaud B., Malet L., Teissedre F., Izaute M., Moustafa F., Geneste J., et al. Validity study of Kessler's Psychological Distress Scales conducted among patients admitted to french emergency department for alcohol comsumption-related disorders. Alcoholism: Clinical and Experimental Research. 2010;34(7):1235-44.
514. Furukawa T.A., Kawakami N., Saitoh M., Ono Y., Nakane Y., Nakamura Y., et al. The performance of the Japanese version of the K6 and K10 in the World Mental Health Survey Japan. International Journal of Methods in Psychiatric Research. 2008;17(3):152-8.
515. Baillie A.J. Predictive gender and education bias in Kessler's Pyschological Distress Scale (K10). Soc Psychiatry Psychiatr Epidemiol. 2005;40:743-8.
516. Spies G., Stein D.J., Roos A., Faure S.C., Mostert J., Seedat S., et al. Validity of the Kessler 10 (K-10) in detecting DSM-IV defined mood and anxiety disorders among pregnant women. Arch Women Mental Health. 2009;12:69-74.
517. Brooks R.T., Beard J., Steel Z. Factor Structure and Interpretation of the K10. Psychological Assessment. 2006;18(1):62-70.
518. Fassaert T., De Wit M.A.S., Tuinebreijer W.C., Wouters H., Verhoeff A.P., Beekman A.T.F., et al. Psychometric properties of an interviewer-administered version of the Kessler Psychological Distress Scale (K10) among Dutch, Moroccan and Turkish respondents. International Journal of Methods in Psychiatric Research. 2009;18(2):159-68.
519. Berle D., Milisevic D., Moses K., Hannan A., Sammut P., Brakoulias V. The factor structure of the Kessler-10 questionnaire in a treatment seeking sample. The Journal of Nervous and Mental Disease. 2010;198(9):660-4.
520. Sunderland M., Mahoney A., Andrews G. Investigating the factor structure of the Kessler Psychological Distress Scale in Community and Clincal Samples of the Australian Population. J Psychopathology and Behavioral Assessment. 2012;34:253-9.

521. McNamara B.J., Banks E., Gubhaju L., Williamson A., Joshy G., Raphael B., et al. Measuring psychological distress in older Aboriginal and Torress Strait Islanders Australians: a comparison of the K10 and K5. Australian and New Zealand Journal of Public Health. 2014;38(6):567-73.
522. Chan S.M, Fung T.C.T. Reliability and validity of the K10 and K6 in screening depressive symptoms in Hong Kong adolescents. Vulnerable children and youth studies: An international interdisciplinary journal for research, policy and care. 2014;9(1):75-85.
523. Furukawa T.A., Kessler R.C., Slade T., Andrews G. The performance of the K6 and K10 screening scales for psychological distress in the Australian National Survey of Mental Health and Well-Being. Psychological Medicine. 2003;33(2):357-62.
524. Carey W.B., McDevitt S.C. Revision of the Infant Temperament Questionnaire. Pediatrics. 1978;61(5):735-8.
525. Prior M., Sanson A.V., Oberklaid F. The Australian Temperament Project. 1989.
526. Sanson AV, Prior M, Garino E, Oberklaid F, Sewell J. The structure of infant temperament: factor analysis of the revised infant temperament questionnaire.
. Infant Behavior & Development. 1987;10(1):97-104.
527. Prior M., Oberklaid F., Northam E. Measurement of temperament in one to three year old children. International Journal of Behavioral Development. 1987;10(1):121-32.
528. Mazaide M., Bouldreault M., Thivierge J., Caperaa P., Cote R. Infant temperament: SES and gender differences and reliability of measurement in a large Quebec sample. Merrill-Palmer Quarterly. 1984;30:213-26.
529. Persson-Blennow I., McNeil T.F. Factor analysis of temperament characteristics in children at 6 months, 1 year, and 2 years of age. British Journal of Educational Psychology. 1982;52:51-7.
530. Sanson A., Prior M., Garino E., Oberklaid F., Sewell J. The Structure of Infant Temperament: Factor Analysis of the Revised Infant Temperament Questionnaire. Infant Behavior and Development. 1987;10:97-104.
531. Bohlin G., Hagekull B., Lindhagen K. Dimensions of infant behavior. Infant Behavior and Development. 1981;4:83-96.
532. Rothbart M.K., Mauro J.A., editors. Questionnaire measures of infant temperament. New Jersey: Lawrence Erlbaum Associates; 1990.
533. Sasaki Y., Mizuno R., Kaneko H., Murase S., Honjo S. Application of the Revised Infant Temperament Questionniare for evaluating temperament in the Japanese infant: creation of an abridged Japanese version. Psychiatry and Clinical Neurosciences. 2006;60:9-17.
534. Gartstein M.A., Knyazev G.G., Slobodskaya H.R. Cross-cultural differences in the structure of infant temperament: United States of America (U.S.) and Russia. Infant Behavior and Development. 2005;28:54-61.
535. Vaugh B.E., Taraldson B.J., Cuchton L., Egeland B. The assessment of infant temperament: a critique of the Carey Infant Temperament Questionnaire. Infant Behavior and Development. 2002;25:98-112.
536. Putnam S.P., Ellis L.K., Rothbart M.K. The structure of temperament from infancy through adolescence. In: Eliasz A., Angleitner A., editors. Advances on research on temperament2001. p. 165-82.

537. Koh G.A., Scott J.A., Daniels L., Woodman R., Kim S., Magarey A.M. Determinants of fruit and vegetable intakes in toddlers. Obesity Reviews. 2014;15(s2):150.
538. Falciglia G.A., Couch S.C., Gribble L.S., Pabst S.M., Frank R. Food neophobia in childhood affects dietary variety. Journal of the American Dietetics Association. 2000;100:1474-81.
539. Tan C.C., Holub S.C. Maternal feeding practices associated with food neophobia. Appetite. 2012;59(2):483-7.
540. Wardle J., Carnell S., Cooke L. Parental control over feeding and children's fruit and vegetable intake: how are they related? Journal of the American Dietetic Association. 2005;105(2):227-32.
541. Fisher J.O., Birch L.L. Restricting access to palatable foods affects children's behavioral response, food selection and intake. American Journal of Clinical Nutrition. 1999;69(6):1264-71.
542. Birch L.L., Fisher J.O. Mother's child-feeding practices influence daughters' eating and weight. American Journal of Clinical Nutrition. 2000;71(5):1054-61.
543. Finistrella V., Manco M., Ferrara A., Rustico C., Presaghi F., Morino G. Cross-sectional exploration of maternal reports of food neophobia and pickiness in preschooler-mother dyads. Journal of American College of Nutrition. 2012;31(3):152-9.
544. Watson D., Pennebaker JW. Health complaints, stress, and distress: Exploring the central role of negative affectivity. Psychological Review. 1989;96(2):234-54.
545. Hughes S.O., Shewchuk R.M. Child temperament, parent emotions, and perceptions of the child's feeding experience. International Journal of Behavioral Nutrition and Physical Activity. 2012;9:64.
546. Ystrom E., Barker M., Vollrath M.E. Impact of mothers' negative affectivity, parental locus of control and child-feeding practices on dietary patterns of 3-year-old children: The MoBa Study. Maternal & Child Nutrition. 2012;8:103-14.
547. Betoko A., Charles M-A., Hankard R., Forhan A., Bonet M., Saurel-Cubizolles M-J., et al. Infant feeding patterns over the first year of life: influence of family characteristics. European Journal of Clinical Nutrition. 2013;67:631-7.
548. Golley R.K., Hendrie G.A, McNaughton S.A. Scores on the Dietary Guideline Index for children and adolescents are associated with nutrient intake and socio-economic position but not adiposity. J Nutr. 2011;141(1340-1347).
549. Smithers L.G., Brazionis L., Golley R.K., Mittinty M.N, Northstone K., Emmet P., et al. Associations between dietary patterns at 6 and 15 months of age and sociodemographic factors. European Journal of Clinical Nutrition. 2012;66(6):658-66.
550. Senguttuvan E., Whiteman S.D., Jensen A.C. Family relationships and adolescents' health attitude and weight: the understudied role of sibling relationships. Family Relations. 2014;63:384-96.
551. Criss M.M., Shaw D.S. Sibling relationships as contexts for delinquency training in low-income families. Journal of Family Pyschology. 2005;19:592-600.
552. Kim J.Y., McHale S.M., Crouter A.C., Osgood D.W. Longitudinal linkages between sibling relationships and adjustment from middle childhood through adolescence. Developmental Psychology. 2007;43:960-73.

553. Stocker C.M., Burwell R.A., Briggs M.L. Sibling conflict in middle childhood predicts children's adjustment in early adolescence. Journal of Family Pyschology. 2002;16:50-7.
554. de Leeuw R.N.H., Snoek H.M., van Leeuwe J.F.J., van Strien T., Engels R.C.M.E. Similiarities and reciprocal influences in eating bheaviour within sibling pairs: a longitudinal study. Eating Behaviors. 2007;8:464-73.
555. Berge J.M., Meyer C., MacLehose R.F., Crichlow R., Neumark-Sztainer D. All in the family: correlations between parents' and adolescent siblings' weight and weight-related behaviours. Pediatric Obesity. 2015;23:833-9.
556. Farrow C.V., Galloway A.T., Fraser K. Sibling eating behaviours and differential child feeding practices reported by parents. Appetite. 2009;52:307-12.
557. Horn M.G., Galloway A.T., Webb R.M., Gagnon S.G. The role of child temperament in parental child feeding practices and attitudes using a sibling design. Appetite. 2011;57:510-6.
558. Payne L.O., Galloway A.T., Webb R.M. Parental use of differential feeding practices with siblings. Internation Journal of Pediatric Obesity. 2011;6:e540-e6.
559. Webber L., Cooke L., Wardle J. Maternal perception of the causes and consequences of sibling differences in eating behaviour. European Journal of Clinical Nutrition. 2010;64:1316-22.
560. Merilo K.F. Is it better the second time around? The American Journal of Maternal/Child Nursing. 1988;13(3):200-6.
561. Krieg D.B. Does motherhood get easier the second-time around? Examining parenting stress and marital quality among mothers having their first or second child. Parenting. 2007;7(2):149-75.
562. Fish M., Stifter C.A. Mother parity as a main and moderating influence on early mother-infant interaction. Journal of Applied Developmental Psychology. 1993;14:557-72.
563. Pradhan E. The relationship between women's education and fertility: World Economic Forum; 2015 [Available from: https://www.weforum.org/agenda/2015/11/the-relationship-between-womens-education-and-fertility/.
564. Australian Bureau of Statistics (ABS). 4102.0 Australian Social Trends, 2008. Canberra: Commonwealth of Australia; 2008.
565. Scott J. A., Binns C.W., Graham K.I., Oddy W.H. Temporal changes in the determinants of breastfeeding initiation. Birth. 2006;33:37-45.
566. Hendricks K., Briefel R., Novak T., Ziegler P. Maternal and child characteristics associated with infant and toddler feeding practices. Journal of the American Dietetic Association. 2006;106:135-48.
567. Hair J.F., Hult G.T.M., Ringle C., Sarstedt M. A primer on partial least squares structural equation modeling (PLS-SEM): Thousand Oaks: Sage; 2017.
568. Song J.W., Chung K.C. Observational studies: cohort and case-control studies. Plastic and Reconstructive Surgery. 2010;126(6):2234-42.
569. Bollen K.A., Pearl J.P. Eight myths about causality and structural equation models. In: Morgan S.L., editor. Handbook of causal analysis for social research: Springer; 2013.
570. Murphy E. Risk, responsibility, and rhetoric in infant feeding. Journal of Contemporary Ethnography. 2000;29(3):291-325.

