

Increasing the fruit and vegetable consumption of preschool children

Rebecca Jane Wyse

BA/B.Comm (Hons Psych) Grad Cert Public Health

**Submitted for
the Degree of Doctor of Philosophy**

School of Medicine and Public Health

Faculty of Health Sciences

The University of Newcastle

March 2012

Statement of Originality

This thesis contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text. I give consent to this copy of my thesis, when deposited in the University Library**, being made available for loan and photocopying subject to the provisions of the Copyright Act 1968.

** Unless an Embargo has been approved for a determined period.

Statement of Collaboration

I hereby certify that the work embodied in this thesis has been done in collaboration with other researchers. I have included as part of the thesis a statement clearly outlining the extent of collaboration, with whom and under what auspices.

Statement of Authorship

Thesis by Publication

(Refer to Rule 50 of the Rules Governing Research Higher Degrees)

I hereby certify that this thesis is in the form of a series of published papers of which I am a joint author. I have included as part of the thesis a written statement from each co-author, endorsed by the Faculty Assistant Dean (Research Training), attesting to my contribution to the joint publications.

Rebecca Wyse

(Date)

Acknowledgements

There are many people to thank. Luke Wolfenden had the original idea for the Healthy Habits intervention and was kind enough to let me be involved in this great project. The Healthy Habits project could not have taken place without the efforts of a wonderful team of people. Amanda Fletcher worked side by side with me in this project and I greatly appreciated her hard work and sense of humour. Jenna Hollis was a fantastic coordinator who helped ensure that the project ran to schedule and to protocol. Lynn Francis, our statistician and programmer, helped us venture into new territory and push the CATI system further than it had been pushed before. This project would not have been possible without the team of CATI interviewers who made over 2,000 phone calls in the course of this trial and who made many, many more attempts. Their determination, conscientiousness and compassion for the participants was remarkable.

Thanks also to the broader team including all the recruiters, Pennie Gibbins, Kelly Chipperfield, and the members of the project advisory group (Luke Wolfenden, Libby Campbell, Amanda Fletcher, Leah Brennan, Karen Campbell, Jenny Bowman, Todd Heard, and John Wiggers) who provided expert guidance. I'd also like to acknowledge the important contribution of Kylie Burke from the Parent Research Centre who trained our project staff and CATI teams, and then facilitated fortnightly supervision, and Leah Brennan who took over this role from Kylie. I am very grateful to Meghan Finch who developed and delivered the training to the interviewers and assessed the eligibility of trial participants, and to Patrick McElduff who generously provided expert statistical advice. Thanks to Hunter New England Population Health for their support during these thesis years, and to Nicole Nathan, Meghan Finch, Kathleen McElwaine, Kate Bartlem, and Jenny Wyse for their assistance with proof reading. I'd also like to acknowledge the authorised supervisors of the preschools in the Hunter region and our parent participants who generously gave their time.

I owe a great deal to my supervisors Luke Wolfenden and Libby Campbell. The wisdom and sound advice that they provided each fortnight (and the frequent drop-ins in between) kept me focused, steady and motivated. The considered and encouraging feedback with each draft and each meeting helped me to develop as a researcher, but their accompanying kindness, understanding and senses of humour helped me to develop as a person. Luke and Libby, any student would be very fortunate to have

either of you as a mentor or supervisor, and I feel so grateful that I was lucky enough to be able to work with both of you. Thank you.

To my parents and family, thanks for all the phone calls, visits, dinners and love and support from near and far. Thank you for the encouragement and confidence to make the most of the opportunities and challenges that life presents. Finally, to Ben, thanks for cooking amazing dinners, sleeping on the couch when I was staying up late, making me exercise, and for putting up with what is an absolute abomination of an office for the best part of 18 months. Thanks for snapping me out of thesis-funks, bolstering my occasionally-wavering sense of self-belief, and for re-introducing me to the Eels at the time when I most needed it. I could not have done this without you.

Publications Included as Part of the Thesis

Wolfenden L, Wyse RJ, Britton BI, Campbell KJ, Hodder RK, Stacey FG, McElduff P, James EL. **Interventions for increasing fruit and vegetable consumption in preschool aged children (Protocol).** *Cochrane Database of Systematic Reviews* 2010, Issue 6.

Wolfenden L, Wyse RJ, Britton BI, Campbell KJ, Hodder RK, Stacey FG, McElduff P, James EL. **Interventions for increasing fruit and vegetable consumption in children aged 5 years and under.** *Cochrane Database of Systematic Reviews* 2012, Issue 11.

Wyse R, Campbell E, Nathan N, Wolfenden, L. **Associations between characteristics of the home food environment and fruit and vegetable intake in preschool children: A cross-sectional study.** *BMC Public Health* 2011, **11**:938

Wyse R, Wolfenden L, Campbell E, Campbell K, Brennan L, Fletcher A, Bowman J, Heard T, Wiggers J. **A pilot study of a telephone-based parental intervention to increase fruit and vegetable consumption in 3–5-year-old children.** *Public Health Nutrition* 2011, **14**:2245-2253

Wyse RJ, Wolfenden L, Campbell E, Brennan L, Campbell KJ, Fletcher A, Bowman J, Heard TR, Wiggers J. **A cluster randomised trial of a telephone-based intervention for parents to increase fruit and vegetable consumption in their 3- to 5-year-old children: study protocol.** *BMC Public Health* 2010, **10**:216

Wyse R, Campbell E, Campbell KJ, Wiggers J, Brennan L, Fletcher A, Bowman J, Heard TR, Wolfenden L. A cluster randomised controlled trial of a telephone-based parent intervention to increase preschoolers' fruit and vegetable consumption. *Am J Clin Nutr* 2012, **96**(1):102-10.

Co-author statement for Chapter 2

I attest that Research Higher Degree candidate **Rebecca Wyse** contributed to the paper/publication entitled:

Interventions for increasing fruit and vegetable consumption in children aged up to 5 years

By:

- Co-authoring the protocol for the systematic review
- Developing and piloting the data extraction form
- Extracting data regarding study characteristics from all included studies
- Extracting data regarding risk of bias from all included studies
- Combining the extraction forms from the independent reviewers
- Contributing to data analysis and interpretation
- Co-authoring the manuscript

Full name of Co-author	Signature of Co-author	Date
Luke Wolfenden		16.02.2012
Ben Britton		29.02.2012
Karen Campbell		15.02.2012
Rebecca Hodder		07.02.2012
Fiona Stacey		15.02.2012
Patrick McElduff		07.03.2012
Erica James		14.02.2012

Signature of Assistant Dean (Research Training) (ADRT)

Full Name of ADRT

Professor John Rostas

Date

07.03.2012

Co-author statement for Chapter 3

I attest that Research Higher Degree candidate **Rebecca Wyse** contributed to the paper/publication entitled:

Associations between characteristics of the home food environment and fruit and vegetable intake in preschool children: A cross-sectional study

By:

- Developing the research question
- Determining the research design
- Determining the measures to be used
- Developing additional data collection tools
- Participating in recruitment
- Overseeing data collection
- Cleaning the data
- Leading the data analysis
- Leading the writing of the manuscript

Full name of Co-author	Signature of Co-author	Date
Elizabeth Campbell		01.03.2012
Nicole Nathan		16.02.2012
Luke Wolfenden		16.02.2012

Signature of Assistant Dean (Research Training) (ADRT)

Full Name of ADRT

Professor John Rostas

Date

07.03.2012

Co-author statement for Chapter 4

I attest that Research Higher Degree candidate **Rebecca Wyse** contributed to the paper/publication entitled:

A pilot study of a telephone-based parental intervention to increase fruit and vegetable consumption in 3–5-year-old children

By:

- Co-developing and testing the intervention scripts and intervention resources
- Contributing to the research design and study methodology
- Determining the measures to be used
- Developing additional data collection tools
- Participating in recruitment
- Overseeing data collection
- Cleaning the data
- Leading the data analysis
- Leading the writing of the manuscript

Full name of Co-author	Signature of Co-author	Date
Luke Wolfenden		16.02.2012
Elizabeth Campbell		01.03.2012
Karen Campbell		15.02.2012
Leah Brennan		14.02.2012
Amanda Fletcher		02.03.2012
Jenny Bowman		16.02.2012
Todd Heard		07.03.2012
John Wiggers		07.03.2012

Signature of Assistant Dean (Research Training) (ADRT)

Full Name of ADRT

Professor John Rostas

Date

07.03.2012

Co-author statement for Chapter 5a

I attest that Research Higher Degree candidate **Rebecca Wyse** contributed to the paper/publication entitled:

A cluster randomised trial of a telephone-based intervention for parents to increase fruit and vegetable consumption in their 3- to 5-year-old children: study protocol

By:

- Contributing to the research design and study methodology
- Determining the research question
- Determining the measures to be used
- Leading the writing of the manuscript

Full name of Co-author	Signature of Co-author	Date
Luke Wolfenden		16.02.2012
Elizabeth Campbell		01.03.2012
Leah Brennan		14.02.2012
Karen Campbell		15.02.2012
Amanda Fletcher		02.03.2012
Jenny Bowman		16.02.2012
Todd Heard		07.03.2012
John Wiggers		07.03.2012

Signature of Assistant Dean (Research Training) (ADRT)

Full Name of ADRT

Professor John Rostas

Date

07.03.2012

Co-author statement for Chapter 5b

I attest that Research Higher Degree candidate **Rebecca Wyse** contributed to the paper/publication entitled:

A cluster randomized controlled trial of a telephone-based parent intervention to increase preschoolers' fruit and vegetable consumption

By:

- Co-developing and testing the intervention scripts and intervention resources
- Contributing to the research design and study methodology
- Determining the measures to be used
- Developing additional data collection tools
- Participating in recruitment
- Overseeing data collection
- Cleaning the data
- Leading the data analysis
- Leading the writing of the manuscript

Full name of Co-author	Signature of Co-author	Date
Elizabeth Campbell		01.03.2012
Karen Campbell		15.02.2012
John Wiggers		07.03.2012
Leah Brennan		14.02.2012
Amanda Fletcher		02.03.2012
Jenny Bowman		16.02.2012
Todd Heard		07.03.2012
Luke Wolfenden		16.02.2012

Signature of Assistant Dean (Research Training) (ADRT)

Full Name of ADRT

Professor John Rostas

Date

07.03.2012

Additional Publications and Presentations

Papers:

Nathan N, Wolfenden L, Butler M, Bell AC, Wyse R, Campbell E, Milat AJ, Wiggers J. **Vegetable and fruit breaks in Australian primary schools: prevalence, attitudes, barriers and implementation strategies.** *Health Educ Res* 2011, **26**(4):722-31.

Conference presentations:

Wyse R, Wolfenden L, Stacey F, Britton B, Hodder R, Campbell K, McElduff P, James E. **A systematic review of randomised controlled trials to increase fruit and vegetable consumption in children aged 0-5.** *Australasian Society for Behavioural Health and Medicine Conference*. Melbourne, February 2012.

Wyse R, Wolfenden L, Campbell E, Brennan L, Campbell K, Fletcher A, Bowman J, Wiggers J. **Increasing fruit and vegetable consumption in 3-5 y.o. children: Efficacy of a telephone-based parent intervention: a cluster randomised trial.** *International Society for Behavioral Nutrition and Physical Activity Conference*. Melbourne, June 2011.

Wolfenden L, Wyse R, Britton B, Campbell K, Hodder R, Stacey F, McElduff P, James E. **Interventions to increase fruit and vegetable consumption amongst preschool aged children: a systematic review of randomised trials** (Poster). *International Society for Behavioral Nutrition and Physical Activity Conference*. Melbourne, June 2011.

Wyse R, Wolfenden L, Campbell E, Campbell K, Brennan L, Fletcher A, Bowman J, Heard T, Wiggers J. **Increasing fruit and vegetable consumption in 3-5 year old children: A cluster RCT of a telephone-based parent intervention, NSW, Australia.** *European Congress on Obesity*. Istanbul, May 2011.

Wyse R, Wolfenden L, Campbell E, Brennan L, Campbell K, Fletcher A, Bowman J, Heard T, Wiggers J. **Increasing fruit and vegetable consumption in 3-5 y.o. children. Preliminary results from a cluster randomised trial of a telephone-based parent intervention, Newcastle, Australia.** *Australasian Society for Behavioural Health and Medicine Conference*. Christchurch, February 2011.

Wyse R, Wolfenden L, Finch M, Fletcher A, Hollis J, Prigg J, Edenden D, Hodder R.
Investigating recruitment strategies within the childcare setting: Two case studies of obesity prevention RCTs. *Australasian Society for Behavioural Health and Medicine Conference*. Christchurch, February 2011.

Wyse R, Wolfenden L, Campbell E, Fletcher A. **Increasing children's fruit and vegetable consumption through a telephone-based parent intervention: Pilot.** *NSW Health Promotion Symposium*. Sydney, November 2010.

Wyse R, Wolfenden L, Campbell E, Fletcher A. **Increasing children's fruit and vegetable consumption via a telephone-based parent intervention: pilot.** Public Health Association of Australia National Conference. Adelaide, September 2010.

Wyse R, Wolfenden L, Campbell E, Fletcher A. **A telephone-based parent intervention to increase children's fruit and vegetable consumption: Pilot Study, Newcastle NSW.** Australian Health Promotion Association, National Conference. Melbourne, June 2010.

Table of Contents

LIST OF TABLES	XIX
LIST OF FIGURES	XXI
LIST OF APPENDICES	XXII
SYNOPSIS	XXIV
CHAPTER ONE: OVERVIEW OF FRUIT AND VEGETABLE CONSUMPTION	1
FRUIT AND VEGETABLE CONSUMPTION	2
<i>The Global Nutrition Context</i>	<i>2</i>
<i>Chapter Purpose and Structure</i>	<i>2</i>
<i>Definitions of Fruits and Vegetables</i>	<i>2</i>
<i>Fruit and Vegetable Dietary Guidelines: What is Adequate Consumption?</i>	<i>3</i>
<i>Prevalence of Inadequate Fruit and Vegetable Consumption</i>	<i>4</i>
FRUIT AND VEGETABLE CONSUMPTION AND CHRONIC DISEASE	5
<i>Fruit and Vegetable Consumption Promotes Good Health</i>	<i>5</i>
<i>Fruit and Vegetable Consumption Protects Against Disease</i>	<i>6</i>
<i>Cancer</i>	<i>6</i>
<i>Coronary Heart Disease</i>	<i>11</i>
<i>Stroke</i>	<i>12</i>
<i>Chronic Obstructive Pulmonary Disease (COPD)</i>	<i>12</i>
<i>Type 2 Diabetes</i>	<i>13</i>
<i>Obesity</i>	<i>13</i>
<i>Review of Chronic Diseases</i>	<i>14</i>
THE CASE FOR ADDRESSING FRUIT AND VEGETABLE CONSUMPTION IN EARLY CHILDHOOD	14
<i>High Prevalence of Inadequate Fruit and Vegetable Consumption</i>	<i>15</i>
<i>Protection Against Future Chronic Disease</i>	<i>15</i>

<i>A Developmentally Appropriate Period for Intervention.....</i>	16
<i>The Establishment of Dietary Preferences</i>	16
<i>The Persistence of Childhood Dietary Habits.....</i>	17
<i>The Importance of the Home Food Environment:</i>	17
THE CONTEXT OF THIS THESIS.....	18
THESIS AIMS	18
<i>Thesis Structure.....</i>	19
REFERENCES	20

CHAPTER TWO: SYSTEMATIC REVIEW OF INTERVENTIONS FOR INCREASING FRUIT AND VEGETABLE CONSUMPTION IN CHILDREN AGED UP TO 5 YEARS 30

BACKGROUND	31
<i>Description of the Condition.....</i>	31
<i>Description of the Intervention.....</i>	31
<i>How the Intervention Might Work</i>	32
<i>Why it is Important to do this Review.....</i>	32
OBJECTIVES.....	33
METHODS	33
<i>Criteria for Considering Studies for this Review</i>	33
<i>Search Methods for Identification of Studies</i>	34
<i>Data Collection and Analysis.....</i>	35
RESULTS.....	38
<i>Results of the Search</i>	38
<i>Characteristics of Included Studies</i>	39
<i>Risk of Bias in Included Studies</i>	42
<i>Effects of Interventions</i>	44
DISCUSSION.....	47
<i>Summary of Main Results</i>	47

<i>Overall Completeness and Applicability of Evidence</i>	48
<i>Quality of the Evidence</i>	49
<i>Potential Biases in the Review Process</i>	49
<i>Agreements and Disagreements with Other Studies or Reviews</i>	50
CONCLUSIONS.....	51
<i>Implications for Practice</i>	51
REFERENCES	53
 CHAPTER THREE: ASSOCIATIONS BETWEEN CHARACTERISTICS OF THE HOME FOOD ENVIRONMENT AND FRUIT AND VEGETABLE INTAKE IN PRESCHOOL CHILDREN: A CROSS-SECTIONAL STUDY	 59
BACKGROUND	60
METHODS	61
<i>Design</i>	61
<i>Ethical Approval</i>	61
<i>Sample</i>	61
<i>Recruitment</i>	62
<i>Data Collection</i>	62
<i>Measures</i>	62
<i>Analysis</i>	65
RESULTS.....	67
DISCUSSION	72
CONCLUSIONS.....	74
REFERENCES	76
 CHAPTER FOUR: A PILOT STUDY OF A TELEPHONE-BASED PARENT INTERVENTION TO INCREASE FRUIT AND VEGETABLE CONSUMPTION IN 3–5- YEAR-OLD CHILDREN	 83
INTRODUCTION	84

EXPERIMENTAL METHODS	85
<i>Design</i>	85
<i>Setting / Subjects</i>	85
<i>Intervention</i>	86
<i>Data Collection and Measures</i>	90
<i>Statistical Analysis</i>	91
RESULTS.....	91
<i>Intervention Efficacy</i>	93
<i>Intervention Feasibility and Acceptability</i>	93
DISCUSSION	95
REFERENCES	98

CHAPTER FIVE A) A CLUSTER RANDOMISED TRIAL OF A TELEPHONE-BASED INTERVENTION FOR PARENTS TO INCREASE FRUIT AND VEGETABLE CONSUMPTION IN THEIR 3- TO 5-YEAR-OLD CHILDREN: STUDY PROTOCOL 104

BACKGROUND	105
METHODS	106
<i>Study Aim</i>	106
<i>Study Design</i>	106
<i>Research Setting</i>	108
<i>Participants and Research Eligibility</i>	108
<i>Recruitment and Allocation</i>	109
<i>Intervention Group</i>	111
<i>Control Group</i>	118
<i>Data Collection and Measures</i>	118
<i>Sample Size</i>	120
<i>Statistical Analysis: Primary Outcome</i>	121
DISCUSSION	121

CONCLUSION.....	122
REFERENCES	123
CHAPTER FIVE B) A CLUSTER RANDOMISED CONTROLLED TRIAL OF A TELEPHONE-BASED PARENT INTERVENTION TO INCREASE PRESCHOOLERS' FRUIT AND VEGETABLE CONSUMPTION	130
INTRODUCTION	131
SUBJECTS AND METHODS.....	132
<i>Design Overview</i>	132
<i>Participants</i>	132
<i>Randomisation and Allocation</i>	133
<i>Experimental Group</i>	133
<i>Data Collection and Blinding</i>	137
<i>Measures</i>	138
<i>Sample Size Calculation</i>	139
<i>Analysis</i>	139
RESULTS.....	140
<i>Participant Characteristics</i>	140
<i>Child Fruit and Vegetable Intake</i>	143
<i>Food Expenditure</i>	145
<i>Process Measures:</i>	145
DISCUSSION	146
REFERENCES	149
CHAPTER SIX: THESIS SUMMARY AND IMPLICATIONS	155
CHAPTER SUMMARY	156
<i>Chapter 2: A systematic review of interventions for increasing fruit and vegetable consumption in children aged up to 5 years</i>	156

<i>Chapter 3: Associations between characteristics of the home food environment and preschool children's fruit and vegetable consumption</i>	<i>157</i>
<i>Chapter 4: Pilot study of an intervention to increase fruit and vegetable consumption in preschool children</i>	<i>158</i>
<i>Chapter 5a) and 5b): A cluster randomised controlled trial of a telephone-based parent intervention to increase preschoolers' fruit and vegetable consumption .</i>	<i>159</i>
IMPLICATIONS FOR RESEARCH AND PRACTICE	160
<i>i) Telephone-Based Fruit and Vegetable Interventions</i>	<i>160</i>
<i>ii) Implications for Public Health Nutrition Research.....</i>	<i>162</i>
<i>iii) Implications for Practitioners and Policy-Makers</i>	<i>164</i>
CONCLUSION.....	168
REFERENCES	169

List of Tables

TABLE 1.1: EVIDENCE FROM WCRF FOR THE ASSOCIATION BETWEEN FRUIT CONSUMPTION AND CANCER TYPE _____	8
TABLE 1.2: EVIDENCE FROM WCRF FOR THE ASSOCIATION BETWEEN VEGETABLE CONSUMPTION AND CANCER TYPE _____	9
TABLE 2.1. SHORT-TERM IMPACT (<12 MONTHS) OF REPEATED EXPOSURE INTERVENTION VERSUS NO INTERVENTION ON CHILD CONSUMPTION OF A TARGET VEGETABLE _____	44
TABLE 2.2. SHORT-TERM IMPACT (<12 MONTHS) OF HOME VISITING INTERVENTION VERSUS USUAL CARE _____	46
TABLE 3.1 - PARENT, CHILD AND HOME FOOD ENVIRONMENT CHARACTERISTICS OF THE STUDY PARTICIPANTS _____	67
TABLE 3.2 - ASSOCIATIONS BETWEEN CDQ SCORE AND CHARACTERISTICS OF THE HOME FOOD ENVIRONMENT: SIMPLE AND MULTIPLE REGRESSION _____	70
TABLE 4.1. OVERVIEW OF INTERVENTION CONTENT _____	87
TABLE 4.2. DEMOGRAPHIC CHARACTERISTICS OF SAMPLE _____	92
TABLE 4.3. DIETARY OUTCOMES PRE- AND POST-INTERVENTION _____	93
TABLE 4.4. NUMBER OF PARENTS WHO WERE OFFERED, WHO AGREED TO ATTEMPT, AND WHO ACTUALLY ATTEMPTED INTERVENTION TASKS _____	94
TABLE 4.5. INTERVENTION ACCEPTABILITY _____	95
TABLE 5.1: OVERVIEW OF INTERVENTION CALL CONTENT: BEHAVIOUR CHANGE TECHNIQUES AND THEIR APPLICATION _____	114
TABLE 5.2. INTERVENTION CONTENT, STRATEGIES AND STRUCTURE _____	134
TABLE 5.3. CHARACTERISTICS OF THE 394 PARTICIPANTS WHO COMPLETED BASELINE BY GROUP. _____	142
TABLE 5.4. INTERVENTION AND CONTROL FRUIT AND VEGETABLE (F&V) SUBSCALE SCORES (MEAN±STANDARD ERROR) AT BASELINE, 2- AND 6-MONTHS _____	144

TABLE 5.5. INTERVENTION AND CONTROL ESTIMATED WEEKLY FOOD EXPENDITURE

(MEAN \pm STANDARD ERROR) AT BASELINE, 2- AND 6-MONTHS _____ 145

List of Figures

FIGURE 2.1: STUDY FLOW DIAGRAM	39
FIGURE 5.1: CONSORT FLOW DIAGRAM ESTIMATING THE PROGRESS OF PRESCHOOLS AND PARENTS THROUGH THE TRIAL	107
FIGURE 5.2: CONSORT DIAGRAM SHOWING CLUSTER (PRESCHOOL) AND PARTICIPANT (PARENT) FLOW THROUGH THE TRIAL	141

List of Appendices

APPENDIX 1: SYSTEMATIC REVIEW SEARCH STRATEGY FROM CENTRAL	A-1
APPENDIX 2: CHARACTERISTICS OF ONGOING STUDIES IDENTIFIED IN THE SYSTEMATIC REVIEW	A-4
APPENDIX 3: STUDIES EXCLUDED FROM THE SYSTEMATIC REVIEW	A-8
APPENDIX 4: CHARACTERISTICS OF STUDIES INCLUDED IN THE SYSTEMATIC REVIEW	A-36
APPENDIX 5: RISK OF BIAS OF STUDIES INCLUDED IN THE SYSTEMATIC REVIEW	A-51
APPENDIX 6: ETHICS APPROVAL FOR STUDIES IN CHAPTER 3, 4 AND 5	A-57
APPENDIX 7: MEASURES FOR CHAPTER 3	A-61
APPENDIX 8: RECRUITMENT PROTOCOL	A-70
APPENDIX 9: RECRUITMENT MATERIALS FOR PRESCHOOLS	A-93
APPENDIX 10: RECRUITMENT MATERIALS FOR PARENTS	A-97
APPENDIX 11A: WEEK 1 INTERVENTION TELEPHONE SCRIPT	A-103
APPENDIX 11B: WEEK 2 INTERVENTION TELEPHONE SCRIPT	A-132
APPENDIX 11C: WEEK 3 INTERVENTION TELEPHONE SCRIPT	A-167
APPENDIX 11D: WEEK 4 INTERVENTION TELEPHONE SCRIPT	A-211
APPENDIX 12: INTERVENTION GUIDEBOOK	A-238
APPENDIX 13: INTERVENTION COOKBOOKS	A-282
APPENDIX 14: MEAL PLANNERS	A-291
APPENDIX 15A: INTERVENTIONIST TRAINING - OVERVIEW OF TRIAL	A-293
APPENDIX 15B: INTERVENTIONIST TRAINING - NUTRITION FOR PRESCHOOLERS	A-306
APPENDIX 16: MEASURES FOR CHAPTER 4	A-321
APPENDIX 17: RECRUITMENT PROMOTIONAL MATERIALS	A-329
APPENDIX 18: PARENT FLIER	A-332
APPENDIX 19: LETTERS NOTIFYING PARENTS OF GROUP ALLOCATION	A-334
APPENDIX 20: INTERVENTION MONITORING (RECORDING SHEET)	A-337
APPENDIX 21: CONTROL GROUP PRINTED MATERIALS (EXCERPTS)	A-342

APPENDIX 22: MEASURES FOR CHAPTER 5	A-349
APPENDIX 23: DATA COLLECTION MONITORING (RECORDING SHEET)	A-355
APPENDIX 24: POSTCARD REMINDERS - 6 MONTHS	A-357

Synopsis

Inadequate fruit and vegetable consumption is associated with increased chronic disease risk and represents a considerable global health burden. As dietary habits develop in early childhood and track into adulthood, intervention at an early age may have long lasting benefits. As such, the aims of this thesis were: to review the existing evidence for the efficacy of interventions to increase the fruit and vegetable consumption of preschool children; to identify the characteristics of the home food environment that are associated with higher levels of fruit and vegetable consumption in preschool children; to develop, pilot and evaluate an intervention to increase the consumption of fruit and vegetables among preschool children; and to provide recommendations for future research and practice regarding interventions to increase the fruit and vegetable consumption of preschool children.

Despite the importance of establishing healthy dietary habits from an early age, there is little research investigating the efficacy of interventions aimed at increasing fruit and vegetable consumption in children prior to starting school. In accordance with the first aim, a systematic review of interventions to increase the fruit and vegetable consumption of children aged 0 to 5 years was conducted (Chapter 2). Only five randomised controlled trials were identified and the review provided no clear evidence in favour of existing intervention approaches.

Chapter 3 addresses the second aim and reports the result of a cross-sectional study investigating the relationship between the home food environment and children's fruit and vegetable consumption. Three hundred and ninety six parents of 3 to 5 year-olds participated in a telephone survey that included the fruit and vegetable subscale from the Children's Dietary Questionnaire and selected measures of the home food environment. It was found that preschool children's fruit and vegetable consumption was positively associated with: parental fruit and vegetable consumption ($p=0.005$); fruit and vegetable availability ($p=0.006$) and accessibility ($p=0.012$) within the home; the frequency of provision of these foods ($p<0.001$); and allowing children to only eat at set meal and snack times ($p=0.006$). Such findings strengthen the evidence in support of the home food environment as an important setting for fruit and vegetable interventions targeting children of this age.

The third aim of the thesis is addressed in Chapters 4 and 5. An intervention was developed to support parents to make changes within their home food environment, focusing on increasing the availability and accessibility of fruit and vegetables, parental role-modelling of fruit and vegetable consumption, and establishing supportive family food routines. It was designed to be delivered to parents over four 30-minute phone calls and accompanying printed resources were also provided. The intervention was piloted in a pre-post trial with 34 parents of 3 to 5 year-olds (Chapter 4). Children's fruit and vegetable consumption was assessed using the fruit and vegetable subscale of the Children's Dietary Questionnaire administered via telephone. Following parent participation in the intervention, children's fruit and vegetable scores were significantly higher than at baseline ($p=0.027$). Furthermore, the findings suggested that parents actively participated in the intervention tasks and activities and judged aspects of the intervention, including the length and number of calls, to be acceptable. Based on the pilot findings, a randomised controlled trial was conducted with 394 parents. The methods employed in this trial are comprehensively described in the study protocol (Chapter 5a) and the 2- and 6-month results of the trial are reported (Chapter 5b). Specifically, generalised estimating equation analysis using all available data found that fruit and vegetable scores of the children in the intervention group were significantly higher than the control group at 2- ($p<0.001$) and 6-months ($p=0.021$).

The thesis concludes with reflections on the implications of the thesis findings for research and practice (Chapter 6). It is suggested that, pending results of longer-term follow-up, an intervention targeting characteristics of the home-food environment and delivered by telephone may be an effective way of supporting parents to increase the fruit and vegetable intake of their preschool children, thus representing an important contribution to public health nutrition.

CHAPTER ONE:
Overview of Fruit and Vegetable Consumption

Fruit and Vegetable Consumption

The Global Nutrition Context

Over the past 50 years industrialisation, urbanisation and globalisation have brought about major changes to the ways that food is produced, processed, distributed, marketed and consumed [1-3]. The high availability and low cost of animal fats, vegetable oils and sugars has contributed to the 'Westernisation' of diets around the world [2]. Globally, diets have increased in energy density, fat and sugar intake, and decreased with respect to fibre, fruit and vegetable content [4]. This thesis has been written in response to the low levels of fruit and vegetable consumption within Australia and internationally, and the need for public health solutions to address this issue of concern.

Chapter Purpose and Structure

This introductory chapter aims to provide an overview of how fruit and vegetable consumption contributes to the health of the population. This chapter outlines the minimum levels of fruit and vegetable consumption recommended for good health and describes the high prevalence of 'inadequate' fruit and vegetable consumption internationally and within Australia. The health benefits of fruit and vegetable intake are then discussed, as well as the burden of disease attributable to inadequate fruit and vegetable consumption. The remainder of the chapter presents evidence in support of early intervention, focusing specifically on young children. The chapter concludes with the aims of this thesis and introduces the papers that form the basis of this thesis-by-publication.

Definitions of Fruits and Vegetables

'Fruits' are generally considered to consist of the sweet, edible flesh that surrounds the seeds of flowering plants [5]. The term 'vegetable' refers to a range of plant parts from a variety of plant types. Vegetables can include leafy green vegetables (e.g. spinach, lettuce), root and tuber vegetables (e.g. carrots, potatoes), edible plant stems (e.g. celery, asparagus), members of the crucifer family of plants (e.g. broccoli, cabbages), gourd vegetables, (e.g. pumpkin, cucumber) and allium vegetables (e.g. onion, garlic) [5]. Fruits and vegetables can be classified based on their botanical definition or their common usage (also known as 'culinary' or 'dietetic' usage) [6]. This thesis, as with most intervention and epidemiological research into fruit and vegetable consumption [6], adopts the common usage. For example, despite being botanically classified as fruits, tomatoes, avocados, eggplants and zucchinis will be considered as vegetables [6]. Although beans and peas are botanically classified as legumes, they will similarly

be considered as vegetables [6]. Furthermore, the classification of fruits and vegetables also varies between the dietary guidelines of different countries and regions [7]. Many guidelines exclude starchy vegetables (such as potatoes or sweet potatoes), as they are thought not to confer the same health benefits as other vegetables [5]. The recommendations of the World Health Organization (WHO) specifically exclude tubers [8] whereas the guidelines of many countries including Australia include potatoes [9]. The tool that is used to assess children's fruit and vegetable consumption in Chapters 3, 4 and 5 of this thesis includes potatoes and sweet potatoes as vegetables, with the exception of hot chips [10].

Fruit and Vegetable Dietary Guidelines: What is Adequate Consumption?

International Guidelines for Adults

The WHO recommends that to maintain health and reduce the risk of chronic disease, adults should consume a minimum of 400 grams per day of fruit and vegetables (excluding potatoes) [11]. This is frequently interpreted to be five serves of approximately 80 grams per day [8]. The World Cancer Research Fund also recommends that individuals consume a minimum of 400 grams of fruit and vegetables daily [12] as does The British Nutrition Foundation [13]. New Zealand Food and Nutrition Guidelines recommend the consumption of at least five servings per day consisting of at least three vegetable servings and at least two fruit servings [14]. The 2010 American Dietary Guidelines recommend consuming a variety of vegetables, especially dark green, red and orange vegetables, and beans and peas but provide no specific recommendation regarding a minimum quantity of fruit and vegetables that should be consumed [15]. The United States Department of Agriculture (USDA) Food Patterns and the Dietary Approaches to Stop Hypertension (DASH) Eating Plans, however, recommend daily consumption of 2.5 and 2.1 cups of vegetables, and 2.0 and 2.5 cups of fruit respectively [15].

International Guidelines for Children

Currently there is no international consensus regarding a minimum level of fruit and vegetable consumption to ensure the healthy growth and development of children. Many countries have developed their own national dietary guidelines for children, however, there is substantial variation between countries regarding specific recommendations [7]. Belgian guidelines for children aged 6 years and older recommend 1 to 3 portions of fruit (excluding juice) and 300 grams of vegetables (excluding potatoes); Swedish guidelines for children up to 10 years recommend 400 grams of fruit and vegetable consumption daily (excluding potatoes and including a

maximum of 100 grams of fruit juice); and Austrian guidelines for 10 to 12 year-olds are 250 grams of fruit and 250 grams of vegetables (excluding potatoes) eaten over five occasions daily [7]. North American recommendations specify the proportion of the child's diet that should be comprised of fruit and vegetables, and advise that half of a child's plate at mealtimes be taken by fruits and vegetables [16]. Guidelines in the United Kingdom recommend that children consume five servings of fruits and vegetables daily [17].

Australian Guidelines for Adults

Australian recommendations for fruit and vegetable consumption are based on two key documents. 'The Dietary Guidelines for Australian Adults' provide a general recommendation that Australians should eat plenty of vegetables and fruit [5], while 'The Australian Guide to Healthy Eating' quantifies the amount of fruit and vegetables that it is recommended to consume daily [9]. It is recommended that Australian adults consume between two and four serves of fruit per day, where a serve is equivalent to: one medium-sized piece (e.g. apple, banana); two small-sized pieces (e.g. apricots, plums); one cup of diced pieces or canned fruit; half a cup of fruit juice; or four dried apricot halves or one and a half tablespoons of sultanas [9]. Between five and eight serves of vegetables and legumes are recommended each day where a serve is equivalent to: half a cup of cooked vegetables; half a cup of cooked dried peas, beans or lentils; one cup of salad vegetables; or one potato [9].

Australian Guidelines for Children

'The Australian Guide to Healthy Eating' recommends children aged 4 to 11 years consume one serve of fruit and two to three serves of vegetables daily [9]. Although at the time of thesis submission, Australian guidelines for children aged 2 for 3 years had not been published, the reports of previous national nutrition surveys applied the minimum guidelines for 4 to 7 year-olds (one serve of fruit and two serves of vegetables) to younger children [18, 19], and this pragmatic approach has also been adopted in this thesis.

Prevalence of Inadequate Fruit and Vegetable Consumption

Internationally

Fruit and vegetable consumption varies from region to region, reflecting differences in the economic, agricultural and cultural environments [20]. Worldwide only a very small proportion of the world's population consumes fruit and vegetables at or above the recommended level [1]. Average consumption in most of the world's regions is below

the WHO recommendation (400 grams/day) with South American, South African, Eastern European and South-East Asian nations reporting the lowest levels of consumption [21]. However, inadequate consumption is not restricted to developing countries with seven European Union Member States with mean fruit and vegetable consumption at less than 70% of the recommended WHO minimum (<275 grams per day) [22]. This trend is also seen among children. Assessment of over 15,000 11-year-olds across nine European countries found that fruit and vegetable consumption ranged from 143 to 265 grams per day, and was well below the dietary guidelines of each surveyed country [7]. Among both adults and children in developed countries, consumption of fruit and vegetables is typically higher among females [7, 23, 24] and those more socio-economically advantaged [23-25].

Australia

Results from the 1995 National Nutrition Survey indicated that 89% of Australian adults were not meeting the recommendations for both fruit and vegetable consumption, with 68% not eating enough fruit and 70% not eating enough vegetables [26]. Similarly, the 2007 Australian National Children's Nutrition and Physical Activity survey indicated that 49% and 86% of children aged 9 to 13 years were not meeting the recommendations for fruit (excluding juice) and vegetables respectively [18]. Similar to international trends, intake of fruit and vegetables are typically higher in women compared to men [26, 27], girls compared to boys (vegetables only) [19], and those from higher relative to lower socio-economic backgrounds [27, 28].

Fruit and Vegetable Consumption and Chronic Disease

Fruit and Vegetable Consumption Promotes Good Health

A balanced diet which includes adequate amounts of fruit and vegetables is known to be important for good health [20]. Fruits and vegetables are low energy-dense sources of vitamins and minerals [29, 30] and their high fibre content maintains bowel and digestive health [31], protects against constipation [32, 33], and is thought to play a role in stabilising glucose levels [34]. Fruit and vegetables are low in fat, salt and sugar, and can help to lower blood pressure [35] and cholesterol levels [36] and, in combination with an active lifestyle, can help maintain a healthy weight [30]. A diet high in fruit and vegetables is especially important for children as they grow and can help the development of strong teeth [37] and bones [38], and can improve sleeping patterns [39].

Fruit and Vegetable Consumption Protects Against Disease

Consumption of an adequate volume and variety of fruits and vegetables can also reduce the risk of disease [40, 41]. Inadequate consumption of fruit and vegetables is estimated to be responsible for 1.8% of the global burden of disease [21]. This compares to 1.3% attributable to inadequate physical activity, 2.3% due to overweight and obesity and 4.1% due to tobacco [21]. Approximately 2.6 million deaths per year worldwide are attributable to inadequate fruit and vegetable consumption [21]. In the European Union alone, over 26,000 deaths per year could be prevented annually among those aged under 65 years if population fruit and vegetable intake increased to the recommended levels [22]. In Australia, inadequate fruit and vegetable consumption is estimated to be responsible for over 4,500 deaths annually (3.5% of total deaths) [42] and data from New Zealand suggest that inadequate fruit and vegetable intake contributes to over 1,500 deaths per year (6% of total deaths) [43].

Worldwide, low fruit and vegetable consumption is responsible for over 26 million Disability Adjusted Life Years (DALYs) per year [44]. The DALYs that are attributable to low fruit and vegetable consumption are highest in middle-income European countries and in South-East Asia [20]. In South Africa, low fruit and vegetable consumption accounts for almost 177,000 DALYs per year (1.1% of the total) [45]. In Australia, low fruit and vegetable consumption is estimated to be responsible for over 55,000 DALYs per year (2.1% of the total), which is a greater health burden than that attributable to illicit drugs, occupational exposures and hazards, or air pollution [42].

Much of the premature mortality and morbidity associated with low fruit and vegetable consumption is due to the increased risk of chronic disease. Evidence is presented below linking low fruit and vegetable consumption to a selected range of chronic diseases including cancers, cardiovascular disease and Chronic Obstructive Pulmonary Disease (COPD). The burden of these conditions that is attributable to inadequate fruit and vegetable consumption is also described.

Cancer

A substantial body of research has accumulated examining the relationship between fruit and vegetable consumption and cancer risk. Such research indicates that these foods protect against the development of certain types of cancers. However, the strength of the relationship is difficult to determine as many of the earlier investigations failed to control for potentially confounding lifestyle factors such as alcohol and tobacco use [46], and the synthesis of findings relied heavily on evidence from case-control

studies which may be adversely affected by recall and selection biases [47], and which may over-estimate the strength of the association [46].

In 1997, The World Cancer Research Fund (WCRF) together with the American Institute for Cancer Research commissioned a series of independent systematic reviews from academic institutions across the United States, the United Kingdom and Europe into the links between dietary intake and cancer [12]. The resulting report 'Food, Nutrition and the Prevention of Cancer: a global perspective' has been acknowledged as the most authoritative report in the field [12]. An updated report was published in 2007 and included the large volume of literature that emerged from the mid 1990s and addressed many of the methodological criticisms of the earlier report. In Table 1.1 and Table 1.2 below, the findings of the updated report are presented by type of cancer and by fruit and vegetable consumption separately. The report classifies the evidence as 'convincing', 'probable', 'limited - suggestive', or 'limited - inconclusive'¹ based on the type, number, methodology and size of included studies [12]. Tables 1.1 and 1.2 only include those cancers for which the evidence is at least 'suggestive' of a relationship with either fruit or vegetable consumption. Other cancers that were investigated as part of the World Cancer Research Fund report but that are not summarised below include cancers of the gallbladder, breast, cervix, prostate, kidney, bladder and skin [12].

¹ A judgement of 'convincing' generally required all of the following; evidence from more than one study type and at least two independent cohort studies of good quality, with no substantial unexplained heterogeneity, the presence of a 'dose response', and strong and plausible experimental evidence.

A judgement of 'probable' generally required all of the following; evidence from at least two independent cohort studies, or at least five case-controlled studies of good quality, with no substantial unexplained heterogeneity, and evidence for biological plausibility.

A judgement of 'limited - suggestive' reflected that the evidence shows a generally consistent direction of effect, but is insufficient to permit a probable or convincing judgement, due to either the limited amount of evidence or methodological flaws. All the following were generally required; evidence from at least two independent cohort studies or at least five case-controlled studies with direction of effect generally consistent, and evidence for biological plausibility.

A judgement of 'limited - no conclusion' reflected that the evidence is so limited that no firm conclusion can be made. For example, the evidence might be limited by the number of studies available, by the inconsistency of direction of effect, or by poor study quality.