571. Burrows T.L., Martin R.J., Collins C.E. A systematic review of the validity of dietary assessment methods in children when compared with the method of doubly labeled water. Journal of the American Dietetic Association. 2010;110(10):1501-10.
572. Richters J.E. Depressed mothers as informants about their children: a critical review of the evidence for distortion. Psychological Bulletin. 1992;112(3):485-99.
573. Evans C.E., Christian M.S., Cleghorn C.L., Greenwood D.C., Cade J.E. Systematic review and meta-analysis of school-based interventions to improve daily fruit and vegetable intake in children aged 5 to 12y. American Journal of Clinical Nutrition. 2012;96(4):889-901.
574. Knai C., Pomerleau J., Lock K., McKee M. Getting children to eat more fruit and vegetables: a systematic review. Preventive Medicine. 2006;42(2):85-95.
575. Cox D.N., Kacker A., Hendrie G.A, Lease H., Bowen J., Poelman A., et al. Increasing vegetable intake amongst children. A strategic investment plan for the Australian Vegetable Industry. In: Food and Nutrition Flagship C, Australia: CSIRO; 2015.
576. Liu L., Zhu J., Yang J., Wu M., Ye B. The effect of a perinatal breastfeeding support program on breastfeeding outcomes in primiparous mothers. Western Journal of Nursing Research. 2016;28.
577. Shealy K.R., Li R., Benton-Davis S., Grummer-Strawn L.M. The CDC Guide to Breastfeeding Interventions. U.S. Department of Health and Human Services, (CDC) Atlanta, Georgia 2005.
578. The Department of Health. Breastfeeding interventions: the evidence - an International Comparison Study into the implementation of the WHO Code and other breastfeeding initiatives: Commonwealth of Australia; 2016 [Available from: http://www.health.gov.au/internet/publications/publishing.nsf/Content/int-comp-whocode-bf-init~int-comp-whocode-bf-init-bfaro~int-comp-whocode-bf-init-bfaro-evid.
579. Spence A.C, Campbell K.J., Crawford D.A., McNaughton S.A, Hesketh K.D. Mediators of improved child diet quality following a health promotion intervention: the Melbourne InFANT Program. International Journal of Behavioral Nutrition and Physical Activity. 2014;11:137.
580. Boyle M.H., Jenkins J.M., Georgiades K., Cairney J., Duku E., Racine Y. Differential-maternal parenting behavior: estimating within and between family effects on children. Child Development. 2004;75(5):1457-76.
581. Patrick H., Nicklas T.A. A review of family and social determinants of children's eating patterns and diet quality. Journal of the American College of Nutrition. 2005;24(2):83-92.

APPENDICES

Appendix 1 – Publication and presentation arising from this thesis

Appendix 2 – Time 1 and Time 2 Questionnaire (relevant parts to this thesis)

Appendix 3 – Mplus syntaxes

Appendix 1 – Publication and presentation arising from this thesis

Appetite 81 (2014) 44–51

Contents lists available at ScienceDirect

Appetite

journal homepage: www.elsevier.com/locate/appet

Research report

Maternal feeding self-efficacy and fruit and vegetable intakes in infants. Results from the SAIDI study ☆

Gloria A. Koh [a,*], Jane A. Scott [b], Richard J. Woodman [c], Susan W. Kim [c], Lynne A. Daniels [d], Anthea M. Magarey [a]

[a] *Nutrition & Dietetics, School of Medicine, Flinders University, PO Box 2100, Adelaide, Australia*
[b] *School of Public Health, Faculty of Health Sciences, Curtin University, Perth, Australia*
[c] *Flinders Prevention, Promotion and Primary Health Care, General Practice, Flinders University, PO Box 2100, Adelaide, Australia*
[d] *Institute of Health and Biomedical Innovation and School of Exercise and Nutrition Sciences, Queensland University of Technology, Kelvin Groove, Qld 4059, Australia*

A R T I C L E I N F O

Article history:
Received 24 December 2013
Received in revised form 2 June 2014
Accepted 4 June 2014
Available online 6 June 2014

Keywords:
Fruit
Vegetable
Self-efficacy
Children
Exposure
Intake

A B S T R A C T

Adequate consumption of fruits and vegetables (FV) is a characteristic of a healthy diet but remains a challenge in nutrition interventions. This cross-sectional study explored the multi-directional relationships between maternal feeding self-efficacy, parenting confidence, child feeding behaviour, exposure to new food and FV intake in a cohort of 277 infants. Mothers with healthy infants weighing ≥2500 g and ≥37 weeks gestation were recruited post-natally from 11 South Australian hospitals. Socio-demographic data were collected at recruitment. At 6 months postnatal, infants were weighed and measured, and mothers completed a questionnaire exploring their perceptions of child feeding behaviour and child exposure to new foods. The questionnaire also included the Short Temperament Scale for Infants, Kessler 10 to measure maternal psychological distress and 5 items measuring maternal feeding self-efficacy. The number of occasions and variety of FV (number of subgroups within food groups) consumed by infants were estimated from a 24-hour dietary recall and 2 days food record. Structural equation modelling was performed using Mplus version 6.11. Median (IQR) variety scores were 2 (1–3) for fruit and 3 (2–5) for vegetable intake. The most popular FV consumed were apple ($n = 108$, 45.0%) and pumpkin ($n = 143$, 56.3%). None of the variables studied predicted the variety of child fruit intake. Parenting confidence, exposure to new foods and child feeding behaviour were indirectly related to child vegetable intake through maternal feeding self-efficacy while total number of children negatively predicted child vegetable variety ($p < 0.05$). This highlights the need for addressing antecedents of maternal feeding self-efficacy and the family eating environment as key strategies towards development of healthy eating in children.

Introduction

Fruits and vegetables (FV) are cornerstones of a healthy diet and provide a cornucopia of essential nutrients such as vitamins, minerals, dietary fibre and phytonutrients. Globally, adults are recommended to consume a minimum of 400 g non-starchy FV daily (World Health Organization, 2003). In children, FV recommendations vary from around half the adult recommendation at two years to the equivalent by adolescence (National Health and Medical Research Council, 2013a). Adequate consumption of FV has been linked to reduced risk of diabetes, cardiovascular diseases and some cancers (National Health and Medical Research Council, 2013a). Despite the benefits of FV, consumption (amount, frequency and variety) falls below recommendations in many countries (Giskes, Turrell, Patterson, & Newman, 2002; Guenther, Dodd, Reedy, & Krebs-Smith, 20062; Hall, Moore, Harper, & Lynch, 2009), and of particular concern are studies showing poor intake of FV in young children (Siega-Riz et al., 2010).

Early childhood is a critical period for the development of food preferences and eating patterns (Birch, 1999; Harris, 2008; Wardle & Cooke, 2008) that may influence weight and health outcomes in later childhood (Birch & Davison, 2001). Given that childhood eating habits (Birch, 1999; Lytle, Seifert, Greenstein, & McGovern, 2000)

☆ *Acknowledgments:* The SAIDI study was funded by the South Australian Department of Health and Ageing. We would like to thank all of the staff involved in each stage of the SAIDI study for their tireless efforts and commitment. Our heartfelt thanks go to all the mothers and infants who participated. The study would not have been possible without them. Our gratitude also goes to Dr. Leigh Roeger for his invaluable input and consultation on all matters concerning structural equation modelling. SAIDI was conceived and implemented as an adjunct to the NOURISH randomised trial led by Lynne A. Daniels and Anthea M. Magarey. We acknowledge all the NOURISH investigators and staff for use of NOURISH protocols and questionnaires. Special thanks also go to Jo Meedeniya for the development of the dietary assessment protocol used in this study.

* Corresponding author.
E-mail address: gloria.koh@flinders.edu.au (G.A. Koh).

http://dx.doi.org/10.1016/j.appet.2014.06.008
0195-6663/

and weight status (Magarey, Daniels, Boulton, & Cockington, 2003; Power & Parsons, 2002) track into adulthood, early interventions that promote healthy eating are urgently required.

For interventions to be successful, it is vital that researchers are able to identify the predictors of food intake and understand how these predictors interact to influence food-related behaviours in children. Studies on determinants of FV intake in children that focused on identifying the target group for intervention (socio-economic status, gender) (Blanchette & Brug, 2005; Rasmussen et al., 2006) do little to explain *why* children were not consuming adequate FV.

In early childhood, the role of the principal carer (mainly mothers) in early feeding is undisputed within the literature. Mothers influence child food intake not only through their feeding practices, but also via their own food preferences (Birch, 1999). Specifically, research shows similarities in FV intake between mother and child (Cooke et al., 2003), suggesting that mothers feed children with food they themselves prefer to eat.

Mothers may also influence children's food intake through their cognitive processes that determine how they make feeding decisions. Self-efficacy, an important aspect of socio-cognitive theory introduced by Albert Bandura (Bandura, 1977), is well studied and has been shown to be highly predictive of a range of health behaviours (Abusabha & Actherberg, 1997). Self-efficacy refers to a self-judgement of how well one can perform across a variety of situations (Judge, Erez, & Bono, 2002). Unlike confidence which refers to measurement of self-worth (Farrow & Blissett, 2007), self-efficacy is concerned with task-specific self-competency (Judge et al., 2002). In early feeding, research on maternal self-efficacy has focused predominantly on breastfeeding behaviours (Yngve & Sjostrom, 2001). There is little research investigating maternal feeding self-efficacy and child FV intake in early childhood, possibly due to the lack of data on food intake in children under 2 years of age (Smithers, Golley, Brazionis, & Lynch, 2011). Nevertheless, one Australian study reported a significant positive relationship between maternal feeding self-efficacy and child vegetable intake at one year of age (Campbell, Hesketh, Silverii, & Abbott, 2010). Studies on children aged 8–12 years revealed similar relationships (Kratt, Reynolds, & Shewchuk, 2000; Weber Cullen et al., 2000). Therefore, there is a strong rationale for studying maternal feeding self-efficacy as a possible predictor of early FV intake.

While the role of mothers in the feeding relationship is important, individual child characteristics may also influence child feeding behaviours and how mothers respond to these. Children respond to new foods to varying degrees. Generally, children who showed stronger inhibitions towards new foods had lower dietary variety (Cooke, 2007) and children who were more responsive to food were more accepting of new foods (Cooke et al., 2003). This relationship may be influenced by children's inherent temperament (Haycraft, Farrow, Meyer, Powell, & Blissett, 2011) and is worth exploring further.

Clearly, the literature suggests that FV intake in young children is influenced by a multitude of factors. However, many of the studies on determinants of FV intake in children are limited by their unidirectional models and lack of consideration of maternal feeding self-efficacy. The aim of this study is to address these limitations by applying structural equation modelling (SEM) to examine the potential role of maternal feeding self-efficacy, and maternal and child feeding behaviours on the variety of children's FV intake in a cohort of Australian children aged 6–7 months. This study will also report child fruit and vegetable intakes (types, frequency and variety) in this same cohort of children.

Methods

The sample

Participants are mother–infant dyads in the South Australian Infants Dietary Intake (SAIDI) study. SAIDI is an observational study that aimed to prospectively examine the maternal feeding practices, and child dietary intake and growth in a cohort of South Australian children 6–24 months of age (Magarey, Perry, & Daniels, 2010). The analysis presented here includes only data from mothers who provided complete data at the time of the first assessment.

Between September 2008 and March 2009, a convenience sample of mother–infant dyads were approached within 1–3 days postpartum at three metropolitan public hospitals, one metropolitan private hospital and seven regional public hospitals in South Australia (SA). Eligible mothers were aged 18 years old or older at the time of the infant's birth, able to speak and write in English without assistance from translators and willing to complete all study requirements. Eligible infants were healthy, full term (≥37 weeks gestation), with a birth weight of ≥2500 g and no congenital or long-term illnesses that may affect feeding.

Mothers agreeing to participate provided contact and socio-demographic details and gave consent for later contact. Socio-demographic details collected at recruitment were maternal age at child birth (years), child gender (male, female), maternal country of birth (Australia, overseas), maternal education (≤Grade 12, Trade/University) and total number of children. Approximately two weeks prior to the child turning six months old, mothers were invited by letter to give consent for study participation. Mothers who consented provided data on family income (6 categories ranging from $0–$385 per week to >$1923 per week) and maternal cigarette smoking status (never smoked, smoking/smoked). Multi-site ethics approvals were obtained from the Southern Adelaide Flinders Clinical Human Research Ethics Committee and from all the Human Research Ethics Committees required to cover recruitment sites.

Anthropometrical measurements

Metropolitan dwelling mothers consenting to further participation were given appointments at which trained study staff measured bare infant weight and length using a Tanita Digital Baby Scale Model BD-590 to the nearest 0.01 kg and a SECA length mat to the nearest 0.5 cm. Weight and length measurements for regional dwelling infants were performed by nurses or child health clinic staff during the infant's six month health check at the doctor's clinic or child health clinics using standard available equipment, and reported to study staff by mothers. Infant weight and length z-scores were calculated according to the WHO growth reference standards (World Health Organization, 2006).

Child and maternal behavioural characteristics

Three items from the Short Temperament Scale for Infants (STSI) (The Australian Temperament Project, 1987) measured infant irritability and ten items from the Kessler 10 (Andrews & Slade, 2001) measured maternal psychological distress (Table 1). Five items from the self-efficacy questionnaire used in the Nutrition Education Aimed at Toddlers (NEAT) project (Horodynski & Stommel, 2005) that are developmentally appropriate for infant feeding measured maternal feeding self-efficacy (Table 1). Mothers' feeding behaviour was assessed by the following questions: how often they offer new foods to child (Never, Almost Never, Sometimes, Often, Very Often) and how many times mothers would offer a new food before deciding that child dislikes the food (Once, 2–5 times, 6–10 times, 11–15 times and ≥16 times). Maternal perception of their child's feeding behaviour was assessed by asking mothers to rate their agreement to a statement that it was easy to feed their child compared to children of similar age (Strongly disagree, Disagree, Agree, Strongly Agree), and how willing child was to eat new foods (Very Unwilling, Unwilling, Neutral, Willing, Very Willing). A question asking mothers to

Table 1
Median, internal consistency and reliability for latent variables in the study ($n = 277$).

Measured/Latent variables[a] [χ^2/df, RMSEA, CFI, TLI, WRMR][b]	Median (IQR)[c]	α[d]	SE[e]	R^2[f]
Maternal feeding self-efficacy[g] [0.52, 0, 1.0, 1.0, 0.21]	5 (4–5)	0.99		
Give baby healthy food	5 (5–5)		0.69	0.47
Can get baby to eat enough	5 (4–5)		0.90	0.81
Can get baby to try vegetables	5 (5–5)		0.90	0.81
Give baby right amount of food	4 (4–5)		0.72	0.51
Can get baby to taste new food	5 (4–5)		0.86	0.75
Maternal psychological distress[h] [1.9, 0.06, 0.99, 0.99, 0.52]	2 (1–2)	0.81		
Feel hopeless	1 (1–2)		0.82	0.67
Feel depressed	1 (1–2)		0.89	0.78
Feel sad	1 (1–1)		0.96	0.93
Often feel tired	2 (2–3)		0.63	0.39
Feel everything was an effort	2 (1–2)		0.70	0.49
Feel nervous	1 (1–2)		0.62	0.38
Child irritability[i] [0, 0, 1.0, 1.0, 0.001]	2 (2–3)	0.63		
Fretful on waking up	2 (2–3)		0.72	0.52
Continues to cry despite soothing	2 (1–3)		0.72	0.52
Cries when left alone to play	2 (2–3)		0.53	0.28

[a] Latent variables in bold.
[b] Model Fit Indices: χ^2/df (Chi-square to degrees of freedom ratio ≤2), RMSEA (Root Mean Square Error of Approximation < 0.06), CFI (Comparative Fit Index ≥ 0.96), TLI (Tucker–Lewis Index ≥ 0.95, WRMR (Weighted Root Mean Residual < 0.90).
[c] Median rating with inter-quartile range.
[d] Cronbach's alpha for internal consistency: $\alpha > 0.7$ (acceptable), $\alpha > 0.8$ (good consistency).
[e] Standardised estimates or also known as standardised factor pattern or standardised factor loading.
[f] Squared multiple correlation (R^2) indicates reliability of the measured item; for example: $R^2 = 0.47$ for the item 'give baby healthy food' means 47% of the variance of the latent variable 'maternal feeding self-efficacy' is explained by this item.
[g] All items rated in 5-point Likert scale with 1 = not confident at all to 5 = very confident.
[h] All items rated in 5-point Likert scale with 1 = none of the time to 5 = all of the time.
[i] All items rated in 6-point Likert scale with 1 = almost never to 6 = almost always.

rate their perception of their parenting skills on a 5-point Likert scale (1 = Not very good at being a parent to 5 = A very good parent) was also included.

Maternal and child food intake

Based on the serve sizes in the Australian Guide to Healthy Eating (National Health and Medical Research Council, 2013a), mothers were asked how many serves of each of fruit and vegetables they typically consume daily, with responses recorded as 1 = None, 2 = One, 3 = Two, 4 = Three to Four and 5 = Five serves or more.

Food intake for children was measured using a standardised multiple-pass 24-hour dietary recall and two days food record method using the same protocol and materials used in the NOURISH study (Daniels et al., 2009). The dietary recall was conducted via telephone interview by trained dietitians. To help mothers correctly estimate portions of foods consumed when recalling or recording intake, 10 pictures corresponding to different levels of a teaspoon (flat, rounded, heaped), a tablespoon (flat, rounded, heaped) and cup (1 cup, ½ cup, 1/3 cup, ¼ cup) were provided. Recall and record days were randomly selected by study staff to cover two weekdays and one weekend day for each child. Mothers completed the food record at home and returned it to study staff using a reply-paid envelope.

All items consumed were entered into Foodworks 2009 version 6 with AUSNUT 2007 database (Xyris Software, 2009) and exported to SPSS version 19 (IBM, 2010) for analysis. FV were allocated to the sub-groups as shown in Table 2. Frequency of intake was calculated as the number of consumption occasions and variety as the number of different sub-groups within each of the fruit and vegetable food groups across the three days of intake.

Statistical analyses

Descriptive analyses were performed using SPSS version 19 (IBM, 2010) and are reported as mean ± SD if normally distributed or median (IQR) if data are skewed. Normality is assumed if data meet all of the following criteria: (i) histogram distribution of data resembles a normal curve, (ii) statistic from Kolmogorov–Smirnov test where non-significance ($p > 0.05$) indicates normality, and (iii) a straight line is observed from inspecting the observed data against expected values from a Normal Q-Q plot.

Confirmatory factor analyses on ordinal variables (Likert scales) were conducted using Mplus version 6.11 (Muthen & Muthen, 2011) to construct each known latent variable (10 items measuring psychological distress, 5 items measuring feeding self-efficacy and 3 items measuring infant irritability). Cronbach's alpha was calculated to assess the reliability of each underlying construct using SPSS version 19 (IBM, 2010).

Table 2
Child fruits and vegetables intake ($n = 277$).

Food	n (%)[a]
Total vegetable	**254 (91.7)**
Pumpkin	143 (56.3)
Carrot	115 (45.3)
Potato	107 (42.1)
Sweet potato	100 (39.4)
Homemade vegetable dishes	75 (29.5)
Mixed vegetables	67 (26.4)
Commercial infant vegetable dishes	60 (23.6)
Broccoli	59 (23.2)
Avocado	45 (17.7)
Peas and green beans	44 (17.3)
Commercial infant mixed vegetables	39 (15.4)
Cauliflower	38 (15.0)
Zucchini	33 (13.0)
Sweet corn	20 (7.9)
Leafy vegetables	16 (6.3)
Garlic and onion	10 (3.9)
Other root vegetables[b]	8 (3.1)
Cabbage	5 (2.0)
Homemade legume dishes	4 (1.6)
Tomato	4 (1.6)
Legume	3 (1.2)
Cucumber	2 (0.8)
Total fruit	**240 (86.6)**
Apple	108 (45.0)
Banana	101 (42.2)
Commercial infant mixed fruits	83 (34.6)
Pear	82 (34.2)
Commercial infant fruit	58 (24.2)
Stone fruits[c]	20 (8.3)
Berries	14 (5.8)
Mixed fruits	13 (5.4)
Commercial infant fruit dishes	8 (3.3)
Melons	6 (2.5)
Citrus	5 (2.1)
Homemade fruit dishes	3 (1.3)
Kiwi fruit	3 (1.3)
Mango	3 (1.3)
Grapes	2 (0.8)
Rhubarb	2 (0.8)
Dried fruits	1 (0.4)
Pawpaw	1 (0.4)

[a] Percentage for total fruit/vegetable is proportion of children in the study who consumed fruit/vegetable while percentage for individual food sub-group is calculated based on those who consumed any fruit/vegetable.
[b] Parsnip, swede and squash.
[c] Examples include peach, apricot, nectarine, cherry, prune and plum.

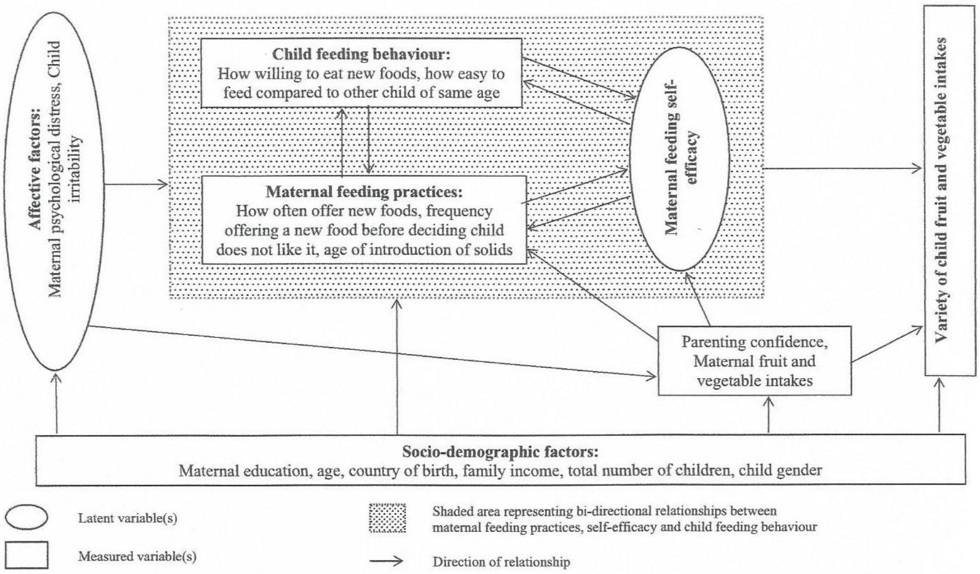


Fig. 1. The conceptual model of the study.

Structural equation modelling (SEM)

SEM allows an examination of the multidirectional relationships and causal dependencies that exist between a number of endogenous and exogenous variables of interest (Schreiber, Stage, King, Nora, & Barlow, 2006). SEM also allows the construction of latent variables; variables that are not measured directly but estimated from measured variables, each of which are believed to contribute to the latent variables (Schreiber et al., 2006). The latent variables in this study are maternal psychological distress, feeding self-efficacy and child irritability. The measured items that construct these latent variables are listed in Table 1. The two main model components of SEM are the structural model and the measurement model. In this study, we used SEM as a confirmatory technique which first requires the measurement model to be correctly fitted. Any instrumental measurement error is accounted for in the construction of latent variables (Schreiber et al., 2006).

Figure 1 summarises the conceptual model that was tested in this study. The varieties of child fruit and vegetable intakes were tested separately using the same model. Socio-demographic factors (maternal education, age, country of birth, family income, total number of children and child gender) form the exogenous variables in the conceptual model that are postulated to influence all of the endogenous variables (maternal psychological distress, feeding self-efficacy, FV intake, how often mother offers new foods to child, frequency a new food is offered to child before deciding child dislikes it, child irritability, child willingness to eat new food, how easy it was to feed child, parenting confidence and child FV variety) in the model. The shaded area in the model represents the bi-directional relationships studied between maternal feeding practices (exposure to new foods), child feeding behaviour and maternal feeding self-efficacy. The variables in the shaded area are hypothesised to predict child FV variety and are predicted by the socio-demographic and affective factors studied. The bi-directional relationship between maternal feeding practices and child feeding behaviour follows the same directions as in the behavioural model proposed by Birch and Davison (2001). The conceptual model in this study expands on this bi-directional relationship through the inclusion of maternal feeding self-efficacy, affective and socio-demographic factors.

SEM was performed using Mplus version 6.11 (Muthen & Muthen, 2011). Parameter estimations for the SEM models were conducted using the weighted least square with mean and variance adjusted for χ^2 (WLSMV) method. The WLSMV is a robust method for non-parametric estimations for SEM with categorical data, and unlike the Maximum Likelihood (ML) method, it does not assume normality of distribution (Hancock & Mueller, 2006). Modifications were made to the hypothetical model to achieve a better fitting and parsimonious model. Modifications were not based on modification indices available through Mplus but on theoretical sense of the model. Models are considered well-fitting if the chi-squared ratio to degrees of freedom (χ^2/df) for the model is ≤2, Root Mean Square Error of Approximation (RMSEA) is <0.06, Comparative Fit Index (CFI) is ≥0.96, Tucker–Lewis Index is (TLI) ≥0.95 and Weighted Root Mean Residual (WRMR) is <0.90 (Schreiber et al., 2006). Statistical significance for correlations and standardised estimates (ß) from the SEM was set at $p < 0.05$.