Table 1.1: Evidence from WCRF for the association between fruit consumption and cancer type

CANCER TYPE	TYPE AND VOLUME OF EVIDENCE	RELATIONSHIP STRENGTH (BASED ON META-ANALYSIS)	WCRF CONCLUSION
Oesophagus	<ul style="list-style-type: none"> • 4 cohort, 36 case-control, 7 ecological studies • All cohort and most other studies found a protective effect 	<ul style="list-style-type: none"> • Per increase of 50g/day: <ul style="list-style-type: none"> - 22% reduced risk - 30% reduced risk (for citrus fruits) (case-control studies) 	Probable
Lung	<ul style="list-style-type: none"> • 25 cohort, 32 case-control, 7 ecological studies • Most studies showed decreased risk 	<ul style="list-style-type: none"> • Per increase of 80g/day: <ul style="list-style-type: none"> - 6% reduced risk (cohort studies) - 20% reduced risk (case-control studies) 	Probable
Stomach	<ul style="list-style-type: none"> • 16 cohort, 51 case-control, 23 ecological studies • Most showed decreased risk, but there was substantial heterogeneity and cohort studies suggested non-significant decreased risk 	<ul style="list-style-type: none"> • Per increase of 50g/day <ul style="list-style-type: none"> - 17% reduced risk (case-control studies) 	Probable
Mouth/Pharynx/Larynx	<ul style="list-style-type: none"> • 1 cohort, 35 case-control, 2 ecological studies • Most studies showed decreased risk 	<ul style="list-style-type: none"> • Per increase of 100g/day <ul style="list-style-type: none"> - 18% reduced risk - 24% reduced risk (for citrus fruits) (case-control studies) 	Probable
Pancreas	<ul style="list-style-type: none"> • 6 cohort, 16 case-control, 8 ecological studies • All cohort and most other studies showed decreased risk 	<ul style="list-style-type: none"> • Non-significant decrease (cohort studies) • Significantly decreased risk (case-control studies) 	Limited - suggestive
Liver	<ul style="list-style-type: none"> • 1 cohort, 5 case-control studies • Cohort and most other studies showed decreased risk 	<ul style="list-style-type: none"> • No meta-analysis results presented 	Limited - suggestive

CANCER TYPE	TYPE AND VOLUME OF EVIDENCE	RELATIONSHIP STRENGTH (BASED ON META-ANALYSIS)	WCRF CONCLUSION
Colo-rectum	<ul style="list-style-type: none"> • 20 cohorts, 57 case-control studies • more than half showed decreased risk (cohort studies) 	<ul style="list-style-type: none"> • Meta-analysis showed no association, but stratification by sex showed a statistically significantly decreased risk for women 	Limited - suggestive
Nasopharynx	<ul style="list-style-type: none"> • 6 case-control studies, most showed decreased risk • 5 case-control studies specific to citrus fruits – all showed decreased risk 	No meta-analysis results presented	Limited - suggestive

Table 1.2: Evidence from WCRF for the association between vegetable consumption and cancer type

CANCER TYPE	TYPE AND VOLUME OF EVIDENCE	RELATIONSHIP STRENGTH (BASED ON META-ANALYSIS)	WCRF CONCLUSION
Oesophagus	<ul style="list-style-type: none"> • 5 cohort, 37 case-control, 6 ecological studies • All studies with raw vegetables and most other studies showed decreased risk 	<ul style="list-style-type: none"> • Per increase of 50g/day: - 31% reduced risk (case-control studies) 	Probable
Lung	<ul style="list-style-type: none"> • 17 cohort, 27 case-control, 6 ecological studies • Most studies showed decreased risk with increased intake 	<ul style="list-style-type: none"> • Non-significant decrease (cohort studies) 	Limited – suggestive
Stomach	<ul style="list-style-type: none"> • 10 cohort, 45 case-control studies, 19 ecological studies • Most showed decreased risk, but cohort studies were less consistent than case-control 	<ul style="list-style-type: none"> • Per increase of 50g/day: -19 reduced risk (green-yellow vegetables) (cohort studies) -15% reduced risk (all vegetables) -21% - green-yellow risk 	Probable

CANCER TYPE	TYPE AND VOLUME OF EVIDENCE	RELATIONSHIP STRENGTH (BASED ON META-ANALYSIS)	WCRF CONCLUSION
		-57% - green leafy vegetables -30% - tomatoes -25% - raw vegetables (case-control studies)	
Colorectum	<ul style="list-style-type: none"> 17 cohort, 71 case-control studies 	<ul style="list-style-type: none"> Meta-analysis showed no association (cohort studies) 	Limited – suggestive
Ovary	<ul style="list-style-type: none"> 5 cohort, 8 case-control, 2 ecological studies All showed decreased risk 	<ul style="list-style-type: none"> Meta-analysis showed statistically significant decreased risk (cohort studies), but a previous pooled analysis of 12 cohort studies showed a non-significant decreased risk 	Limited – suggestive
Endometrium	<ul style="list-style-type: none"> 10 case-control studies Most showed decreased risk 	<ul style="list-style-type: none"> Meta-analysis showed decreased risk (case-control data) 	Limited – suggestive
Mouth/Pharynx/Larynx	<ul style="list-style-type: none"> 31 case-control, 3 ecological studies Most studies showed decreased risk 	<ul style="list-style-type: none"> Per increase of 50g/day: - 28% reduced risk 	Probable
Nasopharynx	<ul style="list-style-type: none"> 5 case-control, 2 ecological studies Nearly all studies showed decreased risk 	<ul style="list-style-type: none"> No meta-analysis results presented 	Limited - suggestive
<i>Vegetables in the WCRF report refers to 'non-starchy' vegetables</i>			

The World Cancer Research Fund concluded that there was probable evidence that fruit consumption protected against oesophageal, lung, stomach, and mouth / pharyngeal / laryngeal cancers, and that there was limited, although suggestive evidence of a protective effect against pancreatic, liver, colorectal, and nasopharyngeal cancers (WRCF). Similarly, it was concluded that vegetable consumption was probably protective against oesophageal, stomach, and mouth / pharyngeal / laryngeal cancers, and limited evidence suggested a protective effect of vegetable consumption against cancers of the lung, colon / rectum, ovary, endometrium and nasopharynx [12].

The Burden of Cancers Attributable to Low Fruit and Vegetable Consumption

If population level consumption were to rise to 600 grams per day, the worldwide burden of stomach and oesophageal cancers would be reduced by 19% and 20%, and the burden of lung and colorectal cancers would be reduced by 12% and 2% [21]. Australian data suggest that 2% of all cancers are attributable to low consumption of fruit and vegetables [42]. The health care cost of the cancer burden associated with low fruit and vegetable consumption is substantial with health costs from four of the five most common cancers (excluding melanoma) estimated to be \$58.8 million per year [48]. Increasing population level consumption could translate into significant cost savings with a one-serve increase in vegetable consumption decreasing the costs of these four cancers by \$24.4 million per year [48].

Coronary Heart Disease

Two large meta-analyses have found evidence of an inverse association between fruit and vegetable consumption and coronary heart disease risk [49, 50]. A meta-analysis of nine cohort studies consisting of over 200,000 individuals and over 5,000 coronary heart disease events found that each additional serve of fruit or vegetables per day decreased the risk of disease by 4% [49]. An analysis of 13 cohorts involving over 270,000 individuals and over 9,000 coronary heart disease events found that, compared to individuals consuming less than three fruit and vegetable serves per day, there was a 17% reduction in disease risk among those consuming more than five serves per day [50].

The Burden of Coronary Heart Disease Attributable to Low Fruit and Vegetable Consumption

Worldwide, heart disease attributable to low fruit and vegetable consumption is responsible for approximately 1.8 millions deaths per year [21]. In Australia, it is responsible for approximately 3,200 deaths (representing 2.4% of total deaths), and

causes significant disability, with almost 38,000 DALYs (1.4% of the total) attributable to this cause [42]. International estimates suggest that increasing fruit and vegetable intake by one serve daily would reduce the risk of coronary heart disease by approximately 10% [21], and that increasing fruit and vegetable consumption to 600 grams per day would reduce the worldwide burden of coronary heart disease by 31% [21]. No estimate of costs specifically attributable to fruit and vegetable related coronary heart disease could be located.

Stroke

High fruit and vegetable consumption appears to have a strong protective effect against stroke. A meta-analysis of data from two cohort studies (The Nurses' Health Study and The Health Professionals' Follow-up Study) analysed data from over 75,000 women and 38,000 men over 14 and 8 years respectively [51]. The analysis controlled for standard cardiovascular risk factors and found that consumption of an additional daily serve of fruit or vegetables was found to reduce the risk of ischemic stroke by 6% [51]. A subsequent meta-analysis combined data from nine independent cohorts consisting of over 250,000 individuals experiencing almost 5,000 stroke events over an average of 13 years [52]. Compared to those consuming less than 3 daily serves of fruit and vegetables, consumption of between 3 and 5 serves reduced the risk of stroke by 11%, and consumption of more than 5 serves was associated with a 26% reduced risk [52]. Green leafy vegetables, cruciferous vegetables and citrus fruits appear to contribute the most to protection against stroke [51].

The Burden of Stroke Attributable to Low Fruit and Vegetable Consumption

Stroke attributable to low fruit and vegetable consumption kills 474,000 people worldwide each year [21]. In Australia, low fruit and vegetable consumption is responsible for over 7,300 DALYs per year [42]. Increasing fruit and vegetable consumption to 600 grams per day is estimated to reduce worldwide stroke burden by 19% [21]. Estimates of the costs of stroke attributable to low fruit and vegetable consumption are not reported separately from the total attributable cardiovascular costs.

Chronic Obstructive Pulmonary Disease (COPD)

COPD refers to the range of diseases affecting the airways of the respiratory tract [40] and includes emphysema, chronic bronchitis and asthma [53]. Evidence is accumulating of an inverse association between fruit and vegetable consumption and

COPD risk with a review of five studies finding that high fruit and vegetable consumption may enhance lung function and reduce the COPD risk [40].

The Burden of COPD Attributable to Low Fruit and Vegetable Consumption

No estimates of the COPD burden specifically attributable to low fruit and vegetable consumption could be located and similarly, no estimates of the financial cost of COPD attributable to low fruit and vegetable consumption could be found.

Type 2 Diabetes

It appears as though a protective effect against type 2 diabetes may be specific only to certain types of fruit and vegetables [54]. Two meta-analyses of cohort studies of over 167,000 and 223,000 individuals found no significant association with diabetes risk [54, 55]. However, an analysis of four cohort studies that specifically reported participants' intake of leafy green vegetables found that each study demonstrated a decreased diabetes risk at higher consumption levels [55]. Further research is needed to determine which fruits and vegetable have a protective effect and to determine the strength of such a relationship.

The Burden of Type 2 Diabetes Attributable to Low Fruit and Vegetable Consumption

Following a dramatic increase over the past two decades, current estimates of the international and Australian prevalence of type 2 diabetes are 6.4% and 3.8% respectively [56, 57]. As further evidence regarding the nature of the association with fruit and vegetable consumption is needed, no estimates could be identified of the burden of type 2 diabetes specifically attributable to low fruit and vegetable consumption. However, based on the analysis of studies specifically investigating the consumption of leafy green vegetables, it appears that an increase in consumption of such foods by approximately 120 grams per day could result in a 14% reduction in the incidence of type 2 diabetes [55]. No measures of the fruit and vegetable specific burden of disease, or associated costs could be found.

Obesity

A review of studies published from 1966 to 2003 found that despite a tendency for higher body mass index (BMI) and lower fruit and vegetable intake to occur together in adults, there was insufficient evidence of an association between fruit and vegetable intake and weight [58]. Newby and colleagues reviewed three cohort studies, all of which showed no association between fruit and vegetable consumption and obesity,

and ten cross-sectional studies, most of which also failed to show an association [59]. Ledoux and colleagues subsequently reviewed twelve intervention studies (one involving children) and eleven longitudinal studies (four involving children) published from 1980 to 2009 that tested the association between fruit and vegetable intake and adiposity [60]. They concluded that there was a weak relationship with weight-loss in overweight adults but that the association in children remained unclear [60]. A review of how fruit and vegetable consumption affects satiety, food intake, and body weight found some evidence that fruit and vegetable consumption may displace the consumption of high energy density foods and hence may lead to weight loss, with evidence supporting two hypothesised mechanisms of weight maintenance [30]. First, the low-density, high-water and high-fibre content of fruit and vegetables may promote satiety (i.e. a state of non-hunger) [30]. Second, fruit and vegetable consumption may effect satiation (i.e. the process that ends an eating episode) as evidence suggests a decrease in the energy density of foods consumed is associated with a spontaneous decrease in energy intake [30]. The review authors concluded that fruit and vegetables play an important role in weight management [30].

The Burden of Obesity Attributable to Low Fruit and Vegetable Consumption

Estimates of the burden of obesity that is specifically attributable to low fruit and vegetable consumption could not be located, nor could an estimate of the financial costs of obesity attributable to low fruit and vegetable consumption, most likely because evidence of this association is still accumulating and is yet to be established.

Review of Chronic Diseases

There is, therefore, substantial evidence supporting an association between higher fruit and vegetable consumption and lower risk of developing chronic diseases, especially certain types of cancer and cardiovascular diseases [40]. Furthermore, in addition to the diseases reviewed above, evidence is accumulating of an association between consumption of these foods and obesity and type 2 diabetes. The chronic diseases for which evidence of an association with fruit and vegetable consumption is strongest are also among the diseases responsible for the highest mortality, morbidity and costs to the healthcare system [61, 62].

The Case for Addressing Fruit and Vegetable Consumption in Early Childhood

Given the high prevalence of inadequate fruit and vegetable consumption across all ages [21], initiatives to increase consumption are required across the lifespan.

Interventions targeting preschool-aged children (those aged 3 to 5 years [63]), however, may have particular merit given: the high prevalence of inadequate fruit and vegetable consumption among children of this age; the protective effect of childhood fruit and vegetable consumption against future chronic diseases; that preschool years represent a developmentally appropriate period for intervention; the importance of the preschool years in establishing food preferences; and evidence suggesting that the dietary habits of childhood persist into adulthood. Evidence in support of this rationale is described below.

High Prevalence of Inadequate Fruit and Vegetable Consumption

Evidence from epidemiological surveys indicates that inadequate fruit and vegetable consumption is common among young children. The United States National Health and Nutrition Examination Survey (1999-2000) indicated that 52% of children aged 2 to 3 years were not meeting the recommended guidelines for fruit and vegetable consumption [64]. Similarly, the more recent Feeding Infants and Toddlers Study (FITS), involving over 3,000 American infants and toddlers, found that up to one third consumed no vegetables or fruit, and among 15 to 18 month-olds, the most common 'vegetable' consumed was French Fries [65]. Findings from the United Kingdom are similar with the National Diet and Nutrition Survey reporting that the variety and quantity of fruit and vegetables consumed by preschool children were very limited. For example, the vegetable consumed in the greatest quantity was baked beans and less than 24% of children surveyed consumed raw vegetables and salads [66]. The 2007 Australian National Children's Nutrition and Physical Activity Survey indicated that 32% of Australian 2 to 3 year-olds consumed inadequate quantities of fruit (excluding juice), and 86% consumed inadequate quantities of vegetables [18]. The consistency with which such population surveys have demonstrated inadequate fruit and vegetable intake among children in early childhood and the high prevalence of this problem in developing nations including Australia provides a convincing basis regarding the need for interventions to increase fruit and vegetable consumption among children of this age.

Protection Against Future Chronic Disease

Beyond imparting immediate health benefits to the child [37], evidence from longitudinal studies suggests that higher fruit and vegetable consumption in childhood may be protective against future chronic disease, with the fruit and vegetable consumption patterns originating in childhood influencing the risk of some cancers and cardiovascular diseases among adults [67, 68]. The strongest evidence for this

relationship comes from the Boyd Orr cohort, which consisted of 4,999 British and Scottish children (aged 0 to 19 years, with a mean age of 8 years) who completed a one-week diet inventory between the years of 1937 and 1939 [67]. Follow-up information was obtained through tracing participants through the National Health Service central register, death certificates, and cancer registries. One study using this dataset reported all-cause mortality and deaths attributed to cardiovascular disease as recorded up until the year 2000, with the average length of follow-up being 37 years [67]. The study found that higher consumption of vegetables in childhood was associated with a lower risk of stroke in adulthood [67]. A related study with over 60 years of follow-up data from over 3,800 participants found that higher fruit consumption in childhood was associated with a lower risk of cancer in adulthood [68]. Collectively, these studies suggest that childhood fruit and vegetable consumption may have a long-term protective effect on premature death due to chronic diseases such as cancer and stroke.

A Developmentally Appropriate Period for Intervention

In the first five years of life, children learn more about food and eating than in any other developmental period [69]. During early childhood a basic knowledge of food develops and children establish an understanding of behavioural norms regarding eating and meal routines [70]. Children of preschool age are responsive to opportunities for social learning and are imitative of the dietary behaviours and eating habits that they observe [71]. Intervention at an earlier developmental stage may be more successful than at later stages as dietary behaviours and habits that are forming are more amenable to change than the ingrained habits of late childhood or adulthood [72]. This sensitive developmental period therefore represents an opportune time for intervention to establish healthy dietary behaviours [69].

The Establishment of Dietary Preferences

The preschool years are often characterised by neophobia or the tendency to reject novel foods [73]. Neophobic reactions of children toward vegetables are particularly common in early childhood [74]. For example, a study of 129 children found that vegetables comprised 46% of the foods that parents reported their children would not consume [75]. Neophobic behaviours represent a significant impediment to the establishment of a healthy and varied child diet [76] and can strengthen with age throughout childhood [73, 77, 78]. Encouragingly, neophobia can be reduced through early intervention such as repeated child exposure to disliked or novel foods [79]. Such

intervention in early childhood is important to avert the potential adverse consequences on child diet with respect to the aversion of vegetable and fruit consumption.

The Persistence of Childhood Dietary Habits

The eating habits established in early childhood serve as the foundation for future eating patterns [80]. For example, exposure to fruit in the first two years of life is associated with consumption of a wider variety of fruits at the time when the child starts school [81]. Results from longitudinal studies suggest that the dietary habits formed at a young age are maintained over time. A British study found that the dietary patterns (categorised as 'junk', 'traditional', or 'healthy') of children at age four were still present at age seven [82]. This finding was supported by evidence from the Framingham Children's Study which measured children's intake of ten nutrients, beginning when they were 3 to 4 years and following them up at multiple points over a 6-year period [83]. For all nutrients, among the children in the highest intake quintile at baseline, 40-67% remained in the top quintile and 60-93% were positioned in the top two quintiles at 7 to 8 years, suggesting that tracking of nutrient intake may begin as early as 3 or 4 years of age [83]. The Cardiovascular Risk in Young Finns Study was a prospective cohort study that followed up children as young as 3 years old for a period of 21 years. It was found that childhood dietary patterns were significant predictors of adult diet after 21 years, suggesting the eating habits established in childhood are maintained into adulthood [84]. As such, nutrition intervention in early childhood has the potential to also affect the dietary habits of adulthood.

The Importance of the Home Food Environment:

The most effective way of delivering nutritional interventions to improve the dietary patterns of young children remains unclear. One approach is to consider key settings that are influential in the developmental process. In the case of young children, the childcare setting, family/community service settings, and the home represent environments in which young children spend time, and in which they could be exposed to intervention strategies. Evidence suggests that the home environment is likely to be influential with systematic reviews finding a relationship between child dietary intake and; parent intake [85-87]; the availability and accessibility of foods within the home [85-87]; as well as family routines and rules regarding eating [85, 86]. Furthermore, exposure to interventions delivered in the home have greater potential for high levels of exposure given this is the setting where children most of their time and where they consume most of their food [88].

The Context of this Thesis

At the time of writing this thesis, increasing child fruit and vegetable consumption was recognised as a priority of public health nutrition nationally and internationally [29, 89]. The need for action is reflected in the health priorities set by developed countries including the United States, United Kingdom and Australia. In the United States, for example, the Healthy People 2020 framework guides the nation's health promotion and disease prevention strategies [90], and its objectives for individuals over the age of 2 years include: to increase fruit consumption to the level of 0.9 cup (or equivalent) per 1,000 calories consumed; and to increase vegetable consumption to the level of 1.1 cups (or equivalent) per 1,000 calories consumed [91]. Similarly, children in the United Kingdom are encouraged via national campaigns to consume '5 a day' [17]. To facilitate such improvements in public health nutrition, governments of these countries have implemented a range of health promotion, social marketing and educational initiatives [92-94].

In Australia, both state and federal initiatives are being developed and actioned to encourage children to increase their fruit and vegetable intake. The most significant initiatives pertain to The National Preventative Health Strategy. This Strategy identifies the national preventative health care priorities for the next decade and describes how they should be addressed through the collaborative efforts of a range of national, state and local agencies and partners [95]. The Strategy, introduced in 2009, includes targets to increase the proportion of children meeting Australian Dietary Guidelines by 15% within six years [95]. In response to this strategy, Australian states and territories have set targets and are currently developing and implementing strategies to increase child fruit and vegetable intake [96, 97].

Thesis Aims

This thesis has been undertaken in the context of such public health concern and calls to action to address child fruit and vegetable intake. The research reported in this thesis therefore represents a timely contribution to the evidence base. This thesis sought to review the evidence for interventions, to investigate factors associated with higher childhood fruit and vegetable intake, and to design and rigorously evaluate an intervention program in order to provide practice-relevant information to policy makers and practitioners tasked with implementing initiatives to increase fruit and vegetable intake among children in the community.

The aims of this thesis are as follows:

- To review the existing evidence for the efficacy of interventions to increase the fruit and vegetable consumption of preschool children,
- To identify the characteristics of the home food environment that are associated with higher levels of fruit and vegetable consumption in preschool children,
- To develop, pilot and evaluate an intervention to increase the consumption of fruit and vegetables among preschool children, and
- To provide recommendations for future research and practice regarding interventions to increase the fruit and vegetable consumption of preschool children.

Thesis Structure

This thesis takes the form of a series of papers that have been published or submitted for publication, and conforms to the University of Newcastle rules regarding thesis submission by publication. Following this introductory chapter, this thesis presents a series of papers that address the thesis aims.

Chapter 2:

A systematic review investigating interventions for increasing fruit and vegetable consumption in children aged 0 to 5 years.

Chapter 3:

A cross-sectional study investigating the associations between characteristics of the home food environment and preschool children's fruit and vegetable consumption.

Chapter 4:

A pre-post pilot study of an intervention to increase fruit and vegetable consumption in preschool children.

Chapter 5:

A detailed protocol outlining the methods of the randomised controlled trial and a paper describing the 2- and 6-month trial outcomes.

Chapter 6:

A review and synthesis of the findings of the above papers, plus a discussion of the implications for practice and suggested directions for future research.

References

1. World Health Organization and the Food and Agriculture Organization of the United Nations: **Diet, nutrition and the prevention of chronic diseases: report of a joint WHO/FAO expert consultation**. Geneva: WHO/FAO; 2003.
2. Drewnowski A, Popkin BM: **The nutrition transition: new trends in the global diet**. *Nutr Rev* 1997, **55**(2):31-43.
3. Popkin BM: **Global nutrition dynamics: the world is shifting rapidly toward a diet linked with noncommunicable diseases**. *Am J Clin Nutr* 2006, **84**(2):289-298.
4. Popkin BM: **The shift in stages of the nutrition transition in the developing world differs from past experiences!** *Public Health Nutr* 2002, **5**(1A):205-214.
5. National Health and Medical Research Council: **Dietary Guidelines for Australian Adults** Canberra: NHMRC; 2003.
6. Baghurst P, Beaumont-Smith N, Baghurst K, Cox DS: **The relationship between the consumption of fruits and vegetables and health status: Report to Department of Health and Aged Care and the Strategic Intergovernmental Nutrition Alliance** CSIRO; 1999.
7. Yngve A, Wolf A, Poortvliet E, Elmadfa I, Brug J, Ehrenblad B, Franchini B, Haraldsdottir J, Krolner R, Maes L *et al*: **Fruit and vegetable intake in a sample of 11-year-old children in 9 European countries: The Pro Children Cross-sectional Survey**. *Ann Nutr Metab* 2005, **49**(4):236-245.
8. World Health Organization and Food and Agriculture Organization of the United Nations: **Report of a Joint FAO/WHO Workshop, 1-3 September, 2004**. Kobe: FAO/WHO; 2005.
9. Kellet E, Smith A, Schmerlaib Y: **The Australian Guide to Healthy Eating: Background information for consumers**. The Australian Government Department of Health and Ageing; 1998.

10. Magarey A, Golley R, Spurrier N, Goodwin E, Ong F: **Reliability and validity of the Children's Dietary Questionnaire; a new tool to measure children's dietary patterns.** *Int J Pediatr Obes* 2009, **4**(4):257-265.
11. World health Organization and Food and Agriculture Organization of the United Nations: **Joint WHO/FAO Expert Consultation on Diet, Nutrition and the Prevention of Chronic Diseases** Geneva: WHO/FAO; 2002.
12. World Cancer Research Fund / American Institute for Cancer Research: **Food, Nutrition, Physical Activity, and the Prevention of Cancer: a Global Perspective.** Washington DC: AICR; 2007.
13. **British Nutrition Foundation: A healthy varied diet**
[<http://www.nutrition.org.uk/healthyliving/healthyeating/a-healthy-varied-diet?start=3>]. Accessed 9 January 2012.
14. Ministry of Health: **Food and Nutrition Guidelines for Healthy Adults: A background paper.** Wellington: Ministry of Health; 2003.
15. U.S. Department of Agriculture and U.S. Department of Health and Human Services: **Dietary Guidelines for Americans, 2010.** Washington: U.S. Government; 2010.
16. **United States Department of Agriculture: Choose My Plate**
[<http://www.choosemyplate.gov/>]. Accessed 19 January 2012.
17. **The National Health Service: 5 A DAY and your family**
[<http://www.nhs.uk/Livewell/5ADAY/Pages/Family.aspx>]. Accessed January 2012.
18. Commonwealth Scientific Industrial Research Organisation: **2007 Australian National Children's Nutrition and Physical Activity Survey: Main Findings.** CSIRO; 2008.
19. Magarey A, Daniels LA, Smith A: **Fruit and vegetable intakes of Australians aged 2-18 years: an evaluation of the 1995 National Nutrition Survey data.** *Aust N Z J Public Health* 2001, **25**(2):155-161.
20. World Health Organization: **Global Health Risks: Mortality and burden of disease attributable to selected major risks.** France: WHO; 2009.

21. Lock K, Pomerleau J, Causer L, Altmann DR, McKee M: **The global burden of disease attributable to low consumption of fruit and vegetables: implications for the global strategy on diet.** *Bull World Health Organ* 2005, **83**(2):100-108.
22. Joffe M, Robertson A: **The potential contribution of increased vegetable and fruit consumption to health gain in the European Union.** *Public Health Nutr* 2001, **4**(4):893-901.
23. Allender S, Peto V, Scarborough P, Boxer A, Rayner M: **Diet, physical activity and obesity statistics.** London: British Heart Foundation; 2006.
24. Vereecken CA, Inchley J, Subramanian SV, Hublet A, Maes L: **The relative influence of individual and contextual socio-economic status on consumption of fruit and soft drinks among adolescents in Europe.** *Eur J Public Health* 2005, **15**(3):224-232.
25. Irala-Estevez JD, Groth M, Johansson L, Oltersdorf U, Prattala R, Martinez-Gonzalez MA: **A systematic review of socio-economic differences in food habits in Europe: consumption of fruit and vegetables.** *Eur J Clin Nutr* 2000, **54**(9):706-714.
26. Magarey A, McKean S, Daniels L: **Evaluation of fruit and vegetable intakes of Australian adults: the National Nutrition Survey 1995.** *Aust N Z J Public Health* 2006, **30**(1):32-37.
27. Flood V, Hector D, Story L. **Report on the consumption of vegetables and fruit in NSW: 2003.** NSW Centre for Public Health Nutrition. In *State of Food and Nutrition in NSW Series* Sydney; 2003.
28. Giskes K, Turrell G, Patterson C, Newman B: **Socio-economic differences in fruit and vegetable consumption among Australian adolescents and adults.** *Public Health Nutr* 2002, **5**(5):663-669.
29. **Food and Agriculture Organization of the United Nations: Increasing fruit and vegetable consumption becomes a global priority**
[http://www.fao.org/english/newsroom/focus/2003/fruitveg1.htm#_jmp0_]. Accessed January 2012.

30. Rolls BJ, Ello-Martin JA, Tohill BC: **What can intervention studies tell us about the relationship between fruit and vegetable consumption and weight management?** *Nutr Rev* 2004, **62**(1):1-17.
31. Kelsay JL, Behall KM, Prather ES: **Effect of fiber from fruits and vegetables on metabolic responses of human subjects I. Bowel transit time, number of defecations, fecal weight, urinary excretions of energy and nitrogen and apparent digestibilities of energy, nitrogen, and fat.** *Am J Clin Nutr* 1978, **31**(7):1149-1153.
32. Roma E, Adamidis D, Nikolara R, Constantopoulos A, Messaritakis J: **Diet and chronic constipation in children: the role of fiber.** *J Pediatr Gastroenterol Nutr* 1999, **28**(2):169-174.
33. Kranz S, Mitchell DC, Siega-Riz AM, Smiciklas-Wright H: **Dietary fiber intake by American preschoolers is associated with more nutrient-dense diets.** *J Am Diet Assoc* 2005, **105**(2):221-225.
34. de Leeuw JA, Jongbloed AW, Verstegen MW: **Dietary fiber stabilizes blood glucose and insulin levels and reduces physical activity in sows (*Sus scrofa*).** *J Nutr* 2004, **134**(6):1481-1486.
35. John JH, Ziebland S, Yudkin P, Roe LS, Neil HA: **Effects of fruit and vegetable consumption on plasma antioxidant concentrations and blood pressure: a randomised controlled trial.** *Lancet* 2002, **359**(9322):1969-1974.
36. Smith-Warner SA, Elmer PJ, Tharp TM, Fosdick L, Randall B, Gross M, Wood J, Potter JD: **Increasing vegetable and fruit intake: randomized intervention and monitoring in an at-risk population.** *Cancer Epidemiol Biomarkers Prev* 2000, **9**(3):307-317.
37. Dye BA, Shenkin JD, Ogden CL, Marshall TA, Levy SM, Kanellis MJ: **The relationship between healthful eating practices and dental caries in children aged 2–5 years in the United States, 1988–1994.** *J Am Dent Assoc* 2004, **135**(1):55-66.
38. Tylansky FA, 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.** *Am J Clin Nutr* 2004, **79**:311-317.

39. Moreira P, Santos S, Padrão P, Cordeiro T, Bessa M, Valente H, Barros R, Teixeira V, Mitchell V, Lopes C, Moreira A: **Food patterns according to sociodemographics, physical activity, sleeping and obesity in Portuguese children.** *Int J Environ Res Public Health* 2010, **7**:1121-1138.
40. Van Duyn MA, Pivonka E: **Overview of the health benefits of fruit and vegetable consumption for the dietetics professional: Selected literature** *J Am Diet Assoc* 2000, **100**:1511-1521.
41. Buchner FL, Bueno-de-Mesquita HB, Ros MM, Overvad K, Dahm CC, Hansen L, Tjonneland A, Clavel-Chapelon F, Boutron-Ruault MC, Touillaud M *et al*: **Variety in fruit and vegetable consumption and the risk of lung cancer in the European prospective investigation into cancer and nutrition.** *Cancer Epidemiol Biomarkers Prev* 2010, **19**(9):2278-2286.
42. Begg S, Vos T, Barker B, Stevenson C, Stanley L, Lopez A: **The burden of disease and injury in Australia 2003.** Canberra: AIHW; 2007.
43. Tobias M, Turley M, Stefanogiannis N, Vander Hoorn S, Lawes C, Mhurchu CN, Rodgers A: **Vegetable and fruit intake and mortality from chronic disease in New Zealand.** *Aust N Z J Public Health* 2006, **30**(1):26-31.
44. Lock K, Pomerleau J, Causer L, McKee M: **Low fruit and vegetable consumption** In *Comparative Quantification of Health Risks: Global and Regional Burden of Disease Attributable to Selected Major Risk Factors. Volume 1.* Edited by Ezzati M, Lopez A, Rodgers A, Murray C. Geneva: World Health Organization; 2004.
45. Schneider M, Norman R, Steyn N, Bradshaw D: **Estimating the burden of disease attributable to low fruit and vegetable intake in South Africa in 2000.** *S Afr Med J* 2007, **97**(8 Pt 2):717-723.
46. Key TJ: **Fruit and vegetables and cancer risk.** *Br J Cancer* 2011, **104**(1):6-11.
47. Michels KB, Edward G, Joshipura KJ, Rosner BA, Stampfer MJ, Fuchs CS, Colditz GA, Speizer FE, Willett WC: **Prospective study of fruit and vegetable consumption and incidence of colon and rectal cancers.** *J Natl Cancer Inst* 2000, **92**(21):1740-1752.

48. Marks G, Pang G, Coyne T, Picton P: **Cancer costs in Australia - the potential impact of dietary change**. Herston: Australian Food and Nutrition Monitoring Unit; 2001.
49. Dauchet L, Amouyel P, Hercberg S, Dallongeville J: **Fruit and vegetable consumption and risk of coronary heart disease: a meta-analysis of cohort studies**. *J Nutr* 2006, **136**(10):2588-2593.
50. He FJ, Nowson CA, Lucas M, MacGregor GA: **Increased consumption of fruit and vegetables is related to a reduced risk of coronary heart disease: meta-analysis of cohort studies**. *J Hum Hypertens* 2007, **21**(9):717-728.
51. Joshipura KJ, Ascherio A, Manson JE, Stampfer MJ, Rimm EB, Speizer FE, Hennekens CH, Spiegelman D, Willett WC: **Fruit and vegetable intake in relation to risk of ischemic stroke**. *JAMA* 1999, **282**(13):1233-1239.
52. He FJ, Nowson CA, MacGregor GA: **Fruit and vegetable consumption and stroke: meta-analysis of cohort studies**. *Lancet* 2006, **367**(9507):320-326.
53. Schunemann HJ, Freudenheim JL, Grant BJ: **Epidemiologic evidence linking antioxidant vitamins to pulmonary function and airway obstruction**. *Epidemiol Rev* 2001, **23**(2):248-267.
54. Hamer M, Chida Y: **Intake of fruit, vegetables, and antioxidants and risk of type 2 diabetes: systematic review and meta-analysis**. *J Hypertens* 2007, **25**(12):2361-2369.
55. Carter P, Gray LJ, Troughton J, Khunti K, Davies MJ: **Fruit and vegetable intake and incidence of type 2 diabetes mellitus: systematic review and meta-analysis**. *BMJ* 2010, **341**:c4229.
56. Shaw JE, Sicree RA, Zimmet PZ: **Global estimates of the prevalence of diabetes for 2010 and 2030**. *Diabetes Res Clin Pract* 2010, **87**(1):4-14.
57. Australian Institute of Health and Welfare: **Diabetes prevalence in Australia: Detailed estimates for 2007–08**. In *Diabetes series no 17 Cat no CVD 56*. Canberra: AIHW; 2011.

58. Tohill BC, Seymour J, Serdula M, Kettel-Khan L, Rolls BJ: **What epidemiologic studies tell us about the relationship between fruit and vegetable consumption and body weight.** *Nutr Rev* 2004, **62**(10):365-374.
59. Newby PK: **Plant foods and plant-based diets: protective against childhood obesity?** *Am J Clin Nutr* 2009, **89**(5):1572S-1587S.
60. Ledoux TA, Hingle MD, Baranowski T: **Relationship of fruit and vegetable intake with adiposity: a systematic review.** *Obes Rev* 2011, **12**(5):e143-150.
61. Neiderlaender E: **Causes of death in the EU.** In *Statistics in Focus: Population and Social Conditions*. European Communities; 2006.
62. Olin G, Rhoades J: **The five most costly medical conditions, 1997 and 2002: Estimates for the U.S. civilian noninstitutionalized population.** In *Statistical Brief #80*. Rockville: Agency for Healthcare Research and Quality; 2005.
63. National Health and Medical Research Council: **Dietary Guidelines for Children and Adolescents in Australia incorporating the Infant Feeding Guidelines for Health Workers.** Commonwealth of Australia; 2003.
64. Guenther PM, Dodd KW, Reedy J, Krebs-Smith SM: **Most Americans eat much less than recommended amounts of fruits and vegetables.** *J Am Diet Assoc* 2006, **106**(9):1371-1379.
65. Fox MK, Pac S, Devaney B, Jankowski L: **Feeding infants and toddlers study: What foods are infants and toddlers eating?** *J Am Diet Assoc* 2004, **104**(1 Suppl 1):s22-30.
66. Gregory J, Collins D, Davies P, Hughes J, Clarke P: **National Diet and Nutrition Survey: children aged 1½ to 4½ years, Volume 1: Report of the Diet and Nutrition Survey.** London: HMSO; 1995.
67. Ness AR, Maynard M, Frankel S, Smith GD, Frobisher C, Leary SD, Emmett PM, Gunnell D: **Diet in childhood and adult cardiovascular and all cause mortality: the Boyd Orr cohort.** *Heart* 2005, **91**(7):894-898.
68. Maynard M, Gunnell D, Emmett P, Frankel S, Davey Smith G: **Fruit, vegetables, and antioxidants in childhood and risk of adult cancer: the Boyd Orr cohort.** *J Epidemiol Community Health* 2003, **57**(3):218-225.

69. Birch LL, Ventura AK: **Preventing childhood obesity: what works?** *Int J Obes (Lond)* 2009, **33 Suppl 1**:S74-81.
70. Department of Human Services: **Promoting healthy eating for children: A planning guide for practitioners.** Victorian Government Department of Human Services; 1995.
71. Dennison B, Faith M: **Prevention of Childhood Obesity in Childcare Settings.** *Handbook of Childhood and Adolescent Obesity: Issues in Clinical Child Psychology* 2009:313-330.
72. Vance B: *Teaching the prekindergarten child: instructional design and curriculum.* Monterey: Brooks/Cole; 1973.
73. Birch LL: **Development of food preferences.** *Annu Rev Nutr* 1999, **19**(1):41-62.
74. Jacobi C, Agras WS, Bryson S, Hammer LD: **Behavioral validation, precursors, and concomitants of picky eating in childhood.** *J Am Acad Child Adolesc Psychiatry* 2003, **42**(1):76-84.
75. Cashdan E: **Adaptiveness of food learning and food aversions in children.** *Soc Sc Inform* 1998, **37**(4):613-632.
76. Dovey TM, Staples PA, Gibson EL, Halford JC: **Food neophobia and 'picky/fussy' eating in children: a review.** *Appetite* 2008, **50**(2-3):181-193.
77. Skinner JD, Carruth BR, Wendy B, Ziegler PJ: **Children's food preferences: a longitudinal analysis.** *J Am Diet Assoc* 2002, **102**(11):1638-1647.
78. Carruth BR, Ziegler PJ, Gordon A, Barr SI: **Prevalence of picky eaters among infants and toddlers and their caregivers' decisions about offering a new food.** *J Am Diet Assoc* 2004, **104**(1):s57-64.
79. Tedstone AE, Aviles M, Shetty PS, Daniels LA: **Effectiveness of interventions to promote healthy eating in preschool children aged 1 to 5 years.** Edited by Meyrick J. London: Health Education Authority; 1998.
80. Savage JS, Fisher JO, Birch LL: **Parental influence on eating behavior: conception to adolescence.** *J Law Med Ethics* 2007, **35**(1):22-34.

81. Skinner JD, Carruth BR, Bounds W, Ziegler P, Reidy K: **Do food-related experiences in the first 2 years of life predict dietary variety in school-aged children?** *J Nutr Educ Behav* 2002, **34**(6):310-315.
82. Northstone K, Emmett P: **Multivariate analysis of diet in children at four and seven years of age and associations with socio-demographic characteristics.** *Eur J Clin Nutr* 2005, **59**(6):751-760.
83. Singer MR, Moore LL, Garrahe EJ, Ellison RC: **The tracking of nutrient intake in young children: the Framingham Children's Study.** *Am J Public Health* 1995, **85**(12):1673-1677.
84. Mikkila V, Rasanen L, Raitakari OT, Pietinen P, Viikari J: **Longitudinal changes in diet from childhood into adulthood with respect to risk of cardiovascular diseases: The Cardiovascular Risk in Young Finns Study.** *Eur J Clin Nutr* 2004, **58**(7):1038-1045.
85. Rasmussen M, Krolner R, Klepp KI, Lytle L, Brug J, Bere E, Due P: **Determinants of fruit and vegetable consumption among children and adolescents: a review of the literature. Part I: Quantitative studies.** *Int J Behav Nutr Phys Act* 2006, **3**:22.
86. Pearson N, Biddle SJ, Gorely T: **Family correlates of fruit and vegetable consumption in children and adolescents: a systematic review.** *Public Health Nutr* 2008, **12**(2):267-283.
87. Blanchette L, Brug J: **Determinants of fruit and vegetable consumption among 6-12-year-old children and effective interventions to increase consumption.** *J Hum Nutr Diet* 2005, **18**:431-443.
88. Adair LS, Popkin BM: **Are child eating patterns being transformed globally?** *Obes Res* 2005, **13**(7):1281-99.
89. Pollard CM, Lewis JM, Binns CW: **Selecting interventions to promote fruit and vegetable consumption: from policy to action, a planning framework case study in Western Australia.** *Aust New Zealand Health Policy* 2008, **5**:27.
90. **Office of Disease Prevention and Health Promotion: Healthy People 2020** [http://www.healthypeople.gov/2020/TopicsObjectives2020/pdfs/HP2020_brochure.pdf]. Accessed November 2011.

91. **Office of Disease Prevention and Health Promotion: Healthy People 2020 Objective Topic Areas**
[<http://www.healthypeople.gov/2020/topicsobjectives2020/pdfs/HP2020objectives.pdf>]. Accessed November 2011.
92. **The National Health Service: 5 A DAY**
[<http://www.nhs.uk/Livewell/5ADAY/Pages/5ADAYhome.aspx>]. Accessed January 2012.
93. **Centers for Disease Control and Prevention: Fruits and Veggies Matter**
[<http://www.fruitsandveggiesmatter.gov/qa/index.html#1>]. Accessed 11 November 2011.
94. Centers for Disease Control and Prevention: **The CDC guide to fruit and vegetable strategies to increase access, availability and consumption**. CDC; 2010.
95. Preventative Health Taskforce: **Australia: The Healthiest Country by 2020: National Preventative Health Strategy – Overview**. Barton; 2009.
96. Division of the Chief Health Officer: **Preventative Health: Strategic Directions 2010-2013**. Brisbane: Queensland Health; 2010.
97. Centre for Health Advancement: **National Partnership Agreement on Preventive Health: NSW Healthy Children's Initiative discussion paper**. Sydney: NSW Health; 2010.

CHAPTER TWO:

Systematic review of interventions for increasing fruit and vegetable consumption in children aged up to 5 years

This chapter is based on a published review protocol and a systematic review submitted for publication:

Wolfenden L, Wyse RJ, Britton BI, Campbell KJ, Hodder RK, Stacey FG, McElduff P, James EL. **Interventions for increasing fruit and vegetable consumption in preschool aged children (Protocol)**. *Cochrane Database of Systematic Reviews* 2010, Issue 6.

Wolfenden L, Wyse RJ, Britton BI, Campbell KJ, Hodder RK, Stacey FG, McElduff P, James EL. **Interventions for increasing fruit and vegetable consumption in children aged 5 years and under**. *Cochrane Database of Systematic Reviews* 2012, Issue 11.

Background

Description of the Condition

Insufficient consumption of fruits and vegetables is associated with micronutrient deficiencies and a range of chronic diseases such as cancer and cardiovascular disease [1]. Globally, 1.8% of the total burden of disease, and over 2.6 million deaths each year are attributable to inadequate fruit and vegetable intake [2]. Consumption of at least 400 grams per day of fruit and vegetables is recommended to reduce the risk of chronic diseases [3]. Nationally representative surveys, however, indicate that throughout most regions of the globe, daily consumption of fruits and vegetables is well below such recommendations [2].

Population surveys of children indicate the need to increase the intake of fruits and vegetables [2, 4, 5]. For example, less than a third of school-aged children from European nations report consuming vegetables on a daily basis [4]. While the mean intake of fruit and vegetables is below the WHO recommendations across all WHO regions, South American, African, and South East Asian nations report the lowest quantities of child fruit and vegetable consumption [2].