Results

Participant characteristics

Around a third ($n = 277$, 34.8%) of eligible mother–child dyads participated and provided complete data for this study. Mothers were 32.1 ± 5.1 years old at child delivery, most had post-school education (trade/University) ($n = 201$, 72.5%), were partnered ($n = 264$, 95%), born in Australia ($n = 237$, 86%) and never smoked ($n = 232$, 84%).

At assessment, children were 27 ± 3.2 weeks old, 46% ($n = 125$) were males and 72% ($n = 199$) were still being breast fed. The mean age at which children were introduced to solids was 21.0 ± 3.8 weeks, with 238 (86%) between 17 and 36 weeks, 31 (11.2%) before 17 weeks and 8 (2.8%) after 36 weeks. Mean child measured weight and length z-scores (World Health Organization, 2006) were 0.1 ± 1.1 and 0.2 ± 1.4 respectively.

Maternal and child fruits and vegetables intake

A majority of mothers reported consuming 2–4 serves of vegetables ($n = 218$, 78.7%) and 1–2 serves of fruits daily ($n = 232$, 83.6%). In three days of dietary assessment, a majority of children consumed fruit (86.6%) and vegetable (91.7%), with a median (IQR) frequency of 4 (1–7) and 6 (3–11) times and median (IQR) variety scores of 2 (1–3) and 3 (2–5) for fruits and vegetables respectively. The most popular vegetables consumed were pumpkin, carrot, potato and sweet potato. The most popular fruits consumed were apple, banana, commercial infant mixed fruits and pear (Table 2).

Maternal and child feeding behaviours

Generally, mothers in this study have positive perceptions of their feeding behaviours and their child's feeding behaviours. The majority of mothers agreed that their child was easy to feed ($n = 192$, 69.3%) and willing to eat new foods ($n = 169$, 61.0%), that they would often ($n = 137$, 49.5%) or sometimes ($n = 67$, 24.2%) offer new foods to their children and ranked themselves as being better than average/good parents ($n = 202$, 72.9%). Most mothers reported that they would offer a new food 2–5 times ($n = 124$, 44.8%) and 6–10 times ($n = 50$, 18.1%), with only 9 (3.2%) reporting that they would only offer new foods once and 18 (6.5%) offering new foods >10 times.

Measurement models for structural equation modelling

Median (IQR) item rankings, Cronbach's alpha (α), standardised factor loadings, and item measure reliability (R^2) for all questionnaire items measuring maternal feeding self-efficacy, maternal psychological distress and infant irritability are shown in Table 1. Median item rankings showed that the majority of mothers in the study reported high levels of feeding self-efficacy (median ranking 5 out of 5), and low levels of psychological distress (median ranking 2 out of 5) and infant irritability (median ranking 2 out of 6), with the higher rankings depicting higher agreement to the latent variable.

Confirmatory Factor Analysis on the Kessler 10 resulted in a one factor solution consisting of 6 items that relate to the theoretical concepts of depressed mood, fatigue and anxiety (Kessler et al., 2002) (χ^2/df < 2, RMSEA < 0.06, CFI > 0.96, TLI > 0.95, WRMR < 0.90). Similarly, all the five items measuring maternal feeding efficacy and three items measuring child irritability fitted well into the respective CFA models (χ^2/df < 2, RMSEA < 0.06, CFI > 0.96, TLI > 0.95, WRMR < 0.90). Cronbach's alpha suggested acceptable to good internal consistencies for the six items measuring maternal psychological distress ($\alpha = 0.81$) and the five items measuring maternal feeding self-efficacy ($\alpha = 0.99$), but less than acceptable for the three items measuring child irritability ($\alpha = 0.63$).

Predictors of maternal feeding self-efficacy and child FV intake

Structural equation modelling of the hypothetical model for both child fruit and vegetable variety resulted in good fitting models (χ^2/df < 2, RMSEA < 0.06, CFI > 0.96, TLI > 0.95, WRMR < 0.90 for each). Maternal feeding self-efficacy was found to be significantly related to vegetable variety (ß = 0.61, $p < 0.05$) and was influenced by parenting confidence (ß = 0.36, $p < 0.01$), how often mother offered new foods (ß = 0.26, $p < 0.05$), frequency a new food was offered before deciding child dislikes it (ß = 0.40, $p < 0.01$) and child willingness to eat new food (ß = 0.70, $p < 0.01$).

Maternal psychological distress negatively influenced parenting confidence (ß = –0.42, $p < 0.01$), frequency of offering a new food before deciding child dislikes it (ß = –0.26, $p < 0.05$), how often new foods were offered to child (ß = –0.14, $p < 0.001$) and maternal vegetable intake (ß = –0.31, $p < 0.01$). Besides maternal feeding self-efficacy, total number of children was also found to be significantly related to child vegetable variety (ß = –0.50, $p < 0.05$). However, the model predicted only 14% of the variance in child vegetable variety. For fruit intake, none of the endogenous and exogenous variables in the model predicted child fruit variety. To summarise, Fig. 2 depicts the significant relationships found for child vegetable variety. Relationships in the conceptual model (Fig. 1) not depicted in Fig. 2 were found to be non-significant.

Discussion

Child consumption of fruits and vegetables

Our findings on children's FV intake showed that although children were given vegetables frequently, the variety of vegetables offered over the three days was limited. Similar results were found for fruit intake. The type of FV eaten indicated early exposure to sweet and/or starchy type FV (pumpkin, carrot, potato, apple, banana, pear), a finding comparable to the Feeding Infants and Toddlers Study (FITS) (Siega-Riz et al., 2010). These FV are popular possibly due to their sweetness and texture, which facilitate acceptability and ease of mashing/puree. The energy density of some of these FV (potato, banana) may also influence acceptability by providing a pleasant feeling of fullness which teaches children to prefer their tastes, texture and smell (Wardle & Cooke, 2008).

The limited variety of FV consumed by children at this age is not a great concern, nor surprising as many had just started solids and milk was the main source of energy. Although there is currently no consensus in infant feeding guidelines on the order in which food groups are introduced, variety between and within food groups is encouraged (National Health and Medical Research Council, 2013b; World Health Organization, 2002). Theoretically, variety of FV intake should increase as infant develops a more stable eating pattern consuming family foods (if recommendations are followed). However, evidence to date showed poor FV variety in diets of adolescents and adults (Gikes, Turrell, Patterson, & Newman, 2002; Guenther, Dodd, Reedy, & Krebs-Smith, 2006). The findings in our study showed that although FV were consumed frequently, variety was limited, suggesting that poor FV variety in adulthood may have its origins in early childhood.

Nutritionally, wide dietary variety can potentially provide nutritional adequacy, especially adequacy of micronutrients (Kennedy, Pedro, Seghieri, Nantel, & Brouwer, 2007; Steyn, Nel, Nantel, Kennedy, & Labadarious, 2006). Behaviourally, dietary variety is important to help infants acquire preferences for new foods (Gerrish & Mennella, 2001; Mennella, Nicklaus, Jagolino, & Yourshaw, 2008). Infants have innate inclination for sweet and salty tastes (Ventura & Worobey, 2013), and infant habituation to these tastes may lead to poor acceptance of bitter tasting foods such as vegetables (Wardle & Cooke, 2008). There is evidence to support this from both experimental studies and community based interventions in children aged five years and above (Cooke, 2007). However, a recent systematic review of interventions to increase FV intake in children under 5 years of age through repeated exposure revealed mixed results (Wolfenden et al., 2012). Interventions that utilised repeated exposure to increase intake of a target vegetable did not result in increased intake of the target vegetable in the short term while interventions that coupled repeated exposure with a tangible non-food or social reward

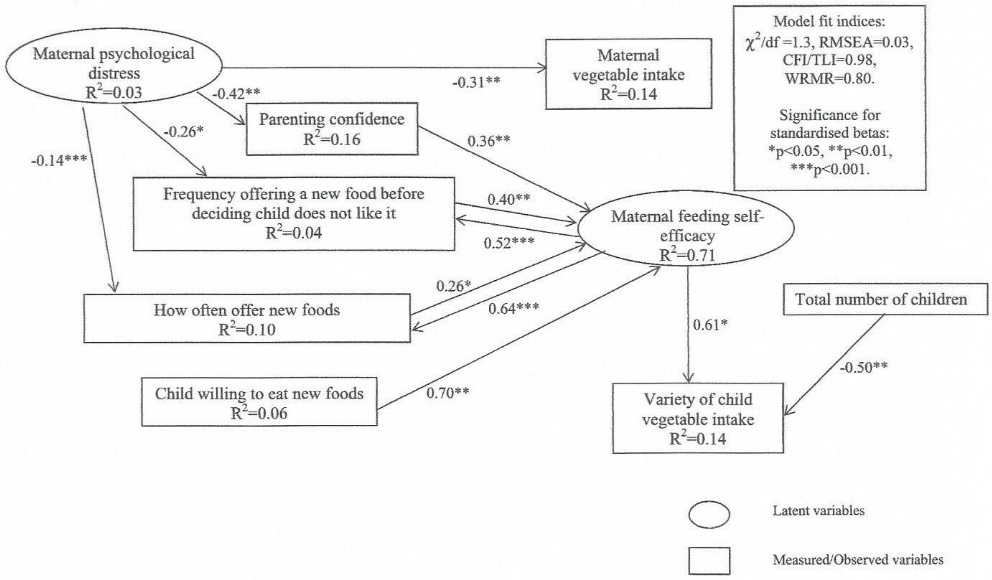


Fig. 2. Significant relationships for maternal feeding self-efficacy and child vegetable intake ($n = 277$).

resulted in increased short term consumption of the target vegetable (Wolfenden et al., 2012). These results suggest that although repeated exposure to FV in early childhood is important, the effect of exposure on intake may be determined by *how* children were encouraged to eat FV. This continues to be a subject of contention amongst health professionals, largely due to the scarcity of evidence.

Factors affecting the variety of child fruit and vegetable consumption

In our study, we found maternal feeding self-efficacy directly associated with child vegetable variety. This adds weight to previous findings that maternal self-efficacy is a significant predictor of child FV intake (Campbell et al., 2010; Weber Cullen et al., 2000). In our study, we demonstrated that in healthy children aged 6–7 months, parenting confidence, how often mother offered new foods, frequency mother offered a new food before deciding child dislikes it and child willingness to eat new foods indirectly affect the variety of child vegetable intake through maternal feeding self-efficacy. To our knowledge, only four studies (Campbell et al., 2010; Kratt et al., 2000; Weber Cullen et al., 2000; West & Sanders, 2009) have specifically explored the relationship between maternal self-efficacy and child dietary outcomes, and of these, only one examined the relationship between maternal self-efficacy and food intake in children under two years of age (Campbell et al., 2010). This study, however, was limited by the unidirectional model used. The other dietary studies on children that reported self-efficacy outcomes were primarily concerned with evaluating self-efficacy as an explanatory component for the effect of an intervention.

Although there is evidence to support the relationship between maternal and child vegetable intake (Cooke et al., 2003), this was not observed in our study. From the literature, the relationship between maternal and child food intake was generally weak in young children and stronger in older children (Birch, 1999). Furthermore in our study, maternal vegetable intake was measured as how many serves of vegetables mothers consumed while child vegetable intake was measured as the number of different sub-groups of vegetables consumed (variety). Dietary variety is a variable commonly used to measure diet quality (Waijers, Feskens, & Ocke, 2007) and is independent of the amount of food consumed. Although greater dietary variety is linked to nutrient adequacy, the link between dietary variety and dietary quantity (e.g. energy, amount/serves consumed) is not well established (Ruel, 2003), especially when variety *within* food groups is considered. This may explain why we were unable to observe a relationship between maternal and child vegetable intake in our study.

The number of children in the household was negatively related to child vegetable variety. Interestingly, this variable was also associated with poor child diet quality (food patterns higher in discretionary food but lower in fruits, vegetable and legume consumption) in other studies (Betoko et al., 2013; Golley, Hendrie, & McNaughton, 2011; Smithers et al., 2012). We theorise that total number of children is a proxy variable for underlying factors associated with having to juggle the needs of more than one child, such as the influence of older siblings in the food intake of the younger child and/or the challenge of managing increased parenting responsibilities associated with having a larger family. Currently, in Australia, early interventions are mainly focused on targeting primiparous mothers. However, given the relationship between number of children and child vegetable variety found in this study, consideration should be given to interventions that target families with more than one child to address the issues related to the family eating environment and the parenting of multiple children.

Our study also showed how maternal psychological distress negatively influenced parenting confidence, how often mothers offer new foods to child and the frequency a new food is offered before deciding that child dislikes it. These variables were then related to maternal feeding self-efficacy and subsequently child vegetable variety. The indirect relationship between maternal psychological distress, feeding self-efficacy and child vegetable intake is not unexpected, given that mothers who are distressed are more self-preoccupied and therefore unable or unwilling to respond to their child's needs (Gondoli & Silverberg, 1997).

In contrast to our findings with respect to vegetable intake, fruit variety was not predicted by any of the variables in the model examined in our study. This may be due to the fact that fruits appeal to children's innate preference for sweetness and consumption is therefore less dependent on maternal self-efficacy, feeding practices and child feeding behaviour. A cross-sectional study conducted on school children to examine consumption of fruit also concluded that fruit and vegetable intakes are influenced by different behavioural factors and that they should be examined separately (Reinaerts, de Nooijer, Candel, & de Vries, 2007). The authors postulated that this could be due to the fact that consumption of fruit is volitional whereas consumption of vegetables is often imposed on the child by others, hence vegetable consumption requires a more conscious effort than fruit. In early feeding, this 'conscious effort' may be explained by examining the role of maternal feeding self-efficacy and feeding practices, as demonstrated in our study.

Despite the significant relationships discussed above, the model examined in our study only explained 14% of the variance in the variety of child vegetable intake. This may be due in part to the nature of our study that targets children who had just started solids and thus had not established a varied diet. The model was also limited by the cross-sectional design of the study. Testing of the model in older children with more established eating habits and repeated testing to assess longitudinal effects should improve the model's predictive power. Inclusion of determinants of FV consumption found in studies conducted in older children (2 to 12 year olds) that are relevant to infants such as child care arrangement, parenting modelling, maternal feeding style, and availability and accessibility to FV (Blanchette & Brug, 2005; Nicklas et al., 2001) may also improve the model.

Another limitation of the study was the use of questionnaires in which mothers were required to self-report the levels of feeding efficacy, psychological distress, parenting confidence, feeding behaviour, FV intake, and their perceptions of infant irritability and feeding behaviours. This may have led to general over-estimation of responses that reflect positive perceptions and practice. Infant feeding raises profound issues of moral responsibility where the mother is often seen as the primary caregiver with responsibilities to maximise growth and health outcomes for her child (Murphy, 2000). To avoid moral judgement, mothers may have reported what is desirable over what is actual practice. Furthermore, due to the voluntary nature, literacy requirements and low response rate of the study, sampling bias was unavoidable. This explains the homogeneity of exogenous and endogenous variables found in this study which limits the generalisability of the results.

Despite its weaknesses, this study is unique in examining the predictors of early feeding at an age when solids were just being introduced to infants. The contemporaneous data collection method of feeding behaviours and dietary intake reduces recall bias as mothers were asked to record current practices. The conceptual model studied is a comprehensive model that includes socio-demographic, affective, behavioural and cognitive factors. Furthermore, through SEM, we were able to clearly show the direction and strength of the observed relationships and how maternal psychological status, exposure to new foods and child feeding behaviour influence the variety of child vegetable intake through maternal feeding self-efficacy.

Therefore, future interventions on early feeding can benefit from modifying the antecedents of maternal feeding self-efficacy as a key strategy towards healthier food choices at the weaning period. Such interventions, may, for example, help mothers set realistic and achievable feeding goals and support mothers through the use of vicarious experiences and verbal persuasions. Mothers may also benefit from having support on how to manage their emotional and mental states while juggling difficult child feeding behaviours. The increase in the reach, accessibility and provision of programmes such as NOURISH (Daniels et al., 2009) may also contribute to help mothers make the appropriate behavioural and food choices in feeding their infants and toddlers.

Conclusions

The children in our study consumed FV frequently but variety was limited to a popular few. Through SEM, we showed that exposure to new foods, parenting confidence and child feeding behaviour were indirectly related to vegetable variety at the weaning period through maternal feeding self-efficacy, and that total number of children directly predicts child vegetable variety. This highlights the need for future interventions to target the whole family and to modify antecedents of maternal feeding self-efficacy as a key strategy towards development of healthy eating in children.

References

Abusabha, R., & Actherberg, C. (1997). Review of self-efficacy and locus of control for nutrition and health related behaviour. *Journal of the American Dietetic Association, 97*(10), 1122–1132.

Andrews, G., & Slade, T. (2001). Interpreting score in the Kessler Psychological Distress Scale (K10). *Australian and New Zealand Journal of Public Health, 25*, 494–497.

Bandura, A. (1977). Self-efficacy. Toward a unifying theory of behavioural change. *Psychological Review, 84*(2), 191–215.

Betoko, A., Charles, M.-A., Hankard, R., Forhan, A., Bonet, M., Saurel-Cubizolles, M.-J., et al. (2013). Infant feeding patterns over the first year of life. Influence of family characteristics. *European Journal of Clinical Nutrition, 67*, 631–637.

Birch, L. L. (1999). Development of food preferences. *Annual Review of Nutrition, 19*, 41–62.

Birch, L. L., & Davison, K. K. (2001). Family environmental factors influencing the developing behavioural control of food intake and childhood overweight. *Pediatric Clinics of North America, 48*(4), 893–907.

Blanchette, L., & Brug, J. (2005). Determinants of fruit and vegetable consumption amoung 6-12 year old children and effective interventions to increase consumption. *Journal of Human Nutrition and Dietetics, 18*(6), 431–443.

Campbell, K., Hesketh, K., Silverii, A., & Abbott, G. (2010). Maternal self-efficacy regarding children's eating and sedentary behaviours in the early years. Association with children's food intake and sedentary behaviours. *International Journal of Pediatric Obesity, 5*(6), 501–508.

Cooke, L. (2007). The importance of exposure for healthy eating in childhood. A review. *Journal of Human Nutrition and Dietetics, 20*(4), 294–301.

Cooke, L., Wardle, J., Gibson, E. L., Sapochnik, M., Sheiham, A., & Lawson, M. (2003). Demograpic, familial and trait predictors of fruit and vegetable consumption by pre-school children. *Public Health Nutrition, 7*(2), 295–302.

Daniels, L. A., Magarey, A. M., Battistutta, D., Nicholson, J. M., Farrell, A., Davidson, G., et al. (2009). The NOURISH randomised control trial. Positive feeding practices and food preferences in early childhood. A primary prevention program for childhood obesity. *BMC Public Health, 9*, 387.

Farrow, C., & Blissett, J. (2007). The development of maternal self-esteem. *Infant Mental Health Journal, 28*(5), 517–535.

Gerrish, C. J., & Mennella, J. A. (2001). Flavor variety enhances food acceptance in formula fed infants. *The American Journal of Clinical Nutrition, 73*(6), 1080–1085.

Giskes, K., Turrell, G., Patterson, C., & Newman, B. (2002). Socioeconomic differences amongst Australian adults in consumption of fruit and vegetables and intakes of vitamins A,C and folate. *Journal of Human Nutrition and Dietetics, 15*(5), 375–385.

Golley, R. K., Hendrie, G. A., & McNaughton, S. A. (2011). Scores on the Dietary Guideline Index for children and adolescents are associated with nutrient intake and socio-economic position but not adiposity. *The Journal of Nutrition, 141*, 1340–1347.

Gondoli, D. M., & Silverberg, S. B. (1997). Maternal emotional distress and diminished responsiveness. The mediating rile of parenting efficacy and parental perspective taking. *Developmental Psychology, 33*(5), 861–868.

Guenther, P.M., Dodd, K.W., Reedy, J., & Krebs-Smith, S.M. (2006). Most Americans eat much less than recommended amounts of fruits and vegetables. *Journal of the American Dietetics Association, 106*(9), 1371–1379.

Hall, J. N., Moore, S., Harper, S. B., & Lynch, J. W. (2009). Global variability in fruit and vegetable consumption. *American Journal of Preventive Medicine, 36*(5), 402–409.

Hancock, G. R., & Mueller, R. O. (2006). Chapter 9. *Structural equation modeling. A second course*. Charlotte, NC: Information Age Publishing.

Harris, G. (2008). Development of taste and food preferences in children. *Current Opinion in Clinical Nutrition and Metabolic Care*, *11*, 315–319.

Haycraft, E., Farrow, C., Meyer, C., Powell, F., & Blissett, J. (2011). Relationships between temperament and eating behaviours in young children. *Appetite*, *56*(3), 689–692.

Horodynski, M. L., & Stommel, M. (2005). Nutrition education aimed at toddlers. An intervention study. *Pediatric Nursing*, *31*(5), 364–372.

IBM. (2010). IBM SPSS Statistics 19.0.0. Chicago.

Judge, T. A., Erez, A., & Bono, J. E. (2002). Are measures of self-esteem, neuroticism, locus of control, and generalised self-efficacy indicators of a common core construct? *Journal of Personality and Social Psychology*, *83*(3), 693–710.

Kennedy, G. L., Pedro, M. R., Seghieri, C., Nantel, G., & Brouwer, I. (2007). Dietary Diversity Score is a useful indicator of micronutrient intake in non-breastfeeding Filipino children. *The Journal of Nutrition*, *137*(2), 472–477.

Kessler, R. C., Andrews, G., Colpe, L. J., Hiripi, E., Mroczek, D. K., Normand, S.-L. T., et al. (2002). Short screening scales to monitor population prevalences and trends in non-specific psychological distress. *Psychological Medicine*, *32*, 959–976.

Kratt, P., Reynolds, K., & Shewchuk, R. (2000). The role of availability as a moderator of family fruit and vegetable consumption. *Health Education & Behavior*, *27*, 471–482.

Lytle, L. A., Seifert, S., Greenstein, S., & McGovern, P. (2000). How do children's eating patterns and food choice change over time? *American Journal of Health Promotion*, *14*, 222–228.

Magarey, A. M., Daniels, A. M., Boulton, T. J., & Cockington, R. A. (2003). Predicting obesity on early adulthood from childhood and parental obesity. *International Journal of Obesity*, *27*, 505–513.

Magarey, A. M., Perry, R. A., & Daniels, L. (2010). Overview of the NOURISH and SAIDI studies. Investigation of the dietary intake of infants and children and trial of an innovative approach to obesity prevention. *Public Health Bulletin South Australia*, *7*(3), 19–23.

Mennella, J. A., Nicklaus, S., Jagolino, A. L., & Yourshaw, L. M. (2008). Variety is the spice of life. Strategies for promotion fruit and vegetable acceptance during infancy. *Physiology & Behavior*, *94*(1), 29–38.

Murphy, E. (2000). Risk, responsibility, and rhetoric in infant feeding. *Journal of Contemporary Ethnography*, *29*(3), 291–325.

Muthen, L. K., & Muthen, B. O. (2011). MPlus version 6.11. Los Angeles, CA.

National Health and Medical Research Council (2013a). *Eat for health. Australian dietary guidelines, summary*. Canberra: National Health and Medical Research Council.

National Health and Medical Research Council (2013b). *Eat for health. Infant feeding guidelines, information for health workers-summary*. Canberra.

Nicklas, T. A., Baranowski, T., Baranowski, J. C., Cullen, K., Rittenberry, L., & Olvera, N. (2001). Family and child-care provider influences on preschool children's fruit, juice, and vegetable consumption. *Nutrition Reviews*, *59*(7), 224–235.

Power, C., & Parsons, T. (2002). Nutrition and other influences in childhood as predictors of adult obesity. *The Proceedings of the Nutrition Society*, *59*, 267–272.

Rasmussen, M., Krolner, R., Klepp, K.-I., Lytle, L., Brug, J., Bere, E., et al. (2006). Determinants of fruit and vegetable consumption among children and adolescents. A review of the literature. PArt 1. Quantitative studies. *The International Journal of Behavioral Nutrition and Physical Activity*, *3*, 22.