Longitudinal studies suggest that eating behaviours established in childhood are likely to persist into adulthood [6, 7]. Encouraging healthy eating among children may therefore represent a particularly effective primary prevention strategy for reducing the risk of chronic diseases [8, 9]. In addition, adequate fruit and vegetable intake during childhood may have a number of immediate beneficial impacts, including reducing the risk of a number of respiratory illnesses [10, 11].

Description of the Intervention

The etiology of fruit and vegetable consumption is complex, involving the dynamic interaction of a variety of factors. Given such complexity, a number of frameworks have been utilised to guide the development of interventions to increase fruit and vegetable intake [12-14]. The conceptual framework developed for the international Pro Children Project suggests that interventions targeting a variety of cultural, physical and social environment factors, as well as those targeting personal factors may be effective in positively influencing fruit and vegetable intake among children [12].

Despite the range of potential intervention targets, previous trials have tended to focus on those determinants more amenable to intervention, such as nutrition knowledge and skills, or the food environment of settings such as schools [15]. Among school-aged

children, systematic reviews suggest that the strongest evidence exists for the efficacy of interventions specifically targeting fruit and vegetable consumption rather than broader healthy eating interventions, multi-component school-based interventions, and interventions incorporating a parent or family element [16]. Similar strategies would be hypothesised to be effective for preschool-aged children.

How the Intervention Might Work

A number of theories have been used to explain a mechanism by which interventions may be able to influence the fruit and vegetable consumption of children [16]. In most instances, psychosocial theories such as Social Cognitive Theory [17], the Theory of Planned Behaviour [18], or the Transtheoretical Model [19] have been used to explain possible causal pathways to fruit and vegetable consumption [16]. Collectively, such theories assert that changes to attitudes, knowledge and skills and perceived norms and expectancies are required for behavioural change. The international Pro Children Project incorporated Social-Ecological Theory in its conceptual theoretical framework of determinants of children's fruit and vegetable consumption [12]. Interventions derived from Social-Ecological Theory recognise the importance of more structural influences on the fruit and vegetable consumption of children, for example, the availability or accessibility of fruit and vegetables in the home or in settings such as schools which children frequent.

Why it is Important to do this Review

Previous reviews have identified a number of factors associated with fruit and vegetable consumption among children [16, 21, 25]. While such reviews provide important information for the development of interventions, only systematic reviews of intervention trials are able to determine the efficacy of strategies to increase child fruit and vegetable consumption. A number of such reviews have been published [20-25], however, few have included preschool-aged children, and most lacked important information relevant to practice, such as the effectiveness of interventions for various sub-populations (such as minority groups), the cost-effectiveness of interventions, or the presence of any unintended adverse effects of the intervention. A comprehensive systematic review on this issue is therefore required to provide guidance for practitioners and policy makers interested in implementing strategies to promote the consumption of fruits and vegetables in early childhood.

Objectives

To assess the effectiveness, cost-effectiveness and associated adverse events of interventions designed to increase the consumption of fruit and/or vegetables among children aged five years and under.

Methods

Criteria for Considering Studies for this Review

Types of Studies

Eligible trials were randomised controlled trials (RCTs), including cluster-randomised controlled trials, that were published in a peer reviewed journal and that:

- compared two or more alternative intervention programs to increase the consumption of fruit and/or vegetables of children aged five years and under; or
- compared an intervention program to increase the consumption of fruit and/or vegetables of children aged five years and under with a standard care or no intervention control group.

Randomised trials which did not include fruit or vegetable intake as the primary trial outcome were excluded.

Types of Participants

Participants could include:

- children aged 5 years and under,
- parents, guardians and families responsible for the care of children aged 5 years and under, or
- professionals responsible for the care of children aged 5 years and under including childcare staff and health professionals.

Types of Interventions

Any educational, experiential, health promotion and/or psychological/ family/ behavioural therapy/ counselling/ management/ structural/ policy/ legislative reform interventions designed to increase fruit and/or vegetable consumption in children aged 5 years and under (as defined in 'Types of Participants') were considered for inclusion. Interventions could be conducted in any setting and could include interventions conducted in the home, childcare/preschool services, health services, or community settings.

Comparison

Any alternate intervention to encourage fruit and vegetable consumption as described above, or a no intervention control or attention control or wait-list control.

Types of Outcome Measures

Studies with evaluated outcomes measuring biomedical and/or dietary indices were included.

Primary Outcomes

- Change in the number of portions or serves of daily fruit and/or vegetable intakes at follow-up as measured by diet recalls, food diaries, food frequency questionnaires or diet records completed by an adult on behalf of the child. Short-term effects (<12 months post-intervention) and long-term effects (at least 12 months post-intervention) were included.
- Change in grams of fruit and/or vegetable intakes at follow-up as measured by diet recalls, food diaries, food frequency questionnaires or diet records completed by an adult on behalf of the child. Short-term effects (<12 months post-intervention) and long-term effects (at least 12 months post-intervention) were included.
- Changes in biomedical markers of fruit and/or vegetable consumption, such as α -carotene, β -carotene, cryptoxanthin, lycopene and lutein. Short-term effects (<12 months post-intervention) and long-term effects (at least 12 months post-intervention) were included.

Secondary Outcomes

Estimates of absolute costs and cost-effectiveness of interventions to increase the consumption of fruits and/or vegetables reported in identified studies were included.

Any reported adverse event of an intervention to increase the consumption of fruits and vegetables reported in identified studies were included. This could include any physical, behavioural, psychological or financial impact on the child, parent or family, or the service or facility where an intervention may have been implemented.

Search Methods for Identification of Studies

We obtained relevant trials published in any language via searches of electronic bibliographic databases, dissertations, hand searching of relevant journals, and following direct communication with authors of included studies.

Electronic Searches

We searched electronic databases including the Cochrane Central Register of Controlled Trials (CENTRAL) on *The Cochrane Library*, MEDLINE, EMBASE, CINAHL and PsycINFO. We searched the metaRegister of clinical trials and the WHO International Clinical Trials Registry Platform. The search strategy for CENTRAL is described in Appendix 1.

Searching Other Resources

We searched the reference lists of relevant articles and performed a hand search of all articles published in the 5 years until 2011 in three relevant international peer reviewed journals (*Journal of Nutrition Education and Behavior*, *Public Health Nutrition*, and *Journal of the American Dietetic Association*). Databases of published dissertations (*Dissertations and Theses*) were searched to identify and contact key authors in an attempt to obtain trials published in peer reviewed journals as well as ongoing trials (Appendix 2).

Data Collection and Analysis**Selection of Studies**

Two review authors (FS and RH) independently screened titles and abstracts of identified papers. Review authors were not blind to the details of the study author or journal. Review authors applied a standardised screening tool to assess eligibility. Papers were screened against the eligibility criteria for the review in a sequential manner, and a paper was excluded based on the first reason for exclusion (order: Participants, Outcome, Comparator, Intervention, Study Design). Based on the paper's title and abstract, papers which clearly did not meet the eligibility criteria of the review were excluded. Two review authors (FS and RH) then independently examined the full text of all remaining papers. Information regarding the reason for ineligibility of any paper for which the full text was reviewed was documented and is presented in Appendix 3. A third review author with expertise in review methodology (LW) resolved any disagreement between review authors (FS and RH) regarding study eligibility. For those papers which did not provide sufficient information to determine eligibility, we contacted the study authors for clarification.

Data Extraction and Management

Two review authors (RW and BB or EJ) independently extracted data from each included trial. Review authors were not blind to the details of the study author or journal. Data was recorded on data extraction forms designed and piloted specifically

for this review. Consultation with a third review author with expertise in review methodology (LW) resolved discrepancies between review authors (RW and BB or EJ) regarding data extraction. Attempts were made to contact authors of included papers in instances where the information required for data extraction was not available from the published report or was unclear. One review author (RW) transcribed extracted data into the systematic review software 'Review Manager'. Where available, the following information was extracted from included trials (Appendix 4):

- Information on the study, research design and methods such as; the study authors; date of publication; date of study initiation; study duration; setting; number of participants; participants' age, gender, ethnicity, and socioeconomic position; sequence generation; allocation concealment; blinding of participants, personnel and outcome assessors; and other concerns regarding bias.
- Information on the experimental conditions of the trial such as the number of experimental conditions; and intervention and comparator components, duration, number of contacts, modalities, interventionist and integrity.
- Information on the trial outcomes and results such as rates of recruitment and attrition; sample size; number of participants per experimental condition; mean and standard deviation of the primary or secondary outcomes described above; any subgroup analyses by gender, population group or intervention characteristics; and incomplete outcome data.

Assessment of Risk of Bias in Included Studies

Two review authors independently assessed the risk of bias in the included studies (RW and BB or EJ). A third review author with expertise in review methodology was consulted to resolve any disagreements between review authors (LW). Authors used the tool outlined in the Cochrane Handbook for Systematic Reviews of Interventions [26] to assess the risk of bias. The tool requires an explicit judgement by the review authors, based on trial information, regarding the risk of bias attributable to the generation of the random sequence, the allocation concealment, the blinding of participants, personnel and outcome assessors, the completeness of outcome data, selective reporting and any other potential threats to validity. Judgements regarding the risk of bias for each trial were recorded in the 'Risk of Bias' tables accompanying the review (Appendix 5).

Measures of Treatment Effect

Where meta-analyses were performed, the intervention effect was expressed as a mean difference where outcomes were reported using a standard metric (such as grams) and as a standardised mean difference where outcomes were reported using different methods or metrics of fruit and vegetable intake.

Unit of Analysis Issues

Cluster randomised trials in the review were assessed for unit of analysis error.

Dealing with Missing Data

Where available, outcomes of trials reporting an intention-to-treat analysis were reported. Given meta-analysis was only conducted on data pooled from two trials, sensitivity analyses to explore the impact on the overall assessment of treatment effects of the inclusion of trials not reporting an intention-to-treat analysis, with high rates of participant attrition or with other missing data, were not performed.

Assessment of Heterogeneity

Statistical heterogeneity was assessed via visual inspection of forest plots of the included trials and using the I^2 statistic. Examination of the trial characteristics (participants, design, interventions, outcomes and risk of bias) was also performed to identify the source of heterogeneity.

Assessment of Reporting Biases

Assessment of reporting bias was difficult given the heterogeneity of the included trial interventions and the limited number of included trials precluding visual inspection of the funnel plots.

Data Synthesis

Trial outcomes were assessed using a variety of dietary assessment tools and were reported in various metrics, including vitamin C from fruit, fruit or vegetable serves, and grams. We used fixed-effect models to perform meta-analysis. Meta-analysis was performed using the 'Review Manager' software. We did not conduct meta-analysis where a high level of heterogeneity was evident. In instances where data could not be combined in a meta-analysis, we have provided a narrative summary of the trial findings according to the review objectives.

Subgroup Analysis and Investigation of Heterogeneity

The impact of interventions for the following subgroups were summarised narratively:

- Interventions targeting boys and girls
- Interventions targeting minority groups including indigenous populations
- Interventions delivered in various settings including health and children's services
- Interventions of varying intensities defined in terms of the number and duration of intervention contacts or components
- Interventions delivered in different delivery modes such as via telephone, the internet or face-to-face

Sensitivity Analysis

Sensitivity analyses could not be conducted as meta-analysis was performed on data pooled from just two trials.

Results

Results of the Search

The searches generated 10740 citations. Screening of titles and abstracts identified 145 papers for formal inclusion or exclusion. Of these, five trials [27-31] met the inclusion criteria (Figure 1.1).

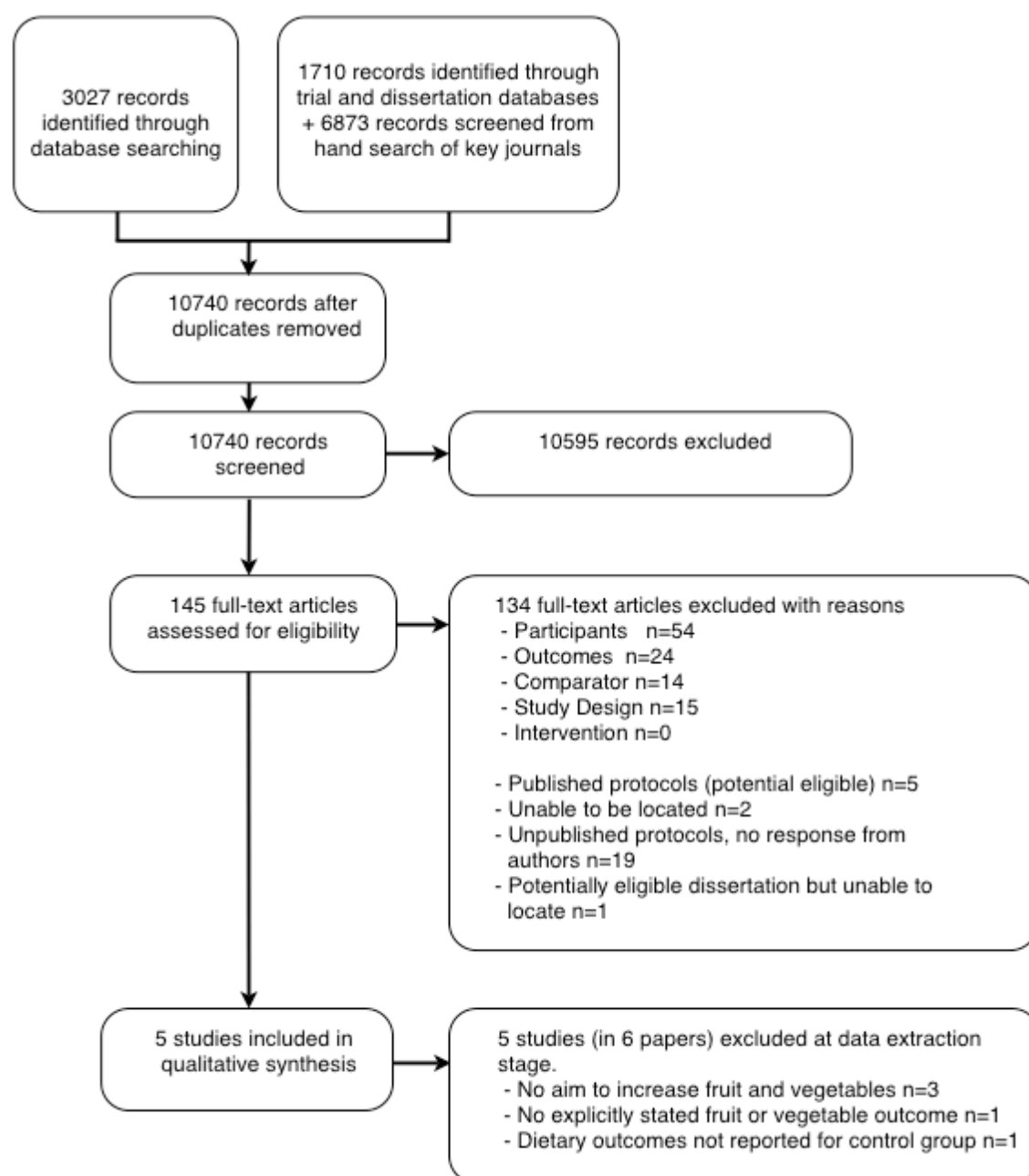


Figure 2.1: Study Flow Diagram

Characteristics of Included Studies

There were 13 trial arms with 3,967 participants randomised across the five included trials. A description of these trials appears in Tables 2.1 to 2.5 below. Two trials, both conducted in the United Kingdom examined the immediate or short-term (<12 month) impact of specific feeding practices in increasing children's intake of a target vegetable [27, 30]. Cooke and colleagues recruited 472 children aged 4 to 6 years from eight schools. Sixteen classes were randomised to one of four conditions. First, over a 3-week period children received 12 exposures to a target vegetable coupled with a

tangible non-food reward (a sticker) if they tasted the vegetable; second, exposure coupled with a social reward (praise) if they tasted the vegetable; third, exposure alone; or fourth, a no treatment control [27]. Intake of the target vegetable was assessed using electronic scales (grams) as part of a free-choice ad libitum consumption task at baseline, immediately post-intervention, and 1 and 3 months post-intervention.

The second trial from the United Kingdom randomised 156 children aged 2 to 6 years and their parents (who had previously participated in a study examining predictors of child fruit and vegetable intake) into one of three experimental conditions [30] including, repeated exposure to a target vegetable, nutrition information, and a no treatment control. In the repeated exposure group, parents received training in exposure feeding and were asked to offer their child a taste of a target vegetable for 14 consecutive days in the home. The importance of not offering a reward for consumption was stressed. Parents in this group also received a diary to record their feeding experiences and stickers for children to place in the diary to signify their degree of liking for the target vegetable. Parents allocated to the nutrition information group were informed about the recommendations for child fruit and vegetable intake, and provided a leaflet with advice and suggestions for increasing consumption. Parents allocated to the no treatment group did not receive any dietary advice or information. Intake of the target vegetable was assessed pre-intervention and approximately 2 weeks later using electronic scales measuring the weight of vegetable on the plate before and after ad libitum consumption.

Two studies tested the impact of home visiting programs implemented in disadvantaged communities [28, 31]. Watt and colleagues recruited 312 mothers of babies from baby clinics serving disadvantaged areas of London [31]. Mothers were randomised to receive an intervention consisting of monthly home visits from when the infant was aged 3 months. Home visits were delivered by trained volunteers who provided practical and non-judgemental support on infant feeding practices, including complementary feeding and when to introduce solids. The intervention emphasised the importance of fruit and vegetable consumption. The volunteer support was designed to complement existing assistance provided by health professionals. Mothers allocated to the control group received standard health professional support only (e.g. health visitors and GPs). Baseline data was collected when infants were 10 weeks old with follow-up data collected 42 weeks (immediately post-intervention) and 68 weeks later (6-months post-intervention). The primary trial outcome, vitamin C from fruit, was

calculated as part of a multiple pass 24 hour food recall and using data from a National Nutrition Survey. Consumption of selected fruits, a secondary trial outcome, was also reported.

High 5 for Kids (H5-KIDS) was a U.S. home visiting initiative designed to increase the fruit and vegetable intake of disadvantaged children aged 2 to 5 years [28]. H5-KIDS was delivered to 759 families who were enrolled in a general parenting and child development program ('Parents as Teachers'). The intervention focused on parental knowledge and modelling of fruit and vegetable intake, non-coercive feeding practices and the availability of fruit and vegetables, and consisted of a tailored newsletter, a series of four home visits of approximately 60 minutes' duration and print and audio-materials for parents and children. The intervention was delivered by parent educators. Families allocated to the control group received only the core 'Parents as Teachers' program, consisting of home visits, on-site group activities and newsletters. Child fruit and vegetable intake was assessed via telephone using a Food Frequency Questionnaire 6 to 11 months after baseline.

One preschool-based intervention was included in the review. The Beastly Healthy at School study aimed to increase children's fruit and vegetable consumption and water intake, and to decrease the consumption of sweetened beverages [29]. The multi-component intervention included classroom-, school- and home-based strategies that targeted children, school staff and parents. Staff received a two-day training workshop plus educational resources and parents received newsletters. Children participated in a range of teacher- and self-guided activities based on experiential education (e.g. food tastings) and developmental education (e.g. learning about the food triangle). Children aged approximately 3 to 5 years of age attending eight Belgium preschools were randomised to receive the intervention, while children attending another eight preschools were allocated to the control. No details were provided regarding the nature of any support or any usual nutritional activities provided to control preschools. Fruit and vegetable intake was assessed using a Food Frequency Questionnaire reported by parents at a 6-month follow-up for 308 and 168 children allocated to intervention and control preschools respectively.

Excluded Studies

Following an assessment of study titles and abstracts, the full texts of 145 articles were sought for further review for study eligibility (Figure 1). Of these, the eligibility of 27 trials could not be established as the study had not been published or was only a

protocol (n=24), or could not be located (n=3). One hundred and seven studies were considered ineligible following the trial screening process (Reasons for exclusion included Participants n=54; Outcomes n=24; Comparator n=14; Study design n=15; Intervention n=0). Additionally six studies (reporting the findings of five trials) were excluded at the point of data extraction given closer inspection of the eligibility criteria. Specifically, two studies, based on the same trial of an atherosclerosis prevention intervention, had no explicit aim to increase fruit and vegetable consumption of children despite reporting longitudinal fruit and vegetable consumption [32, 33]. A co-twin study reported by Faith and colleagues also did not aim to increase fruit and vegetable intake, rather, sought to test a methodological concept [34]. Similarly, an intervention described by Aboud and colleagues did not primarily aim to increase fruit and vegetable consumption and only assessed fruit and vegetable consumption post-hoc to describe the mechanism behind a change in weight status among study participants [35]. A study by Khoshnevisan and colleagues reported dietary outcomes for the intervention group only and was therefore excluded [36] and a study by Johnson and colleagues [37] was excluded as the outcome measure was not a quantity-based assessment of fruit and vegetable consumption.

Risk of Bias in Included Studies

Allocation (selection bias)

Information regarding the risk of bias in the included studies is described in Appendix 5. In four of the five studies, the randomisation sequence was generated by computer or random number tables [27-29, 31] and the method of sequence generation in the remaining study [30] was unclear. In two of the five studies [30, 31], participant allocation was concealed from recruiters, thus representing a low risk of selection bias. The risk was unclear in two studies [27, 29], and was considered to be high in the remaining study [28] where recruiters were aware of participants' allocation as they were being recruited.

Blinding (Performance Bias and Detection Bias)

Performance Bias

In four of the five studies [28-31] the intervention was delivered (at least in part) to parents who were not blinded to group allocation, and in three of these trials [28, 29, 31] parents also provided outcome data regarding their children's fruit and vegetable consumption. These three studies were determined to be at high risk of performance bias given the potential for reported trial outcomes to be influenced by the parents' knowledge of group allocation. Two trials [27, 30] used an objective outcome measure

(weight of vegetable consumed as assessed by electronic scales), and as such were deemed to have a low risk of performance bias, despite those delivering the intervention being aware of participant allocation.

Detection Bias

In one trial [29] children's fruit and vegetable consumption was reported by parents who were not blind to group allocation, and as such there was considered to be a potentially high risk of detection bias. In the other four trials [27, 28, 30, 31], a third party (such as a research assistant or telephone interviewer) was used to collect data regarding children's fruit and vegetable consumption. In two of these trials [28, 31] outcome assessors were blind to allocation, representing a low risk of detection bias, while in other two trials [27, 30] outcomes were objectively assessed (ad libitum consumption of a target vegetable was measured pre- and post-intervention), and even though outcome assessors were not blind to participant allocation, the risk that detection bias would influence trial outcomes was deemed to be low.

Incomplete Outcome Data (Attrition Bias)

All studies had data missing at follow-up. Three studies were judged to have a low risk of attrition bias [27, 28, 30] due to high retention rates (>80%) which were similar across all groups. In two studies [29, 31] there was judged to be a high risk of attrition bias due to high attrition rates at follow up (Vereecken et al. 45-47%; Watt et al. 30-34%).

Selective Reporting (Reporting Bias)

One trial was prospectively registered with trial outcomes pre-specified [31] and the reported outcomes matched those in the register, representing a low risk of reporting bias. For all other trials, there was insufficient information to determine risk of bias due to selective reporting.

Other Potential Sources of Bias

All cluster randomised trials either adjusted their analyses to take the effects of clustering into account [27, 29] and/or conducted tests to determine that adjustment was not required [27, 28]. The study by Wardle and colleagues [30] conducted analyses using all available data as well as data from only those participants in the exposure arm who received at least ten out of a possible 14 exposures. Meta-analysis was performed on the restricted sample of participants from the exposure arm (n=34)

as raw data for the full sample (n=48) was not reported. No further sources of bias could be identified.

Effects of Interventions

Effectiveness, Cost-effectiveness and Associated Adverse Events of Intervention

All included trials reported the impact of the effectiveness of the intervention on a measure of child fruit or vegetable intake. None of the trials reported information regarding any adverse events or unintended adverse consequences of the intervention. Similarly, none of the included trials reported any information on intervention costs, or conducted cost analyses. There was considerable heterogeneity among included studies in terms of the interventions trialled, study populations, and methods of assessing fruit and/or vegetable intake. Meta-analyses were therefore conducted by pooling data from similar interventions and are reported as appropriate in this review. Otherwise, trial findings are synthesised narratively.

The effects of interventions targeting child feeding practices were mixed [27, 30]. Target vegetable consumption among children receiving a repeated food exposure intervention was significantly higher than among children receiving a no treatment control in the study by Cooke and colleagues [27] and approached significance in the study authored by Wardle and colleagues [30] immediately following the intervention period. However, at the 3 month follow-up, this effect of exposure (with no reward) was non-significant in the study by Cooke and colleagues [27]. Meta-analysis of vegetable intake at the final follow-up for both trials (<3 months) revealed no overall intervention effect (MD 1.37 95% CI -2.78 - 5.52) as shown in Table 2.1. Findings of the meta-analysis should be interpreted with caution as outcome data from both trials were positively skewed and were not transformed as part of pooled analyses.

Table 2.1. Short-term impact (<12 months) of repeated exposure intervention versus no intervention on child consumption of a target vegetable

OUTCOME	STUDIES	N	STATISTICAL METHOD	EFFECT ESTIMATE
Vegetable intake (g)	2	281	Mean Difference (IV, Fixed, 95% CI)	1.37 [-2.78, 5.52]

It appears that the provision of rewards sustains the effect of exposure in the short term. Significant intervention effects were reported in the two reward experimental arms in the study by Cooke and colleagues [27]. The mean target vegetable

consumption of children allocated to receive repeated food exposures with a tangible reward (a sticker) or repeated exposures with a social reward (praise) were higher (by up to approximately 30 grams) immediately post-intervention and at the 1- and 3-month follow-up compared with a no treatment control. Consumption among children receiving exposure plus tangible reward was also higher than among children receiving a repeated exposure alone immediately post intervention and at 1-3 month follow-up. Comparison between the two reward conditions revealed significantly greater intake of the target vegetable among children receiving exposure plus tangible reward versus the exposure plus social reward immediately post-intervention but not at the later follow-up.

The trial by Wardle and colleagues also tested the provision of basic nutrition information to parents in one experimental arm [30]. The provision of basic nutritional information did not significantly increase mean target vegetable consumption immediately post-intervention.

Studies trialling home visiting interventions failed to significantly increase child fruit and vegetable consumption [28, 31]. In addition to standard health professional support, children of mothers allocated to receive nine home visits from a trained volunteer, (once monthly from when the infant was 12 weeks of age) did not report greater consumption of vitamin C from fruit relative to a control group receiving only standard health professional support when the child was 12 or 18 months old [31]. At age 12 months, however, children of mothers allocated to the intervention group were more likely to consume apples, pears, boiled potatoes and carrots, but not bananas or leafy green vegetables, a secondary outcome of the trial. At 18 months of age, children were more likely to consume pears and potatoes relative to control children. A 6 to 11 month follow-up of the H5-KIDS program, consisting of a tailored letter, print and audio materials and a series of four home visits by parent educators found no overall increase in child intake of fruit ($p=0.34$), vegetables ($p=0.10$), or fruit and vegetables combined ($p=0.20$) relative to children in the comparison condition [28]. A significant positive intervention effect (of up to one third of a serve) was reported in a subgroup analysis of healthy weight (relative to overweight) children for combined fruit and vegetable intake ($p=0.02$). Meta-analysis pooling outcome data for fruit intake (an outcome measure common to both trials) at the final follow-up for both trials (<12 months post-intervention) revealed no significant increase in child consumption of fruit (SMD 0.01 95% CI -0.01-0.11) as shown in Table 2.2.

Table 2.2. Short-term impact (<12 months) of home visiting intervention versus usual care

OUTCOME	STUDIES	N	STATISTICAL METHOD	EFFECT ESTIMATE
Fruit Intake (g)	2	1518	Std. Mean Difference (IV, Fixed, 95% CI)	0.01 [-0.09, 0.11]

The Beastly Healthy at School, multi-component preschool-based intervention had a small but significant impact on child fruit consumption [29]. Children attending intervention preschools increased their fruit consumption by 6 grams from baseline at the 6-month follow-up, while fruit consumption among children in control preschools reduced by 4 grams over the same period ($p=0.04$). There were no differences between groups in terms of vegetable consumption.

Interventions Targeting Boys and Girls

All trials included in this review included both boys and girls. The impacts of intervention for gender subgroups were not reported in any of the included trials.

Interventions Targeting Minority Groups and Indigenous Populations

Three of the included trials examined the impact of interventions on predominantly disadvantaged populations [27, 28, 31]. One trial recruited participants through schools where the proportion of children who had English as a second language, came from minority ethnic backgrounds or were eligible for free school meals was above average [27]. Data describing these characteristics of the study sample, however, was not reported. The study demonstrated that repeated food exposure coupled with reward significantly increased the consumption of a target vegetable. Similarly, both home visiting interventions, for which results were mixed, recruited participants from disadvantaged communities [28, 31]. One study recruited children and families from the 'Parents as Teachers' program, which provides services to parents from pregnancy until the child is 3 years old, but extends services until the child is 5 in the case of underserved families, single or minority parent homes, or those living in poverty. As this study recruited parents with children aged 2 to 5 years, disadvantaged families comprised a substantial proportion of the overall sample, for example 50-60% of participating families earned less than \$US35,000 per annum [28]. The second study recruited from baby clinics in disadvantaged London neighbourhoods. The sample included 50% of participants from an ethnic minority, 57% living in social housing, and 28% lone parents [31].

Interventions Delivered in Various Settings

While two of the included trials recruited study participants from preschools/schools [27, 29] only one trial assessed the impact of an intervention targeting the policies or practices of this setting. The intervention had a small but significant increase in child consumption of fruit but not vegetables [29]. The remaining studies were home-based interventions, of which intervention effects were mixed.

Interventions of Varying Intensity

In trials that incorporated home visits, the number of scheduled visits ranged from four contacts [28] to nine contacts [31], with visits in both interventions lasting approximately 60 minutes. Despite the differences between the two trials in terms of intervention intensity, both studies failed to find overall positive intervention effects on the primary trial outcome. In the more intensive trial, the average number of completed visits was five [31], whereas the intervention of lesser intensity was delivered in its entirety to 78% of participants [28]. The two trials examining the impact of repeated food exposure were similar with regard to intensity with Wardle and colleagues reporting a maximum of 14 exposures over consecutive days [30], and Cooke and colleagues reporting a maximum of 12 exposures over consecutive school days [27] in their respective trials. In the multi-component preschool-based intervention the duration or frequency of intervention contacts was not reported [29].

Interventions Delivered in Different Modalities

Three of the five trials used face-to-face intervention delivery only [27, 30, 31]. The remaining two trials used face-to-face delivery in combination with other strategies: computer-tailored newsletters and storybooks [28], and school-based education, training, policy and environmental change [29]. Trials which employed face-to-face only intervention delivery formats, and those which incorporated a broader range of intervention modalities reported mixed findings in terms of intervention effects.

Discussion**Summary of Main Results**

Despite the importance of encouraging fruit and vegetable consumption among children in early childhood, the review identified few randomised controlled trials investigating interventions attempting to do this. The included trials were heterogeneous, and collectively the findings were equivocal, providing few effective options for policy makers to improve child fruit and vegetable intake.

Two trials investigating home visiting programs provided to disadvantaged groups did not have a clear positive intervention effect on fruit and vegetable intake immediately after the intervention or 6-months post-intervention [28, 31]. A multi-component preschool-based intervention failed to significantly increase child consumption of vegetables, but did report a small significant increase in mean child consumption of fruit 6 months following baseline assessment [29]. Two trials examining feeding strategies to encourage child consumption of a target vegetable [27, 30] indicated that repeated food exposure alone is not effective in increasing vegetable intake post-intervention. However, coupling repeated food exposure with a tangible non-food or social reward was effective in increasing targeted vegetable consumption in the short term (<3 months post-intervention) [27].

Overall Completeness and Applicability of Evidence

The paucity of published randomised trials identified in this review is surprising given efforts globally to increase fruit and vegetable intake [1]. Nonetheless, previous systematic reviews of broader dietary interventions for children under 5 years have similarly identified few randomised trials [38]. None of the included trials in this review examined long-term (>12 months post-intervention) effects of interventions, reported cost analyses or examined any unintended adverse effects. These factors are important considerations for health practitioners and policy makers but are often not reported in randomised trials [39] or examined in systematic reviews [40, 41]. Furthermore, the limited number of trials identified for inclusion also prevented thorough examination of the impact of the interventions by gender, for indigenous populations, across various settings, of different intensities or delivered using various modalities. Encouragingly, a number of trial protocols (Appendix 2) were identified which may address some of these gaps in the literature and are likely to be eligible for inclusion in future updates of the review. These include a multi-component preschool-based intervention [42], and a brief four contact telephone-based intervention delivered by trained non-health professionals [43].

The external validity of the review findings are limited. All trials were conducted in North America or Western Europe. None of the included trials compared participant characteristics to their sampled population and some did not specify trial inclusion or exclusion criteria [28, 29]. Where recruitment was conducted via schools, clinics or 'Parents as Teacher' programs, participation rates were generally high (>80%) and study attrition ranged from 12-34% [27, 28, 31]. With the exception of the Beastly Healthy at School study, participation rates of sites subject to randomisation in cluster

trials were not reported. In the Beastly Healthy at School trial the preschool participation rate was just 10% suggesting the trial findings may not generalise [29]. The study by Wardle and colleagues, recruited a convenience sample of 156 children and parents from a larger cohort, who had previously participated in a separate study, and expressed interest in future research participation [30]. Such participants may differ systematically to parents of children under 5 years in the broader community [44].

Quality of the Evidence

In many cases trial quality was difficult to assess given a lack of available information reported in the published manuscripts. Overall, one of the five trials was judged to be of high methodological quality [27], with three studies judged to be of moderate quality [28, 30, 31], and one study judged to be of low quality [29]. Only one study had been prospectively registered [31]. The most significant issue affecting the quality of the included trials was the inability to blind participants to group allocation, exposing trials to performance bias which can inflate the intervention effect. Similarly, social desirability bias, which can also inflate intervention effects is likely within trials that did not blind participants to group allocation or use an objective outcome measure [45]. Finally, opportunities for meta-analysis could be improved by consistent assessment measures of fruit and vegetable intake and the reporting of trial outcomes in a manner consistent with CONSORT guidelines.

Potential Biases in the Review Process

The review employed a comprehensive and rigorous methodology including a broad search strategy, the screening of trials and extraction of data from two independent reviewers, and the appraisal of risk of bias within the included studies. Furthermore, the review did not restrict publications based on language. Two aspects of selection bias, however, are worth noting. First, we excluded trials where fruit and vegetable intake was not considered to be a primary trial outcome to avoid any potential confounding effects of other behavioural interventions (such as physical activity). This restriction may lead to over-estimates of intervention effects if in practice they are delivered in the context of other health initiatives. Second, the review included only trials which had been published in peer reviewed journals, which may also lead to overly positive estimates of intervention effects given the tendency for trials with positive findings to be more likely to be published, or published more quickly in peer reviewed journals [26].

Agreements and Disagreements with Other Studies or Reviews

The equivocal findings of this review regarding the impact of home visiting programs are similar to those reported in previous reviews of dietary interventions. For example, a comprehensive review of the impact of home visiting programs concluded that there was little evidence to recommend home visiting as means of improving child diet given the mixed findings of the reviewed studies [46]. Among the trials with a positive intervention effect included in the review by Elkan and colleagues [46] was a pre-post study of an intensive intervention provided to low income mothers of children aged 1 to 4 years [47]. In this study, dietician-trained GPs and health visitors provided advice and support as part of a primary care home visiting intervention lasting up to 20 weeks. Post-intervention improvements in diet were reported, including the consumption of fruits and vegetables. A more recent home visiting intervention [48] identified in a later review [49] also employed a pre-post design to examine a home visiting intervention delivered to predominantly low income Hispanic children under 6 years by a public health nurse. The intervention sought to improve macronutrient intake, as well as reduce high fat snack consumption and increase healthy snack consumption. Post-intervention assessments found reductions in caloric intake but no change in macronutrients [48].

Similarly, there are few controlled trials available to contextualise the mixed findings of the multi-component preschool-based intervention reported by Vereecken and colleagues [29]. A recent systematic review of interventions to improve diet, physical activity or prevent weight gain for children 5 years of age or under, and which included both randomised and non-randomised designs, identified nine studies of interventions implemented in preschool or childcare settings [38]. Three studies included some assessment of dietary outcome. In the first, Head Start preschools were assigned to either; a menu intervention to reduce the fat content of meals provided to children in care; the same menu intervention plus nutrition education; or a third usual care control condition [50]. Both intervention arms of the trial reduced the fat content of foods served to children relative to the preschools in the control condition. The remaining two trials assessed the impact of a healthy eating and physical activity obesity prevention program 'Hip-Hop to Health Jr', implemented in two different populations attending Head Start preschools [51, 52]. In one trial [51], intervention children reported less saturated fat intake at the 1-year follow-up, but not total fat, or dietary fibre. No improvements in dietary intake were reported in the second trial [52]. Nonetheless, systematic reviews of school-based fruit and vegetable interventions have frequently concluded that multi-component initiatives are effective in increasing fruit and

vegetable consumption in older children, suggesting that such strategies warrant investigation in preschools [20-23].

An early systematic review of healthy eating interventions for preschoolers [53] published by the Health Education Authority concluded that repeated food exposure is effective in enhancing children's willingness to consume novel foods provided tasting was included as a part of the exposure. Enhanced food acceptance following repeated food exposure has also been reported in other reviews and controlled trials [54] examining the impact of repeated exposure on the consumption of preschool-aged children, and the trials included in this review [27, 30]. As Cooke and colleagues point out in the background review of research for their randomised trial, evidence regarding the use of rewards to encourage child consumption of targeted foods appears more equivocal [27]. The positive impact of both social and non-tangible rewards reported by Cooke and colleagues, were however, consistent with previous trials in community settings using tangible non-food rewards and social reward targeting the fruit or vegetable intake of school children [55].

Conclusions

Implications for Practice

This review provides little specific direction for health policy makers and practitioners interested in achieving increases in the fruit and vegetable consumption of preschool children. Among those trials which significantly increased consumption, the effect sizes were small and intervention effects typically assessed only in the short term.

Notwithstanding this, a number of the intervention settings and strategies reported in the included studies have potential public health appeal. Home visiting appears to be effective in reaching disadvantaged populations as evidenced by the high response and low attrition rates in the included home visiting studies [28, 31]. Both studies also trialled strategies which could be considered suitable for broader dissemination. In the trial by Watt and colleagues, the intervention was delivered by volunteers, a low cost approach to intervention delivery [31]. Haire-Joshu and colleagues, incorporated the fruit and vegetable program into an existing service for disadvantaged families [28], a cost efficient and potentially sustainable intervention approach, which was also reported to be highly acceptable to both the parent educators who delivered the program and the parents who received it. Such findings suggest that, provided effective programs can be developed, programs delivered via home visiting may have merit in improving fruit and vegetable intake among disadvantaged families.

Findings from the two trials of feeding strategies have broad application [27, 30]. The pairing of repeated food exposure and a tangible non-food reward, or social reward is effective in increasing children's consumption of a target vegetable, at least in the short term. Such strategies should therefore be considered for inclusion in future interventions targeting children aged 5 years and under, across a variety of settings, particularly those targeting parent-child feeding interactions in the home. Given the large numbers of children that attend such childcare services, and the capacity of these services to influence children's diets whilst in their care, childcare services are often advocated as important settings to improve child diet [56].

While the trial by Vereeken and colleagues reported in this review significantly increased children's fruit consumption, the effect size was meagre. The authors attribute increased access to fruit at intervention preschools as primarily responsible for the intervention effect. This is consistent with previous reviews of the correlates of child fruit and vegetable intake [16, 21] suggesting that simply providing fruits to children whilst in care is likely to increase their consumption. Furthermore, despite parent newsletters, information evenings and other preschool-based activities, the authors suggest that greater engagement of parents may be required, a strategy also found to enhance the impact of school-based nutrition programs [23].

Given the lack of high quality research in this area, there is considerable scope for policy makers, researchers and practitioners to develop and evaluate the impact of a variety of initiatives to improve child fruit and vegetable intake. Behavioural interventions delivered via health professionals, telephone or computer-based programs, interventions delivered through preschools, play-groups, sports clubs, or co-operatives, and those which address access issues through subsidies or other incentives all have merit, and rigorous evaluation of such interventions for children of preschool age would contribute greatly to the available evidence base to inform practice. As the aetiology of child diet is complex, interventions which target multiple determinants across a number of settings may be most likely to be effective.

References

1. World Health Organization and the Food and Agriculture Organization of the United Nations: **Diet, nutrition and the prevention of chronic diseases: report of a joint WHO/FAO expert consultation**. Geneva: WHO/FAO; 2003.
2. Lock K, Pomerleau J, Causer L, Altmann DR, McKee M: **The global burden of disease attributable to low consumption of fruit and vegetables: implications for the global strategy on diet**. *Bull World Health Organ* 2005, **83**(2):100-108.
3. World Health Organization: **Diet, nutrition and the prevention of chronic diseases**. In *Technical Report Series, No 797*. Geneva: World Health Organization; 1997.
4. Currie C, Roberts C, Morgan A, Smith R, Settertobulte W, Samdal O, Rasmussen VB: **Young peoples health in context. Health Behavior in School-aged Children (HBSC) study: International report from the 2001/2002 survey**. Denmark: World Health Organization; 2004.
5. Yngve A, Wolf A, Poortvliet E, Elmadfa I, Brug J, Ehrenblad B, Franchini B, Haraldsdottir J, Krolner R, Maes L *et al*: **Fruit and vegetable intake in a sample of 11-year-old children in 9 European countries: The Pro Children Cross-sectional Survey**. *Ann Nutr Metab* 2005, **49**(4):236-245.
6. Lien N, Lytle LA, Klepp KI: **Stability in consumption of fruit, vegetables, and sugary foods in a cohort from age 14 to age 21**. *Prev Med* 2001, **33**(3):217-226.
7. Mikkila V, Rasanen L, Raitakari OT, Pietinen P, Viikari J: **Longitudinal changes in diet from childhood into adulthood with respect to risk of cardiovascular diseases: The Cardiovascular Risk in Young Finns Study**. *Eur J Clin Nutr* 2004, **58**(7):1038-1045.
8. Maynard M, Gunnell D, Emmett P, Frankel S, Davey Smith G: **Fruit, vegetables, and antioxidants in childhood and risk of adult cancer: the Boyd Orr cohort**. *J Epidemiol Community Health* 2003, **57**(3):218-225.

9. Ness AR, Maynard M, Frankel S, Smith GD, Frobisher C, Leary SD, Emmett PM, Gunnell D: **Diet in childhood and adult cardiovascular and all cause mortality: the Boyd Orr cohort.** *Heart* 2005, **91**(7):894-898.
10. Antova T, Pattenden S, Nikiforov B, Leonardi GS, Boeva B, Fletcher T, Rudnai P, Slachtova H, Tabak C, Zlotkowska R *et al*: **Nutrition and respiratory health in children in six Central and Eastern European countries.** *Thorax* 2003, **58**(3):231-236.
11. Forastiere F, Pistelli R, Sestini P, Fortes C, Renzoni E, Rusconi F, Dell'Orco V, Ciccone G, Bisanti L: **Consumption of fresh fruit rich in vitamin C and wheezing symptoms in children. SIDRIA Collaborative Group, Italy (Italian Studies on Respiratory Disorders in Children and the Environment).** *Thorax* 2000, **55**(4):283-288.
12. Klepp KI, Perez-Rodrigo C, De Bourdeaudhuij I, Due PP, Elmadfa I, Haraldsdottir J, Konig J, Sjostrom M, Thorsdottir I, Vaz de Almeida MD *et al*: **Promoting fruit and vegetable consumption among European schoolchildren: rationale, conceptualization and design of the pro children project.** *Ann Nutr Metab* 2005, **49**(4):212-220.
13. Miller M, Stafford H: **An intervention portfolio to promote fruit and vegetable consumption: The process and portfolio.** Melbourne: National Public Health Partnership; 2000.
14. World Health Organization and Food and Agriculture Organization of the United Nations: **Report of a Joint FAO/WHO Workshop, 1-3 September, 2004.** Kobe: FAO/WHO; 2005.
15. Hector D, Shrewsbury V: **Building solutions for preventing childhood obesity. Module 2: Interventions to increase consumption of fruit and vegetables.** Sydney: NSW Centre for Overweight and Obesity; 2008.
16. Rasmussen M, Krolner R, Klepp KI, Lytle L, Brug J, Bere E, Due P: **Determinants of fruit and vegetable consumption among children and adolescents: a review of the literature. Part I: Quantitative studies.** *Int J Behav Nutr Phys Act* 2006, **3**:22.
17. Bandura A: *Social foundations of thought and action: A social cognitive theory.* New Jersey: Prentice Hall; 1986.

18. Ajzen I: **The theory of planned behavior**. *Organ Behav Hum Dec* 1991, **50**(2):179-211.
19. Prochaska JO, DiClemente CC: *The transtheoretical approach: crossing traditional boundaries of therapy*. Illinois: Dow Jones Irwin; 1984.
20. Burchett H: **Increasing fruit and vegetable consumption among British primary schoolchildren: a review**. *Health Education* 2003, **103**(2):99-109.
21. Ciliska D, Miles E, O'Brien MA, Turl C, Tomasik HH, Donovan U, Beyers J: **Effectiveness of community-based interventions to increase fruit and vegetable consumption**. *J Nutr Educ* 2000, **32**(6):341-352.
22. French SA, Stables G: **Environmental interventions to promote vegetable and fruit consumption among youth in school settings**. *Prev Med* 2003, **37**(6):593-610.
23. Knai C, Pomerleau J, Lock K, McKee M: **Getting children to eat more fruit and vegetables: a systematic review**. *Prev Med* 2006, **42**(2):85-95.
24. Delgado-Noguera M, Tort S, Martinez-Zapata MJ, Bonfill X: **Primary school interventions to promote fruit and vegetable consumption: a systematic review and meta-analysis**. *Prev Med* 2011, **53**(1-2):3-9.
25. Howerton MW, Bell BS, Dodd KW, Berrigan D, Stolzenberg-Solomon R, Nebeling L: **School-based nutrition programs produced a moderate increase in fruit and vegetable consumption: meta and pooling analyses from 7 studies**. *J Nutr Educ Behav* 2007, **39**(4):186-196.
26. The Cochrane Collaboration: *Cochrane Handbook for Systematic Reviews of Interventions (Version 5.1.0)*. Chichester: John Wiley & Sons; 2009.
27. Cooke LJ, Chambers LC, Anez EV, Croker HA, Boniface D, Yeomans MR, Wardle J: **Eating for pleasure or profit: the effect of incentives on children's enjoyment of vegetables**. *Psychol Sci* 2011, **22**(2):190-196.
28. Haire-Joshu D, Elliott MB, Caito NM, Hessler K, Nanney MS, Hale N, Boehmer TK, Kreuter M, Brownson RC: **High 5 for Kids: the impact of a home visiting program on fruit and vegetable intake of parents and their preschool children**. *Prev Med* 2008, **47**(1):77-82.

29. Vereecken C, Huybrechts I, van Houte H, Martens V, Wittebroodt I, Maes L: **Results from a dietary intervention study in preschools "Beastly Healthy at School"**. *Int J Public Health* 2009, **54**(3):142-149.
30. Wardle J, Cooke LJ, Gibson EL, Sapochnik M, Sheiham A, Lawson M: **Increasing children's acceptance of vegetables; a randomized trial of parent-led exposure**. *Appetite* 2003, **40**(2):155-162.
31. Watt RG, Tull KI, Hardy R, Wiggins M, Kelly Y, Molloy B, Dowler E, Apps J, McGlone P: **Effectiveness of a social support intervention on infant feeding practices: randomised controlled trial**. *J Epidemiol Community Health* 2009, **63**(2):156-162.
32. Ruottinen S, Niinikoski H, Lagström H, Rönnemaa T, Hakanen M, Viikari J, Jokinen E, Simell O: **High Sucrose Intake Is Associated With Poor Quality of Diet and Growth Between 13 Months and 9 Years of Age: The Special Turku Coronary Risk Factor Intervention Project**. *Pediatrics* 2008, **121**:e1676-e1685.
33. Talvia S, Rasanen L, Lagström H, Pahkala K, Viikari J, Ronnemaa T, Arffman M, Simell O: **Longitudinal trends in consumption of vegetables and fruit in Finnish children in an atherosclerosis prevention study (STRIP)** *Eur J Clin Nutr* 2006, **60**:172–180.
34. Faith MS, Rose E, Matz PE, Pietrobelli A, Epstein LH: **Co-twin control designs for testing behavioral economic theories of child nutrition: methodological note** *Int J Obesity* 2006, **30**:1501–1505.
35. Aboud FE, Mooret AC, Akhter S: **Effectiveness of a community-based responsive feeding programme in rural Bangladesh: a cluster randomized field trial** *Matern Child Nutr* 2008, **4**:275-286.
36. Khoshnevisan F, Kimiagar M, Kalantaree N, Valaee N, Shaheedee N: **Effect of Nutrition Education and Diet Modification in Iron Depleted Preschool Children in Nurseries in Tehran: a Pilot Study** *Int J Vitam Nutr Res* 2004, **74**(4):264-268.
37. Johnson Z, Howell F, Molloy B: **Community Mothers' Programme: Randomised controlled trial of non-professional intervention in parenting**. *BMJ* 1993, **306**:1449-1452.

38. Hesketh KD, Campbell KJ: **Interventions to prevent obesity in 0-5 year olds: an updated systematic review of the literature.** *Obesity* 2010, **18 Suppl 1**:S27-35.
39. Summerbell CD, Waters E, Edmunds LD, Kelly S, Brown T, Campbell KJ: **Interventions for preventing obesity in children.** *Cochrane Database Syst Rev* 2005(3):CD001871.
40. Wolfenden L, Wiggers J, Tursan d'Espaignet E, Bell AC: **How useful are systematic reviews of child obesity interventions?** *Obes Rev* 2010, **11**(2):159-165.
41. Hopewell S, Wolfenden L, Clarke M: **Reporting of adverse events in systematic reviews can be improved: survey results.** *J Clin Epidemiol* 2008, **61**(6):597-602.
42. Adams J, Zask A, Dietrich U: **Tooty Fruity Vegie in Preschools: an obesity prevention intervention in preschools targeting children's movement skills and eating behaviours** *Health Promot J Aust* 2009, **20**:112-119.
43. Wyse RJ, Wolfenden L, Campbell E, Brennan L, Campbell KJ, Fletcher A, Bowman J, Heard TR, Wiggers J: **A cluster randomised trial of a telephone-based intervention for parents to increase fruit and vegetable consumption in their 3- to 5-year-old children: study protocol.** *BMC Public Health* 2010, **10**:216.
44. Trauth JM, Musa D, Siminoff L, Jewell IK, Ricci E: **Public attitudes regarding willingness to participate in medical research studies.** *J Health Soc Policy* 2000, **12**(2):23-43.
45. Hebert JR, Clemow L, Pbert L, Ockene IS, Ockene JK: **Social desirability bias in dietary self-report may compromise the validity of dietary intake measures.** *Int J Epidemiol* 1995, **24**(2):389-398.
46. Elkan R, Kendrick D, Hewitt M, Robinson JJ, Tolley K, Blair M, Dewey M, Williams D, Brummell K: **The effectiveness of domiciliary health visiting: a systematic review of international studies and a selective review of the British literature.** *Health Technol Assess* 2000, **4**(13):i-v, 1-339.

47. James J, Brown J, Douglas M, Cox J, Stocker S: **Improving the diet of under fives in a deprived inner city practice.** *Health Trends* 1992, **24**(4):161-164.
48. Worobey J, Pisuk J, Decker K: **Diet and behavior in at-risk children: evaluation of an early intervention program.** *Public Health Nurs* 2004, **21**(2):122-127.
49. Campbell KJ, Hesketh KD: **Strategies which aim to positively impact on weight, physical activity, diet and sedentary behaviours in children from zero to five years. A systematic review of the literature.** *Obes Rev* 2007, **8**(4):327-338.
50. Williams CL, Strobino BA, Bollella M, Brotanek J: **Cardiovascular risk reduction in preschool children: the "Healthy Start" project.** *J Am Coll Nutr* 2004, **23**(2):117-123.
51. Fitzgibbon ML, Stolley MR, Schiffer L, Van Horn L, KauferChristoffel K, Dyer A: **Two-year follow-up results for Hip-Hop to Health Jr.: a randomized controlled trial for overweight prevention in preschool minority children.** *J Pediatr* 2005, **146**(5):618-625.
52. Fitzgibbon ML, Stolley MR, Schiffer L, Van Horn L, KauferChristoffel K, Dyer A: **Hip-Hop to Health Jr. for Latino preschool children.** *Obesity* 2006, **14**(9):1616-1625.
53. Tedstone AE, Aviles M, Shetty PS, Daniels LA: **Effectiveness of interventions to promote healthy eating in preschool children aged 1 to 5 years.** Edited by Meyrick J. London: Health Education Authority; 1998.
54. Contento I, Balch GI, Bronner YL, Lytle LA, Maloney SK, Olson CM, Swadener S: **The effectiveness of nutrition education and implications for nutrition education policy, programs and research: a review of research.** *J Nutr Educ* 1995, **27**(6):277-418.
55. Hendy HM: **Comparison of five teacher actions to encourage children's new food acceptance.** *Ann Behav Med* 1999, **21**(1):20-26.
56. Story M, Kaphingst KM, French S: **The role of child care settings in obesity prevention.** *Future Child* 2006, **16**(1):143-168.

CHAPTER THREE:

Associations between characteristics of the home food environment and fruit and vegetable intake in preschool children: A cross-sectional study

This chapter is a published paper:

Wyse R, Campbell E, Nathan N, Wolfenden L. **Associations between characteristics of the home food environment and fruit and vegetable intake in preschool children: A cross-sectional study.** *BMC Public Health* 2011, 11:938.

Background

Adequate consumption of fruit and vegetables provides children with essential nutrients for healthy growth and development [1] and may displace the consumption of energy-dense, nutrient-poor foods associated with childhood overweight and obesity [2-6]. Given that childhood diet is a significant determinant of adult diet [7] and higher fruit and vegetable consumption in childhood is associated with decreased risk of adult chronic disease [8, 9], the benefits of adequate childhood fruit and vegetable consumption appear to extend throughout the lifespan. Despite this, internationally and within Australia, a high proportion of children have inadequate fruit and vegetable intake [10, 11]. Identifying factors associated with higher childhood fruit and vegetable consumption may assist in the development of interventions to address this public health issue.

Many factors influence the foods that children eat: the demographic and socio-economic characteristics of their families [12, 13]; their individual preferences and genetic predispositions [14, 15]; psychosocial factors [16]; and characteristics of their environment [17, 18]. Given the amount of time children spend in the home, this environment represents a potentially promising setting in which to improve young children's fruit and vegetable consumption. Rosenkranz's ecological model of the home food environment hypothesises that child diet in this setting is influenced by three domains: built and natural environments; political and economic environments; and socio-cultural environments [19]. Of these, those most proximal to a child's life, such as home accessibility and availability of foods (built and natural environments) and parental diet, parenting practices and rules, and family eating patterns (socio-cultural environments) may be most amenable to intervention. As such, research investigating associations between these characteristics of the home environment and children's fruit and vegetable consumption is warranted.

Studies of school-aged children have found parental fruit and vegetable intake and the accessibility and availability of fruit and vegetables in the home [14, 17, 18] to be consistently associated with children's consumption. However, research involving children of preschool age (children aged 3 to 5 years [20]) is limited. For example, a 2007 systematic review that included environmental correlates of children's fruit and vegetable intake identified just three studies involving children of preschool-age, compared with 30 studies involving children aged 5 to 18 years [18], while a more recent systematic review only included studies of children aged 6 years and older [17].

The factors influencing dietary habits in early childhood may be distinct from those affecting school-aged children due to preschoolers' earlier developmental stage and greater dependence on their family [17]. The few studies that have investigated associations between such factors and fruit and vegetable consumption in preschool children found positive associations with parental fruit and vegetable intake [21-23] and parental role-modelling [24]; and negative associations with eating in front of the television [25] and parental pressure to eat [23, 25]. However, only a minority of these studies have used both a comprehensive, validated assessment of child fruit and vegetable consumption and multivariate analyses to isolate the effect of individual variables and control for the influence of socio-demographic characteristics [22, 23]. As such, this study sought to address these limitations, and identify characteristics of the home food environment associated with fruit and vegetable consumption in a sample of Australian preschool children.

Methods

Design

A cross-sectional survey of parents of preschool-aged children was conducted via Computer Assisted Telephone Interview (CATI).

Ethical Approval

The data for the present study forms the baseline dataset for a cluster randomised controlled trial of a telephone-based parent intervention to increase fruit and vegetable consumption in preschool children [26]. Ethical approval for the broader trial was obtained from the Human Research Ethics Committees of the University of Newcastle (Ref No. H-2008-0410) and the Hunter New England Area Health Service (Ref No. 08/10/15/5.09) (Appendix 6).

Sample

Study participants were parents of 3 to 5 year-old children attending non-government preschools within the Hunter region of New South Wales, Australia. Almost 90% of preschools within New South Wales are either privately or community owned and operated [27]. All participants had previously volunteered to participate in a telephone-based randomised controlled trial of a fruit and vegetable intervention [26]. Preschools were ineligible if they provided children with meals, if they catered exclusively for children with special needs, were government preschools (as the conduct of this research was not approved in these institutions) or if they had participated in child healthy eating research projects within the previous six months. Parents were eligible if

they resided with their preschool child for at least 4 days per week and were responsible for their child's meals and snacks at least half of the time. If children had dietary restrictions that were incompatible with the Australian Dietary Guidelines for fruit and vegetable consumption (as determined by an Accrediting Practicing Dietitian), their parents were deemed ineligible.

Recruitment

Recruitment procedures are described in detail elsewhere [26] and are based on a systematic review identifying effective strategies for recruiting parents for study participation through schools [28]. Briefly, all eligible preschools within the study area were invited to participate. At consenting preschools, a research assistant distributed study information and consent forms to parents as they dropped off or picked up their child. Parents indicated their consent by ticking a box on the consent form and returning it to a drop box at the preschool. Recruitment of preschools began in February 2010 and recruitment of parents began in March 2010 and was conducted over a 6-month period. The consent form contained questions about the parent's residential suburb, the child's age, gender, and usual fruit and vegetable consumption (average number of serves per day). In order to assess bias due to selective non-participation, parents who did not wish to participate in the study were encouraged to also complete a consent form with this information and return it to the preschool.

Data Collection

Consenting parents were contacted to complete a telephone survey (Appendix 7) via CATI delivered by trained telephone interviewers experienced in conducting health-related interviews. The survey was conducted from April to October 2010. Parents were instructed to answer with respect to their preschool-aged child. If they had more than one child aged 3 to 5 years, they were instructed to select the child who would have the next birthday.

Measures

Participant Characteristics

The survey included items to assess the socio-demographic characteristics of parents and children. Parents were asked their age, gender, highest level of education, annual household income and whether they identified as Aboriginal and/or Torres Strait Islander. Parents were also asked to report their child's date of birth and gender, the number of days per week that they resided with their child, and how often they were responsible for providing their child with meals and snacks (always, most of the time,

half of the time, seldom, never). Items were sourced from population health surveys [29].

Children's Fruit and Vegetable Intake

Participants also completed the fruit and vegetable subscale of the Children's Dietary Questionnaire (CDQ) [30]. This subscale requires parents to report the variety and frequency of fruit and vegetables consumed by their child over the past 24 hours and past 7 days. This tool includes potatoes and sweet potatoes in the assessment of vegetable consumption, but parents are specifically instructed not to include hot chips. Fruit and vegetable juices are excluded from questions assessing the frequency and variety of fruit intake, with the exception of a question regarding number of occasions of fruit or vegetable consumption over the past 24 hours. The subscale score ranges from 0 to 28 and a score of 14 or more suggests that the child has intake patterns consistent with fruit and vegetable dietary guidelines [30]. Changes on this score could arise from a range of possible changes to children's fruit and vegetable consumption patterns, for example, a one-point increase could result from eating an additional type of fruit or vegetable, or eating fruit or vegetable at an additional occasion in the previous 24 hours. This subscale has been established as reliable in comparable samples of preschoolers (Intraclass correlation coefficient = 0.75), and has been established as valid against a 7-day dietary checklist in a sample of school-aged children (Spearman's correlation coefficient = 0.58) [30].

Characteristics of the Home Food Environment

Characteristics of the home food environment were assessed within seven domains: parental role-modelling of fruit and vegetable consumption, pressure to eat, parental provision of fruit and vegetables, fruit and vegetable availability, fruit and vegetable accessibility, mealtime practices and family eating policies. Where possible, items were taken from existing validated home food environment measures including The Healthy Home Survey [31], The Child Feeding Questionnaire [32] and The National Nutrition Survey [33]. Where known, the reliability and validity of items are provided alongside each item. Study items with unknown psychometric properties are also identified.

a) Parental role-modelling of fruit and vegetable consumption

Items from the National Nutrition Survey were included to assess the average number of serves of fruit and vegetables consumed each day by parents [33]. Answers to these questions have been positively associated with objective biomarkers of fruit and vegetable intake including α -carotene, β -carotene, β -cryptoxanthin, lutein/zeaxanthin

and red-cell folate [34]. A lack of existing role-modelling items that were specific to fruit and vegetable consumption, quantitative, and targeted at parents of preschool children led the study team to develop two items to assess this. Specifically, parents were asked separate questions regarding the number of times they had consumed fruits, and the number of times they had consumed vegetables, in front of their child on the previous day. The validity of these items is unknown.

b) Pressure to eat

The 'Pressure to Eat' subscale from Birch's Child Feeding Questionnaire was included to measure the extent to which parents try to control the amount and type of food eaten by their child [32]. Scores range from one to five and a higher score indicates more pressure. The four-item scale has been shown to be internally consistent (Cronbach's $\alpha = 0.70$) and reliability estimates for the four items of this subscale are 0.19-0.52 [32].

c) Parental provision of fruit and vegetables

As no items or scales could be identified that measured the extent to which parents provided their children with fruit and vegetables, two questions were developed specifically for this study, and as such their psychometric properties are unknown. Separate questions were asked regarding the number of occasions on the previous day that the parent provided their child with fruits and vegetables.

d) Availability of fruit and vegetables in the home

As no appropriate measure of home fruit and vegetable availability that was brief, suitable for telephone data collection, and appropriate for use within an Australian sample could be sourced, a separate measure was developed. This was assessed by asking parents to identify foods that they currently had in their home from a list of 19 commonly consumed fruits and 24 commonly consumed vegetables from the Children's Dietary Questionnaire. Fruit and vegetables could be available in any form; fresh, tinned, frozen or dried. The number of varieties of fruits and vegetables were then summed. The validity and reliability of this item is unknown.

e) Accessibility of fruit and vegetables in the home

Accessibility was assessed by asking whether fruit and vegetables in the home were stored in a form that facilitated their consumption, for example, washed and chopped. The vegetable item was taken from the Healthy Home Survey (Item reliability, $\kappa = 0.57$, Item validity, $\kappa = 0.43$) [31]. The reliability and validity of the Healthy Home

survey items were established in a study of 85 American families with 3 to 8 year-old children by having 50% of the sample re-do the survey one week after the first administration, and by a home visit to 95% of participants [31]. As there was no equivalent item for fruit, this was adapted from the vegetable item, specifically: *Do you have any ready to eat fresh fruit on a shelf in the refrigerator or on the kitchen counter now, for example, fruit you have washed or chopped to make ready to eat, like bunches of grapes, berries, or oranges?*

f) Mealtime practices

The extent to which the family was adopting mealtime practices that encouraged child fruit and vegetable consumption was measured using items from the Healthy Home Survey. Items included the location where most meals are eaten, the number of days per week the family sits at a table to eat dinner together, and the number of days per week the child eats dinner in front of the television (Item reliability kappa = 0.73-0.80) [31].

g) Family eating policies

Questions from the Healthy Home Survey were also included to assess the extent to which parents adopted eating policies that encouraged fruit and vegetable consumption. On a five-point likert scale ('all of the time' to 'never') parents recalled the frequency with which they did each of the following: ask their child to eat everything on their plate at dinner; restrict dessert if their child does not eat the food on their plate at dinner; reward their child with desserts, snacks or confectionary if they finish their dinner; allow their child to eat only at set meal times; and allow their child to help him/herself to snacks when at home (Item reliability kappa = 0.40–0.75) [31].

Analysis

All analyses were conducted using SAS 9.2 (SAS Institute Inc., Cary, NC, USA). Descriptive statistics were used to describe the sample. Where quantitative items were used to collect information about environmental characteristics relating to fruits and vegetables separately, these totals were summed to form a single variable, for example, parental intake, parental role-modelling, fruit and vegetable availability within the home and parental providing behaviour. Similarly, the two accessibility items were combined into a single item indicating whether both fruit and vegetables were stored in a ready-to-eat format or whether fruit, or vegetables, or both fruit and vegetables were not currently stored in this way. Consistent with previous research on Australian parents of preschoolers [35] parental education was dichotomised into 'university

educated' and 'other', and annual household income was split into less than \$100,000 and \$100,000 or more. Categorical variables used to assess eating policies were recoded dichotomously, whereby 'all of the time' and 'most of the time' responses were combined to reflect consistent adoption of these policies, and 'some of the time', 'rarely' and 'never' were also combined. Non-normal continuous variables (days per week the family eats dinner together at a table, days per week the child eats dinner in front of the television) were treated as dichotomous categorical variables. The cut points were set at the frequencies with which the highest levels of children's fruit and vegetable consumption have previously been associated [36-39]. Therefore the number of days per week the family eats dinner together at a table was split into 7 days and less than 7 days, and the number of days per week the child eats dinner in front of the television was split into 0 days and 1 or more days. Similarly, the location where most meals were eaten was recoded into 'table' and 'other' [40].

A series of simple regression models was run investigating the association between each characteristic of the home food environment and children's fruit and vegetable consumption. Simple regression models also investigated socio-demographic characteristics for which associations with children's fruit or vegetable intake had previously been found; parental education [12], household income [41], child gender [21] and child age [21]. As numerous simple regression models were being tested, a Bonferroni adjustment was applied to the p-value (0.003) to account for the increased likelihood of type one error [42]. As evidence suggests fruit and vegetable consumption varies between children attending different childcare centres [43], all regression analyses used generalised linear mixed models (Proc Mixed) with a random intercept term to adjust for the correlation of measurements within a preschool.

A screening criterion of $p < 0.25$ was adopted to determine which variables would be included in the multiple regression analysis. A criterion of $p < 0.25$ was used as evidence suggests that adopting the traditional threshold ($p < 0.05$) can exclude variables of known importance [44, 45]. A backwards stepwise approach was used to determine the final multiple regression model with the least significant characteristic of the home food environment removed and the analysis re-run until only significant variables remained. Socio-demographic variables that satisfied the screening criterion ($p < 0.25$) were controlled for in the multiple regression model (i.e. they were included in the stepwise process and retained in the final model).

Results

The sample consisted of 396 parents, recruited from 30 preschools across the Hunter region. Of the 57 preschools within the sampling frame, 30 consented, 19 were ineligible, seven refused to participate and one could not be contacted. Children from approximately 2,200 families attended the 30 preschools, and 417 parents consented to participate, with a further 178 returning a form indicating that they did not consent to participate. Of those consenting, ten refused to participate when contacted to complete the survey, six were ineligible and five could not be contacted, resulting in a total of 396 parents providing data for the analysis. The study sample and the characteristics of their home food environments are described in Table 3.1.

Table 3.1 - Parent, child and home food environment characteristics of the 396 study participants

SAMPLE CHARACTERISTICS	MEAN (SD) / %
Parent Characteristics	
Mean age (SD) - years	35.5 (5.3)
Gender - female	96%
Aboriginal and/or Torres Strait Islander	2%
Highest educational level	
Year 7-9	2%
Year 10	11%
Year 11-12	10%
TAFE (Technical and Further Education)	30%
University	47%
Annual household income*	
< \$20,000	4%
\$20,000 - \$39,999	9%
\$40,000 - \$59,999	11%
\$60,000 - \$79,999	15%
\$80,000 - \$99,999	19%
≥ \$100,000	41%

SAMPLE CHARACTERISTICS	MEAN (SD) / %
Child Characteristics	
Mean age (SD) - years	4.3 (0.6)
Gender - female	49%
Mean daily serves of fruit (SD) [#]	2.3 (1.0)
Mean daily serves of vegetables (SD) [#]	2.1 (1.1)
Home Food Environment Characteristics	
<i>Parental role-modelling</i>	
Daily serves of fruit & vegetables	5.0 (1.8)
Occasions/day model fruit & vegetable consumption	2.3 (1.4)
<i>Pressure to eat</i>	
Pressure to eat	3.1 (0.7)
<i>Parent providing behaviour</i>	
Times/day parent provides fruit & vegetables	3.2 (1.3)
<i>Fruit and vegetable availability</i>	
Different varieties of fruit & vegetables in home	21.7 (4.8)
<i>Fruit and vegetable accessibility</i>	
Fruit and vegetables kept in ready-to-eat format (% yes)	39%
<i>Mealtimes practices</i>	
Always eat together as a family (7 nights per week)	57%
Never eat in front of TV (0 nights per week)	47%
Family eats most meals at table/bench (% all/most of the time)	87%
<i>Family eating policies (% who all/most of the time ...)</i>	
Ask child to eat everything on their plate at dinner	50%
Restrict dessert if child does not eat dinner	59%
Reward with dessert if child finishes dinner	29%
Only allow child to eat at set mealtimes	39%
Allow child to help him/herself to snacks	4%

* Excluding n=17 (don't know or refused)

[#] Information collected from consent form

There were no significant differences between participants and those non-consenters who returned a form with respect to child age, gender, daily serves of fruit or vegetables, or level of disadvantage based on residential postcode [46]. However, only a small proportion (approximately 10%) of the families who did not participate returned

a completed consent form. In comparison with a regionally representative sample of children aged 2 to 4 years, a similar proportion of children in this study consumed at least one serve of fruit per day, but a higher proportion of children in the study consumed at least two serves of vegetables per day [47].

Most parents (99%) lived with their child 7 days a week and most (74%) reported that they were 'always' responsible for their child's meals and snacks, with 22% and 5% reporting they were responsible 'most of the time' and 'half of the time' respectively. Parents consumed an average of five serves of fruit and vegetables each day and consumption levels approximated that of female adults within the region² [47]. On average, parents ate fruit and vegetables in front of their children on more than two occasions per day and provided their children with fruit and vegetables more than three times a day. While, on average, households had almost 22 different types of fruit and vegetables available in the house, fewer than half of those households (39%) kept both fruit and vegetables in a ready-to-eat, accessible format. On average, families ate together at a table 5.6 days a week (with 57% eating together 7 days a week) and children ate dinner in front of the television on an average of 2.2 days a week (with 47% not doing this at all, i.e. 0 days per week). The majority of families (87%) ate most meals at a table. Although 59% of parents indicated that they would restrict dessert 'most' or 'all of the time' when their child did not eat their dinner, 29% rewarded their child with dessert for finishing dinner. Only 4% of parents allowed their child to access snacks themselves.

The mean score for the fruit and vegetable subscale for children within the study was 14.8 (sd 4.6). Table 3.2 displays the strength of the associations between children's fruit and vegetable score and characteristics of the home food environment and socio-demographic characteristics in simple and multiple regression models.

² A state-wide survey that included 1,320 respondents from the Hunter New England Local Health District indicated that 18% of females consumed at least five serves of vegetables daily (vs 14% in the study sample) and 61% consumed at least two serves of fruit daily (vs 57% in the study sample) [47].

Table 3.2 - Associations between CDQ score and characteristics of the home food environment: simple and multiple regression

CHARACTERISTIC (N=396)	SIMPLE REGRESSION		MULTIPLE REGRESSION [†]	
	REGRESSION CO-EFFICIENT (95% CI)	P-VALUE	REGRESSION CO-EFFICIENT (95% CI)	P-VALUE
Parental role-modelling				
Daily serves of fruit & vegetables (F&V)	0.87 (0.64-1.11)	<0.001	0.30 (0.09-0.50)	0.005
Occasions/day models F&V consumption	1.09 (0.78-1.40)	<0.001		
Pressure to eat				
Pressure to eat	-0.78 (-1.40- -0.17)	0.012		
Parent providing behaviour				
Times/day parent provides F&V	2.22 (1.96-2.49)	<0.001	1.80 (1.53-2.09)	<0.001
Fruit and vegetable availability				
Different varieties of F&V in the home	0.34 (0.25-0.43)	<0.001	0.12 (0.03-0.20)	0.006
Fruit and vegetable accessibility*				
F&V kept in ready to eat format (Yes)	1.80 (0.87-2.73)	<0.001	0.90 (0.20-1.60)	0.012
Mealtime practices*				
Always eat together as a family (7 nights per week)	0.90 (-0.02-1.82)	0.055		
Never eat dinner in front of TV (0 nights per week)	0.87 (-0.04-1.79)	0.061		
Family eats most meals at table/bench (All or most of the time)	0.48 (-0.86-1.82)	0.480		

CHARACTERISTIC (N=396)	SIMPLE REGRESSION		MULTIPLE REGRESSION [†]	
	REGRESSION	P-VALUE	REGRESSION	P-VALUE
	CO-EFFICIENT (95% CI)		CO-EFFICIENT (95% CI)	
Family eating policies*				
<i>(% who all of most of the time ...)</i>				
Ask child to eat everything on plate at dinner	-0.05 (-0.96-0.87)	0.922		
Restrict dessert if child does not eat dinner	-0.68 (-1.60-0.25)	0.151		
Reward with dessert if child finishes dinner	-0.79 (-1.79-0.21)	0.121		
Only allow child to eat at set mealtimes	1.38 (0.46-2.31)	0.003	1.00 (0.31-1.68)	0.006
Allow child to help him/herself to snacks	-1.59 (-3.90-0.72)	0.177		
Socio-demographic characteristics[#]				
Parental education - University	1.13 (0.22-2.05)	0.015		
Annual household income >\$100,000	0.87 (-0.05-1.79)	0.065		
Child gender	0.64 (-0.27-1.55)	0.169		
Child age	-0.12 (-0.87-0.64)	0.765		

* Dichotomous characteristics

[†] Twelve characteristics of the Home Food Environment were initially entered into the multiple regression model [Daily serves of F&V, Occasions/day parent models F&V consumption, Pressure to eat, Times/day parent provides F&V, Different varieties of F&V in the home, F&V kept in ready to eat format (Yes), Always eat together as a family (7 nights per week), Never eat dinner in front of TV (0 nights per week), Restrict dessert if child does not eat dinner, Reward with dessert if child finishes dinner, Only allow child to eat at set mealtimes, Allow child to help him/herself to snacks] and three demographic characteristics [Parental education (University), household income (>\$100,000), child gender] and a backwards stepwise approach was used to determine the final model.

[#] Parental education, household income and child gender were controlled for in the multivariate model but were not significant; $p=0.172$, $p=0.848$, $p=0.164$ respectively.

Simple regression analysis found statistically significant positive associations ($p < 0.003$) between children's fruit and vegetable consumption and the following factors: parental fruit and vegetable intake; occasions per day where parents role-model fruit and vegetable consumption; provision of fruit or vegetables to children; variety of fruit and vegetables available in the home; keeping fruit and vegetables in a ready-to-eat format (e.g. washed and chopped); and only allowing children to eat at set meal times.

Twelve characteristics of the home food environment had a p-value less than 0.25 in the simple regression models and were entered into the backward stepwise regression along with parental education, household income and child gender. The assumptions of multiple regression were tested and found to be acceptable. The regression coefficients, 95% confidence intervals and p-values for the five significant variables ($p < 0.05$) that were retained in the final regression model are shown in the final two columns of Table 3.2.

Multiple regression analysis indicated that higher fruit and vegetable consumption in children was significantly associated with: higher fruit and vegetable intake in parents, more frequent provision of fruit and vegetables to children throughout the day, having a wider variety of fruits and vegetables available in the home, having fruit and vegetables stored in a ready-to-eat format, and generally only allowing children to eat at set mealtimes. These variables remained significant despite controlling for parental education, household income and the gender of the child. This model of the characteristics of the home food environment accounted for 48% of the variation in the child's fruit and vegetable score. The regression coefficients suggest that, all other factors held constant, each additional occasion that parents provide their children with fruit or vegetables throughout the day is associated with an average increase in children's fruit and vegetable score of 1.80 points, and ensuring that children generally only eat at set mealtimes is associated with an average increase of 1.00 points in the fruit and vegetable score. The coefficients of the remaining three significant variables within the model ranged from 0.12 to 0.90.

Discussion

This study is one of only a handful of studies examining associations between characteristics of the home food environment and the fruit and vegetable consumption of preschool-aged children. Furthermore, it is among the first to investigate these relationships through multiple regression analysis and with a reliable and valid

measure of fruit and vegetable intake. The study found that greater fruit and vegetable consumption in children was positively associated with parent's own fruit and vegetable consumption; the frequency with which parents provide these foods to their child; the availability and accessibility of these foods in the home; and with maintaining set mealtimes. Such findings provide insights into factors that influence young children's vegetable and fruit intake.

The positive association between child and parent fruit and vegetable intake is supported by studies involving preschool-aged children [21-23] as well as older children and adolescents [14, 18, 48, 49] and supports previous recommendations that modification of parent diet be a key strategy for interventions targeting children's eating habits [5, 21, 23, 40, 50]. A lack of significant association between child fruit and vegetable intake and parental consumption of these foods in front of their children, however, suggests that the influence of parental role-modelling is complex [51, 52]. Further research investigating the mechanisms by which parental intake may influence child consumption may yield important insights for future interventions.

A unique aspect of this study was the examination of parental provision of fruit and vegetables as a correlate of child consumption. Although the reported positive association is somewhat intuitive for children of this age, the finding accentuates the critical role that parents play in facilitating fruit and vegetable consumption through provision of these foods. Within the study sample at least, the findings also suggest that there is considerable scope to further improve child fruit and vegetable intake through encouraging more frequent provision. On average, parents provided fruit or vegetables to their child on 3.2 occasions per day, with dinner being the most prevalent occasion for serving vegetables, and morning tea the most prevalent occasion for serving fruit. Given that it is recommended that children of this age have three meals and two to three small snacks daily [53], introducing fruit and vegetables at additional occasions throughout the day, particularly the provision of vegetables for morning or afternoon teas, could represent an effective intervention strategy. Further, the findings of this study and those with older children [54, 55] demonstrate a greater likelihood for children to eat fruits and vegetable if these foods are stored at home in a ready-to-eat form. As preparation time is a commonly cited barrier to fruit and vegetable consumption [56, 57], having ready-to-eat fruit and vegetables on hand may increase the likelihood of parents feeding their preschool child these foods rather than convenient, pre-packaged, snack foods. As only 39% of parents in this study reported storing fruit *and* vegetables in this way, strategies that make it easier for parents to

purchase, prepare and store ready-to-eat fruits and vegetables are needed and likely to facilitate increased parent provision of these foods to their child.

These findings should be considered in the context of the study limitations. First, this data is cross-sectional, precluding conclusions regarding causality. Further research is warranted to determine if these associations are evident in longitudinal research, and if changes to such characteristics mediate the changes to child fruit and vegetable intake following intervention. Second, use of parent volunteers may have introduced selection bias as study participants may not be representative of the broader population from which they were drawn. Compared to a random sample of 764 mothers of 2 to 5 year-olds in the broader study region, parents in this study were more educated (47% vs 36% with a university education) and from higher income households (41% vs 20% earning over \$100,000 per year) [35] and their children had higher levels of vegetable consumption than a regionally representative sample of children aged 2 to 4 years [47]. The strength of the associations found in this study is therefore unknown among families from less advantaged backgrounds. Furthermore, most participants identified themselves as the parent that was primarily responsible for feeding their child, and only 4% of the participants were fathers, most likely due to fathers being less likely to drop children at childcare [58] and being less likely to have primary responsibility for food within the household [59]. This may restrict the generalisability of study findings to mothers, and the primary food provider, rather than parents more broadly. The inclusion of measures of the home food environment with unknown validity and reliability is a further limitation of this research and further research is required to develop and refine appropriate measures suitable for population-based investigation. Finally, this research examined the combined consumption of fruit and vegetables. The analyses did not allow for the identification of the relative associations of environmental characteristics with fruit and vegetable intake separately [60]. Future research should seek to address these limitations.

Conclusions

The study findings suggest that a range of factors within the home food environment appear to be associated with young children's fruit and vegetable intake. The final regression model which included parental intake and parental provision of fruit and vegetables to their children, the availability and accessibility of fruit and vegetables in the home, and having set mealtimes accounted for almost half of the variation in children's fruit and vegetable consumption. Such results suggest that there are

modifiable factors within the home environment that may be appropriate targets for future interventions aimed at increasing fruit and vegetable consumption in preschool-aged children to address this substantial public health problem.

References

1. Smith A, Kellet E, Schmerlaib Y: **The Australian Guide to Healthy Eating: Background information for nutrition educators**. Canberra: Commonwealth Department of Health and Family Services; 1998.
2. Lin B, Morrison RM: **Higher fruit consumption linked with lower body mass index**. *Food Review* 2002, **25**(3):28-32.
3. Tohill BC: **Dietary intake of fruit and vegetables and management of body weight**. World Health Organization; 2005.
4. Wosje KS, Khoury PR, Claytor RP, Copeland KA, Hornung RW, Daniels SR, Kalkwarf HJ: **Dietary patterns associated with fat and bone mass in young children**. *Am J Clin Nutr* 2010, **92**(2):294-303.
5. Epstein LH, Gordy CC, Raynor HA, Beddome M, Kilanowski CK, Paluch R: **Increasing fruit and vegetable intake and decreasing fat and sugar intake in families at risk for childhood obesity**. *Obes Res* 2001, **9**(3):171-178.
6. NSW Centre for Public Health Nutrition: **Report on the consumption of vegetables and fruit in NSW: 2003**. In *State of Food and Nutrition in NSW Series*. Sydney; 2003.
7. Mikkila V, Rasanen L, Raitakari OT, Pietinen P, Viikari J: **Longitudinal changes in diet from childhood into adulthood with respect to risk of cardiovascular diseases: The Cardiovascular Risk in Young Finns Study**. *Eur J Clin Nutr* 2004, **58**(7):1038-1045.
8. Maynard M, Gunnell D, Emmett P, Frankel S, Davey Smith G: **Fruit, vegetables, and antioxidants in childhood and risk of adult cancer: the Boyd Orr cohort**. *J Epidemiol Community Health* 2003, **57**(3):218-225.
9. Ness AR, Maynard M, Frankel S, Smith GD, Frobisher C, Leary SD, Emmett PM, Gunnell D: **Diet in childhood and adult cardiovascular and all cause mortality: the Boyd Orr cohort**. *Heart* 2005, **91**(7):894-898.
10. Yngve A, Wolf A, Poortvliet E, Elmadfa I, Brug J, Ehrenblad B, Franchini B, Haraldsdottir J, Krolner R, Maes L *et al*: **Fruit and vegetable intake in a**

- sample of 11-year-old children in 9 European countries: The Pro Children Cross-sectional Survey.** *Ann Nutr Metab* 2005, **49**(4):236-245.
11. Commonwealth Scientific Industrial Research Organisation: **2007 Australian National Children's Nutrition and Physical Activity Survey: Main Findings.** CSIRO; 2008.
 12. Dubois L, Farmer A, Girard M, Burnier D, Porcherie M: **Demographic and socio-economic factors related to food intake and adherence to nutritional recommendations in a cohort of pre-school children.** *Public Health Nutr* 2011, **14**(6):1096-1104.
 13. Laitinen S, Rasanen L, Viikari J, Akerblom HK: **Diet of Finnish Children in Relation to the Family's Socio-Economic Status.** *Scand J Soc Med* 1995, **23**(2):88-94.
 14. Rasmussen M, Krolner R, Klepp KI, Lytle L, Brug J, Bere E, Due P: **Determinants of fruit and vegetable consumption among children and adolescents: a review of the literature. Part I: Quantitative studies.** *Int J Behav Nutr Phys Act* 2006, **3**:22.
 15. Birch LL: **Development of food preferences.** *Annu Rev Nutr* 1999, **19**(1):41-62.
 16. McClain AD, Chappuis C, Nguyen-Rodriguez ST, Yaroch AL, Spruijt-Metz D: **Psychosocial correlates of eating behavior in children and adolescents: a review.** *Int J Behav Nutr Phys Act* 2009, **6**:54.
 17. Pearson N, Biddle SJ, Gorely T: **Family correlates of fruit and vegetable consumption in children and adolescents: a systematic review.** *Public Health Nutr* 2009, **12**(2):267-283.
 18. van der Horst K, Oenema A, Ferreira I, Wendel-Vos W, Giskes K, van Lenthe F, Brug J: **A systematic review of environmental correlates of obesity-related dietary behaviors in youth.** *Health Educ Res* 2007, **22**(2):203-226.
 19. Rosenkranz RR, Dzewaltowski DA: **Model of the home food environment pertaining to childhood obesity.** *Nutr Rev* 2008, **66**(3):123-140.

20. National Health and Medical Research Council: **Dietary Guidelines for Children and Adolescents in Australia incorporating the Infant Feeding Guidelines for Health Workers**. Commonwealth of Australia; 2003.
21. Cooke LJ, Wardle J, Gibson EL, Sapochnik M, Sheiham A, Lawson M: **Demographic, familial and trait predictors of fruit and vegetable consumption by pre-school children**. *Public Health Nutr* 2004, **7**(2):295-302.
22. Vereecken CA, Keukelier E, Maes L: **Influence of mother's educational level on food parenting practices and food habits of young children**. *Appetite* 2004, **43**(1):93-103.
23. Fisher JO, Mitchell DC, Smiciklas-Wright H, Birch LL: **Parental influences on young girls' fruit and vegetable, micronutrient, and fat intakes**. *J Am Diet Assoc* 2002, **102**:58-64.
24. Sweetman C, McGowan L, Croker H, Cooke L: **Characteristics of Family Mealtimes Affecting Children's Vegetable Consumption and Liking**. *J Am Diet Assoc* 2011, **111**(2):269-273.
25. Spurrier NJ, Magarey AA, Golley R, Curnow F, Sawyer MG: **Relationships between the home environment and physical activity and dietary patterns of preschool children: a cross-sectional study**. *Int J Behav Nutr Phys Act* 2008, **5**:31.
26. Wyse RJ, Wolfenden L, Campbell E, Brennan L, Campbell KJ, Fletcher A, Bowman J, Heard TR, Wiggers J: **A cluster randomised trial of a telephone-based intervention for parents to increase fruit and vegetable consumption in their 3- to 5-year-old children: study protocol**. *BMC Public Health* 2010, **10**:216.
27. **Harrington M: Preschool education in Australia**
[http://www.aph.gov.au/library/Pubs/BN/2007-08/PreschoolEdAustralia.htm#_Toc198010804]. Accessed 5 February 2010.
28. Wolfenden L, Kypri K, Freund M, Hodder R: **Obtaining active parental consent for school-based research: a guide for researchers**. *Aust N Z J Public Health* 2009, **33**(3):270-275.