Reinaerts, E., de Nooijer, J., Candel, M., & de Vries, N. (2007). Explaining school children's fruit and vegetable consumption. The contributions of availability, accesibility, exposure, parental consumption and habit in addition to psychosocial factors. *Appetite*, *48*(2), 248–258.

Ruel, M. T. (2003). Operationalizing dietary diversity. A review of measurement issues and research priorities. *The Journal of Nutrition*, *133*(11), 3911S–3926S.

Schreiber, J. B., Stage, F. K., King, J., Nora, A., & Barlow, E. A. (2006). Reporting structural equation modelling and confirmatory factor analysis results. A review. *The Journal of Educational Research*, *99*(6), 323–337.

Siega-Riz, A. M., Derming, D. M., Reidy, K. C., Fox, M. K., Condon, E., & Briefel, R. R. (2010). Food consumption patterns of infants and toddlers. Where are we now? *Journal of the American Dietetic Association*, *110*(12), S38–S51.

Smithers, L. G., Brazionis, L., Golley, R. K., Mittinty, M. N., Northstone, K., Emmet, P., et al. (2012). Associations between dietary patterns at 6 and 15 months of age and sociodemographic factors. *European Journal of Clinical Nutrition*, *66*(6), 658–666.

Smithers, L. G., Golley, R. K., Brazionis, L., & Lynch, J. W. (2011). Characterizing whole diets of young children from developed countries and the association between diet and health. A systematic review. *Nutrition Reviews*, *69*(8), 449–467.

Steyn, N. P., Nel, J. H., Nantel, J., Kennedy, G., & Labadarious, D. (2006). Food variety and dietary diversity scores in children. Are they good indicators of dietary adequacy? *Public Health Nutrition*, *9*(5), 644–650.

The Australian Temperament Project. (1987). *The Short Temperament Scale for Infants*.

Ventura, A. K., & Worobey, J. (2013). Early influences on the development of food preferences. *Current Biology*, *23*(9), R401–R408.

Waijers, P. M. C. M., Feskens, E. J. M., & Ocke, M. C. (2007). A critical review of predefined diet quality scores. *The British Journal of Nutrition*, *97*, 219–231.

Wardle, J., & Cooke, L. (2008). Genetic and environmental determinants of children's food preferences. *The British Journal of Nutrition*, *99*(1), S15–S21.

Weber Cullen, K., Baranowski, T., Rittenberry, L., Cosart, C., Owens, E., Hebert, D., et al. (2000). Socioenvironmental influences on children's fruit, juice and vegetable consumption as reported by parents:realiability and validity of measures. *Public Health Nutrition*, *3*(3), 345–356.

West, F., & Sanders, M. R. (2009). The lifestyle behavior checklist. A measure of weight-related problem behavior in obese children. *Internation Journal of Obesity*, *7*(4), 266–273.

Wolfenden, L., Wyse, R. J., Britton, B. I., Campbell, K. J., Hodder, R. K., Stacey, F. G., et al. (2012). Interventions for increasing fruit and vegetable consumption in children aged 5 years and under. *Cochrane Database of Systematic Reviews*, (11), CD008552.

World Health Organization (2002). *complementary feeding. Report of the global consultation-summary of guiding principles for complementary feeding of the breastfed child*. Geneva.

World Health Organization (2003). *WHO technical report series 916. Diet, nutrition and the prevention of chronic diseases*. Geneva.

World Health Organization (2006). *WHO child growth standards. Length/height-for-age, weight-for-age, weight-for-length, weight-for-height and body mass index-for-age. Methods and development*. Geneva, Switzerland: World Health Organization.

Xyris Software. (2009). FoodWorks 2009 version 6. Australia.

Yngve, A., & Sjostrom, M. (2001). Breastfeeding determinants and a suggested framework for action in Europe. *Public Health Nutrition*, *2*(2b), 729–739.

weight loss interventions that engage men. The objective of this study was to provide a comprehensive process evaluation of the interventions delivered in the SHED-IT community weight loss trial for men. In a randomised controlled trial, 159 overweight and obese men (BMI 25.0–40.0 kg/m^2) were randomized to either a paper-based (Resources) or internet-based (Online) version of a gender-tailored weight loss intervention, or a control group. The SHED-IT interventions were informed by Bandura's Social Cognitive Theory and included no face-to-face contact. During the intervention, men were encouraged to complete a Support Book containing a number of social-cognitive tasks, such as goal setting, creating social support strategies and self-monitoring of diet, physical activity and weight. At post-test, Support Book compliance was examined and men also completed a process evaluation questionnaire. At 6-months, weight was significantly reduced ($p < 0.001$) in both the Online group (–4.7 kg, 95% CI –6.1, –3.2) and Resources group (–3.7 kg, 95%CI –4.9, –2.5) relative to control group (–0.5 kg, 95%CI –1.4, 0.4), with no significant difference between intervention groups ($p > 0.05$). Most men engaged with the social-cognitive tasks; however, compliance declined over time and utilisation of social support networks and reward selection was poor. In a multiple regression model, the number of goals set (β [95% CI] = –0.3 [–0.6, –0.1], p = 0.011) and the number of weight records documented (β [95% CI] = –0.21 [–0.39, –0.02], p = 0.027) independently predicted weight loss. The process evaluation indicated that men found the programs to be supportive, enjoyable and beneficial. This process evaluation provides valuable information to inform the development of novel obesity treatment strategies that engage men.

T5:S25.46
Determinants of fruit and vegetable intakes in toddlers

Koh, G*[1]; Scott, J[2]; Daniels, L[3]; Woodman, R[4]; Kim, S[4]; Magarey, A[1]

[1]*Nutrition & Dietetics, School of Medicine, Flinders University;* [2]*Faculty of Health Sciences, Curtin University;* [3]*Institute of Health & Biomedical Innovation & School of Exercise & Nutrition Sciences, Queensland University of Technology;* [4]*Flinders Prevention, Promotion & Primary Health Care, General Practice, Flinders University*

Poor exposure and consumption of fruits and vegetables (FV) in early childhood influence lifelong eating habits that may influence weight and health outcomes. This study explored the multi-directional relationships between maternal socio-demographic and psycho-behavioural factors in predicting of FV intake in a cohort of 218 14-month old children from the South Australian Infants Dietary Intake study. Mothers with healthy infants weighing ≥2500 g and ≥37 weeks' gestation were recruited post-natally from 11 South Australian hospitals. Socio-demographic data were collected at recruitment. At 14 months postnatal, mothers completed a questionnaire exploring their perceptions of child feeding behaviour, exposure to novel foods, reactivity, maternal psychological distress and feeding self-efficacy. The number of sub-groups (variety) of FV consumed by children were estimated from a 24-hour dietary recall and 2-day food record. Structural Equation Modelling was performed using MPlus 6.11. Median variety (IQR) scores were 3(1–4) for fruit and 4(1–6) for vegetable. Parity was inversely related to the variety of vegetable intake (–1.0, $p < 0.001$) while maternal feeding self-efficacy predicted the variety of vegetables consumed (0.12, $p < 0.05$) via the frequency novel foods were offered. The variety of fruit intake was predicted by maternal fruit intake (0.31, $p < 0.05$). Future interventions should consider a whole family approach and address the antecedents of maternal feeding self-efficacy.

T5:S25.47
Does the rate of weight loss influence the success of long term weight maintenance?

Purcell, K*[1]; Sumithran, P[1]; Prendergast, L[2]; Bouniu, C[1]; Sgambellone, R[1]; Delbridge, E[1]; Proietto, J[1]

[1]*University of Melbourne;* [2]*La Trobe University*

Weight loss guidelines recommend gradual weight loss (GWL) for the treatment of obesity. This reflects a widely held opinion that the faster one loses weight, the faster it will be regained (1). The aim of this study was to investigate the impact of the rate of weight loss on the rate of regain.

We enrolled 204 obese participants in a two phase (1 and 2), non-blinded, dietary intervention trial. Phase 1 was the weight loss phase. All participants were asked to lose 15% of their weight and were randomised in a 1:1 ratio to either a 12-week rapid weight loss (RWL) program or a 36-week GWL program. Phase 2 was the weight maintenance phase, where participants who lost 15 ± 2.5% of their body weight during phase 1 were placed on a weight maintenance diet for 144 weeks.

Following phase 1, 78.4% of the RWL participants achieved the weight loss goal compared to 52.4% of the GWL participants ($p < 0.001$). At the end of phase 2, both the GWL and RWL participants regained most of their lost weight (76.3 ± 5.6% versus 76.3 ± 5.3%, respectively; NS). The rate of weight regain did not significantly differ between the two treatment groups.

Substantial weight loss is more likely to be achieved if undertaken rapidly. The rate of weight loss does not influence the rate at which weight is regained. These findings are at odds with current dietary recommendations.

1. Casazza K , et al. Myths, Presumptions, and Facts about Obesity. N Engl J Med 2013; 368: 446–454.

Disclosure: JP former chair of Nestlé (Australia) Ltd Medical Advisory Board.

Funding: The study was supported by National Health and Medical Research Council (NH&MRC) project grant (628748). JP is partly supported by The Sir Edward Dunlop Medical Research Foundation.

T5:S25.48
Improvements in biomarkers of type 2 diabetes risk following a home-based lifestyle intervention: the PULSE randomised controlled trial – a multi-component type 2 diabetes prevention program for men

Aguiar, E*; Morgan, P; Collins, C; Plotnikoff, R; Callister, R

Priority Research Centre for Physical Activity and Nutrition, The University of Newcastle

Aim: To determine the efficacy of the PULSE program (Prevention Using LifeStyle Education) – a multi-component lifestyle intervention for type 2 diabetes (T2D) prevention tailored for men.

Methods: A 6-month randomised controlled trial. Eligibility required men to be at high risk based on the Australian Diabetes Risk (AUSDRISK) screening tool. After baseline assessments (anthropometrics, fitness tests and blood tests), men were randomised (stratified by BMI and age) to the intervention (n = 53)

Appendix 2 – Time 1 and Time 2 Questionnaires (relevant parts to thesis)

Time 1 Questionnaire

Government of South Australia
Department of Health

Flinders UNIVERSITY

SAIDI
Feeding SA's Future

Thank you for taking the time to complete this questionnaire. There are many different approaches to feeding babies. This questionnaire asks about your approach and feelings related to feeding your baby and being a parent.

This questionnaire may look long, but most questions only require you to tick a box or circle a number. Parents have found it easy to complete.

There are no right or wrong answers – we are interested in your views. Please answer the questions as honestly as possible. If you are not sure how to answer a question, please mark the answer that is closest to your opinion.

Your individual responses will remain confidential and will not be shared with anyone. To help us do this, please do not write your name anywhere on this questionnaire.

It is important for the study, that, if possible, you answer all the questions that apply to you.

This questionnaire should take you 30 minutes to complete. For administrative and research purposes, at the end of this questionnaire, we will ask you to fill in the date you had completed this questionnaire.

Please bring your completed questionnaire to your assessment appointment.

This section is only about the fluids you give your baby.