29. Centre for Epidemiology and Research: **2008 Report on Adult Health from the New South Wales Population Health Survey**. Sydney: NSW Department of Health; 2009.
30. Magarey A, Golley R, Spurrier N, Goodwin E, Ong F: **Reliability and validity of the Children's Dietary Questionnaire; a new tool to measure children's dietary patterns**. *Int J Pediatr Obes* 2009, **4**(4):257-265.
31. Bryant MJ, Ward DS, Hales D, Vaughn A, Tabak RG, Stevens J: **Reliability and validity of the Healthy Home Survey: A tool to measure factors within homes hypothesized to relate to overweight in children**. *Int J Behav Nutr Phys Act* 2008, **5**(1):23.
32. Birch LL, Johnson SL, Grimm-Thomas K, Orlet Fisher J: **The Child Feeding Questionnaire (CFQ). Operational Definitions of Factors, Scoring, and Summing Instructions**. PA: The Pennsylvania State University; 1998.
33. Australian Bureau of Statistics: **National Nutrition Survey: Users' Guide (4801.0)**. Canberra: ABS; 1995.
34. Coyne T, Ibiebele TI, McNaughton S, Rutishauser IHE, O'Dea K, Hodge AM, McClintock C, Findlay MG, Lee A: **Evaluation of brief dietary questions to estimate vegetable and fruit consumption using serum carotenoids and red-cell folate**. *Public Health Nutr* 2005, **8**(3):298-308.
35. Wolfenden L, Hardy LL, Milat A, Bell C, Sutherland R, Wiggers J: **Prevalence and socio-demographic associations of overweight and obesity among children attending childcare services in rural and regional New South Wales Australia**. *Nutr Diet* 2011, **68**(1):15-20.
36. Gillman MW, Rifas-Shiman SL, Frazier AL, Rockett HR, Camargo CA, Jr., Field AE, Berkey CS, Colditz GA: **Family dinner and diet quality among older children and adolescents**. *Arch Fam Med* 2000, **9**(3):235-240.
37. Neumark-Sztainer D, Hannan PJ, Story M, Croll J, Perry C: **Family meal patterns: Associations with sociodemographic characteristics and improved dietary intake among adolescents** *J Am Diet Assoc* 2003, **103**:317-322.

38. Coon KA, Goldberg J, Rogers BL, Tucker KL: **Relationships between use of television during meals and children's food consumption patterns.** *Pediatrics* 2001, **107**(1):E7.
39. Matheson DM, Killen JD, Wang Y, Varady A, Robinson TN: **Children's food consumption during television viewing.** *Am J Clin Nutr* 2004, **79**(6):1088-1094.
40. Golan M, Fainaru M, Weizman A: **Role of behaviour modification in the treatment of childhood obesity with the parents as the exclusive agents of change.** *Int J Obes Relat Metab Disord* 1998, **22**(12):1217-1224.
41. Crawford PB, Obarzanek E, Schreiber GB, Barrier P, Goldman S, Frederick MM, Sabry ZI: **The Effects of Race, Household Income, and Parental Education on Nutrient Intakes of 9- and 10-Year-Old Girls.** *Ann Epidemiol* 1995, **5**(5):360-368.
42. Howell DC: *Fundamental Statistics for the Behavioral Sciences*. 4th edition. Pacific Grove: Brooks/Cole; 1999.
43. Cockcroft J, Durkin M, Masding C, Cade J: **Fruit and vegetable intakes in a sample of pre-school children participating in the 'Five for All' project in Bradford.** *Public Health Nutr* 2005, **8**(7):861-869.
44. Hosmer DW, Lemeshow S: *Applied Logistic Regression*. New York: John Wiley & Sons; 1989.
45. Bendel RB, Afifi AA: **Comparison of Stopping Rules in Forward "Stepwise" Regression.** *J Amer Statistical Assoc* 1977, **72**:46-53.
46. Australian Bureau of Statistics: **Census of Population and Housing: Socio-Economic Indexes for Areas (SEIFA) (2033.0.55.001).** Canberra: ABS; 2006.
47. Centre for Epidemiology and Research: **New South Wales Population Health Survey 2009 (HOIST).** NSW Department of Health; 2009.
48. Blanchette L, Brug J: **Determinants of fruit and vegetable consumption among 6-12-year-old children and effective interventions to increase consumption.** *J Hum Nutr Diet* 2005, **18**:431-443.

49. Pearson N, Biddle SJ, Gorely T: **Family correlates of fruit and vegetable consumption in children and adolescents: a systematic review.** *Public Health Nutr* 2008, **12**(2):267-283.
50. Hart CN, Raynor HA, Jelalian E, Drotar D: **The association of maternal food intake and infants' and toddlers' food intake.** *Child Care Health Dev* 2010, **36**(3):396-403.
51. Sutherland LA, Beavers DP, Kupper LL, Bernhardt AM, Heatherton T, Dalton MA: **Like Parent, Like Child: Child food and beverage choices during role playing.** *Arch Pediatr Adolesc Med* 2008, **162**(11):1063-1069
52. Tibbs T, Haire-Joshu D, Schechtman KB, Brownson RC, Nanney MS, Houston C, Auslander W: **The relationship between parental modeling, eating patterns, and dietary Intake among African-American parents.** *J Am Diet Assoc* 2001, **101**:535-541.
53. Grandgenett R: **Kids and Healthy Snacking: They Go Together** [<http://parentinged.msu.edu/Portals/0/docs/Kids%20and%20Healthy%20Snacking.pdf>]. Accessed 4 July 2011.
54. Wind M, de Bourdeaudhuij I, te Velde SJ, Sandvik C, Due P, Klepp KI, Brug J: **Correlates of fruit and vegetable consumption among 11-year-old Belgian-Flemish and Dutch schoolchildren.** *J Nutr Educ Behav* 2006, **38**(4):211-221.
55. Cullen KW, Baranowski T, Owens E, Marsh T, Rittenberry L, de Moor C: **Availability, accessibility, and preferences for fruit, 100% fruit juice, and vegetables influence children's dietary behavior.** *Health Educ Behav* 2003, **30**(5):615-626.
56. Dwyer J, Needham L, Simpson JR, Heeney ES: **Parents report intrapersonal, interpersonal, and environmental barriers to supporting healthy eating and physical activity among their preschoolers.** *Appl Physiol Nutr Metab* 2008, **33**(2):338-346.
57. Yeh MC, Ickes SB, Lowenstein LM, Shuval K, Ammerman AS, Farris R, Katz DL: **Understanding barriers and facilitators of fruit and vegetable consumption among a diverse multi-ethnic population in the USA.** *Health Promot Int* 2008, **23**(1):42-51.

58. Raikes HH, Summers JA, Roggman LA: **Father Involvement in Early Head Start Programs.** *Fathering: A Journal of Theory, Research, and Practice about Men as Fathers* 2005, **3**(1):29-58.
59. Harnack L, Story M, Martinson B, Neumark-Sztainer D, Stang J: **Guess who's cooking? The role of men in meal planning, shopping, and preparation in US families.** *J Am Diet Assoc* 1998, **98**(9):995-1000.
60. Glasson C, Chapman K, James E: **Fruit and vegetables should be targeted separately in health promotion programmes: differences in consumption levels, barriers, knowledge and stages of readiness for change.** *Public Health Nutr* 2010, **14**:694-701.

CHAPTER FOUR:

A pilot study of a telephone-based parent intervention to increase fruit and vegetable consumption in 3–5-year-old children

This chapter is a published paper:

Wyse R, Wolfenden L, Campbell E, Campbell K, Brennan L, Fletcher A, Bowman J, Heard T, Wiggers J. **A pilot study of a telephone-based parental intervention to increase fruit and vegetable consumption in 3–5-year-old children.** *Public Health Nutrition* 2011, **14**(12):2245-2253.

Introduction

Adequate childhood fruit and vegetable consumption is an issue of public health importance as a diet that includes plenty of fruit and vegetables helps children achieve optimal growth and development [1] and maintain a healthy weight [2-4], and can protect against chronic diseases in adulthood [5, 6]. Despite this, worldwide, many children consume insufficient quantities of fruits and vegetables [7]. Initiatives to increase childhood fruit and vegetable consumption may therefore represent an effective strategy in preventing childhood obesity and future chronic disease.

Early childhood represents a sensitive period in the formation of children's dietary behaviours [8] and parents are particularly influential in this process [9]. A number of parent-modifiable factors within the home environment have been found to be consistently associated with increased child fruit and vegetable consumption. These factors include fruit and vegetable availability and accessibility [10-12], parental role-modelling of fruit and vegetable consumption [10, 12], and the presence of supportive family eating routines [10, 11]. As such, supporting parents to make positive changes to the home environment may represent an appropriate focus for interventions attempting to increase fruit and vegetable consumption in young children.

Parents report the need for support in overcoming skill and knowledge barriers [13-16] to facilitate healthy eating behaviours in their children. Methods of providing parents with support that are effective in increasing fruit and vegetable consumption, that can be feasibly delivered to large numbers of parents at relatively low cost, and that are considered acceptable to parents, represent public health approaches likely to benefit child nutrition [17]. Against these criteria, the provision of support via telephone appears to compare favourably with other modes of delivering support to parents. Telephone-based interventions have been identified as effective [18], efficient [19], feasible [20] and acceptable [21] in changing physical activity, smoking and dietary behaviours in adults. The telephone provides a potential means of accessing most parents with preschool-aged children, and currently has a broader reach than interventions delivered via the Internet [22], and can more feasibly be delivered to large numbers of parents compared with face-to-face strategies [18].

Despite the potential advantages of telephone-delivered support, systematic reviews of obesity prevention interventions for children 0 to 5 years [23], of parent interventions targeting children's nutrition and physical activity [24], and of interventions to increase

children's fruit and vegetable consumption [25] have failed to identify any telephone-based interventions for parents targeting fruit and vegetable consumption in their preschool-aged child. Given the lack of published data, best practice models of intervention development and evaluation recommend that new interventions are developed systematically based on relevant theory and research and then pilot tested to assess acceptability, compliance, delivery of the intervention, recruitment and retention before initiating a randomised controlled evaluation [26]. As such, the aim of this pilot study was to assess the potential efficacy of a brief telephone-based parent intervention in increasing the consumption of fruit and vegetables among 3 to 5 year-old children, as well as to assess the feasibility of the intervention and its acceptability to parents.

Experimental Methods

Design

This pilot study employed a pre-post study design without a comparison group. Volunteer parents of 3 to 5 year-olds attending preschools were recruited to participate in the intervention. Telephone surveys were conducted with parents approximately one week prior to and one week following intervention delivery.

Setting / Subjects

Eligibility

Parents were recruited through non-government preschools in the Hunter region, in New South Wales, Australia. Preschools provide programs for children in the two years prior to starting full time education and 89% within the state are operated by non-government organisations [27]. Sixty-four percent of 4 year-olds in New South Wales attend preschool [27]. Parents were eligible to participate if they had a child 3 to 5 years old attending a participating preschool, if they resided with that child for at least four days a week (in order for the child to be sufficiently exposed to the intervention strategies that the parent may implement), and if they understood English. Parents of children with conditions requiring specialised dietary information or advice, as determined by a dietitian, were excluded.

Recruitment

Eight preschools were randomly selected from a list of all 47 non-government preschools in the region and preschool supervisors were contacted via mail and then phone call to obtain permission to recruit parents (Appendix 8). A research assistant visited consenting preschools on two occasions to distribute study information and

consent forms to parents as they dropped-off or picked-up their child (Appendix 10). The research assistant attended on a third occasion to distribute reminder letters to parents (Appendix 10). Recruitment took place in October 2009. All parents were encouraged to complete the consent form regardless of their intention to participate. The consent form consisted of three items relating to study eligibility: whether the parent resided with their child, the child's age, and any child allergies or dietary restrictions. Questions were also included regarding their residential postcode, the child's gender, the child's usual consumption of fruit and vegetables, and whether or not they consented to participate in the study. An accredited practising dietitian reviewed the information provided by parents about child allergies and dietary restrictions and determined whether entry into the study was appropriate. All other eligibility items were confirmed via telephone prior to collection of baseline data.

Intervention

Intervention development was guided by a family-based intervention model drawing on Socio-Ecological Theory and focusing on introducing new familial norms associated with healthy eating [28]. Other interventions based on this model have successfully introduced environmental change in the family home to support healthy eating habits [29] and reduce poor eating habits in overweight and obese children [30]. The current intervention consisted of four weekly telephone support calls (Appendix 11), each of approximately 30 minutes' duration, and a series of instructional resources including a workbook (Appendix 12), a cookbook (Appendix 13) and a pad of meal planners (Appendix 14), as well as water bottles for all family members. The support calls were scripted and were delivered by interviewers using Computer Assisted Telephone Interview (CATI) [31]. The scripts were used to facilitate structured conversations between interviewers and parents, and the CATI system controlled the delivery of the script by requiring the interviewer to enter the participant's response before the next section of the script would be displayed on the computer screen. Scripts were developed in consultation with psychologists, dietitians, and health promotion practitioners experienced in parenting or dietary or telephone interventions, and were extensively pre-tested. Scripting ensured a common structure and content across each call while multiple scripted pathways facilitated the provision of tailored information based on parents' individual practices and home food environment. Table 4.1 provides an overview of the intervention call content including behaviour change techniques [32] on which the script was based and examples of how these techniques were applied [28, 33].

Table 4.1. Overview of Intervention Content

DOMAINS	CONTENT	BEHAVIOUR CHANGE TECHNIQUE [32]	APPLICATION OF BEHAVIOUR CHANGE TECHNIQUE
Week 1 Availability & Accessibility	<ul style="list-style-type: none"> • Dietary recommendations and serving sizes • Children's food diary 	<ul style="list-style-type: none"> • Prompt self-monitoring of behaviour 	<ul style="list-style-type: none"> • Parents are encouraged to monitor their children's intake of fruit, and vegetables over 3 days.
	<ul style="list-style-type: none"> • Ways to provide fruit and vegetables throughout the day • Setting goals 	<ul style="list-style-type: none"> • Prompt specific goal-setting 	<ul style="list-style-type: none"> • Parents are encouraged to set a program goal.
Week 2 Availability & Accessibility, Supportive Family Eating Routines	<ul style="list-style-type: none"> • Changing the family routine • Availability & accessibility of foods in the home • Mealtime practices 	<ul style="list-style-type: none"> • Prompt intention formation • Provide general encouragement • Teach to use prompts or cues 	<ul style="list-style-type: none"> • Parents decide which activities they will attempt in the coming week. • Interviewers provide positive feedback about any helpful practices occurring in the home. • Parents learn the HELPS acronym, i.e. try to eat when Hungry, not attempting anything else at the same time (focus on Eating), at an appropriate Location to eat, from a Plate, and while Sitting [28].
	<ul style="list-style-type: none"> • Meal planning • Review of goals 	<ul style="list-style-type: none"> • Prompt review of behavioural goals 	<ul style="list-style-type: none"> • Parents review the goals they set during the previous calls and evaluate their progress.

DOMAINS	CONTENT	BEHAVIOUR CHANGE TECHNIQUE [32]	APPLICATION OF BEHAVIOUR CHANGE TECHNIQUE
Week 3 Parental role-modelling, Supportive Family Eating Routines	<ul style="list-style-type: none"> • The Ps and Cs division of feeding responsibility 	<ul style="list-style-type: none"> • Teach to use prompts or cues 	<ul style="list-style-type: none"> • Parents learn the Ps and Cs: Parents are encouraged to Plan, Prepare and Provide. Children are encouraged to Choose (whether, what and how much to eat) [33].
	<ul style="list-style-type: none"> • Mealtime strategies to encourage vegetable consumption • Role-modelling of fruit and vegetable consumption 	<ul style="list-style-type: none"> • Prompt intention formation • Provide general encouragement • Prompt identification as a role-model 	<ul style="list-style-type: none"> • Parents decide which activities they will attempt in the coming week. • Interviewers provide positive feedback about any helpful practices occurring in the home. • Parents are provided information about their importance in role-modelling fruit and vegetable consumption. Their consumption is compared with national nutrition recommendations. Tailored feedback is provided.
Week 4 Availability & Accessibility, Parental role-modelling, Supportive Family Eating Routines	<ul style="list-style-type: none"> • Review of weeks 1-3 	<ul style="list-style-type: none"> • Provide general encouragement 	<ul style="list-style-type: none"> • Interviewers provide positive feedback about any helpful practices occurring in the home.
	<ul style="list-style-type: none"> • Planning for the future and dealing with difficult situations • Review of goals 	<ul style="list-style-type: none"> • Prompt barrier identification • Prompt review of behavioural goals 	<ul style="list-style-type: none"> • Parents are encouraged to identify barriers that will prevent them implementing what they have learnt and to generate solutions. • Parents review their program goal, evaluate their progress and identify how they can maintain the change.

Using the script, the interviewers helped parents to set goals, identify opportunities to improve family routines or characteristics of the home environment associated with child healthy eating, identify barriers to change, assisted with problem solving, and encouraged parents to engage in behaviour change strategies. During the 4-week intervention participants completed a basic 3-day food diary for their child, and were encouraged to try a range of additional activities depending upon their existing household routines. During the calls interviewers provided parents with tailored information and strategies to support the implementation of these activities. If parents agreed to attempt any of the suggested activities, the script prompted the interviewer to ask about their attempt in the subsequent call and interviewers provided feedback, highlighted achievements and discussed ideas and strategies for improving future attempts. Activities and information were focused on the three following domains:

1) Availability and Accessibility of Foods within the Home

Parents were encouraged to ensure that fruit and vegetables were available in the home and stored in a form that facilitated their consumption i.e. washed and chopped [34]. They were also encouraged to reduce the home availability and accessibility of non-core foods such as confectionary [35].

2) Role-Modelling of Fruit and Vegetable Consumption [10]

Parents were encouraged to increase the serves of fruit and vegetables that they consumed in front of their child, and to display behaviours supportive of fruit and vegetable consumption.

3) Supportive Family Eating Routines

Parents were encouraged to eat meals as a family [11], eat meals without the television on [11], establish and enforce family rules around eating [10] and develop boundaries around when and how food is offered to their child [33].

The intervention was delivered by six interviewers with no formal health qualifications but with experience in conducting health related telephone interviews. All interviewers had completed secondary education and vocational training, and one had completed a university degree in a non-health field. They were selected based on their competency in undertaking role-plays and small group activities, such as answering parents' commonly asked questions, during a 2-day training workshop delivered by health promotion practitioners, an accredited practising dietitian and a psychologist specialising in parenting (Appendix 15). Selected interviewers then completed a further

10 hours of self-paced practice including mock intervention calls with members of the research team to ensure that they were adhering to the script and were confident in their delivery. During the period of intervention delivery, members of the research team monitored interviewers for consistency, confidence and ease of script delivery and two group sessions were held to provide feedback on performance and discuss any issues arising from monitoring.

Data Collection and Measures

Baseline and follow-up data were collected from parents via CATI approximately one week prior to, and one week following intervention (Appendix 16). For each participant, data collection was conducted by an interviewer who was not involved in intervention delivery. Additional data to assess intervention feasibility were obtained from the CATI system which automatically recorded information about each intervention call attempt and all responses provided. Baseline data collection commenced in November 2009 and follow up data collection concluded in December 2010.

Demographics

The baseline survey included demographic items assessing parent gender, age, education, income, and household composition, as well as child gender and age. Demographic items were sourced from the New South Wales Population Health Survey [36].

Intervention Efficacy

Subscales of the Children's Dietary Questionnaire (CDQ) were used to assess children's diet at baseline and follow-up. This parent reported questionnaire compares children's dietary patterns to Australian recommendations [37] with higher scores indicating a greater variety and/or frequency of foods consumed (hereafter referred to as consumption). The Fruit and Vegetable subscale was used to assess change in children's fruit and vegetable consumption. The scale has established reliability (Intraclass correlation coefficient=0.75) and validity against 7-day food checklists (Spearman correlation=0.58) and is sensitive to change in fruit and vegetable consumption at a group level [37]. Scores on this subscale can range from 0 to 28 with a score of 14 or more indicating a pattern of consumption consistent with dietary guidelines [37]. Based on scale scoring, a one-point increase on this subscale equates to, for example, a child consuming on average an additional type of fruit or vegetable each day (variety), or consuming fruit or vegetables at an additional eating occasion each day (frequency). The Non-Core Foods subscale assesses consumption of food

items such as potato crisps, soft drink and confectionary, with scores ranging from 0 to 10, and a score of 2 or less consistent with dietary guidelines [37]. This subscale was included to assess broader changes in the child's diet associated with the intervention.

Intervention Feasibility and Acceptability

Measures of intervention feasibility included the proportion of participants completing all four calls, and the average call length, days elapsed between calls, and number of call attempts. To assess acceptability the number of participants who agreed to and then attempted intervention activities was calculated from parent responses to standardised questions asked of parents as part of the scripted telephone intervention. This information was entered by the interviewer according to predetermined response options and recorded by the CATI system. In addition the follow-up survey included eight Likert scale items (on a five-point scale from 'strongly disagree' to 'strongly agree') assessing the acceptability of the number, length, content, format and relevance of the intervention calls, as well as the relevance and ease of understanding of the intervention resources, and whether program participation was worthwhile. 'Strongly agree' and 'agree' responses to Likert scale items of acceptability were combined and reported as a proportion of all responses.

Statistical Analysis

Statistical analysis was undertaken using SAS 9.2 (SAS Institute Inc., Cary, NC, USA). Descriptive statistics were reported as means, standard deviations (sd) and percentages. Median and range were reported for skewed variables. Intervention efficacy was assessed by comparing baseline and follow-up mean Fruit and Vegetable, and Non-Core Foods subscale scores using paired t-tests (alpha set at 0.05, two-tailed test) adjusted for clustering by preschool through the use of the Proc Surveymeans command.

Results

Four of the eight preschools approached (50%) consented to participate in the study and approximately 305 recruitment packs were distributed to families. There were approximately 300 families with children enrolled in the four preschools on the days of recruitment. A total of 72 parents (24%) returned a consent form, 37 (12%) consented to participate, 35 (12%) completed the baseline survey and 34 (11% of total families) completed the first intervention call and the follow-up survey. Consenters and the 35 non-consenters who returned their consent form were similar with regard to child's age,

child's fruit and vegetable consumption, and the disadvantage level of their suburb of residence [38]. However, a higher proportion of parents who consented had boys (65%) compared to non-consenters (48%). The demographic characteristics of those who started the intervention are presented in Table 4.2.

Table 4.2. Demographic Characteristics of Sample

CHARACTERISTIC	PERCENTAGE / MEAN	SD
Parents (n=34)		
Gender (female)	97%	
Age (years)	36.3	5.2
Household Income		
<\$40,000	6%	
\$40,000	18%	
\$60,000	18%	
\$80,000	12%	
\$100,000 or more	38%	
Don't Know	9%	
Highest Education attained		
Year 10	15%	
Year 12	18%	
TAFE / trade qualification	24%	
University / tertiary	44%	
Children per household	2.0	0.8
Children (n=34)		
Gender (female)	32%	
Age (years)	4.5	0.8

The parent sample consisted predominantly of females, but the majority of children who were the focus of the intervention were boys. Compared to a survey (with a response rate of 66%) of parents of 2 to 5 year-old children attending randomly selected childcare centres in the broader study region, the current sample had higher levels of maternal education (44% vs 36% with a university education) and household income (38% vs 20% with a household income exceeding \$100,000) [39].

Intervention Efficacy

There was a significant increase in the mean score on the Fruit and Vegetable subscale and a non-significant decrease in Non-Core Foods score, as shown in Table 4.3.

Table 4.3. Dietary Outcomes Pre- and Post-Intervention

OUTCOME (N=34)	PRE		POST		P-VALUE
	MEAN	(SD)	MEAN	SD	
CDQ Fruit & Vegetable subscale	15.5	(5.1)	18.1	(4.1)	p=0.027
CDQ Non-core Foods subscale	2.7	(1.4)	2.2	(1.0)	p=0.203

Prior to the intervention, 32% of parents reported that their children were not meeting fruit and vegetable dietary guidelines (CDQ scores below 14) whereas following the intervention this decreased to 18%.

Intervention Feasibility and Acceptability

All participants who started the intervention (97%) completed all four calls. The average call length was 30.8 minutes (sd 7.5), the median number of days between calls was seven (range 2 – 19), and the median number of attempts to complete each call was two (range 1 – 13 attempts). Ninety-seven percent of participants completed the intervention within the 4-week proposed schedule.

Table 4.4 displays the proportion of participants that agreed to and attempted intervention activities. All participants set a program goal regarding their child's fruit and vegetable intake. The most common goals related to increasing the amount (23%) or variety (19%) of vegetables their child ate, providing healthier snacks (19%), and being a healthy role-model for their child (14%).

Table 4.4. Number of parents who were offered, who agreed to attempt, and who actually attempted intervention tasks

INTERVENTION TASK	CALL	NUMBER OF PARENTS OFFERED ^a (% OF TOTAL)	NUMBER WHO AGREED TO ATTEMPT (% OF THOSE OFFERED)	NUMBER WHO ACTUALLY ATTEMPTED (% OF THOSE WHO AGREED)
Setting program goal	1	34 (100%)	34 (100%)	23 (70%) ^{b,c}
Completing fruit & vegetable diary in workbook (1-3 days)	1	34 (100%)	34 (100%)	32 (94%)
Availability and Accessibility				
Chopping up fruit & vegetables	2	21 (62%)	17 (81%)	14 (82%)
Moving 'non-core' foods so child can not access them	2	12 (35%)	9 (75%)	6 (67%)
Making a rule that the child must ask permission to eat 'non-core' foods	2	4 (12%)	1 (25%)	1 (100%)
Role-modelling				
Role-modelling healthy eating behaviour	3	29 (85%)	27 (93%)	26 (96%) ^b
Supportive family eating routines				
Eating dinner as a family without the television (for an additional night)	2	20 (59%)	17 (85%)	16 (94%)
Trying a mealtime strategy to encourage vegetable consumption ^d	3	34 (100%)	26 (76%)	23 (88%)

^aParticipants were only offered a task if they weren't already regularly doing it, and if it were relevant to their situation, ^bMissing data from one participant, ^cGoal attempted and achieved by the week 4 support call, ^dStrategies could include giving verbal praise instead of food rewards, trying a new meal, serving a sample of vegetable if blending vegetables into a meal.

Table 4.5 displays the proportion of participants who agreed or strongly agreed with intervention acceptability items.

Table 4.5. Intervention Acceptability

INDICATOR OF INTERVENTION ACCEPTABILITY	% AGREE OR STRONGLY AGREE (N=34)
Number of support calls was appropriate	97%
Support calls were an appropriate length	94%
Calls did not contain too much information	91% ^a
Was able to act on information in support calls	97%
Acceptable to talk about these issues over the phone	97%
Guidebook was easy to understand	100%
Resources were relevant	97%
Participation in the program was worthwhile	97%

^a Question inverted. Actual question was "The calls contained too much information". 91% disagreed or strongly disagreed.

Discussion

The pilot findings demonstrate that the variety and/or frequency of children's fruit and vegetable consumption significantly increased following delivery of a parent intervention consisting of four telephone support calls and print resources. The increase in vegetable and fruit consumption also corresponded with a non-significant decrease in the variety and frequency of children's consumption of non-core foods. Furthermore, assessments of intervention feasibility and acceptability indicate that parents actively engaged in intervention tasks, participated in all telephone contacts and perceived the program as highly acceptable. Collectively the findings suggest that the intervention may have considerable public health merit and is worthy of more rigorous evaluation to determine intervention effectiveness in the broader population.

The significant increase in mean Fruit and Vegetable score is difficult to contextualise given the lack of research utilising telephone-based parent interventions to target dietary outcomes in young children. The study findings are in contrast with a telephone-delivered interactive voice recording (IVR) intervention, which consisted of up to ten contacts for parents of older, school-aged children and failed to show a consistent impact on fruit and vegetable consumption [40]. The findings are, however, supported by the results of a randomised controlled trial in which an eight-contact telephone-based parent intervention was efficacious in improving a variety of dietary

indices in school-aged children, although fruit and vegetable consumption was not assessed [41]. Findings of this pilot study are also consistent with the positive impact of telephone-based nutrition interventions in adults [20, 42-48].

The intervention attrition rate was lower than rates previously reported in dietary interventions utilising internet [49, 50] or face-to-face [51, 52] support programs for parents, and is consistent with similar telephone-based interventions for adults [44]. Such findings indicate that parents are willing to receive and continue with an intervention via this delivery format. Encouragingly, process data indicate that beyond receiving the four telephone calls, parents engaged in intervention tasks, suggesting that parents perceived the intervention content to be appropriate. Evidence of active parent participation combined with ratings of parent acceptability in excess of 90% suggests that this intervention may be well-received by parents of preschool children.

While the results of this pilot study are promising, a number of limitations should be acknowledged. First, the absence of a comparison group and short follow-up period mean that changes in consumption may not be attributable to the intervention, and that suggested efficacy is limited to immediate impact. However, given the significant increase in fruit and vegetable consumption in this small sample, investigation into the longer-term effects in a controlled study is warranted. Second, while the Children's Dietary Questionnaire is a valid and reliable measure of child dietary patterns, and is recommended for intervention research [37], more rigorous assessments of child dietary intake such as multiple 24-hour dietary recalls would represent a more robust measure capable of quantifying actual fruit and vegetable intake [53] and should be considered for use in future research. Third, most parents in the sample reported that their children's dietary patterns were already consistent with recommended guidelines for fruit and vegetable intake. However, a post-hoc analysis of the eleven participants who reported that their children were not meeting fruit and vegetable dietary guidelines at baseline revealed a significant increase of 5.0 points on the Fruit and Vegetable subscale ($p=0.014$), suggesting the intervention is potentially efficacious among at-risk children. Finally, the response rate of 11% is lower than previous estimates of parent interest in telephone-based support services to encourage child healthy eating and physical activity (39%) [54]. Participants in this sample were more likely to be university educated, have higher household income, and have children consuming greater quantities of fruits and vegetables than random samples of parents in the study area [36, 55]. However, subgroup analyses of parents with lower education levels and lower household income revealed that the intervention significantly increased children's fruit

and vegetable scores by 3.8 points ($p=0.025$), suggesting the intervention might be efficacious among these under-represented participants. Nonetheless, such limitations mean the generalisability of the intervention findings is restricted to parents and children sharing characteristics of the study sample. Employing more comprehensive recruitment strategies [56] may improve study participation rates, and improve the external validity of findings from future trials.

Despite these limitations the results from this pilot study are encouraging. The public health application of a relatively brief intervention, consisting of print resources plus four telephone contacts, delivered by trained telephone interviewers rather than health professionals, is likely to be particularly appealing to health services given limited resources and access to specialist staff. Such interventions may provide feasible healthy eating support within the community. The findings of this trial warrant further investigation in an adequately powered randomised controlled trial with an extended follow-up period, and additional research into intervention efficacy in lower income and less educated samples.

References

1. National Health and Medical Research Council: **Dietary Guidelines for Children and Adolescents in Australia incorporating the Infant Feeding Guidelines for Health Workers**. Commonwealth of Australia; 2003.
2. Lin B, Morrison RM: **Higher fruit consumption linked with lower body mass index**. *Food Review* 2002, **25**(3):28-32.
3. Wosje KS, Khoury PR, Claytor RP, Copeland KA, Hornung RW, Daniels SR, Kalkwarf HJ: **Dietary patterns associated with fat and bone mass in young children**. *Am J Clin Nutr* 2010, **92**(2):294-303.
4. Tohill BC: **Dietary intake of fruit and vegetables and management of body weight**. World Health Organization; 2005.
5. Ness AR, Maynard M, Frankel S, Smith GD, Frobisher C, Leary SD, Emmett PM, Gunnell D: **Diet in childhood and adult cardiovascular and all cause mortality: the Boyd Orr cohort**. *Heart* 2005, **91**(7):894-898.
6. Maynard M, Gunnell D, Emmett P, Frankel S, Davey Smith G: **Fruit, vegetables, and antioxidants in childhood and risk of adult cancer: the Boyd Orr cohort**. *J Epidemiol Community Health* 2003, **57**(3):218-225.
7. Yngve A, Wolf A, Poortvliet E, Elmadfa I, Brug J, Ehrenblad B, Franchini B, Haraldsdottir J, Krolner R, Maes L *et al*: **Fruit and vegetable intake in a sample of 11-year-old children in 9 European countries: The Pro Children Cross-sectional Survey**. *Ann Nutr Metab* 2005, **49**(4):236-245.
8. Birch LL, Fisher JO: **Development of eating behaviors among children and adolescents**. *Pediatrics* 1998, **101**(3 Pt 2):539-549.
9. Benton D: **Role of parents in the determination of the food preferences of children and the development of obesity**. *Int J Obes Relat Metab Disord* 2004, **28**(7):858-869.
10. Pearson N, Biddle SJ, Gorely T: **Family correlates of fruit and vegetable consumption in children and adolescents: a systematic review**. *Public Health Nutr* 2009, **12**(2):267-283.

11. Rasmussen M, Krolner R, Klepp KI, Lytle L, Brug J, Bere E, Due P: **Determinants of fruit and vegetable consumption among children and adolescents: a review of the literature. Part I: Quantitative studies.** *Int J Behav Nutr Phys Act* 2006, **3**:22.
12. van der Horst K, Oenema A, Ferreira I, Wendel-Vos W, Giskes K, van Lenthe F, Brug J: **A systematic review of environmental correlates of obesity-related dietary behaviors in youth.** *Health Educ Res* 2007, **22**(2):203-226.
13. Pagnini DL, Wilkenfeld RL, King LA, Booth ML, Booth SL: **Mothers of pre-school children talk about childhood overweight and obesity: The Weight Of Opinion Study.** *J Paediatr Child Health* 2007, **43**(12):806-810.
14. Reed DB: **Focus groups identify desirable features of nutrition programs for low-income mothers of preschool children.** *J Am Diet Assoc* 1996, **96**(5):501-503.
15. Spear BA: **The need for family meals.** *J Am Diet Assoc* 2006, **106**(2):218-219.
16. Hesketh K, Waters E, Green J, Salmon L, Williams J: **Healthy eating, activity and obesity prevention: a qualitative study of parent and child perceptions in Australia.** *Health Promot Int* 2005, **20**(1):19-26.
17. Glasgow RE, Vogt TM, Boles SM: **Evaluating the public health impact of health promotion interventions: the RE-AIM framework.** *Am J Public Health* 1999, **89**(9):1322-1327.
18. Eakin EG, Lawler SP, Vandelanotte C, Owen N: **Telephone interventions for physical activity and dietary behavior change: a systematic review.** *Am J Prev Med* 2007, **32**(5):419-434.
19. Graves N, Barnett AG, Halton KA, Veerman JL, Winkler E, Owen N, Reeves MM, Marshall A, Eakin E: **Cost-effectiveness of a telephone-delivered intervention for physical activity and diet.** *PLoS One* 2009, **4**(9):e7135.
20. Djuric Z, Ellsworth JS, Ren J, Sen A, Ruffin MT: **A randomized feasibility trial of brief telephone counseling to increase fruit and vegetable intakes.** *Prev Med* 2010, **50**(5-6):265-271.

21. Tzelepis F, Paul CL, Walsh RA, Wiggers J, Duncan SL, Knight J: **Active telephone recruitment to quitline services: are nonvolunteer smokers receptive to cessation support?** *Nicotine Tob Res* 2009, **11**(10):1205-1215.
22. International Telecommunications Union: **Information society statistical profiles 2009: Asia and the Pacific**. Geneva: ITU; 2009.
23. Campbell KJ, Hesketh KD: **Strategies which aim to positively impact on weight, physical activity, diet and sedentary behaviours in children from zero to five years. A systematic review of the literature**. *Obes Rev* 2007, **8**(4):327-338.
24. Golley RK, Hendrie GA, Slater A, Corsini N: **Interventions that involve parents to improve children's weight-related nutrition intake and activity patterns - what nutrition and activity targets and behaviour change techniques are associated with intervention effectiveness?** *Obes Rev* 2010, **12**(2):114-130.
25. Knai C, Pomerleau J, Lock K, McKee M: **Getting children to eat more fruit and vegetables: a systematic review**. *Prev Med* 2006, **42**(2):85-95.
26. Craig P, Dieppe P, Macintyre S, Mitchie S, Nazareth I, Petticrew M: **Developing and evaluating complex interventions: the new Medical Research Council guidance**. *BMJ* 2008, **337**:a1655.
27. Steering Committee for the Review of Government Service Provision: **Report on Government Services 2008, Volume 1: Early Childhood, Education and Training; Justice; Emergency Management**. Canberra: Productivity Commission; 2008.
28. Golan M, Weizman A: **Familial approach to the treatment of childhood obesity: conceptual mode**. *J Nutr Educ* 2001, **33**(2):102-107.
29. Golan M, Kaufman V, Shahar DR: **Childhood obesity treatment: targeting parents exclusively v. parents and children**. *Br J Nutr* 2006, **95**(5):1008-1015.
30. Golan M, Fainaru M, Weizman A: **Role of behaviour modification in the treatment of childhood obesity with the parents as the exclusive agents of change**. *Int J Obes Relat Metab Disord* 1998, **22**(12):1217-1224.

31. Choi BC: **Computer assisted telephone interviewing (CATI) for health surveys in public health surveillance: methodological issues and challenges ahead.** *Chronic Diseases in Canada* 2004, **25**(2):21-27.
32. Abraham C, Michie S: **A taxonomy of behavior change techniques used in interventions.** *Health Psychol* 2008, **27**(3):379-387.
33. Satter E: **Feeding dynamics: helping children to eat well.** *J Pediatr Health Care* 1995, **9**(4):178-184.
34. Hearn MD, Baranowski T, Baranowski J, Doyle C, Smith M, Lin LS, Renisow K: **Environmental influences on dietary behavior among children: Availability and accessibility of fruit and vegetables enable consumption.** *J Health Educ* 1998, **29**(1):26-32.
35. Spurrier NJ, Magarey AA, Golley R, Curnow F, Sawyer MG: **Relationships between the home environment and physical activity and dietary patterns of preschool children: a cross-sectional study.** *Int J Behav Nutr Phys Act* 2008, **5**:31.
36. Centre for Epidemiology and Research: **2008 Report on Adult Health from the New South Wales Population Health Survey.** Sydney: NSW Department of Health; 2009.
37. Magarey A, Golley R, Spurrier N, Goodwin E, Ong F: **Reliability and validity of the Children's Dietary Questionnaire; a new tool to measure children's dietary patterns.** *Int J Pediatr Obes* 2009, **4**(4):257-265.
38. Australian Bureau of Statistics: **Census of Population and Housing: Socio-Economic Indexes for Areas (SEIFA) (2033.0.55.001).** Canberra: ABS; 2006.
39. Wolfenden L, Hardy LL, Milat A, Bell C, Sutherland R, Wiggers J: **Prevalence and socio-demographic associations of overweight and obesity among children attending childcare services in rural and regional New South Wales Australia.** *Nutr Diet* 2011, **68**(1):15-20.
40. Estabrooks PA, Shoup JA, Gattshall M, Dandamudi P, Shetterly S, Xu S: **Automated telephone counseling for parents of overweight children: a randomized controlled trial.** *Am J Prev Med* 2009, **36**(1):35-42.

41. Paineau DL, Beaufile F, Boulier A, Cassuto DA, Chwalow J, Combris P, Couet C, Jouret B, Lafay L, Laville M *et al*: **Family dietary coaching to improve nutritional intakes and body weight control: a randomized controlled trial.** *Arch Pediatr Adolesc Med* 2008, **162**(1):34-43.
42. Vale MJ, Jelinek MV, Best JD, Dart AM, Grigg LE, Hare DL, Ho BP, Newman RW, McNeil JJ: **Coaching patients On Achieving Cardiovascular Health (COACH): a multicenter randomized trial in patients with coronary heart disease.** *Arch Intern Med* 2003, **163**(22):2775-2783.
43. Burke LE, Dunbar-Jacob J, Orchard TJ, Sereika SM: **Improving adherence to a cholesterol-lowering diet: a behavioral intervention study.** *Patient Educ Couns* 2005, **57**(1):134-142.
44. Kris-Etherton PM, Taylor DS, Smiciklas-Wright H, Mitchell DC, Bekhuis TC, Olson BH, Slonim AB: **High-soluble-fiber foods in conjunction with a telephone-based, personalized behavior change support service result in favorable changes in lipids and lifestyles after 7 weeks.** *J Am Diet Assoc* 2002, **102**(4):503-510.
45. Pakiz B, Flatt SW, Mills KC, Jordan LJ, Carethers JM, Rock CL: **Quality of life and diet intervention in individuals at risk for recurrence of colorectal adenomas.** *Psychooncology* 2005, **14**(2):85-93.
46. Pierce JP, Newman VA, Flatt SW, Faerber S, Rock CL, Natarajan L, Caan BJ, Gold EB, Hollenbach KA, Wasserman L *et al*: **Telephone counseling intervention increases intakes of micronutrient- and phytochemical-rich vegetables, fruit and fiber in breast cancer survivors.** *J Nutr* 2004, **134**(2):452-458.
47. Djuric Z, Vanloon G, Radakovich K, Dilauro NM, Heilbrun LK, Sen A: **Design of a Mediterranean exchange list diet implemented by telephone counseling.** *J Am Diet Assoc* 2008, **108**(12):2059-2065.
48. Newman VA, Flatt SW, Pierce JP: **Telephone counseling promotes dietary change in healthy adults: results of a pilot trial.** *J Am Diet Assoc* 2008, **108**(8):1350-1354.

49. Baranowski T, Baranowski JC, Cullen KW, Thompson DI, Nicklas T, Zakeri IE, Rochon J: **The Fun, Food, and Fitness Project (FFFP): the Baylor GEMS pilot study.** *Ethnic Dis* 2003, **13**(1 Suppl 1):S30-39.
50. Cullen KW, Thompson D: **Feasibility of an 8-week African American web-based pilot program promoting healthy eating behaviors: Family Eats.** *Am J Health Behav* 2008, **32**(1):40-51.
51. Golley RK, Magarey AM, Baur LA, Steinbeck KS, Daniels LA: **Twelve-month effectiveness of a parent-led, family-focused weight-management program for prepubertal children: a randomized, controlled trial.** *Pediatrics* 2007, **119**(3):517-525.
52. Sacher P, Wolman J, Chadwick P, Swain C: **Mini-MEND: MEND's early years healthy lifestyle programme for 24 year olds and their families.** *Nutrition Bulletin* 2008, **33**(4):364-367.
53. Thompson F, Subar A: **Dietary assessment methodology.** In *Nutrition in the Prevention and Treatment of Disease*. 2nd edition. Edited by Coulston A, Boushey C. Burlington, MA: Elsevier Academic Press; 2008:3-39.
54. Wolfenden L, Bell C, Wiggers J, Butler M, James E, Chipperfield K: **Engaging parents in child obesity prevention: Support preferences of parents.** *J Paediatr Child Health* 2012, **48**(2):E4-6.
55. Wolfenden L, Hardy LL, Milat A, Bell C, Sutherland R, Wiggers J: **Prevalence and socio-demographic associations of overweight and obesity among children attending childcare services in rural and regional New South Wales Australia.** *Nutr Diet* 2011, **68**(1):15-20.
56. Wolfenden L, Kypri K, Freund M, Hodder R: **Obtaining active parental consent for school-based research: a guide for researchers.** *Aust N Z J Public Health* 2009, **33**(3):270-275.

CHAPTER FIVE a)

A cluster randomised trial of a telephone-based intervention for parents to increase fruit and vegetable consumption in their 3- to 5-year-old children: Study protocol

This chapter is a published paper:

Wyse RJ, Wolfenden L, Campbell E, Brennan L, Campbell KJ, Fletcher A, Bowman J, Heard TR, Wiggers J. **A cluster randomised trial of a telephone-based intervention for parents to increase fruit and vegetable consumption in their 3- to 5-year-old children: study protocol.** *BMC Public Health* 2010, **10**:216.

Background

Inadequate fruit and vegetable consumption contributes to a variety of chronic diseases and is estimated to be responsible for 2.6 million deaths per year worldwide [1]. A substantial proportion of adults [2, 3] and children [4] from developed countries, including Australia [5, 6], consume insufficient quantities of fruit and vegetables. The 2002 World Health Report estimated that 4% of the disease burden in developed countries was attributable to low fruit and vegetable intake [5]. Increasing consumption in early childhood may be an effective strategy to reduce the risk of subsequent chronic disease associated with insufficient fruit and vegetable consumption, as dietary patterns in childhood appear to track into adulthood [6].

Parents are likely to be influential in the development of children's eating behaviours [7]. Parental practices associated with increased child consumption of fruit and vegetables include increasing the availability and accessibility of fruit and vegetables within the home [8], role-modelling fruit and vegetable consumption [9] and establishing family eating routines supportive of fruit and vegetable consumption, such as eating meals as a family [10] and not in view of a television [11]. Despite such influence, a lack of knowledge and skills can prevent parents from utilising these opportunities to promote healthy eating habits in their children [12].

Assisting parents to create supportive home environments can be an effective strategy to increase the fruit and vegetable consumption of their children [13]. However, studies involving traditional means of delivering interventions to parents, such as education sessions, often report high drop-out rates [14] and low attendance due to barriers associated with transport, work schedules and lack of interest [15]. Parent participation in healthy eating interventions is also reportedly constrained by specific barriers associated with preschool-aged children, including unpredictable sleep times and frequent sickness [16]. Telephone-based interventions may overcome many of these barriers and provide a convenient and effective means for parents to receive healthy eating support for their children. For example, previous research with adults has found that telephone support is an acceptable method of delivering health information [17] and is an effective strategy in modifying a range of health behaviours, including smoking [18], physical activity [19] and diet [20-22]. Furthermore, almost all Australian households have telephones [23]; thus, telephone-delivered interventions have the capacity for broad reach, and may hold promise in specifically targeting disadvantaged communities [24].

Despite the potential of telephone-based interventions to provide effective and acceptable support to parents, the authors are not aware of any randomised controlled trials of such interventions specifically targeting healthy eating behaviours in preschool children. The study attempts to address this gap in evidence through the conduct of a cluster randomised controlled trial of a telephone-based parent-focused intervention to increase the fruit and vegetable consumption of children aged 3 to 5 years. This paper describes the methodology to be employed in the conduct of this trial.

Methods

Study Aim

The aim of this study is to examine the efficacy of a 4-week telephone-based parent intervention in increasing fruit and vegetable consumption of 3- to 5-year-old children, as assessed by parental report.

Study Design

Overview of Study Design

The study employs a cluster randomised design, as outlined in Figure 5.1. The research will be reported in accordance with the requirements of the CONSORT statement [25]. Parents of 3- to 5-year-old children attending randomly selected preschools in the Hunter region of New South Wales, Australia, are being approached to participate. Preschools will be randomised to either control or intervention groups using a random number function in Microsoft Excel. Parents of children attending preschools allocated to the intervention group will receive a series of instructional resources and four 30-minute telephone calls delivered weekly by trained telephone interviewers. Parents of children attending preschools allocated to the control group will receive a readily available nutrition resource published by the Australian Government [26]. To assess the efficacy of the intervention, surveys will be conducted with parents via Computer Assisted Telephone Interview (CATI) at baseline (occurring one to two weeks prior to commencement of intervention delivery) and 2, 6, 12 and 18 months following baseline data collection.

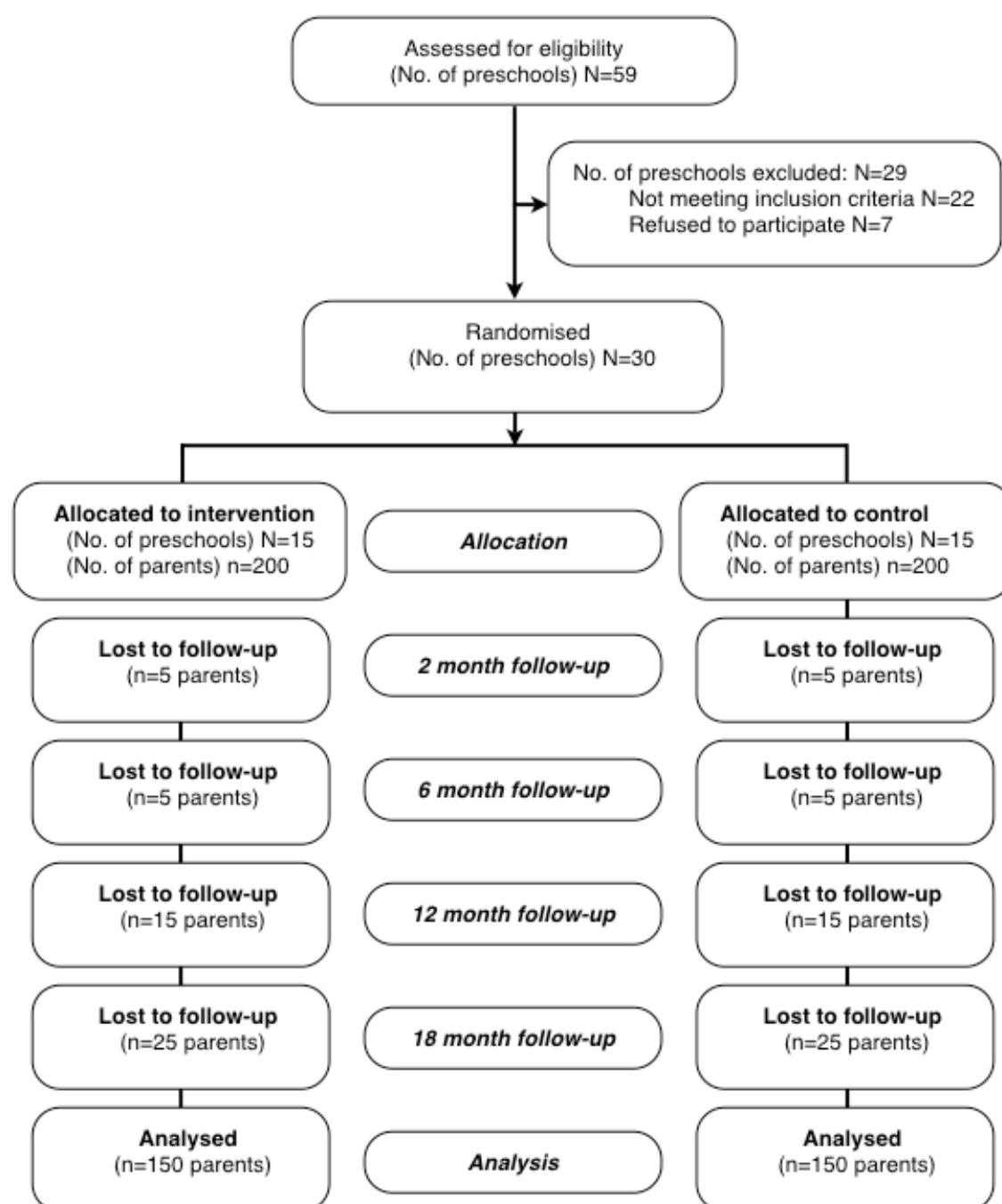


Figure 5.1: CONSORT flow diagram estimating the progress of preschools and parents through the trial

The trial is funded by the Cancer Institute New South Wales (Ref no. 08/ECF/1-18). In-kind support for the trial is also provided by the Hunter New England Population Health Service. The trial has been approved by the Human Research Ethics Committees of the University of Newcastle (Ref No. H-2008-0410) and the Hunter New England Area Health Service (Ref No. 08/10/15/5.09) (Appendix 6).

Research Setting

The study region encompasses non-metropolitan 'major cities' and 'inner regional' areas as described by the Australian Standard Geographic Classification system [27]. The region has lower indices of socio-economic status than the national average and has 485,700 residents, with 18,200 children aged 3 to 5 years [27]. Nine percent of Hunter residents speak languages other than English [28].

Participants and Research Eligibility***Preschools***

Thirty preschools will be recruited into the trial. Preschools in Australia provide educational and developmental programs for children (3 to 5 years) for up to two years prior to the commencement of full-time primary school education [29]. Preschool services are usually provided by qualified teachers for approximately 6 hours per weekday [30]. Sixty-four percent of all 4-year-old children in New South Wales attend preschool, with an average attendance of 17 hours per week [31]. Each preschool in the study area provides, on average, care for 27 children per day [32].

A current list of all preschools in the region that are licensed to provide care for 3- to 5-year-old children will be obtained from the New South Wales Department of Community Services (the licensing agency). Preschools will be excluded from the trial if they; provide meals to children in their care (as this limits parents' capacity to influence the foods their children consume), cater exclusively for children with special needs (given the specialist care required for such children), are Government preschools (as conduct of the research has not been approved by the New South Wales Government Department of Education and Training), or have participated in child healthy eating research projects within 6 months of the commencement of recruitment. Information regarding eligibility of preschool services will be confirmed by preschool supervisors during phone contact as part of the recruitment process (Appendix 8).

Parents

Four hundred parents will be recruited to the study. To be eligible, each participant must be a parent of a child aged 3 to 5 years attending a participating preschool, must reside with that child for at least four days a week (in order for the child to be sufficiently exposed to the intervention strategies that the parent may implement), must have some responsibility for providing meals and snacks to that child, and must be able to understand spoken and written English. Information regarding parent eligibility

will be ascertained from completed study consent forms and verified during phone contact with parents immediately prior to baseline data collection. Parents will be excluded from the trial if their children have special dietary requirements or allergies that would necessitate specialised tailoring of the intervention or that may be adversely affected by the intervention. Such exclusions will be determined by an Accredited Practising Dietitian who is independent of the research team.

Recruitment and Allocation

Preschools

Prior to formal requests to participate, the research trial will be promoted to preschools within the region through existing networks established by the *Good for Kids. Good for Life* program, a high-profile childhood obesity prevention program in the region [33]. Agreement has been reached with the *Good for Kids* program for this research project to utilise the *Good for Kids* brand and the program's existing communication channels with preschools. Specifically, newsletters and program emails will be used to make preschool supervisors aware of the trial and of what will be required of them if they consent to participate (Appendix 17).

Participating preschools and the order in which they are to be approached to participate will be randomly selected from the New South Wales Department of Community Services database by an independent statistician using a random number function in Microsoft Excel. Recruitment will be staggered over a 4- to 5-month period due to intervention delivery capacity constraints. Preschools will therefore be approached in batches, until the desired sample of parents is achieved (Appendix 8). The supervisors of the selected preschools will be sent letters and consent forms (Appendix 9) informing them of the study and requesting permission to recruit parents through their services. Consent will be obtained when the supervisor faxes or posts the consent form back to the research team. Two weeks after the initial information letters are sent to supervisors, a study research assistant will telephone supervisors who have not yet returned their consent forms to answer any questions they may have and to remind them to return their forms, confirming their consent or otherwise (Appendix 8). Similar recruitment methods employed by the researchers as part of an Australian healthy eating and physical activity study were successful in achieving a childcare service participation rate of 84% [32].

Parents

In order to maximise parent participation in the study, a recruitment strategy based on a review of successful recruitment practices within the school setting [34] has been devised. Recruitment will incorporate the following four strategies recommended to maximise research participation.

1. Recruitment oversight

One member of the research team will act as a dedicated recruitment coordinator. All preschool supervisors and parents will be provided with the direct phone number of the coordinator for all enquiries regarding research participation. The coordinator will also manage the rate at which preschools are recruited and monitor preschool and parent consent form return rates. The recruitment coordinator will not be involved in the delivery of the telephone support or the collection of data.

2. Promotion of the research prior to requests for participation

A promotional flier explaining the study will be sent to supervisors to disseminate to all parents at consenting preschools (Appendix 18). The flier will inform parents of the trial and the opportunity to participate, and will include endorsement of the research by a clinical psychologist and parenting expert. Such contact prior to a formal request to participate has been shown to increase response rates to postal questionnaires [35] and will be important in engaging parents where face-to-face contact is not possible. The project name, flier and recruitment documentation will include the *Good for Kids* logo and brand name [33]. Following a recent media campaign, unpublished data indicated that 59% of parents within the area reported that they were aware of the *Good for Kids* program.

3. Dissemination of recruitment materials via methods to maximise parent engagement

The recruitment coordinator will arrange for recruitment packs to be delivered to each participating preschool, enough for one per family of each enrolled child aged 3 to 5 years. Distribution of these packs to parents will occur via methods considered by the preschool supervisor to be most effective and appropriate in engaging parents. Where possible, research staff will attend the preschool, hand out recruitment packs to parents and be available to answer parent questions. The recruitment pack consists of an information sheet, a consent form and a return envelope (Appendix 10). The pack is brightly coloured and specifies that the study is being conducted in conjunction with a university; these strategies are suggested to increase response rates among those parents who have only received written communication during recruitment [35].

4. Parent reminders

One to two weeks after delivery of the recruitment packs, reminder letters will be disseminated to parents, reminding them of the study and the opportunity to participate (Appendix 10).

Parents will be asked to return the consent forms in the envelopes provided and place them in drop-boxes at their children's preschools within three weeks. The consent form includes a brief set of questions to establish the child's usual fruit and vegetable consumption (Appendix 10). In order to identify any bias due to selective non-participation, all parents of 3- to 5-year-old children will be encouraged to complete the items on the consent forms and return them, regardless of whether they choose to participate.

Random Allocation of Preschools

Following the recruitment of parents within a preschool, an independent statistician will randomly allocate the preschool to an intervention or a control group using a randomisation function in Microsoft Excel. Randomisation at the unit of the preschool, rather than the individual parent, will reduce the potential for intervention contamination between parents whose children attend the same preschool [36]. Based on evidence suggesting that children's eating environments differ by socio-economic status [37], the randomised allocation will be stratified by the socio-economic status of the area in which the preschool is located [38]. Preschools with a postcode in the top 50% of the state, based on Socio-Economic Indexes for Areas (SEIFA) [39] will be defined as 'high socio-economic area preschools' and those within the lower 50% will be defined as 'low socio-economic area preschools'. Preschools will be randomised in a 1:1 (intervention:control) ratio in randomly sequenced blocks of between two and six preschools. Block randomisation will maximise the likelihood that the number of participants allocated to each group remains approximately equal [40]. Due to the difficulty in concealing group allocation from participants, parents will not be blinded, and following baseline data collection they will receive letters informing them that they will receive either print materials or telephone support (Appendix 19).

Intervention Group

The 200 parents randomised to the intervention group will receive a workbook and other resources (Appendices 12-14) and weekly scripted telephone contacts of approximately 30 minutes' duration delivered over 4 weeks (Appendix 11). Telephone-based interventions of a similar intensity have previously been found to be effective in

adults [41, 42]. Given evidence of the effectiveness of this relatively low number of intervention calls, the trial advisory group recommended a similarly brief intervention be developed, based on the greater likelihood of such an intervention being adopted into public health policy. Each telephone contact aims to provide parents with appropriate knowledge and skills to modify three key domains within the home food environment: availability and accessibility of fruit and vegetables; supportive family eating routines, and parental role-modelling (See Table 5.1).

Development and Pre-testing of the Intervention

The script has been developed by an expert advisory group of clinical and health psychologists, dietitians and health promotion practitioners. The script utilises CATI software [43] to tailor support based on parental report of the home food environment. Intervention development was guided by an existing framework for behavioural therapy development in clinical settings [44]. The pre-testing process involved three phases where the research team piloted preliminary versions of the telephone script and workbook, and refined the intervention based on the feedback received. Each phase of pre-testing was conducted with eight to 12 volunteer health promotion practitioners, parenting experts and parents of young children. Volunteers were asked to comment on the content, structure, presentation and length of the intervention, and were encouraged to suggest how the telephone script or workbook could be improved. Feedback from the members of the research team who administered the pre-test telephone calls to volunteers was also sought regarding the ease of administration of the script and the level of volunteer engagement in the intervention.

Following each pre-testing phase, feedback was collated and proposed intervention amendments were discussed by the research team and adopted where feasible. The primary amendments to the telephone script that resulted from pre-testing included; reducing the length of the calls, changing the order of presentation of intervention content, reducing repetition, providing more examples to clarify key issues, simplifying language, removing jargon, making the script more conversational, and including more opportunities for interaction between parents and interviewers. The primary amendments to the workbook included the addition of more practical information and tools for parents, improving readability through simplifying language, using subheadings and reducing the volume of text, and improvements to the presentation of the workbook to make it more appealing, such as use of bright colours, illustrations and photographs.

Intervention Content

The telephone intervention script (Appendix 11) is designed to help parents modify their home food environments through addressing three key domains listed in Table 5.1. The first column of the table lists each domain at the point at which it appears in the schedule of support calls, while the second column lists the specific topics that are used to explore each of the given domains. Each domain has been associated with increased fruit and vegetable consumption in children as described below.

a) Availability and Accessibility of Fruit and Vegetables [10, 47]

The telephone intervention encourages parents to ensure that fruit and vegetables are available and accessible in the home and that they are prepared, presented or maintained in a ready-to-eat form that encourages their consumption [45]. This could include offering cut-up pieces of fruit or vegetable at snack times, and ensuring fruit is visible by storing it in fruit bowls.

b) Supportive Family Eating Routines

The intervention will seek to improve parent knowledge and facilitate the acquisition of skills to support parents to eat meals as a family [10] without the television on [11], establish and enforce family rules about eating [9] and develop boundaries regarding when and how food is offered to their children [46].

c) Parental Role-Modelling of Fruit and Vegetable Consumption [9]

Parents will be encouraged to increase the number of serves of fruit and vegetables that they consume in front of their children and to express supportive attitudes toward the consumption of fruit and vegetables to their children, for example, by making positive and encouraging comments.

Table 5.1: Overview of intervention call content: behaviour change techniques and their application

DOMAINS	CONTENT	BEHAVIOUR CHANGE TECHNIQUE	APPLICATION OF BEHAVIOUR CHANGE TECHNIQUE
Availability & Accessibility	<ul style="list-style-type: none"> • Dietary recommendations and serving sizes • Children's food diary 	<ul style="list-style-type: none"> • Prompt self-monitoring of behaviour 	<ul style="list-style-type: none"> • Parents are encouraged to monitor their children's intake of fruit, and vegetables over 3 days.
	<ul style="list-style-type: none"> • Ways to provide fruit and vegetables throughout the day • Setting goals 	<ul style="list-style-type: none"> • Prompt specific goal-setting 	<ul style="list-style-type: none"> • Parents are encouraged to set a program goal.
Availability & Accessibility, Supportive Family Eating Routines	<ul style="list-style-type: none"> • Changing the family routine • Availability & accessibility of foods in the home • Mealtime practices 	<ul style="list-style-type: none"> • Prompt intention formation • Provide general encouragement • Teach to use prompts or cues 	<ul style="list-style-type: none"> • Parents decide which activities they will attempt in the coming week. • Interviewers provide positive feedback about any helpful practices occurring in the home. • Parents learn the HELPS acronym, i.e. try to eat when Hungry, not attempting anything else at the same time (focus on Eating), at an appropriate Location to eat, from a Plate, and while Sitting.
	<ul style="list-style-type: none"> • Meal planning • Review of goals 	<ul style="list-style-type: none"> • Prompt review of behavioural goals 	<ul style="list-style-type: none"> • Parents review the goals they set during the previous calls and evaluate their progress.

DOMAINS	CONTENT	BEHAVIOUR CHANGE TECHNIQUE	APPLICATION OF BEHAVIOUR CHANGE TECHNIQUE
Week 3 Parental role- modelling, Supportive Family Eating Routines	<ul style="list-style-type: none"> • The Ps and Cs division of feeding responsibility 	<ul style="list-style-type: none"> • Teach to use prompts or cues 	<ul style="list-style-type: none"> • Parents learn the Ps and Cs: Parents are encouraged to Plan, Prepare and Provide. Children are encouraged to Choose (whether, what and how much to eat) [46].
	<ul style="list-style-type: none"> • Mealtime strategies to encourage vegetable consumption • Role-modelling of fruit and vegetable consumption 	<ul style="list-style-type: none"> • Prompt intention formation • Provide general encouragement • Prompt identification as a role-model 	<ul style="list-style-type: none"> • Parents decide which activities they will attempt in the coming week. • Interviewers provide positive feedback about any helpful practices occurring in the home. • Parents are provided information about their importance in role-modelling fruit and vegetable consumption. Their consumption is compared with national nutrition recommendations. Tailored feedback is provided.
Week 4 Availability & Accessibility, Parental role- modelling, Supportive Family Eating Routines	<ul style="list-style-type: none"> • Review of weeks 1-3 • Planning for the future and dealing with difficult situations • Review of goals 	<ul style="list-style-type: none"> • Provide general encouragement • Prompt barrier identification • Prompt review of behavioural goals 	<ul style="list-style-type: none"> • Interviewers provide positive feedback about any helpful practices occurring in the home. • Parents are encouraged to identify barriers that will prevent them implementing what they have learnt and to generate solutions. • Parents review their program goal, evaluate their progress and identify how they can maintain the change.

Participants will also be asked to undertake homework activities to encourage them to apply, directly into their home environment, the strategies and information covered in the telephone calls. Incorporating homework assignments into health behaviour interventions has been found to increase the size of the intervention effect [47]. Homework activities will be optional and tailored to the needs of the participant, based on recommended home food environment practices not currently undertaken by the participant.

Intervention Resources

Based on evidence indicating telephone-based dietary interventions are more effective when used in conjunction with print and other resources [19], all intervention participants will be mailed resource kits following completion of the baseline survey. The kit is comprised of a participant workbook containing information and activities, a pad of meal planners and a cookbook including recipes high in fruit and vegetables (Appendices 12-14). The resources will be used to facilitate participant engagement in the telephone support calls and assist participants to complete intervention activities between telephone contacts.

Conceptual Model

The telephone-based intervention accords with the model of family-based intervention proposed by Golan and colleagues [48] in the treatment and prevention of childhood obesity. Their model, which draws upon socio-ecological theory, focuses on introducing new familial norms associated with healthy eating. This is achieved through making changes within the home food environment, providing positive parental role-modelling and increasing parenting- and nutrition-related knowledge and skills. Interventions based on such a model have been shown to be effective in bringing about environmental changes in participants' homes to support healthy eating [49] and in reducing poor eating habits of overweight and obese children of participants [50].

The intervention utilises a number of specific behaviour change techniques to initiate the change process as described in Table 5.1. The third column lists the behaviour change techniques used and the fourth column links each technique to its application in the context of the topic listed in column 2. These behaviour change techniques include prompting intention formation, barrier identification, specific goal-setting and the reviewing of such goals, self-monitoring of behaviour and identification as a role-model, teaching to use prompts or cues, and providing general encouragement, as described in the taxonomy proposed by Abraham and Michie [51].

Intervention Personnel, Recruitment and Training

Consistent with other telephone-based health behavioural interventions [18, 19], intervention support will be delivered by trained telephone interviewers. Interviewers delivering the intervention will have experience in conducting health-related telephone surveys, but have no formal qualifications in psychology, dietetics, parenting, health promotion or other health professions. The use of telephone interviewers without specialist skills may mean that adoption of this intervention by government agencies is more feasible. Interviewers without specialist skills have previously been found to be effective in improving other health behaviours [18]. If effective in this context, their use may facilitate the adoption of this type of intervention where use of specialist staff may not be feasible due to cost and the shortage of staff with such skills.

To recruit suitable staff and to equip them with the necessary knowledge and skills to deliver the intervention, potential telephone interviewers were invited to attend a 2-day training workshop (Appendix 15). The training was developed and delivered by a registered dietitian, a clinical psychologist specialising in parenting, and health promotion practitioners (with post-graduate qualifications and experience in public health). The research team and clinical psychologist judged interviewer competency, based on the completion of role-plays [52] and small group exercises during training and those considered sufficiently competent were selected to deliver the intervention. The selected interviewers were then required to complete a further minimum 10 hours of self-paced practice, including script and workbook familiarisation. They were also required to practise each script with a member of the research team to ensure that required levels of competency and adherence had been met [52] and that they were able to deliver the script in a confident, conversational style and respond appropriately to participant queries.

During the first two months of intervention delivery, all interviewers will participate in fortnightly group supervision, facilitated by a psychologist. A self-regulatory model of peer supervision [53] will be utilised to facilitate learning, improve interviewer performance and help standardise intervention delivery. Members of the research team will monitor the supervision sessions and provide feedback as required.

Intervention Monitoring

To ensure integrity of intervention delivery during the trial, members of the research team will have weekly contact with interviewers to keep abreast of common issues and concerns so that they may be addressed in a consistent manner. During each 4-week

batch of telephone calls, members of the research team will monitor at least two completed calls made by each interviewer to assess adherence with the intervention protocol. Specifically, the research team member will record whether the interviewer covers the key themes and information for each call, the extent to which the interviewer deviates from the script, the length of the call and whether the interviewer adequately answers any questions asked (Appendix 20).

The records of the recruitment coordinator will be audited following the recruitment of each batch of participants. A separate member of the research team will review the dates on which allocation letters are mailed. They will also review the attempt dates, receipt dates and completion dates of intervention and data collection telephone calls for each trial participant. This periodic review of documentation will assess whether the intervention is progressing in a timely manner and in accordance with the study protocol [54].

Control Group

Participants allocated to the control group will receive a 22-page booklet, 'The Australian Guide to Healthy Eating: Background information for consumers' [26] (Appendix 21). This is a national food guide published by the Australian Government Department of Health and Ageing. This publication will be posted to participants following completion of the baseline survey.

Data Collection and Measures

Baseline and follow-up data will be collected through a CATI survey administered to all participants (Appendix 22). The survey will take approximately 30 minutes to complete. Data collection interviewers will be provided with training to ensure that they understand and adhere to data collection protocols, and to practise the survey script.

Baseline data will be collected one to two weeks prior to intervention delivery. Calls will be monitored for adherence to the training protocol. Members of the research team will monitor approximately ten percent of the first batch of baseline calls (Appendix 23) and compare the delivery of the survey to the script as written. Any deviations from the protocol will be addressed with the interviewer immediately following the completion of the call. Each interviewer will then be monitored at least once in each subsequent batch of surveys to ensure consistency over time. The survey administered at baseline will be repeated at four time points: 2, 6, 12 and 18 months following baseline data collection. To minimise attrition, prior to follow-up data collection calls at 6, 12 and 18

months, participants will receive letters thanking them for their participation to date and reminding them that they will shortly be telephoned to participate in follow-up phone calls [55] (Appendix 24).

Data collection interviewers will not participate in trial recruitment or intervention delivery and will be blind to participant group allocation. Furthermore, at the start of each follow-up data collection interview, participants will be asked not to disclose their group allocation to the interviewers. To assess the effectiveness of the blinding, following the collection of trial outcome data, interviewers will be asked to nominate the groups to which they believe the participants were allocated [56].

Measures

Demographics

Demographic items regarding parents' gender, age, Aboriginal and/or Torres Strait Islander status, education, income, postcode and household composition (e.g. the number of children in the household), as well as questions regarding the child's gender and age, will be assessed at baseline. Items used to assess demographics will be sourced from the NSW Health Survey Program, a regular government behavioural risk factor surveillance survey [57].

Process Measures

The CATI system will record information regarding the outcome of each attempted call (e.g. engaged, answering machine, call-back arranged, call partially complete, call complete or refusal), the interviewer who attempted the call, the date and time of the attempt, the call duration and the responses provided by the participant throughout the call. During intervention delivery calls, participants will be asked whether they received the intervention resources and what homework activities they attempted. This will allow for an assessment of the extent to which the intervention was delivered and received as planned.

Primary Outcome Measure: Fruit and Vegetable Consumption

The primary outcome is the change in the fruit and vegetable intake of the preschool children. Fruit and vegetable intake will be assessed using the fruit and vegetable subscale of the Children's Dietary Questionnaire. This questionnaire was developed to assess Australian children's dietary patterns in relation to current national guidelines and has been recommended for use in assessing the efficacy of interventions to improve children's eating habits [58].

This semi-quantitative food frequency questionnaire asks parents to report the frequency and variety of foods consumed by their children over the previous seven days and the previous 24 hours. Scores on the fruit and vegetable subscale range from 0 to 28, with a score of 14 recommended based on current national dietary guidelines [58]. A one-point increase on this subscale could equate to, for example, a child consuming on average an additional type of fruit or vegetable each day (variety), or consuming fruit or vegetables at an additional eating occasion each day (frequency). An increase of this magnitude of fruit and vegetable variety or frequency of consumption is consistent with effect sizes of fruit and vegetable consumption reported in previous child fruit and vegetable interventions, and has the potential to have significant public health impact [59]. Reliability and validity of this tool has been established using multiple samples of Australian children, including preschoolers [58]. The fruit and vegetable subscale was found to be internally consistent (Alpha = 0.76), reliable (Intra-class correlation coefficient = 0.75) and valid as assessed against a 7-day food checklist (Spearman's correlation coefficient = 0.58) [58].

Sample Size

A sample size of approximately 300 participants (150 per group) at the 18-month follow-up will allow a detectable difference between intervention and control groups of 1.27 on the fruit and vegetable subscale of the Children's Dietary Questionnaire, with 80% power at the 0.05 significance level. This sample size accounts for the effect of clustering by assuming an interclass correlation coefficient of 0.03 (unpublished data from the *Good for Kids* program) and assumes 10 participants per preschool remain at the 18-month follow-up (as explained below).

Four hundred participants will be required to be recruited at baseline to achieve the desired sample of 300 at the 18-month follow-up. Based on preschools caring for an average of 27 children each day [32], and assuming children attend preschool for an average of 2.8 days per week (i.e. 17 hours over 6-hour long days), it is expected that up to 48 parents of children, on average, will be eligible to participate in the trial from each consenting preschool. A parent participation rate of 30% [17] will yield approximately 14 parents per preschool at baseline, of whom 10 will remain at 18 months, assuming a 25% attrition rate [60]. It is thus estimated that 30 preschools will be required to generate a sample of 300 parents at the conclusion of the trial.

Statistical Analysis: Primary Outcome

All statistical analyses will be performed with SAS 9.2 (SAS Institute Inc., Cary, NC, USA) statistical software. To assess the initial impact of the intervention and the extent to which any intervention effect is maintained in the longer term, the primary outcome analyses for the trial will be conducted on participant scores on the fruit and vegetable subscale of the Children's Dietary Questionnaire collected at the 2-month and 18-month follow-up time periods. For the primary outcome analyses, an alpha value of 0.05 will be utilised to determine statistical significance.

Outcome data will be analysed using general estimating equations based on the intention-to-treat principle, where participants are analysed based on the groups to which they were allocated, regardless of the treatment type or exposure that they actually received [61]. General estimating equation models will account for any clustering effect of preschools. To ensure the results of the primary analysis are robust against the missing data assumption of the general estimating equation, a sensitivity analysis will be performed whereby participants' observations at baseline will be used as a substitute for subsequent missing data. A per-protocol analysis will also be conducted whereby outcome data will only be included in analyses if participants received and completed all four telephone support calls. Conducting both intention-to-treat and per-protocol analyses is recommended when assessing trial outcomes [61].

Discussion

To the authors' knowledge, this is the first randomised controlled trial to evaluate a telephone-based parent intervention to increase the fruit and vegetable intake of preschool-aged children. The intervention has been developed to maximise the likelihood of having a positive effect on fruit and vegetable consumption through the use of a relevant conceptual model during intervention development, and employing specific behaviour change strategies to target characteristics of the home food environment known to be associated with increased fruit and vegetable intake. The study demonstrates many strengths: the experimental randomised design; the implementation of procedures to reduce potential threats to internal validity, such as the blinding of data collection interviewers and computer-based randomisation of groups undertaken by an independent statistician; the use of an outcome measure with established validity and reliability; and the recruitment of study participants from a setting which most 4-year-old children attend on multiple days of the week. If found to be effective, an intervention of this intensity, utilising trained staff rather than

experienced health professionals, is considered to have the potential to be implemented on a community-wide basis, as currently exists for adult risk behaviours [18].

Conclusion

This manuscript provides a comprehensive description of the study methods to be employed as part of a randomised controlled trial of a telephone-based parent intervention to increase the fruit and vegetable intake of children aged 3 to 5 years. The successful implementation of this trial will provide strong evidence on which to base judgements regarding the efficacy of this intervention approach.

References

1. Lock K, Pomerleau J, Causer L, Altmann DR, McKee M: **The global burden of disease attributable to low consumption of fruit and vegetables: implications for the global strategy on diet.** *Bull World Health Organ* 2005, **83**(2):100-108.
2. Ministry of Health: **The Health of New Zealand: Total population** Wellington: Ministry of Health; 2004.
3. Allender S, Peto V, Scarborough P, Boxer A, Rayner M: **Diet, physical activity and obesity statistics.** London: British Heart Foundation; 2006.
4. Yngve A, Wolf A, Poortvliet E, Elmadfa I, Brug J, Ehrenblad B, Franchini B, Haraldsdottir J, Krolner R, Maes L *et al*: **Fruit and vegetable intake in a sample of 11-year-old children in 9 European countries: The Pro Children Cross-sectional Survey.** *Ann Nutr Metab* 2005, **49**(4):236-245.
5. World Health Organization: **World Health Report 2002 - Reducing risks, promoting health life.** Geneva: WHO; 2002.
6. Mikkila V, Rasanen L, Raitakari OT, Pietinen P, Viikari J: **Longitudinal changes in diet from childhood into adulthood with respect to risk of cardiovascular diseases: The Cardiovascular Risk in Young Finns Study.** *Eur J Clin Nutr* 2004, **58**(7):1038-1045.
7. Benton D: **Role of parents in the determination of the food preferences of children and the development of obesity.** *Int J Obes Relat Metab Disord* 2004, **28**(7):858-869.
8. Blanchette L, Brug J: **Determinants of fruit and vegetable consumption among 6-12-year-old children and effective interventions to increase consumption.** *J Hum Nutr Diet* 2005, **18**:431-443.
9. Pearson N, Biddle SJ, Gorely T: **Family correlates of fruit and vegetable consumption in children and adolescents: a systematic review.** *Public Health Nutr* 2008, **12**(2):267-283.

10. Cooke LJ, Wardle J, Gibson EL, Sapochnik M, Sheiham A, Lawson M: **Demographic, familial and trait predictors of fruit and vegetable consumption by pre-school children.** *Public Health Nutr* 2004, **7**(2):295-302.
11. Coon KA, Goldberg J, Rogers BL, Tucker KL: **Relationships between use of television during meals and children's food consumption patterns.** *Pediatrics* 2001, **107**(1):E7.
12. Omar MA, Coleman G, Hoerr S: **Healthy eating for rural low-income toddlers: caregivers' perceptions.** *J Community Health Nurs* 2001, **18**(2):93-106.
13. Haire-Joshu D, Elliott MB, Caito NM, Hessler K, Nanney MS, Hale N, Boehmer TK, Kreuter M, Brownson RC: **High 5 for Kids: the impact of a home visiting program on fruit and vegetable intake of parents and their preschool children.** *Prev Med* 2008, **47**(1):77-82.
14. Klohe-Lehman DM, Freeland-Graves J, Clarke KK, Cai G, Voruganti VS, Milani TJ, Nuss HJ, Proffitt JM, Bohman TM: **Low-income, overweight and obese mothers as agents of change to improve food choices, fat habits, and physical activity in their 1-to-3-year-old children.** *J Am Coll Nutr* 2007, **26**(3):196-208.
15. Havas S, Anliker J, Damron D, Langenberg P, Ballesteros M, Feldman R: **Final results of the Maryland WIC 5-A-Day Promotion Program.** *Am J Public Health* 1998, **88**(8):1161-1167.
16. Wolman J, Skelly E, Kolotourou M, Lawson M, Sacher P: **Tackling toddler obesity through a pilot community-based family intervention.** *Community Pract* 2008, **81**(1):28-31.
17. Wolfenden L, Bell C, Wiggers J, Butler M, James E, Chipperfield K: **Engaging parents in child obesity prevention: Support preferences of parents.** *J Paediatr Child Health* 2012, **48**(2):E4-6.
18. Ossip-Klein DJ, McIntosh S: **Quitlines in North America: evidence base and applications.** *Am J Med Sci* 2003, **326**(4):201-205.

19. Eakin EG, Lawler SP, Vandelanotte C, Owen N: **Telephone interventions for physical activity and dietary behavior change: a systematic review.** *Am J Prev Med* 2007, **32**(5):419-434.
20. Pierce JP, Newman VA, Flatt SW, Faerber S, Rock CL, Natarajan L, Caan BJ, Gold EB, Hollenbach KA, Wasserman L *et al*: **Telephone counseling intervention increases intakes of micronutrient- and phytochemical-rich vegetables, fruit and fiber in breast cancer survivors.** *J Nutr* 2004, **134**(2):452-458.
21. Newman VA, Flatt SW, Pierce JP: **Telephone counseling promotes dietary change in healthy adults: results of a pilot trial.** *J Am Diet Assoc* 2008, **108**(8):1350-1354.
22. Djuric Z, Vanloon G, Radakovich K, Dilauro NM, Heilbrun LK, Sen A: **Design of a Mediterranean exchange list diet implemented by telephone counseling.** *J Am Diet Assoc* 2008, **108**(12):2059-2065.
23. Australian Bureau of Statistics: **Australian Social Trends 2001 (4102.0).** Canberra: ABS; 2001.
24. Eakin EG, Reeves MM, Lawler SP, Oldenburg B, Del Mar C, Wilkie K, Spencer A, Battistutta D, Graves N: **The Logan Healthy Living Program: a cluster randomized trial of a telephone-delivered physical activity and dietary behavior intervention for primary care patients with type 2 diabetes or hypertension from a socially disadvantaged community--rationale, design and recruitment.** *Contemp Clin Trials* 2008, **29**(3):439-454.
25. Campbell MK, Elbourne DR, Altman DG: **CONSORT statement: extension to cluster randomised trials.** *BMJ* 2004, **328**(7441):702-708.
26. Kellet E, Smith A, Schmerlaib Y: **The Australian Guide to Healthy Eating: Background information for consumers.** The Australian Government Department of Health and Ageing; 1998.
27. Population Health Division: **The health of the people of New South Wales - Report of the Chief Health Officer.** Sydney: NSW Department of Health; 2006.

28. Australian Bureau of Statistics: **Census of Population and Housing: Socio-Economic Indexes for Areas (SEIFA) (2033.0.55.001)**. Canberra: ABS; 2006.
29. Australian Bureau of Statistics: **Childhood education and care (4402.0)**. Canberra: ABS; 2009.
30. Steering Committee for the Review of Government Service Provision: **Report on Government Services 2008, Volume 1: Early Childhood, Education and Training; Justice; Emergency Management**. Canberra: Productivity Commission; 2008.
31. **Harrington M: Preschool education in Australia**
[http://www.aph.gov.au/library/Pubs/BN/2007-08/PreschoolEdAustralia.htm#_Toc198010804]. Accessed 5 February 2010.
32. Wolfenden L, Neve M, Farrell L, Lecathelinais C, Bell C, Milat A, Wiggers J, Sutherland R: **Physical activity policies and practices of childcare centres in Australia**. *J Paediatr Child Health* 2011, **47**(3):73-76.
33. **Good for Kids. Good for Life** [<http://www.goodforkids.nsw.gov.au>]. Accessed September 2011.
34. Wolfenden L, Kypri K, Freund M, Hodder R: **Obtaining active parental consent for school-based research: a guide for researchers**. *Aust N Z J Public Health* 2009, **33**(3):270-275.
35. Edwards P, Roberts I, Clarke M, DiGuseppi C, Pratap S, Wentz R, Kwan I: **Increasing response rates to postal questionnaires: systematic review**. *BMJ* 2002, **324**(7347):1183.
36. Campbell MK, Mollison J, Steen N, Grimshaw JM, Eccles M: **Analysis of cluster randomized trials in primary care: a practical approach**. *Fam Pract* 2000, **17**(2):192-196.
37. Campbell K, Crawford D, Jackson M, Cashel K, Worsley A, Gibbons K, Birch LL: **Family food environments of 5-6-year-old-children: does socioeconomic status make a difference?** *Asia Pac J Clin Nutr* 2002, **11**(3):s553-561.

38. Australian Bureau of Statistics: **SocioEconomic Index for Areas (SEIFA) (2033.0.55.001)**. Canberra: ABS; 2008.
39. Australian Bureau of Statistics: **An Introduction to SocioEconomic Indexes for Areas (SEIFA) (2039.0)**. Canberra: ABS; 2006.
40. McEntegart D: **The pursuit of balance using stratified and dynamic randomization techniques: An overview**. *Drug Inf J* 2003, **37**:16.
41. Green BB, McAfee T, Hindmarsh M, Madsen L, Caplow M, Buist D: **Effectiveness of telephone support in increasing physical activity levels in primary care patients**. *Am J Prev Med* 2002, **22**(3):177-183.
42. Elley CR, Kerse N, Arroll B, Robinson E: **Effectiveness of counselling patients on physical activity in general practice: cluster randomised controlled trial**. *BMJ* 2003, **326**(7393):793.
43. Choi BC: **Computer assisted telephone interviewing (CATI) for health surveys in public health surveillance: methodological issues and challenges ahead**. *Chronic Diseases in Canada* 2004, **25**(2):21-27.
44. Rounsaville BJ, Carroll KM, Onkene LS: **A Stage Model of Behavioral Therapies Research: Getting Started and Moving on From Stage I**. *Clin Psychol Sci Prac* 2001, **8**:133-142.
45. Hearn MD, Baranowski T, Baranowski J, Doyle C, Smith M, Lin LS, Renisow K: **Environmental influences on dietary behavior among children: Availability and accessibility of fruit and vegetables enable consumption**. *J Health Educ* 1998, **29**(1):26-32.
46. Satter E: **Feeding dynamics: helping children to eat well**. *J Pediatr Health Care* 1995, **9**(4):178-184.
47. Stice E, Shaw H, Bohon C, Marti CN, Rohde P: **A meta-analytic review of depression prevention programs for children and adolescents: factors that predict magnitude of intervention effects**. *J Consult Clin Psychol* 2009, **77**(3):486-503.
48. Golan M, Weizman A: **Familial approach to the treatment of childhood obesity: conceptual mode**. *J Nutr Educ* 2001, **33**(2):102-107.