1. Has your baby ever been breastfed?

☐₀ No → **_Please move to question6_**
☐₁ Yes

2. Was your baby breastfed when you first came home from hospital?

☐₁ Yes
☐₀ No

3. How are you **currently** feeding your baby?

☐₁ Breastfeeding only (no water, formula, juices or fluids) **_Please move to SECTION B_**
☐₂ Breastfeeding fully, with occasional water and juices **_Please move to question 12_**
☐₄ Combination (breast and formula feeding) **_Please move to question 6_**
☐₃ Formula feeding only **_Please move to question 4_**

4. How old was your baby when you stopped breastfeeding?

____₀ less than one week OR ____₁ days OR ____₂ weeks OR ____₃ months ☐₄ don't know

5. What is the main reason you stopped breastfeeding your baby?(select one only)

☐₁ Teething
☐₂ Baby bored
☐₃ Felt it was time to stop
☐₄ Resumed work
☐₅ Pregnant
☐₆ Not producing any / adequate milk
☐₇ Other *please describe:* __________

6. At what age was your baby first given infant formula regularly?
(Regularly = more than twice a week for several continuous weeks)

____₁ days OR ____₂ weeks OR ☐₄ don't know

7. Has your baby ever been given cow's milk as a drink regularly?
(Regularly = more than twice a week for several continuous weeks)

☐₁ Yes
☐₀ No → **_Please move to question 10_**

8. At what age was your baby first given cow's milk as a drink regularly?

____₁ days OR ____₂ weeks OR ☐₄ don't know

1. Has your baby **ever** been given solid or semi-solid food?

☐₀ No → **_Please move to SECTION D_**

☐₁ Yes

2. At what age was your baby first given any solid or semi-solid food ?

☐₀ less than one week OR ____₂ weeks OR ____₃ months ☐₄ don't know

3. Is your baby having solids and semi-solid food regularly?
(Regularly = more than twice a week for several continuous weeks)

☐₀ No → **_Please move to SECTION D_**

☐₁ Yes

4. At what age was your baby given solid or semi-solid food regularly?

____₁ days OR ____₂ weeks OR ☐₄ don't know

5. Please indicate if your baby eats the following textures.

	Can eat	**Eats sometimes**	**Won't eat**	**Never offered**
Pureed/smooth foods (shop bought or home-made)	1	2	3	4
Food mashed finely	1	2	3	4
Food mashed with lumps	1	2	3	4
Food finely chopped	1	2	3	4
Finger food	1	2	3	4
Food I have chewed to soften a little	1	2	3	4

Please respond to each of the following questions regarding your child's eating style, *by ticking the appropriate box.*

6. How willing is your baby to eat foods s/he had never eaten before?

☐1 Very willing ☐2 Willing ☐3 Neutral ☐4 Unwilling ☐5 Very unwilling

7. How often is your baby offered foods s/he had never eaten before?

☐1 Very often ☐2 Often ☐3 Sometimes ☐4 Almost never ☐5 Never

8. How many times do you offer a food to your baby before deciding whether s/he likes the food?

☐1 Once ☐2 2 – 5 ☐3 6 – 10 ☐4 11 – 15 ☐5 16 – 20+

9. Who decides **what** your baby eats – you or your baby?

☐1 You only ☐2 Mostly you ☐3 You and your baby equally ☐4 Mostly your baby ☐5 Your baby only

10. Who decides **how much** food your baby eats – you or your baby?

☐1 You only ☐2 Mostly you ☐3 You and your baby equally ☐4 Mostly your baby ☐5 Your baby only

How much do you agree with the following statements? Please tick the appropriate box

11. Compared to other children of similar age, my baby is very easy to feed.

☐1 Strongly agree ☐2 Agree ☐3 Disagree ☐4 Strongly disagree

12. How often does your baby refuse food?

☐1 Very often ☐2 Often ☐3 Sometimes ☐4 Hardly ever

13. When your baby refuses food they **usually** eat, do you.....?
*Please circle **one number per line:***

	Never	Rarely	Some-times	Often	Always
Insist your baby eats it	1	2	3	4	5
Offer a milk drink instead	1	2	3	4	5
Offer another food/s that s/he usually likes	1	2	3	4	5
Encourage to eat by turning mealtime into a game e.g. pretending loaded spoon is an aeroplane	1	2	3	4	5
Encourage to eat by offering a food reward e.g. dessert	1	2	3	4	5
Encourage to eat by offering a reward other than food	1	2	3	4	5
Offer no food until next usual meal or snack time	1	2	3	4	5
Accept that your baby may not be hungry and take the food away	1	2	3	4	5
Punish your baby in some way	1	2	3	4	5

14. How do you respond if your baby refuses a new food that they **have not tried** before?
*Please circle **one number per line:***

	Never	Rarely	Some-times	Often	Always
Assume your baby doesn't like it and do not offer again	1	2	3	4	5
Next time, mix it with other foods and disguise it	1	2	3	4	5
Offer this food again, with another food my baby likes	1	2	3	4	5

4. The following statements relate to your confidence with feeding your baby solids.

If you ***have not*** started feeding your baby solids, please move on to **Section F**.

Please circle **one number per line** that describes how you feel.

	Not confident at all				Very Confident
	1	2	3	4	5
I give my baby healthy foods.	1	2	3	4	5
I can get my baby to eat enough.	1	2	3	4	5
I can get my baby to try vegetables.	1	2	3	4	5
I give my baby the right amounts of food.	1	2	3	4	5
I can get my baby to taste new foods.	1	2	3	4	5

1. For each statement *please circle* ***one number*** which best describes your baby at the present time.

	Almost never	Not often	Varies – Usually does not	Varies – Usually does	Frequent	Almost always
My baby is pleasant (smiles, laughs) when first arriving in unfamiliar places (friend's house, shop)	1	2	3	4	5	6
My baby stays still during procedures like hair brushing and nail cutting	1	2	3	4	5	6
My baby makes happy sounds (coos, smiles, laughs) when being changed or dressed	1	2	3	4	5	6
My baby is fretful on waking up and/or going to sleep (frowns, cries)	1	2	3	4	5	6
My baby's first reaction (at home) to approach by strangers is acceptance	1	2	3	4	5	6
My baby accepts regular procedures (hair brushing, face washing etc) at any time without protest	1	2	3	4	5	6
My baby amuses self for ½ hour or more in cot or playpen (looking at mobile, playing with toy etc)	1	2	3	4	5	6
My baby accepts within a few minutes a change in place of bath or person giving the bath	1	2	3	4	5	6
My baby can be distracted from fretting or squirming during a procedure (nail cutting, hair brushing etc) by a game, singing, TV etc	1	2	3	4	5	6
My baby continues to cry in spite of several minutes of soothing	1	2	3	4	5	6
My baby's first reaction to seeing a doctor or infant nurse is acceptance (smiles, coos)	1	2	3	4	5	6
My baby cries when left to play alone	1	2	3	4	5	6

2. We are interested in your baby's sleeping behaviour. *Please use the spaces provided to write in the total number of hours that your baby sleeps during the day and during the night.*

On average, my baby sleeps ____ hours in total during the day and ____ hours in total during the night

1. In general, would you say your own health is…?

☐1	☐2	☐3	☐4	☐5
Excellent	Very good	Good	Fair	Poor

2. How many serves of vegetables do you usually eat each day?
(A 'serve' = ½ cup cooked vegetables or 1 cup of salad vegetables)

☐1	☐2	☐3	☐4	☐5
0	1	2	3-4	5 or more

3. How many serves of fruit do you usually eat each day?
(A 'serve' = 1 medium piece of fruit or 1 cup of diced pieces)

☐1	☐2	☐3	☐4	☐5
0	1	2	3-4	5 or more

4. About how many times each week do you do at least 30 minutes of moderate or vigorous physical activity? (like walking briskly, riding a bike, tennis, swimming, running, etc)

☐1	☐2	☐3	☐4	☐5	☐6	☐7	☐8
None	1	2	3	4	5	6	7

5. How often do you currently smoke cigarettes?

☐1	☐2	☐3	☐4
Do not smoke at all	Used to smoke, but no longer do so	Less than once a day	At least once per day

6. On average, on how many days of the week would you have a drink containing alcohol?

☐1	☐2	☐3	☐4	☐5	☐6	☐7
Have never drunk	Not in the last year	Monthly or less	1 or less than 1 per week	2 to 3 days per week	4 to 5 days per week	6 or more days per week

7. On days when you do drink, how many standard drinks would you **usually** drink?
(Remember: a standard drink is 10g of alcohol. Many ready to drink beverages will state the number of standard drinks on the bottle/can. As a guide, a standard drink is 100mls of wine, 1 can of light beer or 1 nip of spirits).

☐1	☐2	☐3	☐4	☐5	☐6	☐7
less than 1	1	2	3	4	5	6 or more

The following questions relate to how you have felt in the **PAST 4 WEEKS.**
Please circle the number that best describes how you have felt.

	None of the time	A little of the time	Some of the time	Most of the time	All of the time
In the past 4 weeks, about how often did you feel tired for no good reason?	1	2	3	4	5
In the past 4 weeks, about how often did you feel nervous?	1	2	3	4	5
In the past 4 weeks, about how often did you feel so nervous that nothing could calm you?	1	2	3	4	5
In the past 4 weeks, about how often did you feel hopeless?	1	2	3	4	5
In the past 4 weeks, about how often did you feel restless or fidgety?	1	2	3	4	5
In the past 4 weeks, about how often did you feel so restless you could not stand still?	1	2	3	4	5
In the past 4 weeks, about how often did you feel depressed?	1	2	3	4	5
In the past 4 weeks, about how often did you feel that everything was an effort?	1	2	3	4	5
In the past 4 weeks, about how often did you feel so sad that nothing could cheer you up?	1	2	3	4	5
In the past 4 weeks, about how often did you feel worthless?	1	2	3	4	5

Parents feelings about and approaches to parenting differ. There are no right or wrong answers.

1. Overall, as a parent, do you feel you are..........
Please tick one box only:

☐1	☐2	☐3	☐4	☐5
...not very good at being a parent?	...a person who has some trouble being a parent?	...an average parent?	...a better than average parent?	...a very good parent

7. Before income tax, superannuation or health insurance is taken out, what is your present yearly income for you and your partner combined? Please include pensions and allowances.

*Please remember to include **all** sources of income.*

- ☐1 $0 - $385 per week ($0 - $20 000 per year)
- ☐2 $386 - $673 per week ($20 001 - $35 000 per year)
- ☐3 $674 - $961 per week ($35 001 - $50 000 per year)
- ☐4 $962 - $1346 per week ($50 001 - $70 000 per year)
- ☐5 $1347 - $1923 per week ($70 0001 - $100 000 per year)
- ☐6 more than $1923 per week (more than $100 000 per year)

CHILD	
1. Gender M / F	☐
2. Weight (kg) (1)	☐☐.☐
3. Weight (kg (2)	☐☐.☐
4. Weight (kg) (3)	☐☐.☐
5. Length (cm) (1)	☐☐☐.☐
6. Length (cm) (2)	☐☐☐.☐
7. Length (cm) (3)	☐☐☐.☐

MOTHER	
8. Gender M / F	☐
9. Weight (kg) (1)	☐☐☐.☐
10. Weight (kg (2)	☐☐☐.☐
11. Weight (kg) (3)	☐☐☐.☐
12. Height (cm) (1)	☐☐☐.☐
13. Height (cm) (2)	☐☐☐.☐
14. Height (cm) (3)	☐☐☐.☐

Time 2 Questionnaire

Government of South Australia
Department of Health

Flinders UNIVERSITY

SAIDI
Feeding SA's Future

ID:

Thank you for taking the time to complete this questionnaire. This questionnaire is similar to the one you filled in 7 months ago.

There are many different approaches to feeding children. This questionnaire asks about your approach and feelings related to (i) feeding your child; and (ii) being a parent.

This questionnaire may look long however most questions just need you to tick a box or circle a number. Parents have found it easy to complete.

There are no right or wrong answers – we are interested in your views. Please answer the questions as honestly as possible. If you are not sure how to answer a question, please mark the answer that is closest to your opinion.

Your individual responses will remain confidential and will not be shared with anyone. To help us do this, we have assigned an ID number at the top of this page. Please do not write your name anywhere on this questionnaire.

Some of the questions may not be relevant to you. However, it is important for the study that you answer all the questions that apply to you except where you are asked to skip a question.

This questionnaire should take you 20-30 minutes to complete.

Please bring your completed questionnaire to your assessment appointment.