49. Golan M, Kaufman V, Shahar DR: **Childhood obesity treatment: targeting parents exclusively v. parents and children.** *Br J Nutr* 2006, **95**(5):1008-1015.
50. Golan M, Fainaru M, Weizman A: **Role of behaviour modification in the treatment of childhood obesity with the parents as the exclusive agents of change.** *Int J Obes Relat Metab Disord* 1998, **22**(12):1217-1224.
51. Abraham C, Michie S: **A taxonomy of behavior change techniques used in interventions.** *Health Psychol* 2008, **27**(3):379-387.
52. Santacroce SJ, Maccarelli LM, Grey M: **Intervention Fidelity.** *Nurs Res* 2004, **53**(1):63-66.
53. Sanders M, Cann W, Markie-Dadds C: **The Triple P Positive Parenting Programme: A universal population-level approach to the prevention of child abuse.** *Child Abuse Review* 2003, **12**(3):155-171.
54. Weijer C, Shapiro S, Fuks A, Glass KC, Skrutkowska M: **Monitoring clinical research: an obligation unfulfilled.** *CMAJ* 1995, **152**(12):1973-1980.
55. Ribisl KM, Walton MA, Mowbray CT, Luke DA, Davidson WS, Bootsmiller BJ: **Minimizing participant attrition in panel studies through the use of effective retention and tracking strategies: Review and recommendations.** *Eval Program Plann* 1996, **19**(1):1-25.
56. Prescott RJ, Counsell CE, Gillespie WJ, Grant AM, Russell IT, Kiauka S, Colthart IR, Ross S, Shepherd SM, Russell D: **Factors that limit the quality, number and progress of randomised controlled trials.** *Health Technol Assess* 1999, **3**(20):1-143.
57. Centre for Epidemiology and Research: **2008 Report on Adult Health from the New South Wales Population Health Survey.** Sydney: NSW Department of Health; 2009.
58. Magarey A, Golley R, Spurrier N, Goodwin E, Ong F: **Reliability and validity of the Children's Dietary Questionnaire; a new tool to measure children's dietary patterns.** *Int J Pediatr Obes* 2009, **4**(4):257-265.

59. Knai C, Pomerleau J, Lock K, McKee M: **Getting children to eat more fruit and vegetables: a systematic review.** *Prev Med* 2006, **42**(2):85-95.
60. Pignone MP, Ammerman A, Fernandez L, Orleans CT, Pender N, Woolf S, Lohr KN, Sutton S: **Counseling to promote a healthy diet in adults: a summary of the evidence for the U.S. Preventive Services Task Force.** *Am J Prev Med* 2003, **24**(1):75-92.
61. Porta N, Bonet C, Cobo E: **Discordance between reported intention-to-treat and per protocol analyses.** *J Clin Epidemiol* 2007, **60**(7):663-669.

CHAPTER FIVE b)

A cluster randomised controlled trial of a telephone-based parent intervention to increase preschoolers' fruit and vegetable consumption

This chapter is a published paper:

Wyse R, Campbell E, Campbell KJ, Wiggers J, Brennan L, Fletcher A, Bowman J, Heard TR, Wolfenden L. **A cluster randomised controlled trial of a telephone-based parent intervention to increase preschoolers' fruit and vegetable consumption.** *Am J Clin Nutr* 2012, **96**(1):102-10.

Introduction

Inadequate fruit and vegetable consumption increases chronic disease risk [1-3] and represents a considerable health burden worldwide [4]. Evidence suggests that childhood dietary patterns track into adulthood [5] and high fruit and vegetable consumption in childhood has been associated with lower risk of adulthood stroke and cancer [6, 7]. As early childhood is important in the development of dietary habits [8], interventions to promote young children's fruit and vegetable intake may help to establish dietary habits that decrease chronic disease risk in adulthood.

Systematic reviews have identified a dearth of quality intervention studies to increase fruit and vegetable consumption in preschoolers (children aged 3 to 5 years) [9, 10]. Of the published trials, most have investigated multi-component interventions conducted in the preschool setting and have predominantly targeted the policies and practices within the preschool environment [11-14]. Interventions targeting the home environment, however, may be particularly effective [9] given that social and physical characteristics of the home environment are among the strongest correlates of children's fruit and vegetable consumption [15, 16]. Despite this, to the authors' knowledge, only one published intervention trial has targeted the home food environment of preschoolers. In this randomised controlled trial of 1,306 disadvantaged, rural-dwelling participants in the United States, an intervention consisting of four home visits, resources and tailored newsletters had no overall effect on child fruit and vegetable intake at a 6 to 11 month follow-up [17].

Given evidence of the efficacy of telephone-delivered interventions in improving adult dietary behaviours [18, 19], telephone interventions delivered to parents and targeting the home environment may represent an effective primary prevention strategy to enhance child fruit and vegetable intake. As such, the authors recently conducted a pre-post pilot trial, and reported a significant post-intervention increase in preschoolers' fruit and vegetable consumption immediately following a four contact, telephone-based intervention [20]. On the basis of the pilot findings, and the broader telephone and health behaviour literature [19], the authors sought to test the longer-term efficacy of the intervention in an appropriately powered randomised controlled trial.

The primary aim of the current study was to assess the efficacy of a telephone-based intervention for parents to increase the fruit and vegetable consumption of their 3 to 5 year-old children. It was hypothesised that the change in children's fruit and vegetable

scores i) from baseline to 2-months, and ii) from baseline to 6-months would be greater among intervention children relative to control. Given dietary patterns that include a high intake of fruits and vegetables have been associated with higher food costs [21], as an assessment of a possible adverse effect, an additional aim was to determine whether intervention participation was associated with an increase in reported weekly household food expenditure.

Subjects and Methods

Design Overview

This trial employed a cluster randomised controlled design and was prospectively registered with the Australian New Zealand Clinical Trials Registry (ACTRN 12609000820202) where all trial outcomes and subgroup analysis reported in this paper were pre-specified. The research was approved by the Human Research Ethics Committees of the University of Newcastle (H-2008-0410) and the Hunter New England Area Health Service (08/10/15/5.09). This paper reports the 2- and 6-month primary trial outcomes collected via telephone interview with parents. The methods used to conduct this trial have been published elsewhere [22] and are described briefly below.

Participants

Parents were recruited through preschools within four Local Government Areas of the Hunter region of New South Wales, Australia, using strategies found to be effective in increasing participation in child health research [23]. All non-government preschools were eligible to participate if they did not provide meals to children, did not exclusively cater for children with special needs, or had not been involved in healthy eating studies within the preceding 6 months. At preschools where the manager consented to participate, a research assistant, blind to preschool allocation, distributed study information and consent forms to parents as they dropped off or picked up their child. The consent form contained questions about the child's usual fruit and vegetable consumption as well child gender, age and residential postcode. To assess bias due to selective non-participation, all parents were asked to complete these details on the consent form, even if they chose not to consent to participate in the study. Parents were eligible to participate if they: had a 3 to 5 year-old child who resided with them for 4 or more days per week; were responsible for providing food to their child at least half of the time; had a child with no dietary requirements that would make Australian fruit

and vegetable intake recommendations unsuitable; and were literate in English. Recruitment took place from February to August 2010.

Randomisation and Allocation

Following the commencement of parent recruitment, a statistician not associated with the project used a random number function in Microsoft Excel to allocate preschools to the intervention or control group. Randomisation was carried out at the level of the preschool to reduce potential contamination from parents at the same preschool sharing intervention information or resources. Randomisation of preschools was stratified by socio-economic status based on the decile of disadvantage classification of the postcode area in which the preschool was located [24]. Preschools were randomised in a 1:1 ratio (intervention:control) in randomly sequenced blocks of between two and six preschools. Parents were informed of group allocation via a letter following baseline data collection.

Experimental Group

Intervention:

Parents allocated to the intervention group received four telephone calls over a period of 4 weeks. Intervention participants were also mailed a series of instructional resources including a guidebook, a meal planner, cookbooks and a water bottle for all family members. A complete description of the intervention is provided in the trial protocol [22] and an overview of the intervention content and structure is provided in Table 5.2. Telephone-delivered interventions of a similar intensity have been previously shown to be effective in increasing adult health behaviours [25, 26].

Table 5.2. Intervention content, strategies and structure

DOMAINS	CONTENT	BEHAVIOUR CHANGE TECHNIQUE	APPLICATION OF BEHAVIOUR CHANGE TECHNIQUE
Availability & Accessibility	<ul style="list-style-type: none"> • Dietary recommendations and serving sizes • Children's food diary 	<ul style="list-style-type: none"> • Prompt self-monitoring of behaviour 	<ul style="list-style-type: none"> • Parents are encouraged to monitor their children's intake of fruit, and vegetables over 3 days.
	<ul style="list-style-type: none"> • Ways to provide fruit and vegetables throughout the day • Setting goals 	<ul style="list-style-type: none"> • Prompt specific goal-setting 	<ul style="list-style-type: none"> • Parents are encouraged to set a program goal.
Availability & Accessibility, Supportive Family Eating Routines	<ul style="list-style-type: none"> • Changing the family routine • Availability & accessibility of foods in the home • Mealtime practices 	<ul style="list-style-type: none"> • Prompt intention formation • Provide general encouragement • Teach to use prompts or cues 	<ul style="list-style-type: none"> • Parents decide which activities they will attempt in the coming week. • Interviewers provide positive feedback about any helpful practices occurring in the home. • Parents learn the HELPS acronym, i.e. try to eat when Hungry, not attempting anything else at the same time (focus on Eating), at an appropriate Location to eat, from a Plate, and while Sitting.
	<ul style="list-style-type: none"> • Meal planning • Review of goals 	<ul style="list-style-type: none"> • Prompt review of behavioural goals 	<ul style="list-style-type: none"> • Parents review the goals they set during the previous calls and evaluate their progress.

DOMAINS	CONTENT	BEHAVIOUR CHANGE TECHNIQUE	APPLICATION OF BEHAVIOUR CHANGE TECHNIQUE
Week 3 Parental role-modelling, Supportive Family Eating Routines	<ul style="list-style-type: none"> • The Ps and Cs division of feeding responsibility 	<ul style="list-style-type: none"> • Teach to use prompts or cues 	<ul style="list-style-type: none"> • Parents learn the Ps and Cs: Parents are encouraged to Plan, Prepare and Provide. Children are encouraged to Choose (whether, what and how much to eat) [27].
	<ul style="list-style-type: none"> • Mealtime strategies to encourage vegetable consumption • Role-modelling of fruit and vegetable consumption 	<ul style="list-style-type: none"> • Prompt intention formation • Provide general encouragement • Prompt identification as a role-model 	<ul style="list-style-type: none"> • Parents decide which activities they will attempt in the coming week. • Interviewers provide positive feedback about any helpful practices occurring in the home. • Parents are provided information about their importance in role-modelling fruit and vegetable consumption. Their consumption is compared with national nutrition recommendations. Tailored feedback is provided.
Week 4 Availability & Accessibility, Parental role-modelling, Supportive Family Eating Routines	<ul style="list-style-type: none"> • Review of weeks 1-3 • Planning for the future and dealing with difficult situations • Review of goals 	<ul style="list-style-type: none"> • Provide general encouragement • Prompt barrier identification • Prompt review of behavioural goals 	<ul style="list-style-type: none"> • Interviewers provide positive feedback about any helpful practices occurring in the home. • Parents are encouraged to identify barriers that will prevent them implementing what they have learnt and to generate solutions. • Parents review their program goal, evaluate their progress and identify how they can maintain the change.

The intervention assumes that children's fruit and vegetable consumption stems from the complex interaction between personal, cultural, and environmental factors and draws upon socio-ecological theory [28]. Specifically, the intervention utilised the conceptual model of family-based intervention proposed by Golan and Weizman [29] in the treatment and prevention of childhood obesity. This model focuses on introducing new familial norms associated with healthy eating. This is achieved through making changes within the home food environment, providing positive parental role-modelling and increasing knowledge and skills related to parenting and nutrition [29]. The intervention used a range of behaviour change techniques as classified in the taxonomy proposed by Abraham and Michie [30] to encourage parents to make such changes (see Table 5.2). These techniques included goal setting, behavioural self-monitoring, intention formation, use of prompts or cues, and reviewing behavioural goals [30]. The calls focused on: increasing fruit and vegetable availability and accessibility in the home, increasing parental role-modelling of fruit and vegetable consumption, and enhancing supportive food routines around the home, such as eating dinner as a family, without the television on. The calls were scripted and delivered using computer assisted telephone interview (CATI) [31] software. Participants had to complete each call before progressing to the next, that is, no intervention calls could be skipped. All participants received information relating to each intervention content area (Table 5.2). Within content areas, however, the information provided was tailored based on assessments made during baseline data collection or earlier intervention calls regarding the participant's home food environment, parenting or dietary practices. For example, to facilitate role-modelling, parents already regularly consuming fruit and vegetables in front of their children (based on baseline assessment) were congratulated and encouraged to maintain this behaviour. Parents not routinely modelling consumption of these foods, however, were given the opportunity to set a goal to work towards achieving this over the next week and were provided with strategies to assist with goal attainment. Parents could be offered between one and four activities to undertake between calls. Data from the pilot trial suggested that parents actively engaged in these tasks [20].

The scripts and the resources were extensively pre-tested and piloted [20]. Five experienced health interviewers with no formal qualifications in nutrition or psychology, and not blind to participant allocation, delivered the scripted telephone support. Interventionists received 2 days of training in script delivery and associated nutrition and parenting issues from an accredited practising dietitian, a psychologist specialising in parenting, and health promotion practitioners, and were then required to complete an

additional 10 hours of delivery practice. For the duration of the intervention delivery period (April to December 2010), interventionists participated in fortnightly group supervision sessions with a psychologist specialising in parenting to ensure that any arising issues were dealt with in an appropriate and standardised manner. Members of the research team monitored each interventionist multiple times throughout the intervention delivery period to assess adherence to the intervention protocol.

Control:

Parents allocated to the control group were mailed the 'Australian Guide to Healthy Eating', a 22-page booklet outlining the dietary guidelines and ways to meet them [32]. They received no further contact until the 2-month follow-up data collection call.

Data Collection and Blinding

All data collection occurred via CATI using trained telephone interviewers. Participants could be contacted on landlines or mobile numbers and were called approximately 1 week following recruitment to complete the baseline survey, and then approximately 2- and 6-months later for follow-up data collection. The 2-month time period was chosen in order to minimise variability in the length of the first follow-up, with 2-months considered to be a sufficient period for the majority of intervention group participants to have completed their four intervention calls, taking into consideration potential interruptions to the call schedule such as school holidays, child sickness and variable work and family commitments. The 6-month follow-up was chosen as a sufficient test of the short-term maintenance of intervention effect. At each time-point, data collectors attempted to contact participants for a 2-month period, and if the call could not be completed, contact was attempted again at the subsequent follow-up point. The baseline survey was conducted from April to October 2010. Parents were instructed to complete the baseline and follow-up surveys with respect to their preschool-aged child. If they had more than one child aged 3 to 5 years, they were instructed to select the child who would have the next birthday. Data collectors received 4 hours of training in script delivery and during the data collection periods were regularly monitored by members of the study team in order to ensure standardised survey delivery across data collectors. Data collectors were blind to group allocation. To assess whether blinding was maintained, following collection of follow-up trial outcomes, the CATI system prompted the data collector to nominate the group to which they thought the participant had been allocated. The proportion of times data collectors correctly identified group allocation at each time point was calculated.

Measures

Participant Characteristics

Information regarding parent and child characteristics was collected from the consent form and the baseline CATI. The consent form included questions about child gender, age and postcode, and two items that assessed the child's usual daily intake of fruit and vegetable servings. These items were included to allow for comparison between those who did and did not consent to study participation. During the CATI, participants were asked their age, gender, annual household income, highest level of education, whether they identified as Aboriginal and/or Torres Strait Islander, the number of children in their household, and the number of servings of fruit and vegetables they consumed daily. Participants also reported their child's date of birth, gender and whether their child identified as Aboriginal and/or Torres Strait Islander.

Child Fruit and Vegetable Intake

Children's fruit and vegetable intake was the primary trial outcome and was assessed at baseline and 2- and 6-month follow-up using the Fruit and Vegetable subscale (F&V) of the Children's Dietary Questionnaire. The subscale has been established as reliable (Test-retest ICC = 0.75) in samples of 39 children aged 4 to 5 years and 92 children aged 5 to 16 years, and established as valid as compared to a 7-day checklist (Spearman correlation co-efficient = 0.58) in samples of 126 children aged 5 to 6 years and 132 children aged 5 to 10 years [33]. Preliminary assessment using data from a sample of 126 children aged 5 to 10 years indicated the subscale demonstrated the ability to detect change in the hypothesised direction (Wilcoxon signed rank test, $p < 0.001$) [33].

The scale requires parents to report the frequency and variety of fruit and vegetables consumed by their child over the past 24 hours and past 7 days. Scores on this scale can range from 0 to 28 with a score of 14 or above indicating that the child is meeting Australian Dietary Guidelines [33]. An increase in the score could arise from a range of changes to children's fruit and vegetable consumption patterns, for example, a one-point increase could result from eating an additional type of fruit or vegetable, or eating fruit or vegetables at an additional occasion in the previous 24 hours.

Food Expenditure

Participants were asked at baseline and each follow-up to estimate their average weekly household expenditure on food; *"On average, how much do you spend on food for your household each week? This includes foods you buy from the supermarket as*

well as any foods you buy and eat outside the home, for example, takeaway, restaurant meals, lunches.” The psychometric properties of this item are unknown.

Process Measures

i) Intervention fidelity: The number of intervention calls completed by participants was automatically recorded by the CATI system. During the monitoring of intervention calls, members of the research team used a checklist to record whether the interventionist discussed the key topics of each call (e.g. serving size recommendations) and the extent to which they delivered the script as per the protocol (always, mostly, sometimes, rarely, or never).

ii) Data collection: The CATI system automatically recorded the date, time, and outcome of each data collection call attempt. The proportion of times data collectors correctly identified participants' group allocation at each time point was calculated.

Sample Size Calculation

The sample size allowed a detectable difference between intervention and control F&V scores of 1.27 (equivalent to a change of 0.25 of a standard deviation) with 80% power at the 0.05 significance level. Assuming an intraclass correlation coefficient of 0.03 (unpublished data from *Good for Kids. Good for Life*, Australia's largest childhood obesity prevention program [34]), it was calculated that recruiting 400 parents from 30 preschools would achieve the desired sample of 300 participants (150 per group) at the final follow-up data collection at 18 months.

Analysis

All statistical tests were performed in SAS Version 9.2 statistical software (SAS Institute Inc., Cary, NC, USA). Descriptive statistics were used to describe the study sample and process measures. Data were analysed using an intention-to-treat approach, whereby all participants were analysed based on the group to which they were allocated. For the analyses of F&V scores at follow-up, a linear regression model within a Generalised Estimating Equation (GEE) framework was used to account for clustering by preschool. The GEE accounts for clustering by weighting each cluster inversely to its variance matrix, which is a function of the within-cluster dependence [35]. Children's F&V score at baseline was included as a covariate. Significance testing was performed with an alpha level of 0.05. Determination of intervention efficacy was based on an a priori specified analysis using all available data [22]. This main analysis compared intervention and control F&V scores at 2 months and at 6 months, and

assumed any missing data at follow-up were missing at random and included all participants with complete baseline and 2-month, and baseline and 6-month data respectively. Little's test was performed to determine whether the missing data were missing completely at random (MCAR) [36]. A sensitivity analysis, specified a priori, was undertaken to ensure the findings of the main analysis were robust against the missing data assumptions of the GEE. This involved imputing missing data at the 2- or 6-month follow-up using baseline observation carried forward. A per-protocol analysis was also undertaken where only intervention participants who had received all four telephone calls were included. When conducting randomised trials, both sensitivity and per protocol analysis are recommended to aid interpretation of the trial outcome [37]. A subgroup analysis was also conducted. The sample was divided into two subgroups, those whose children were, and those whose children were not meeting national dietary guidelines for fruit and vegetable consumption at baseline (i.e. a baseline F&V score greater than or equal to 14, or less than 14), and a GEE model was fitted which included a subgroup by experimental group interaction. Changes in reported food expenditure at 2 and 6 months were also assessed using a GEE model adjusting for baseline values, using participants with no missing data at 2 and 6 months respectively on this measure.

Results

Participant Characteristics

Children from approximately 2,200 families attended the 30 eligible and consenting preschools. In total, 418 parents returned a signed consent form indicating a willingness to participate, 394 of who completed the baseline telephone survey and were included in the study. One hundred and seventy eight parents did not consent to participate but returned a form with completed demographic details. Figure 5.2 outlines preschool and participant flow through the trial.

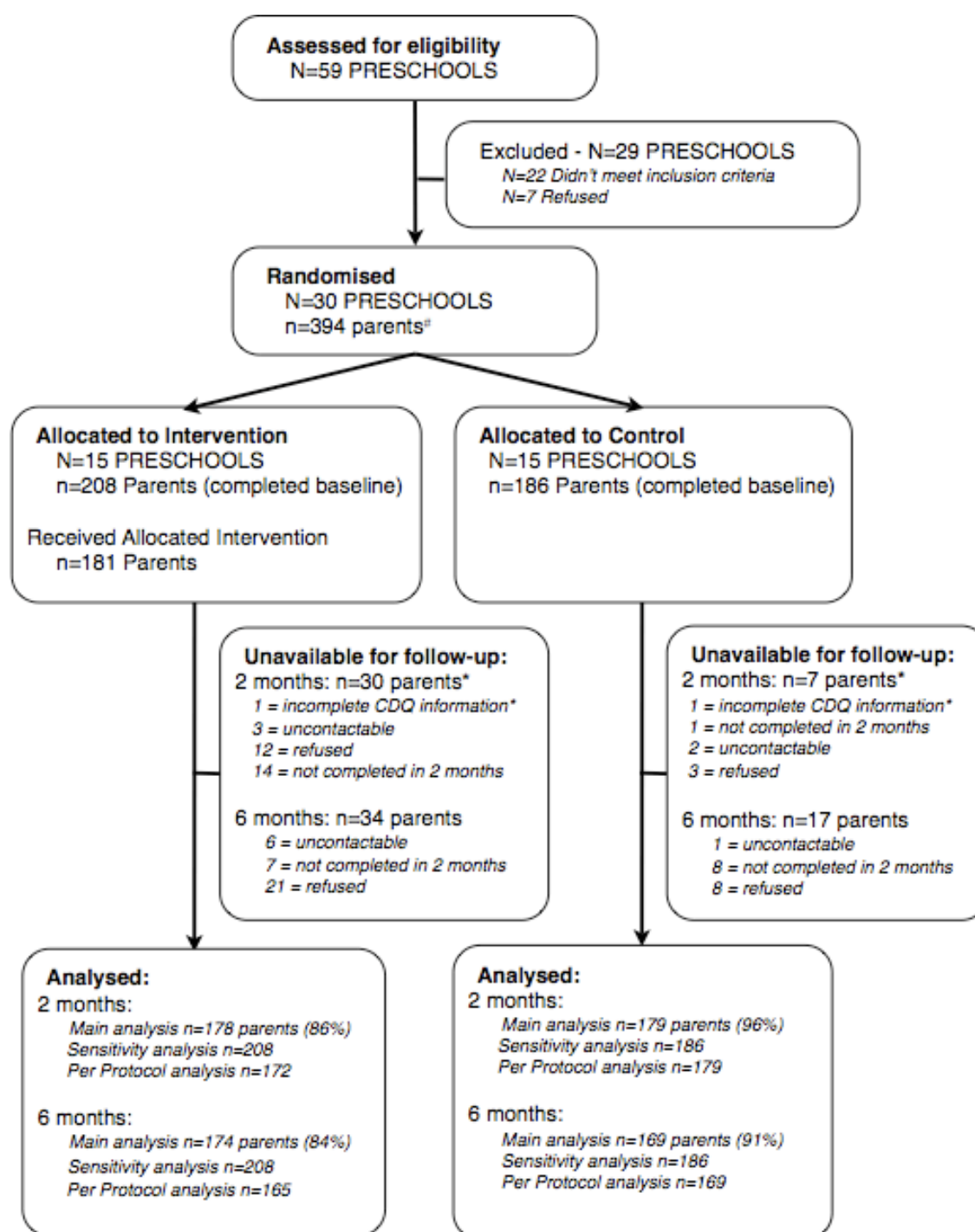


Figure 5.2: CONSORT diagram showing cluster (preschool) and participant (parent) flow through the trial

[#] Although 418 parents consented, 24 parents did not participate because they were subsequently uncontactable (n=5), did not meet inclusion criteria (n=9), or refused to complete the baseline survey when contacted (n=10)

* 2 parents excluded from 2-month analysis as they had been away from their child for the past 24 hours and/or past 7 days, and were unable to answer questions about their child's fruit and vegetable consumption.

The characteristics of participants allocated to the intervention and control groups were similar (Table 5.3). There were no significant differences in child age, gender or daily intake of fruit or vegetables between the children of study participants and the children of the 202 parents who either did not consent or who initially consented but did not complete the baseline survey. When compared to a random sample of parents of 3 to 5 year-olds from the broader study region, participants in the current study had higher levels of education (47% vs 36% with tertiary education) and higher household income (41% vs 20% \geq \$100,000) [38]. The proportion of the children consuming at least one daily fruit serving in the current sample was similar to a random sample of 2 to 4 year-old children in broader region (96% vs 96%), but more children in the study sample were consuming two or more servings of vegetables each day (65% vs 48%) [39].

Table 5.3. Characteristics of the 394 participants who completed baseline by group.

PARENT AND CHILD DEMOGRAPHICS	CONTROL N=186 MEAN \pm SD / %	INTERVENTION N=208 MEAN \pm SD / %
Parent Demographics		
Age (years)	35.7 \pm 5.0	35.2 \pm 5.6
Gender (female)	96.8%	95.2%
Household income \geq \$100,000	40.2%	42.4%
University education	49.5%	45.2%
Aboriginal and/or Torres Strait Islander	3.2%	1.0%
Number of children (<16 years) in household	2.3 \pm 0.7	2.3 \pm 0.8
Daily servings of fruit	1.8 \pm 1.0	1.8 \pm 1.1
Daily servings of vegetables	3.1 \pm 1.3	3.3 \pm 1.3
Child Demographics		
Age (years)	4.3 \pm 0.6	4.3 \pm 0.6
Gender (female)	45.7%	51.0%
Aboriginal and/or Torres Strait Islander	4.8%	1.0%
Daily servings of fruit*	2.2 \pm 1.0	2.3 \pm 1.0
Daily servings of vegetables*	2.0 \pm 1.2	2.1 \pm 1.1

* Information taken from consent form

Between-group differences at baseline were tested (χ^2 tests for categorical data, *t*-tests for continuous data, $p < 0.05$) and there were no significant differences between the intervention and control groups.

In total, 86% and 84% of participants allocated to the intervention, and 96% and 91% of participants allocated to the control group provided 2- and 6-month follow-up data

respectively. There were no significant differences in the demographic or baseline fruit and vegetable intake between intervention group participants who completed and who did not complete the 2- or 6-month follow-up surveys. Among the control group, participants who did not complete the 6-month follow-up consumed more vegetable servings per day (3.8 vs 3.0, $p=0.013$) at baseline and were less likely to have a tertiary education qualification (24% vs 52%, $p=0.025$) than control participants who provided 6-month data.

Child Fruit and Vegetable Intake

Analysis revealed that the mean F&V subscale scores were significantly higher in the intervention compared to the control group at both the 2-month and 6-month follow-up (Table 5.4). Little's test ($\chi^2 = 15.233$, 2 df, $p<0.001$) [36] was significant, suggesting that group allocation and children's fruit and vegetable score at baseline predicted missing data at follow-up. In the sensitivity analysis, the intervention effect remained significant when children's F&V scores at baseline were carried forward for missing data at the 2-month follow-up, and although the effect approached significance when such values were carried forward at the 6-month follow-up, the effect was not significant (Table 5.4). Per-protocol analysis revealed that intervention participants who completed all four intervention calls had significantly higher F&V subscale scores than control participants at 2-months and 6-months (Table 5.4). The subgroup analysis comparing children who did and did not meet the dietary guidelines at baseline found that the subgroup by experimental group interaction term was not significant.

Table 5.4. Intervention and Control Fruit and Vegetable (F&V) subscale scores (mean±standard error) at baseline, 2- and 6-months

ANALYSIS	TIME POINT	CONTROL MEAN±SEM	INTERVENTION MEAN±SEM	REGRESSION COEFFICIENT* (95% CI)	P-VALUE
Main analysis	Baseline (n=394)	14.5±0.4	15.0±0.3		
	2 month (n=357)	15.4±0.3	17.0±0.3	1.28 (0.54,2.03)	<0.001
	6 month (n=343)	15.9±0.3	17.0±0.3	0.80 (0.12,1.49)	0.021
Sensitivity analysis	Baseline (n=394)	14.5±0.4	15.0±0.3		
	2 month (n=394)	15.3±0.3	16.6±0.3	0.98 (0.26,1.70)	0.008
	6 month (n=394)	15.8±0.2	16.7±0.2	0.59 (-0.05,1.22)	0.069
Per Protocol analysis	Baseline (n=367)	14.5±0.4	15.2±0.4		
	2 month (n=351)	15.4±0.3	17.1±0.3	1.34 (0.59,2.10)	<0.001
	6 month (n=334)	15.9±0.3	17.1±0.3	0.87 (0.17,1.56)	0.014

* Adjusted for baseline F&V scores

Data were analysed using a GEE framework, adjusted for children's F&V score at baseline and clustering within preschools ($p<0.05$).

Food Expenditure

At the 2-month follow-up, the estimated weekly food expenditure in intervention households was significantly lower than control households, adjusting for the baseline values, and at 6-months there was no significant difference as shown in Table 5.5.

Table 5.5. Intervention and control estimated weekly food expenditure (mean±standard error) at baseline, 2- and 6-months

ESTIMATED WEEKLY FOOD EXPENDITURE	CONTROL MEAN±SEM	INTERVENTION MEAN±SEM	REGRESSION COEFFICIENT* (95% CI)	P-VALUE
Baseline (n=392)	\$234±3	\$241±7		
2 month (n=358)	\$252±5	\$235±5	-\$20 [-\$32,-\$8]	<0.001
6 month (n=342)	\$246±5	\$245±7	-\$5 [-\$17,\$7]	0.426

* Adjusted for baseline expenditure

Data were analysed using a GEE framework, adjusted for weekly food expenditure baseline at baseline and clustering within preschools ($p<0.05$).

Process Measures:

i) Intervention Fidelity

Of the 208 participants allocated to the intervention, 87% completed all four intervention calls. There were no significant differences in parent or child demography or baseline fruit and vegetable consumption between those who completed all intervention calls (n=181) and those who did not (n=27). Sixteen participants did not complete the first call, six participants only completed the first call, four completed the first two calls, and one participant completed three calls. The mean duration of all intervention calls was 29 minutes (34, 30, 26 and 28 minutes for calls 1 to 4 respectively). In total, 44 intervention calls were monitored, representing 6% of all completed calls and an average of nine calls per interventionist. Across all monitored calls, interventionists covered 97% of key content areas, and in over 80% of calls they 'rarely' deviated from the script. In instances where calls deviated from the script, interventionists were provided with feedback immediately following the call, and the issue was raised during fortnightly supervision.

ii) Data Collection

On average, 74 days (2.4 months) elapsed between baseline and the scheduled 2-month data collection call, and an average of 198 days (6.5 months) elapsed between baseline and the scheduled 6-month call and there were no differences between

groups in the time elapsed from baseline to either follow-up point. At the conclusion of the 2- and 6-month follow-ups, data collectors correctly identified participants' group allocation in 59% ($p < 0.001$) and 56% ($p = 0.027$) of cases respectively, which represents slightly more cases than would be expected by chance. In accordance with the study protocol, 43 data collection calls (4%) were monitored across the three time points, and in every instance, interviewers delivered the questions as per the protocol 'all' or 'most of the time'.

Discussion

This is the first randomised controlled trial of a telephone-based primary prevention intervention to increase fruit and vegetable consumption in preschool-aged children. Analysis using all available data revealed that children whose parents were randomly allocated to receive four weekly scripted support calls plus printed nutrition material had higher fruit and vegetable scores at 2- and 6-months post-baseline compared to children whose parents were randomly allocated to receive printed nutrition material alone. The sensitivity analysis, which adopted a conservative imputation approach (baseline observation carried forward), found a significant intervention effect at 2-months, which approached but did not reach significance at 6-months. The effect of the intervention did not vary between children who were and were not meeting fruit and vegetable dietary guidelines at baseline. Furthermore, increases in child fruit and vegetable scores did not coincide with increases in household expenditure on food, suggesting that the intervention did not pose any additional financial burden on families. Although not in the anticipated direction, the short-term decrease in the expenditure of the intervention group could be the result of provision of information during the intervention calls regarding: shopping on a budget; the comparable nutritional value of cheaper alternatives to fresh fruit and vegetables (e.g. canned or frozen); and advice to buy fresh produce when in season and on special.

The findings are promising given the limited effectiveness of interventions attempting to increase young children's fruit and vegetable consumption. The only randomised controlled trial of an intervention that explicitly targeted the home food environment to encourage fruit and vegetable consumption of preschool children failed to increase fruit and vegetable consumption overall, but increased intake among a subsample of normal-weight children [17]. The intervention, which also consisted of four intervention contacts, was delivered via home visits to a sample of predominantly disadvantaged families (20-25% university educated, 50-60% with an annual household income

<\$35,000) [17]. The contrasting findings may reflect the difficulties experienced by socio-economically disadvantaged parents, relative to the current sample, in increasing child fruit and vegetable intake. While the impact of this telephone-based intervention on children from disadvantaged families is not known, more intensive telephone-based support which is considerate of the distinct challenges of disadvantaged families (including cost, work schedules, lack of time, and lack of skills and confidence [40-42]) may maximise the potential effectiveness and acceptability of a telephone-based approach to such parents. Nonetheless, the results are consistent with the pilot study [20] and with systematic reviews finding strong evidence of the efficacy of adult dietary interventions delivered by telephone [19, 43].

Given the positive trial findings, the research has a number of important public health implications. First, the intervention was relatively brief, scripted, and delivered by non-specialist staff. Such attributes suggest that the intervention could easily be integrated into existing telephone support services [44] and may be relatively inexpensive compared with services utilising specialist health professionals for the provision of child nutrition support. Second, the intervention had high retention rates (87%), and has previously been found to be acceptable to parents [20], suggesting broad appeal of this form of support. Finally, the intervention was delivered using a modality that affords almost population-wide access in the developed world [45]. As such, the intervention has the potential to overcome barriers to parent use of traditional support services such as conflicting or inflexible schedules, time constraints and transport difficulties [41, 46], particularly those barriers faced by rural and socio-economically disadvantaged households [41], and should be tested with a more disadvantaged sample. Collectively, such research suggests that the telephone-based intervention may represent an appealing policy option for governments or other health agencies to improve public health nutrition and reduce future chronic disease.

Strengths of this study include the experimental design, the standardisation of intervention delivery (via scripted dialogue appearing on computer screens), and consideration of unintended cost effects of the intervention. There are, however, a number of study limitations that warrant consideration. The sample included participants that were, on average, more educated and had higher household income than a random sample of parents within the study region, and as such, further investigation examining intervention effectiveness in more disadvantaged populations is recommended. Furthermore, the generalisability of the findings may be limited by the higher proportion of children sampled who were consuming the recommended number

of daily vegetables servings at baseline, compared to the broader study area. The subgroup analysis, however, suggested that there was no significant difference in intervention efficacy for children consuming high, as compared with low, levels of fruit and vegetables at baseline. As is common in trials of behavioural interventions [47] parent participants in this trial were unblinded and the primary outcome measure was subjectively assessed by parent-report, increasing the risk of a biased assessment of intervention effect [48]. Furthermore the primary outcome was assessed using a food frequency questionnaire. While this tool represented the only measure of fruit and vegetable consumption available to the research team that had been validated on a sample of Australian preschool children [33, 49], a more comprehensive method of dietary assessment such as food records or 24-hour recall may have yielded more accurate assessments of intake [50] and allowed for more meaningful comparison with other studies. Finally, by the end of each survey, outcome assessors were 6-9% more likely than chance to correctly identify the group to which participants were allocated, potentially increasing the risk of detection bias [48].

A number of opportunities for further research exist. Although the analysis using all available data revealed a significant intervention effect at both 2- and 6-month follow-up, the sensitivity analysis fell short of significance at 6 months. Research is therefore required to confirm these findings. While the presence of a short-term intervention effect is encouraging, further investigation to determine whether the effect is maintained in the longer term is also warranted. Research into the optimal schedule of telephone contacts could increase the efficiency of the intervention by determining the maximum effect that can be obtained for a given level of resources. Investigating the characteristics of the home food environment that mediated the relationship between the intervention and dietary behaviour (for example, parent knowledge, self-efficacy, fruit and vegetable availability) would also allow a greater understanding of the causal pathways, further intervention refinement, and may result in greater efficiencies in intervention delivery [51]. Notwithstanding the study limitations, and the value of further research in this area, the study represents an important contribution to the scientific literature regarding public health interventions addressing childhood fruit and vegetable consumption.

References

1. World Cancer Research Fund / American Institute for Cancer Research: **Food, Nutrition, Physical Activity, and the Prevention of Cancer: a Global Perspective**. Washington DC: AICR; 2007.
2. Dauchet L, Amouyel P, Hercberg S, Dallongeville J: **Fruit and vegetable consumption and risk of coronary heart disease: a meta-analysis of cohort studies**. *J Nutr* 2006, **136**(10):2588-2593.
3. He FJ, Nowson CA, MacGregor GA: **Fruit and vegetable consumption and stroke: meta-analysis of cohort studies**. *Lancet* 2006, **367**(9507):320-326.
4. Lock K, Pomerleau J, Causer L, Altmann DR, McKee M: **The global burden of disease attributable to low consumption of fruit and vegetables: implications for the global strategy on diet**. *Bull World Health Organ* 2005, **83**(2):100-108.
5. Mikkila V, Rasanen L, Raitakari OT, Pietinen P, Viikari J: **Longitudinal changes in diet from childhood into adulthood with respect to risk of cardiovascular diseases: The Cardiovascular Risk in Young Finns Study**. *Eur J Clin Nutr* 2004, **58**(7):1038-1045.
6. Ness AR, Maynard M, Frankel S, Smith GD, Frobisher C, Leary SD, Emmett PM, Gunnell D: **Diet in childhood and adult cardiovascular and all cause mortality: the Boyd Orr cohort**. *Heart* 2005, **91**(7):894-898.
7. Maynard M, Gunnell D, Emmett P, Frankel S, Davey Smith G: **Fruit, vegetables, and antioxidants in childhood and risk of adult cancer: the Boyd Orr cohort**. *J Epidemiol Community Health* 2003, **57**(3):218-225.
8. Birch LL: **Development of food preferences**. *Annu Rev Nutr* 1999, **19**(1):41-62.
9. Hector D, Shrewsbury V: **Building solutions for preventing childhood obesity. Module 2: Interventions to increase consumption of fruit and vegetables**. Sydney: NSW Centre for Overweight and Obesity; 2008.
10. Campbell KJ, Hesketh KD: **Strategies which aim to positively impact on weight, physical activity, diet and sedentary behaviours in children from**

- zero to five years. A systematic review of the literature.** *Obes Rev* 2007, **8**(4):327-338.
11. Bayer O, von Kries R, Strauss A, Mitschek C, Toschke AM, Hose A, Koletzko BV: **Short- and mid-term effects of a setting based prevention program to reduce obesity risk factors in children: a cluster-randomized trial.** *Clin Nutr* 2009, **28**(2):122-128.
 12. Witt KE, Dunn C: **Increasing fruit and vegetable consumption among preschoolers: Evaluation of Color Me Healthy.** *J Nutr Educ Behav* 2011, **44**(2):107-113.
 13. Vereecken C, Huybrechts I, van Houte H, Martens V, Wittebroodt I, Maes L: **Results from a dietary intervention study in preschools "Beastly Healthy at School".** *Int J Public Health* 2009, **54**(3):142-149.
 14. Hardy LL, King L, Kelly B, Farrell L, Howlett S: **Munch and Move: evaluation of a preschool healthy eating and movement skill program.** *Int J Behav Nutr Phys Act* 2010, **7**:80.
 15. Pearson N, Biddle SJ, Gorely T: **Family correlates of fruit and vegetable consumption in children and adolescents: a systematic review.** *Public Health Nutr* 2008, **12**(2):267-283.
 16. Rasmussen M, Krolner R, Klepp KI, Lytle L, Brug J, Bere E, Due P: **Determinants of fruit and vegetable consumption among children and adolescents: a review of the literature. Part I: Quantitative studies.** *Int J Behav Nutr Phys Act* 2006, **3**:22.
 17. Haire-Joshu D, Elliott MB, Caito NM, Hessler K, Nanney MS, Hale N, Boehmer TK, Kreuter M, Brownson RC: **High 5 for Kids: the impact of a home visiting program on fruit and vegetable intake of parents and their preschool children.** *Prev Med* 2008, **47**(1):77-82.
 18. Vanwormer JJ, Boucher JL, Pronk NP: **Telephone-based counseling improves dietary fat, fruit, and vegetable consumption: a best-evidence synthesis.** *J Am Diet Assoc* 2006, **106**(9):1434-1444.

19. Eakin EG, Lawler SP, Vandelanotte C, Owen N: **Telephone interventions for physical activity and dietary behavior change: a systematic review.** *Am J Prev Med* 2007, **32**(5):419-434.
20. Wyse R, Wolfenden L, Campbell E, Campbell K, Brennan L, Fletcher A, Bowman J, Heard T, Wiggers J: **A pilot study of a telephone-based parental intervention to increase fruit and vegetable consumption in 3-5-year-old children.** *Public Health Nutr* 2011, **14**(12):2245-2253.
21. Drewnowski A, Darmon N, Briend A: **Replacing fats and sweets with vegetables and fruits--a question of cost.** *Am J Public Health* 2004, **94**(9):1555-1559.
22. Wyse RJ, Wolfenden L, Campbell E, Brennan L, Campbell KJ, Fletcher A, Bowman J, Heard TR, Wiggers J: **A cluster randomised trial of a telephone-based intervention for parents to increase fruit and vegetable consumption in their 3- to 5-year-old children: study protocol.** *BMC Public Health* 2010, **10**:216.
23. Wolfenden L, Kypri K, Freund M, Hodder R: **Obtaining active parental consent for school-based research: a guide for researchers.** *Aust N Z J Public Health* 2009, **33**(3):270-275.
24. Australian Bureau of Statistics: **Census of Population and Housing: Socio-Economic Indexes for Areas (SEIFA) (2033.0.55.001).** Canberra: ABS; 2006.
25. Green BB, McAfee T, Hindmarsh M, Madsen L, Caplow M, Buist D: **Effectiveness of telephone support in increasing physical activity levels in primary care patients.** *Am J Prev Med* 2002, **22**(3):177-183.
26. Elley CR, Kerse N, Arroll B, Robinson E: **Effectiveness of counselling patients on physical activity in general practice: cluster randomised controlled trial.** *BMJ* 2003, **326**(7393):793.
27. Satter E: **Feeding dynamics: helping children to eat well.** *J Pediatr Health Care* 1995, **9**(4):178-184.
28. Robinson T: **Applying the socio-ecological model to improving fruit and vegetable intake among low-income African Americans.** *J Community Health* 2008, **33**(6):395-406.