TIME 2

A BREASTFEEDING, FORMULA FEEDING & OTHER FLUIDS

1. Has your child **ever** been breastfed?

☐0 No ➡ ***Please move to question 6***

☐1 Yes

2. Are you **currently** breastfeeding your child?

☐1 Yes ➡ ***Please move to question 5***

☐0 No

3. How old was your child when you stopped breastfeeding?

☐1 less than one week **OR** ____ days **OR** ____ weeks **OR** ____ months **OR** ☐4 don't know

4. What is the **main** reason you stopped breastfeeding your child? *Please tick **one** option.*

☐1 Child teething
☐2 Child bored
☐3 Felt it was time to stop
☐4 Resumed work
☐5 Pregnant
☐6 Not producing any / adequate milk
☐7 Other *please describe:* ____________________

5. Has your child **ever** had formula?

☐0 No ➡ ***Please move to question 8***

☐ Yes
At what age was your child first given formula (**not** Toddler Milk or Step 3) regularly?
(regularly = more than twice a week for several continuous weeks)

____ days **OR** ____ weeks **OR** ____ months **OR** ☐4 don't know

B SOLID & SEMI-SOLID FOODS

1. At what age was your child first given solid or semi-solid food regularly?
(regularly = more than twice a week for several continuous weeks)

____ weeks **OR** ____ months **OR** ☐4 don't know

2. What was the **first** solid or semi-solid food that was given to your child?
*Please tick **one** box only.*

☐1 Infant cereal
☐2 Rusk
☐3 Milk based dessert
☐4 Yoghurt
☐5 Cooked/pureed/mashed fruit
☐6 Cooked/pureed/mashed vegetables
☐7 Cooked vegetables as finger food
☐8 Bread and rolls
☐9 Biscuits
☐10 Fresh fruit
☐11 Raw vegetables
☐12 Other: ____________________
☐13 Can't remember
☐14 Combination of any of the above
Please describe:
____
____

3. Please tell us about the texture of food your child eats **now**. *Please circle or tick **one** per row.*

	Eats often	Eats sometimes	Will not eat	Never bee offered
Pureed/smooth foods (commercial or home-made)	1	2	3	☐
Food mashed finely	1	2	3	☐
Food mashed with lumps	1	2	3	☐
Food finely chopped	1	2	3	☐
Finger food	1	2	3	☐
Food I have chewed to soften a little	1	2	3	☐

C FOOD REFUSAL & FOOD FUSSINESS

1. "Compared to other children of similar age, my child is very easy to feed". How much do you agree with this statement? *Please tick **one** box.*

□1	□2	□3	□4
Strongly agree	Agree	Disagree	Strongly disagree

2. How often does your child refuse food? *Please tick **one** box.*

□1	□2	□3	□4
Very often	Often	Sometimes	Hardly ever

3. Do you think your child is a picky or fussy eater? *Please tick **one** box.*

□1	□2	□3	□4
Very picky	Somewhat picky	Not picky	Not sure

Please respond to each of the following questions regarding your child's **current** eating style, by ticking **one** box per question.

4. How willing is your child to eat foods s/he had never eaten before?

□1	□2	□3	□4	□5
Very willing	Willing	Neutral	Unwilling	Very unwilling

5. How often is your child offered foods s/he had never eaten before?

□1	□2	□3	□4	□5
Very often	Often	Sometimes	Almost never	Never

6. How many times do you offer a food to your child before deciding whether s/he likes the food?

□1	□2	□3	□4	□5
Once	Twice	3-5	6-10	11+

7. Who decides **what** your child eats – you or your child?

□1	□2	□3	□4	□5
You only	Mostly you	You and your child equally	Mostly your child	Your child only

3. The following statement relate to your confidence with feeding your child. *Please circle* **one number per row** that describes how you feel.

	Not confident at all 1 ←			→	**Very confident 5**
I can get my child to sit through a meal.	1	2	3	4	5
I give my child healthy meals.	1	2	3	4	5
I can get my child to eat enough at meals.	1	2	3	4	5
I am able to serve meals at regular times everyday.	1	2	3	4	5
I can get my child to try veggies.	1	2	3	4	5
I give my child the right amounts of food.	1	2	3	4	5
I can feed my child a meal without making dessert a reward.	1	2	3	4	5
I can get my child to taste new foods.	1	2	3	4	5

G YOUR CHILD'S NATURE

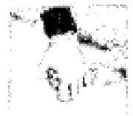
1. For each statement, please circle one number which best describes your baby at the present time.

	Almost never	Not often	Variable usually does not	Variable usually does	Frequently	Almost always
My child is pleasant (smiles, laughs) when first arriving in unfamiliar places.	1	2	3	4	5	6
My child plays continously for more than 10 minutes at a time with a favourite toy.	1	2	3	4	5	6
My child sits still while waiting for food.	1	2	3	4	5	6
My child cries after a fall or bump.	1	2	3	4	5	6
My child fusses or whines when bottom is cleaned after bowel movements.	1	2	3	4	5	6
My child smiles when unfamiliar adults play with him/her.	1	2	3	4	5	6
My child response to frustration intensely (screams, yells).	1	2	3	4	5	6
My child allows face washing without protest (squirming, turning away).	1	2	3	4	5	6
My child plays actively (bangs, throws, runs) with toys indoors.	1	2	3	4	5	6
My child runs to get where s/he wants to go.	1	2	3	4	5	6
My child stops play and watches when someone walks by.	1	2	3	4	5	6
My child goes back to the same activity after a brief interruption (snack, trip to the toilet).	1	2	3	4	5	6
My child has moody 'off' days when s/he is irritable all day.	1	2	3	4	5	6
My child stays with a routine task (dressing, picking up toys, hair brushing, nail cutting) for 5 minutes or more.	1	2	3	4	5	6
My child shows much bodily movements (stomps, writhes, swings arms) when upset or crying.	1	2	3	4	5	6

	Almost never	Not often	Variable usually does not	Variable usually does	Frequently	Almost always
My child stops to examine new objects throroughly (5 minutes or more).	1	2	3	4	5	6
My child is moody for more than a few minutes when corrected or disciplined.	1	2	3	4	5	6
My child is still shy of strangers after 15 minutes.	1	2	3	4	5	6
My child frowns or complains when left to play by himself/herself.	1	2	3	4	5	6

H

HOW YOU FEEL AS A PARENT



Parent feelings about and approaches to parenting differ. There are no right or wrong answers.

1. Overall, as a parent, do you feel you are…*Please tick **one** box only.*

☐1	☐2	☐3	☐4	☐5
not very good at being a parent?	a person who has some trouble being a parent?	an average parent?	a better than average parent?	a very good parent?

2. These questions ask about the way you generally feel about or behave with your child. *Please circle only one number per statement.*

	Not at all how I feel ↓					I feel			Exactly how	↓
I am very good at keeping my child amused	1	2	3	4	5	6	7	8	9	10
I am very good at calming my child when s/he is upset or crying	1	2	3	4	5	6	7	8	9	10
I am very good at keeping my child busy while I'm doing housework	1	2	3	4	5	6	7	8	9	10
I am very good at routine tasks of caring for my child (feeding my child, changing my child's nappies and giving my child a bath)	1	2	3	4	5	6	7	8	9	10

3. These statements ask about your relationship with your child, **over the last 6 months.** *Please circle one number per statement.*

	Never/ almost never	Rarely	Sometimes	Often	Always/ almost always
I express affection by hugging, kissing and holding my child.	1	2	3	4	5
I give my child reasons why rules should be obeyed.	1	2	3	4	5
I tell my child how happy s/he makes me.	1	2	3	4	5
I get very upset or angry when my child is hurt or may be hurt.	1	2	3	4	5
I take my child to the doctor if I notice any signs of sickness.	1	2	3	4	5

8. In the past **4 weeks**, how often did you feel…?[i] *Please circle only **one** number per row.*

	None of the time	A little of the time	Some of the time	Most of the time	All of the time
tired out for no good reason?	1	2	3	4	5
nervous?	1	2	3	4	5
so nervous that nothing could calm you down?	1	2	3	4	5
hopeless?	1	2	3	4	5
restless or fidgety?	1	2	3	4	5
so restless that you could not sit still?	1	2	3	4	5
depressed?	1	2	3	4	5
that everything was an effort?	1	2	3	4	5
so sad that noting could cheer you up?	1	2	3	4	5
worthless?	1	2	3	4	5

YOUR HEALTH & LIFESTYLE

1. In general, would you say your own health is…?

☐1 Excellent ☐2 Very good ☐3 Good ☐4 Fair ☐5 Poor

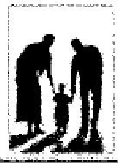
2. How many serves of vegetables do you usually eat each day?
(A 'serve' = ½ cup cooked vegetables or 1 cup of salad vegetables)

☐1 None ☐2 1 ☐3 2 ☐4 3-4 ☐5 5 or more

3. How many serves of fruit do you usually eat each day?
(A 'serve' = 1 medium piece of fruit or 1 cup of diced pieces)

☐1 None ☐2 1 ☐3 2 ☐4 3-4 ☐5 5 or more

J YOUR HOUSEHOLD & FAMILY INCOME



The answers to these questions allow us to know how similar SAIDI study members are to the average Australian. Please remember, all information supplied in this questionnaire is confidential and individual responses will not be used.

1. Please write the number of children currently living with you 5 days a week or more, **apart from the study child**:

_____ 0-1 years old   _____ 1-2 years old   _____ 3-4 years old

_____ 5 years old and above

2. Are you currently pregnant?

☐0 No

☐1 Yes

14. Before income tax, superannuation or health insurance is taken out, what is the present yearly income for **you and your partner combined**? *Please remember to include **all** sources of income, including pensions and allowances, and paid leave)*

☐1 $0 - $385 per week ($0 - $20 000 per year)

☐2 $386 - $673 per week ($20 001 - $35 000 per year)

☐3 $674 - $961 per week ($35 001 - $50 000 per year)

☐4 $962 - $1346 per week ($50 001 - $70 000 per year)

☐5 $1347 - $1923 per week ($70 0001 - $100 000 per year)

☐6 more than $1923 per week (more than $100 000 per year)

THIS PAGE IS FOR OFFICE USE ONLY --- PLEASE DO NOT COMPLETE

ID:

TO BE COMPLETED AT:-

☐ SAIDI Metropolitan clinic

☐ Regional child health clinic

☐ Regional GP

CHILD		
1.	Gender M / F	☐
2.	Weight (kg) (1)	☐☐.☐☐
3.	Weight (kg (2)	☐☐.☐☐
4.	Weight (kg) (3)	☐☐.☐☐
5.	Length (cm) (1)	☐☐☐.☐
6.	Length (cm) (2)	☐☐☐.☐
7.	Length (cm) (3)	☐☐☐.☐

Please indicate times that are NOT suitable for a member of the study team to contact you to talk about what your baby is eating.

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday (9 -1 only)
9 - 11						
11 – 2						
2 – 5						
5 - 7						

☒ = not convenient

Appendix 3 – Mplus Syntaxes

Example Mplus syntax for CFA

```
TITLE:  CFA for feeding efficacy at T1
DATA: FILE IS\\MyDocuments\SAIDI\DATA\Maindata\T1_Feb2013.csv;
VARIABLE:   NAMES= id sex tnoc y10 uni
              kess k1 k2 k3 k4 k5 k6 k7 k8 k9 k10
              temp t1 t2 t3 t4 t5 t6 t7 t8 t9 t10 t11 t12
              se e1 e2 e3 e4 e5 e6 e7
              vegv fruitv eatfd offerfd freqoff
              easyfd prting vegser fruser;
              USEVARIABLES ARE e3 e4 e5 e6 e7;
              CATEGORICAL ARE E3 E4 E5 E6 E7;
              MISSING are all (99 55 999);
MODEL: eff by e3* e4@1 e5 e6 e7;
OUTPUT: tech4 STANDARDIZED (STD) MODINDICES;
```

Example Mplus syntax for DIFFTEST

```
TITLE:  EXAMPLE DIFFTEST
DATA:   FILE IS \\My Documents\SAIDI\DATA\Maindata\T1_June2013.csv;
VARIABLE:   NAMES= id k1 k2 k3 k4 k5 k6 k7 k8 k9 k10
            t1 t2 t3 t4 t5 t6 t7 t8 t9 t10 t11 t12
            e1 e2 e3 e4 e5 e6 e7
            eatfd offerfd times bbeasy parent
            vegm fruitm vf vv vf3 vv3 ff fv ff3 fv3;
            USEVARIABLES ARE
            k1 k2 k4 k7 k8 k9
            e3 e4 e5 e6 e7
            t4 t10 t12
            eatfd offerfd bbeasy parent vegm
            vv3 times;
            CATEGORICAL ARE k1 k2 k4 k7 k8 k9
            e3 e4 e5 e6 e7 t4 t10 t12
            eatfd offerfd bbeasy parent times;
            MISSING are all (99 55 999);
ANALYSIS:   PARAMETERIZATION = THETA;
            DIFFTEST = mydiff.dat;
MODEL: dep by k1* k2 k4 k7 k8 k9@1;
            eff by e3* e4@1 e5 e6 e7;
            irri by t4* t10@1 t12;
            dep on irri;
            vegm on dep;
            bbeasy on irri eatfd eff vegm;
            eatfd on irri eff vegm;
            parent on dep irri eff;
            offerfd on dep eff vegm;
            times on dep eff vegm;
            eff on eatfd bbeasy times offerfd parent vegm dep irri;
            vv3 on eff;
OUTPUT: tech4 STANDARDIZED (STD) MODINDICES;
Savedata:   difftest \\My Documents\SAIDI\DATA\Maindata\difftest
```