29. Golan M, Weizman A: **Familial approach to the treatment of childhood obesity: conceptual mode.** *J Nutr Educ* 2001, **33**(2):102-107.
30. Abraham C, Michie S: **A taxonomy of behavior change techniques used in interventions.** *Health Psychol* 2008, **27**(3):379-387.
31. Choi BC: **Computer assisted telephone interviewing (CATI) for health surveys in public health surveillance: methodological issues and challenges ahead.** *Chronic Diseases in Canada* 2004, **25**(2):21-27.
32. Kellet E, Smith A, Schmerlaib Y: **The Australian Guide to Healthy Eating: Background information for consumers.** The Australian Government Department of Health and Ageing; 1998.
33. Magarey A, Golley R, Spurrier N, Goodwin E, Ong F: **Reliability and validity of the Children's Dietary Questionnaire; a new tool to measure children's dietary patterns.** *Int J Pediatr Obes* 2009, **4**(4):257-265.
34. **Good for Kids. Good for Life** [<http://www.goodforkids.nsw.gov.au>]. Accessed September 2011.
35. Liang KY, Zeger SL: **Regression analysis for correlated data.** *Annu Rev Public Health* 1993, **14**:43-68.
36. Little RJA: **A test of missing completely at random for multivariate data with missing values.** *J Am Stat Assoc* 1988, **83**(404):1198-1112.
37. Porta N, Bonet C, Cobo E: **Discordance between reported intention-to-treat and per protocol analyses.** *J Clin Epidemiol* 2007, **60**(7):663-669.
38. Wolfenden L, Hardy LL, Milat A, Bell C, Sutherland R, Wiggers J: **Prevalence and socio-demographic associations of overweight and obesity among children attending childcare services in rural and regional New South Wales Australia.** *Nutr Diet* 2011, **68**(1):15-20.
39. Centre for Epidemiology and Research: **New South Wales Population Health Survey 2007-2008 (HOIST).** NSW Department of Health; 2008.
40. Omar MA, Coleman G, Hoerr S: **Healthy eating for rural low-income toddlers: caregivers' perceptions.** *J Community Health Nurs* 2001, **18**(2):93-106.

41. Katz I, La Placa V, Hunter S: *Barriers to inclusion and successful engagement of parents in mainstream services*. York: Joseph Rowntree Foundation; 2007.
42. Winkler E, Turrell G: **Confidence to cook vegetables and the buying habits of Australian households**. *J Am Diet Assoc* 2009, **109**(10):1759-1768.
43. Goode AD, Reeves MM, Eakin EG: **Telephone-delivered interventions for physical activity and dietary behavior change: An updated systematic review**. *Am J Prev Med* 2012, **42**(1):81-88.
44. O'Hara BJ, Bauman AE, King EL, Phongsavan P: **Process evaluation of the advertising campaign for the NSW Get Healthy Information and Coaching Service**. *Health Promot J Aust* 2011, **22**(1):68-71.
45. **International Telecommunications Union: Global ICT Developments** [<http://www.itu.int/ITU-D/ict/statistics/ict/index.html>]. Accessed 9 November 2011.
46. Lamb-Parker F, Piotrkowski CS, Baker AJL, Kessler-Sklar S, Clark B, Peay L: **Understanding barriers to parent involvement in Head Start: a research-community partnership**. *Early Child Res Q* 2001, **16**:35-51.
47. Boutron I, Tubach F, Giraudeau B, Ravaud P: **Blinding was judged more difficult to achieve and maintain in nonpharmacologic than pharmacologic trials**. *J Clin Epidemiol* 2004, **57**(6):543-550.
48. The Cochrane Collaboration: *Cochrane Handbook for Systematic Reviews of Interventions (Version 5.1.0)*. Edited by Higgins J, Green S: The Cochrane Collaboration; 2011.
49. **Australasian Child and Adolescent Obesity Research Network (ACAORN): ACAORN repository of tools to measure dietary intake in children and adolescents - September 2009** [www.acaorn.org.au/streams/nutrition/Pub_Repository_diet_assess_tools_Sept2009.pdf]. Accessed 1 February 2012.
50. McPherson RS, Hoelscher DM, Alexander M, Scanlon KS, Serdula MK: **Dietary assessment methods among school-aged children: validity and reliability**. *Prev Med* 2000, **31**(2):s11-33.

51. Cerin E, Mackinnon DP: **A commentary on current practice in mediating variable analyses in behavioural nutrition and physical activity.** *Public Health Nutr* 2009, **12**(8):1182-1188..

CHAPTER SIX:
Thesis Summary and Implications

Chapter Summary

Inadequate consumption of fruit and vegetables has been linked to an increased risk of chronic diseases including cancer [1] and cardiovascular diseases [2-5] and is responsible for considerable burden of disease [6]. This has led to calls for governments and non-government organisations to take action to increase fruit and vegetable consumption [7-10]. Interventions to increase children's fruit and vegetable intake may be of particular importance given that: dietary preferences are established in early childhood [11]; childhood fruit and vegetable consumption is protective against chronic diseases in adulthood [12, 13]; and childhood diet influences the consumption patterns of adulthood [14, 15], which are in turn associated with chronic disease risk [16]. This thesis sought to investigate strategies to increase fruit and vegetable consumption among preschool children. The findings from the papers that comprise the thesis are described below and a discussion of the implications of the findings for future research and practice follows.

Chapter 2: A systematic review of interventions for increasing fruit and vegetable consumption in children aged up to 5 years

This chapter consisted of a systematic review of randomised controlled trials of interventions to increase fruit and vegetable consumption in children aged 0 to 5 years. CENTRAL, MEDLINE, EMBASE, CINAHL, PsycINFO, electronic bibliographic and dissertation databases and electronic trial registers were searched, and three international nutrition journals and the reference lists of included trials were reviewed in order to identify eligible randomised controlled trials. Two independent reviewers screened the titles and abstracts of identified papers and two independent reviewers extracted data and assessed the risk of bias of the included studies. A third reviewer resolved disagreements between the independent reviewers. Five trials, with 13 trial arms and 3,967 participants were included in the review [17-21].

Given the small number of included studies, the heterogeneity of the interventions, and the variability in assessment methods, limited conclusions could be drawn regarding the characteristics of effective interventions. Meta-analysis of two trials of exposure-based interventions found no significant increase in short-term consumption of a target vegetable (MD: 1.37, 95% CI: -2.78-5.52), although one trial demonstrated that exposure paired with reward was effective in increasing consumption. Home visiting programs provided to disadvantaged groups did not significantly increase overall fruit intake in the short term (SMD: 0.01, 95% CI: -0.01-0.11). A multi-component preschool-based intervention failed to significantly increase children's vegetable

consumption, but a small significant increase in children's fruit consumption was reported 6 months following baseline assessment. The review found no strong evidence in support of any of the included intervention approaches and identified opportunities for additional intervention research within this age group.

Chapter 3: Associations between characteristics of the home food environment and preschool children's fruit and vegetable consumption

Systematic reviews suggest that characteristics of the home food environment including the availability and accessibility of fruit and vegetables (the physical environment) and parental modelling and intake (the socio-cultural environment) are associated with the fruit and vegetable consumption of school-aged children [22-24]. Given developmental differences between children of school- and of preschool-age [25] and differences in the amount of time they spend in the home setting, additional research was required to assess whether these associations were present among younger children. This chapter described the results of a cross-sectional study examining the relationship between characteristics of the home food environment and fruit and vegetable consumption in a sample of preschool children. A cross-sectional telephone survey was conducted with 396 parents of 3 to 5 year-old children attending preschools within the Hunter region, New South Wales, Australia. Associations were investigated between children's fruit and vegetable intake and characteristics of the home food environment including parental role-modelling, parental providing behaviour, fruit and vegetable availability, fruit and vegetable accessibility, pressure to eat, family eating policies and family mealtime practices. Characteristics which were associated with children's fruit and vegetable consumption in simple regression models were entered into a backwards stepwise multiple regression analysis using generalised linear mixed models and controlling for parental education, household income, and child gender.

The multiple regression analysis found positive associations between children's fruit and vegetable consumption and parental fruit and vegetable intake ($p=0.005$), fruit and vegetable availability ($p=0.006$) and accessibility ($p=0.012$), the number of occasions each day that parents provided their child with fruit and vegetables ($p<0.001$), and all or most of the time allowing children to eat only at set meal times ($p=0.006$). Combined, these characteristics of the home food environment accounted for 48% of the variation in the child's fruit and vegetable score.

Identifying environmental characteristics that are associated with higher fruit and vegetable consumption is necessary to determine appropriate targets for interventions within the home setting. This study identified a range of modifiable characteristics within the home food environment that are associated with fruit and vegetable consumption among preschool children. Findings suggest that targeting the availability and accessibility of fruits and vegetables in the home, parental role-modelling and provision of these foods, and having structured meal and snack times may facilitate increased fruit and vegetable intake among preschoolers.

Chapter 4: Pilot study of an intervention to increase fruit and vegetable consumption in preschool children

This chapter investigated the potential efficacy of a brief parent intervention, consisting of four telephone calls and written nutrition materials, in increasing fruit and vegetable consumption in children aged 3 to 5 years. The feasibility of intervention delivery and acceptability to parents was also assessed. The intervention was developed to support parents to change the home food environment in ways that are hypothesised to facilitate increased fruit and vegetable consumption in their child. Involving parents is a key component of successful interventions to increase children's fruit and vegetable consumption [26], yet engaging parents can be challenging [27]. Telephone-based interventions may represent a feasible alternative to traditional ways of accessing parents such as face-to-face group intervention.

Thirty-four parents were recruited to this pre-post study through four preschools located in the Hunter region of New South Wales. Participants received four 30-minute intervention telephone calls over 4 weeks delivered by trained telephone interventionists. The scripted support calls focused on fruit and vegetable availability and accessibility within the home, parental role-modelling of fruit and vegetable consumption, and implementing supportive family eating routines. Telephone surveys were conducted approximately 1 week prior to and following intervention delivery and fruit and vegetable consumption was assessed using a subscale of the Children's Dietary Questionnaire, previously determined to be valid and reliable in samples of Australian children [28].

Children's scores on the fruit and vegetable subscale had significantly increased at the follow-up assessment ($p=0.027$). Post-hoc analyses provided evidence of intervention efficacy among children from lower socio-economic backgrounds, and among those who were not meeting the dietary guidelines for fruit and vegetable consumption. The

intervention was feasible to deliver to parents as all participants who started the intervention completed all four calls, and aspects of the intervention calls, including the number, length, content, format and relevance, were considered acceptable by over 90% of parents. Furthermore, the results suggest that interventionists with no formal qualifications in nutrition, psychology or parenting could successfully deliver the intervention.

Chapter 5a) and 5b): A cluster randomised controlled trial of a telephone-based parent intervention to increase preschoolers' fruit and vegetable consumption

Given the promising findings of the pilot trial, an adequately powered, cluster randomised controlled trial was conducted to assess the efficacy of this telephone-based parent intervention in increasing the fruit and vegetable consumption of children aged 3 to 5 years. The first part of Chapter 5 consisted of the published protocol detailing how the trial was conducted. The second part of the chapter described the 2- and 6-month trial results.

Subjects were 394 parents of children aged 3 to 5 years recruited through 30 preschools in the Hunter region. Parents allocated to the intervention received printed resources plus four 30-minute telephone calls targeting aspects of the home food environment that are associated with children's fruit and vegetable consumption [22-24]. Parents allocated to the control group received generic printed nutrition information. Children's fruit and vegetable consumption was assessed using the fruit and vegetable subscale of the Children's Dietary Questionnaire [28] which was administered via telephone interview at baseline and 2- and 6-months later. Intervention and data collection calls were monitored to ensure that intervention fidelity and standardisation of data collection were maintained.

Analysis of all the available data showed that fruit and vegetable scores were significantly higher among intervention children compared to control children at 2- ($p<0.001$) and 6-months ($p=0.021$). A sensitivity analysis, which imputed missing data using the baseline observation carried forward approach, revealed a significant effect at 2-months ($p=0.008$) and an effect approaching but not reaching significance at 6-months ($p=0.069$). Furthermore, this change was achieved without a corresponding increase in the estimated weekly food expenditure of the intervention group, indicating there was no adverse financial outcome resulting from intervention participation. This randomised controlled trial provides quality evidence of the efficacy of a telephone-based parent intervention that may have promise in increasing the fruit and vegetable

consumption of a previously under-researched group of children. If shown to have sustained efficacy, this intervention may represent an appealing option for health agencies to improve public health nutrition and reduce future chronic disease.

Implications for Research and Practice

The aim of this thesis was to investigate strategies to increase fruit and vegetable consumption in preschool-aged children by: reviewing the evidence for existing interventions; identifying characteristics of the home food environment that are associated with high levels of consumption; and evaluating an intervention to increase preschoolers' consumption of fruit and vegetables. The thesis findings have a number of implications i) for further research into telephone-based fruit and vegetable interventions, ii) for public health nutrition research more broadly, and iii) for public health policy makers and practitioners tasked with reducing the burden of disease associated with inadequate fruit and vegetable intake.

i) Telephone-Based Fruit and Vegetable Interventions

Mechanisms of Intervention Effect

Given evidence of short-term intervention efficacy, research is warranted to better understand how the intervention improved children's fruit and vegetable consumption. Mediation analysis identifies the mechanisms by which one variable influences another [29] and provides a link between the theory or framework upon which an intervention is based, the proposed mediating processes, and the success or failure of an intervention [30]. The identification of mediating processes facilitates the development of more effective interventions by isolating effective components that should be retained and ineffective components that can be removed [31]. This can reduce costs and improve intervention efficiency [32].

Although recommended as an important aspect of intervention research [33, 34], intervention mediators (though implicit in many interventions) are often poorly described and are rarely tested [30]. No studies involving preschool children, for example, were included in two recently published systematic reviews of the mediators of dietary interventions targeting children [35, 36]. Review authors reported that the included studies were only of moderate quality, limited in size, and often used tools with unknown validity and reliability that were not sufficiently sensitive to detect a mediating effect [35]. Such methodological limitations of mediation studies with older children and the dearth of mediation studies with younger children are significant

barriers to understanding the mechanisms by which interventions may positively influence children's dietary habits. A quality mediation analysis of an efficacious fruit and vegetable intervention for preschoolers would therefore represent a novel and important contribution to public health nutrition research and practice.

The intervention supported parents to increase the availability and accessibility of fruit and vegetables in the home, increase parental role-modelling, and create supportive family food routines. The selection and inclusion of these characteristics was based on the findings of previous cross-sectional and non-interventional longitudinal studies [22-24]. It is therefore unknown whether the changes in the characteristics of the home food environment identified in Chapter 3 contributed to the increases in fruit and vegetable consumption reported in Chapters 4 and 5. The experimental design and sample size of the trial reported in Chapter 5 make the trial data potentially amenable to a mediation analysis to investigate such a hypothesis. Notwithstanding the limitations acknowledged above, a mediation analysis of this telephone-based intervention would be valuable in informing the development and refinement of future interventions delivered by telephone. Although the cross-sectional findings of Chapter 3 and the experimental findings of the randomised controlled trial provide support for Rosenkranz's model linking child diet to the home food environment [37], a mediation analysis would provide stronger support for this model and is recommended.

Maintenance of Intervention Effects

Chapter 5 investigated the short-term efficacy (2- and 6-months post-baseline) of the telephone-based intervention. However, in order to achieve long-term health benefits, short-term dietary improvements must be maintained. Long-term assessment is relatively novel within this limited field of intervention research, with none of the studies included in the systematic review (Chapter 2) assessing intervention effects at or beyond 12-months post-intervention. Longer-term assessment of the participants of the randomised trial (Chapter 5) is therefore warranted and would represent an important contribution to the field.

Intervention effects typically attenuate over time [38] and the decrease in the effect size from the 2-month to the 6-month assessment suggests that this may be occurring in the randomised controlled trial (Chapter 5). Strategies that help maintain intervention effects are important to maximise the long-term benefit of public health interventions. Despite this, maintenance strategies are rarely investigated. A recent systematic review of physical activity and dietary interventions among adults, for example, found

that only 35% of trials reported maintenance outcomes³ [39]. The review concluded that interventions were more successful at maintaining behaviour change when: the intervention period lasted for more than 24 weeks; the intervention included a greater number of contacts; follow-up prompts were included; and when more than six behaviour change strategies were used [39].

Recent technological advancements [40] and increases in mobile phone ownership [41, 42] have resulted in opportunities to incorporate maintenance strategies into telephone-based interventions without substantially increasing the burden to participants. Text messaging is one such opportunity. A review of interventions delivered via text message found this modality to be effective in improving a variety of adult health behaviours [43] and could therefore be used to deliver recommended maintenance strategies, such as multiple contacts over extended periods and behavioural prompts [39]. For example, as an adjunct to verbal telephone-based contact, text messaging may be used to provide participants with additional 'booster' contacts at a very low cost [44]. Booster texts could also be used to remind participants of the intervention's main messages or their personal goals, provide motivational messages or prompt behaviour during periods where the risk of behavioural relapse may be high. While this delivery format may be appealing to busy parents [45] and may be an effective way of engaging hard-to-reach parents [43], the use of such technology to increase the fruit and vegetable consumption of young children has not yet been tested (Chapter 2).

ii) Implications for Public Health Nutrition Research

Establishing the Clinical Significance of Dietary Change

The pilot study (Chapter 4) and the randomised controlled trial (Chapter 5) found statistically significant increases in children's fruit and vegetable scores following their parents' participation in a four contact telephone intervention. However, the extent of the health benefits associated with participation in this and other fruit and vegetable interventions is unclear given the uncertainty regarding the clinical significance of dietary changes in children [46, 47]. Relatively small, sustained intervention effects, across a large number of children, have the potential to generate important reductions in disease risk at a population level [48]. However, assessment of the clinical significance of dietary interventions in early life requires quantification of the reduction

³ 'Maintenance' was defined as a significant between group difference on a behavioural outcome at least 3 months post intervention contact

in risk over the life course that is attributable to changes in vegetable and fruit intake. Large prospective cohort studies or long-term intervention studies are needed to estimate these benefits, and although these studies are costly, such data would prove particularly valuable for health policy makers and practitioners interested in maximising health improvements from finite health resources. As the establishment of epidemiological evidence regarding clinical significance is a precursor for rigorous cost-effectiveness analysis, at present, the ability to draw conclusions regarding cost-effectiveness and to compare different forms of intervention according to this criteria, is limited. It is important to acknowledge that alternative approaches such as Internet and mobile phone based interventions may be more cost-effective and should be trialled as components of future parent interventions.

Improving Assessment of Children's Fruit and Vegetable Intake

The quality of evaluation is dependent, in part, on the quality of the assessment tools. The fruit and vegetable subscale from the Children's Dietary Questionnaire was used to assess children's fruit and vegetable consumption in the studies reported in Chapters 3, 4 and 5. This food frequency questionnaire was selected based on its psychometric properties and ease of administration to large numbers of parents. At the time of study design, the Children's Dietary Questionnaire was the only dietary assessment tool with established reliability and validity in samples of Australian preschool children [28, 49]. While the tool has been recommended for use in intervention research, the correlation coefficient assessing instrument validity was relatively modest (Spearman correlation co-efficient = 0.58).

Although biological markers represent less subjective assessments of intake, they are often laborious and expensive, specific to certain nutrients (e.g. Vitamin C) rather than food groups (e.g. fruit) [50], and may represent an impediment to parental consent for child assessment. This makes them largely inappropriate for use in complex public health intervention research. Food records have the potential to provide more quantitatively accurate dietary assessments [51], however, they are also considerably burdensome to participants and come at significant financial costs to research projects [51]. Food frequency questionnaires are perhaps the most widely used form of dietary assessment in public health nutrition intervention research. Although such questionnaires require less participant time and are relatively inexpensive and easy to administer, they are more susceptible to social desirability and other biases [51]. Novel and creative alternatives to dietary assessment, particularly for children, are therefore

required [52] that provide accurate information but that are not overly expensive or demanding of participants.

New technologies have the potential to improve the accuracy and efficiency of dietary assessment [53], while remaining acceptable to users, including participants from disadvantaged backgrounds [54]. Assessment of food intake using a personal digital assistant (PDA) computerised device was shown to be comparable to a 24-hour recall in a sample of adults with no dietary restrictions [53]. Similarly, the assessment of energy intake using a photo-based recording system was shown to be comparable to assessment using doubly-labelled water [55]. Furthermore, in a laboratory-based study, no significant differences were found in terms of macronutrient intake and recorded energy from the photo-based recording system as compared to a weighed food intake [55]. The integration of these data collection systems into software compatible with Smartphones has the potential to revolutionise the collection and use of dietary data for nutrition research. The use of existing software and participants' own Smartphone (hardware) may considerably reduce data collection costs. Compliance with data collection procedures could be improved as data can be entered in real time, and text messaging could be used to routinely prompt participants to record their food intake [55]. The use of inbuilt cameras and the ability to scan barcodes may enable precise information to be recorded about the pre-packaged foods that are consumed with relatively little effort by participants [56]. A number of software packages for dietary assessment and photo-based recording are already available in the market place for download [57] and their utility for public health research warrants investigation.

iii) Implications for Practitioners and Policy-Makers

The Efficiencies of Environmental Interventions

The cross-sectional study in Chapter 3 demonstrated that characteristics of the home food environment are associated with preschoolers' fruit and vegetable consumption, and Chapters 4 and 5 established that an intervention targeting characteristics of the home food environment could result in short-term increases in intake among preschoolers. As such, the findings of this thesis underscore the potential influence of the home food environment on children's dietary behaviours and emphasise the importance of the home as a potential setting for interventions attempting to modify children's dietary behaviours. Given the study sample under-represented families from low-socioeconomic backgrounds, future research should explore whether socio-

economic status moderates the relationship between the home food environment and dietary behaviours.

The characteristics of the home environment that are thought to improve children's dietary habits, for example family meals and meals without television, have also been associated with healthier dietary behaviours in adolescents and adults [58, 59]. As such, dietary interventions that modify aspects of the home and family environment may influence the health behaviour of family members beyond the immediate target of the intervention. Indeed, additional exploratory analysis of trial data presented in Chapter 5 suggests that the telephone-based intervention significantly increased the fruit and vegetable consumption of intervention parents. At the 2-month follow-up, compared to control parents, daily vegetable intake among intervention parents was 0.7 of a serving higher ($p < 0.001$) and daily fruit intake was 0.3 of a serving higher ($p < 0.001$) after adjusting for baseline values. These results are consistent with the findings of Golan, Fainaru and Weizman who demonstrated that an intervention delivered to parents, which included changes to the home environment, had a significant impact on the health behaviours of the parent who received the intervention and the overweight child who was the target of the intervention [60]. The trial findings provide support for the parent-based intervention model proposed by Golan and colleagues in their research into childhood obesity prevention and treatment [61], suggesting that parents are key targets of interventions designed to change the behaviour of their children. Investigation of the extent to which the dietary habits of family members not directly involved in the intervention, such as siblings and partners, change as a result of changes to the home food environment may provide a more compelling case for the implementation and adoption of such initiatives by health policy makers and practitioners.

Interventions that seek to modify the home and family food environment could potentially influence multiple health behaviours. Evidence suggests there is an overlap between the characteristics of the home environment that are associated with children's dietary intake and with their sedentary behaviour. For example, installation of a television locking device reduced children's television viewing by 33% and also decreased the number of meals eaten in front of the television [62]. Furthermore, a non-interventional 19-month longitudinal study showed that change in the number of hours per day spent watching television was negatively associated with the change in children's fruit and vegetable consumption [63]. Although a home environment intervention which included multiple behaviour targets reduced children's television

viewing and improved diet [64], the mediators of such changes are unknown. As such, it is unknown whether environmental interventions targeting children's dietary behaviours in isolation can also affect other health behaviours. Further investigation of this hypothesis is required.

The Potential of Telephone Delivery

There is now strong evidence for the short-term efficacy of adult dietary and physical activity interventions delivered via telephone [65, 66]. Evidence is accumulating of their efficacy in primary school students [67, 68] and the studies in this thesis provide preliminary evidence of short-term efficacy among preschool children (Chapters 4 and 5). Studies suggest that telephone delivered interventions can overcome geographical barriers in reaching parents in rural and remote areas [69] and may be particularly useful in reducing the barriers faced by parents of young children [70] including inflexible schedules, transport difficulties, and child-minding responsibilities [69, 71]. Evidence from the pilot study suggests that parents of young children actively engage in telephone-based interventions and find the delivery modality acceptable (Chapter 4). On the basis of these findings and the results of the randomised controlled trial in Chapter 5, telephone-based interventions targeting children of preschool-age may represent an appealing option to improve public health nutrition.

A number of government and non-government organisations now operate telephone information, support, and triage services to promote the adoption of healthy lifestyle behaviours among adults [72]. Telephone services have been an integral component of smoking cessation initiatives since the early 1980s [73]. The Cancer Institute NSW currently operates a free quitline where counsellors provide information, advice and strategies to assist smokers prepare to quit and prevent relapse [74]. Telephone services focused on other preventative behaviours are also emerging. The NSW 'Get Healthy Coaching Service' is a telephone service addressing issues of weight loss, healthy eating and physical activity [75]. These services demonstrate that within NSW there is precedent for population health prevention strategies being delivered in the form of government run telephone support services. Furthermore, a number of characteristics of the telephone-based intervention trialled in Chapters 4 and 5 indicate that it may be amenable to be integrated into such services, namely, the relatively brief (four contact) format, the scripted intervention, and reliance on telephone interviewers rather than experienced clinicians.

Existing telephone-based services, however, are often under-utilised, therefore limiting the public health impact of this form of intervention [76, 77]. For example, the 'Get Healthy Coaching Service' was accessed by just 0.2% of the overweight or obese population in NSW in its first 10 months of operation [78]. To improve health at a population level, the required rate of participation was estimated to be 3-6% [78]. Despite 30% of parents indicating an interest in using a telephone-based service to help them improve the healthy eating and physical activity of their children [79], under trial circumstances, the response rates for the pilot study (Chapter 4) and the randomised controlled trial (Chapter 5) were substantially lower at 12% and 18% respectively. This suggests that despite evidence of the potential efficacy of the intervention in Chapters 4 and 5, without strategies to actively promote parent use of a fruit and vegetable telephone service, it would be unlikely to generate improvements in public health nutrition. The investigation of strategies to enhance uptake of health promoting telephone-based services for parents therefore may be an important avenue for future scientific inquiry to ensure that the benefits of investment in efficacy research translate to a community health benefit.

While mass media campaigns have been found to increase use of telephone-based services [78, 80], proactively recruiting participants may represent a more cost effective approach. A recent Australian study demonstrated that a 'cold-calling' telemarketing approach using selection of random numbers from the electronic telephone directory recruited 52% of all eligible smokers contacted, at a cost of US\$59 per recruited smoker [81]. This reached a far greater proportion of smokers than the 4% within the Australian community who use the Quitline of their own volition [80] and was achieved at a reasonable cost [81]. A similar study was successful in recruiting almost one in four adults to the NSW 'Get Healthy Coaching Service' for weight loss, healthy eating, and physical activity support [82]. Furthermore, the proactive recruitment strategy was considered acceptable by 86% of those contacted [82]. Proactive recruitment approaches may also yield higher participation rates among disadvantaged groups in the community [83]. Nonetheless, recruiting proactively to telephone-based health support services is still relatively novel, and to the authors' knowledge has not been previously tested in the context of recruiting parents to telephone-based preventative health services targeting their children. As such, further evaluation is warranted among parents of preschool-aged children to determine whether they are cost effective, can sufficiently increase intervention reach to afford a population health benefit, and facilitate greater reach among at-risk and disadvantaged populations [83].

Conclusion

Despite the early childhood years representing a sensitive period for the development of healthy eating habits, there is a paucity of evidence for effective interventions to increase the fruit and vegetable consumption of preschool children. This thesis provides evidence of the associations between a supportive home food environment and higher levels of fruit and vegetable consumption among children of preschool age. A four contact telephone-based intervention was developed to support parent to create home food environments that facilitated children's consumption of fruit and vegetables. A pre-post pilot study and a randomised controlled trial demonstrated that this intervention was acceptable to parents, feasible to deliver, and efficacious in the short-term. Notwithstanding the limitations in evaluating child dietary interventions, this thesis provides preliminary evidence of the public health utility of a telephone-based parent intervention to increase the fruit and vegetable consumption of preschool children.

References

1. World Cancer Research Fund / American Institute for Cancer Research: **Food, Nutrition, Physical Activity, and the Prevention of Cancer: a Global Perspective**. Washington DC: AICR; 2007.
2. He FJ, Nowson CA, MacGregor GA: **Fruit and vegetable consumption and stroke: meta-analysis of cohort studies**. *Lancet* 2006, **367**(9507):320-326.
3. He FJ, Nowson CA, Lucas M, MacGregor GA: **Increased consumption of fruit and vegetables is related to a reduced risk of coronary heart disease: meta-analysis of cohort studies**. *J Hum Hypertens* 2007, **21**(9):717-728.
4. Dauchet L, Amouyel P, Hercberg S, Dallongeville J: **Fruit and vegetable consumption and risk of coronary heart disease: a meta-analysis of cohort studies**. *J Nutr* 2006, **136**(10):2588-2593.
5. Joshipura KJ, Ascherio A, Manson JE, Stampfer MJ, Rimm EB, Speizer FE, Hennekens CH, Spiegelman D, Willett WC: **Fruit and vegetable intake in relation to risk of ischemic stroke**. *JAMA* 1999, **282**(13):1233-1239.
6. Lock K, Pomerleau J, Causer L, Altmann DR, McKee M: **The global burden of disease attributable to low consumption of fruit and vegetables: implications for the global strategy on diet**. *Bull World Health Organ* 2005, **83**(2):100-108.
7. World Health Organization: **Fruit and Vegetable Promotion Initiative – report of the meeting, Geneva, 25–27 August 2003**. Geneva: WHO; 2003.
8. International Union Against Cancer: **Evidence-Based Cancer Prevention: Strategies for NGOs. A UICC Handbook for Europe**. Geneva: IUAC; 2004.
9. United States Department of Agriculture Food and Nutrition Service: **Increasing Fruit and Vegetable Consumption through the USDA Nutrition Assistance Programs: A Progress Report**. USDA; 2008

10. Centre for Health Advancement: **National Partnership Agreement on Preventive Health: NSW Healthy Children's Initiative Discussion Paper**. Sydney: NSW Health; 2010.
11. Birch LL: **Development of food preferences**. *Annu Rev Nutr* 1999, **19**(1):41-62.
12. Ness AR, Maynard M, Frankel S, Smith GD, Frobisher C, Leary SD, Emmett PM, Gunnell D: **Diet in childhood and adult cardiovascular and all cause mortality: the Boyd Orr cohort**. *Heart* 2005, **91**(7):894-898.
13. Maynard M, Gunnell D, Emmett P, Frankel S, Davey Smith G: **Fruit, vegetables, and antioxidants in childhood and risk of adult cancer: the Boyd Orr cohort**. *J Epidemiol Community Health* 2003, **57**(3):218-225.
14. Mikkila V, Rasanen L, Raitakari OT, Pietinen P, Viikari J: **Longitudinal changes in diet from childhood into adulthood with respect to risk of cardiovascular diseases: The Cardiovascular Risk in Young Finns Study**. *Eur J Clin Nutr* 2004, **58**(7):1038-1045.
15. Mikkila V, Rasanen L, Raitakari OT, Pietinen P, Viikari J: **Consistent dietary patterns identified from childhood to adulthood: the cardiovascular risk in Young Finns Study**. *Br J Nutr* 2005, **93**(6):923-931.
16. Kerver JM, Yang EJ, Bianchi L, Song WO: **Dietary patterns associated with risk factors for cardiovascular disease in healthy US adults**. *Am J Clin Nutr* 2003, **78**(6):1103-1110.
17. Cooke LJ, Chambers LC, Anez EV, Croker HA, Boniface D, Yeomans MR, Wardle J: **Eating for pleasure or profit: the effect of incentives on children's enjoyment of vegetables**. *Psychol Sci* 2011, **22**(2):190-196.
18. Haire-Joshu D, Elliott MB, Caito NM, Hessler K, Nanney MS, Hale N, Boehmer TK, Kreuter M, Brownson RC: **High 5 for Kids: the impact of a home visiting program on fruit and vegetable intake of parents and their preschool children**. *Prev Med* 2008, **47**(1):77-82.
19. Vereecken C, Huybrechts I, van Houte H, Martens V, Wittebroodt I, Maes L: **Results from a dietary intervention study in preschools "Beastly Healthy at School"**. *Int J Public Health* 2009, **54**(3):142-149.

20. Wardle J, Cooke LJ, Gibson EL, Sapochnik M, Sheiham A, Lawson M: **Increasing children's acceptance of vegetables; a randomized trial of parent-led exposure.** *Appetite* 2003, **40**(2):155-162.
21. Watt RG, Tull KI, Hardy R, Wiggins M, Kelly Y, Molloy B, Dowler E, Apps J, McGlone P: **Effectiveness of a social support intervention on infant feeding practices: randomised controlled trial.** *J Epidemiol Community Health* 2009, **63**(2):156-162.
22. Blanchette L, Brug J: **Determinants of fruit and vegetable consumption among 6-12-year-old children and effective interventions to increase consumption.** *J Hum Nutr Diet* 2005, **18**:431–443.
23. Pearson N, Biddle SJ, Gorely T: **Family correlates of fruit and vegetable consumption in children and adolescents: a systematic review.** *Public Health Nutr* 2008, **12**(2):267-283.
24. Rasmussen M, Krolner R, Klepp KI, Lytle L, Brug J, Bere E, Due P: **Determinants of fruit and vegetable consumption among children and adolescents: a review of the literature. Part I: Quantitative studies.** *Int J Behav Nutr Phys Act* 2006, **3**:22.
25. Zeinstra GG, Koelen MA, Kok FJ, de Graaf C: **Cognitive development and children's perceptions of fruit and vegetables; a qualitative study.** *Int J Behav Nutr Phys Act* 2007, **4**:30.
26. Knai C, Pomerleau J, Lock K, McKee M: **Getting children to eat more fruit and vegetables: a systematic review.** *Prev Med* 2006, **42**(2):85-95.
27. Perry CL, Bishop DB, Taylor G, Murray DM, Mays RW, Dudovitz BS, Smyth M, Story M: **Changing fruit and vegetable consumption among children: the 5-a-Day Power Plus program in St. Paul, Minnesota.** *Am J Public Health* 1998, **88**(4):603-609.
28. Magarey A, Golley R, Spurrier N, Goodwin E, Ong F: **Reliability and validity of the Children's Dietary Questionnaire; a new tool to measure children's dietary patterns.** *Int J Pediatr Obes* 2009, **4**(4):257-265.
29. MacKinnon DP, Fairchild AJ, Fritz MS: **Mediation analysis.** *Annu Rev Psychol* 2007, **58**:593-614.

30. Reynolds KD, Bishop DB, Chou CP, Xie B, Nebeling L, Perry CL: **Contrasting mediating variables in two 5-a-day nutrition intervention programs.** *Prev Med* 2004, **39**(5):882-893.
31. Mackinnon DP, Dwyer JH: **Estimating Mediated Effects in Prevention Studies.** *Evaluation Rev* 1993, **17**(2):144-158.
32. Cerin E, Mackinnon DP: **A commentary on current practice in mediating variable analyses in behavioural nutrition and physical activity.** *Public Health Nutr* 2009, **12**(8):1182-1188.
33. Baranowski T: **Understanding the behavioral linkages needed for designing effective interventions to increase fruit and vegetable intake in diverse populations.** *J Am Diet Assoc* 2011, **111**(10):1472-1475.
34. Lubans DR, Morgan PJ, Callister R, Collins CE, Plotnikoff RC: **Exploring the mechanisms of physical activity and dietary behavior change in the program x intervention for adolescents.** *J Adolesc Health* 2010, **47**(1):83-91.
35. van Stralen MM, Yildirim M, Velde ST, Brug J, van Mechelen W, Chinapaw MJ: **What works in school-based energy balance behaviour interventions and what does not? A systematic review of mediating mechanisms.** *Int J Obes (Lond)* 2011, **35**(10):1251-1265.
36. Cerin E, Barnett A, Baranowski T: **Testing theories of dietary behavior change in youth using the mediating variable model with intervention programs.** *J Nutr Educ Behav* 2009, **41**(5):309-318.
37. Rosenkranz RR, Dzewaltowski DA: **Model of the home food environment pertaining to childhood obesity.** *Nutr Rev* 2008, **66**(3):123-140.
38. Gehr BT, Weiss C, Porzsolt F: **The fading of reported effectiveness. A meta-analysis of randomised controlled trials.** *BMC Med Res Methodol* 2006, **6**:25.
39. Fjeldsoe B, Neuhaus M, Winkler E, Eakin E: **Systematic review of maintenance of behavior change following physical activity and dietary interventions.** *Health Psychol* 2011, **30**(1):99-109.

40. Wolfenden L, Brennan L, Britton BL: **Intelligent obesity interventions using Smartphones.** *Prev Med* 2010, **51**(6):519-520.
41. International Telecommunications Union: **Information society statistical profiles 2009: Asia and the Pacific.** Geneva: ITU; 2009.
42. International Telecommunications Union: **Information society statistical profiles 2009: Americas.** Geneva: ITU; 2009.
43. Fjeldsoe BS, Marshall AL, Miller YD: **Behavior change interventions delivered by mobile telephone short-message service.** *Am J Prev Med* 2009, **36**(2):165-173.
44. Yates BC, Anderson T, Hertzog M, Ott C, Williams J: **Effectiveness of follow-up booster sessions in improving physical status after cardiac rehabilitation: health, behavioral, and clinical outcomes.** *Appl Nurs Res* 2005, **18**(1):59-62.
45. Sharma R, Hebbal M, Ankola AV, Murugabupathy V: **Mobile-phone text messaging (SMS) for providing oral health education to mothers of preschool children in Belgaum City.** *J Telemed Telecare* 2011, **17**(8):432-436.
46. Lowe CF, Horne PJ, Tapper K, Bowdery M, Egerton C: **Effects of a peer modelling and rewards-based intervention to increase fruit and vegetable consumption in children.** *Eur J Clin Nutr* 2004, **58**(3):510-522.
47. Ciliska D, Miles E, O'Brien MA, Turl C, Tomasik HH, Donovan U, Beyers J: **Effectiveness of community-based interventions to increase fruit and vegetable consumption.** *J Nutr Educ* 2000, **32**(6):341-352.
48. Glasgow RE, Vogt TM, Boles SM: **Evaluating the public health impact of health promotion interventions: the RE-AIM framework.** *Am J Public Health* 1999, **89**(9):1322-1327.
49. **Australasian Child and Adolescent Obesity Research Network (ACAORN): ACAORN repository of tools to measure dietary intake in children and adolescents - September 2009**
[www.acaorn.org.au/streams/nutrition/Pub_Repository_diet_assess_tools_Sept2009.pdf]. Accessed 1 February 2012.

50. Cade J, Thompson R, Burley V, Warm D: **Development, validation and utilisation of food-frequency questionnaires - a review.** *Public Health Nutr* 2002, **5**(4):567-587.
51. Thompson F, Subar A: **Dietary assessment methodology.** In *Nutrition in the Prevention and Treatment of Disease*. 2nd edition. Edited by Coulston A, Boushey C. Burlington, MA: Elsevier Academic Press; 2008:3-39.
52. McPherson RS, Hoelscher DM, Alexander M, Scanlon KS, Serdula MK: **Dietary assessment methods among school-aged children: validity and reliability.** *Prev Med* 2000, **31**:s11-33.
53. Beasley J, Riley WT, Jean-Mary J: **Accuracy of a PDA-based dietary assessment program.** *Nutrition* 2005, **21**(6):672-677.
54. Shiffman S, Stone AA, Hufford MR: **Ecological momentary assessment.** *Annu Rev Clin Psychol* 2008, **4**:1-32.
55. Martin CK, Correa JB, Han H, Allen HR, Rood JC, Champagne CM, Gunturk BK, Bray GA: **Validity of the Remote Food Photography Method (RFPM) for Estimating Energy and Nutrient Intake in Near Real-Time.** *Obesity* 2011.
56. **Chen N, Rabb M, Lee YY, Schatz B: Feasibility of long-term monitoring of everyday health through Smartphones**
[<https://www.ideals.illinois.edu/bitstream/handle/2142/18804/Paper.pdf?sequence=2>]. Accessed 10 February 2012.
57. **App Store** [www.apple.com/au/mac/app-store]. Accessed February 2012.
58. Boutelle KN, Birnbaum AS, Lytle LA, Murray DM, Story M: **Associations between perceived family meal environment and parent intake of fruit, vegetables, and fat.** *J Nutr Educ Behav* 2003, **35**(1):24-29.
59. Videon TM, Manning CK: **Influences on adolescent eating patterns: the importance of family meals.** *J Adolesc Health* 2003, **32**(5):365-373.
60. Golan M, Fainaru M, Weizman A: **Role of behaviour modification in the treatment of childhood obesity with the parents as the exclusive agents of change.** *Int J Obes Relat Metab Disord* 1998, **22**(12):1217-1224.

61. Golan M, Weizman A: **Familial approach to the treatment of childhood obesity: conceptual mode.** *J Nutr Educ* 2001, **33**(2):102-107.
62. Robinson TN: **Reducing children's television viewing to prevent obesity: a randomized controlled trial.** *JAMA* 1999, **282**(16):1561-1567.
63. Boynton-Jarrett R, Thomas TN, Peterson KE, Wiecha J, Sobol AM, Gortmaker SL: **Impact of television viewing patterns on fruit and vegetable consumption among adolescents.** *Pediatrics* 2003, **112**(6):1321-1326.
64. French SA, Gerlach AF, Mitchell NR, Hannan PJ, Welsh EM: **Household obesity prevention: Take Action--a group-randomized trial.** *Obesity* 2011, **19**(10):2082-2088.
65. Eakin EG, Lawler SP, Vandelanotte C, Owen N: **Telephone interventions for physical activity and dietary behavior change: a systematic review.** *Am J Prev Med* 2007, **32**(5):419-434.
66. Goode AD, Reeves MM, Eakin EG: **Telephone-delivered interventions for physical activity and dietary behavior change: An updated systematic review.** *Am J Prev Med* 2012, **42**(1):81-88.
67. Paineau DL, Beaufile F, Boulier A, Cassuto DA, Chwalow J, Combris P, Couet C, Jouret B, Lafay L, Laville M *et al*: **Family dietary coaching to improve nutritional intakes and body weight control: a randomized controlled trial.** *Arch Pediatr Adolesc Med* 2008, **162**(1):34-43.
68. Estabrooks PA, Shoup JA, Gattshall M, Dandamudi P, Shetterly S, Xu S: **Automated telephone counseling for parents of overweight children: a randomized controlled trial.** *Am J Prev Med* 2009, **36**(1):35-42.
69. Katz I, La Placa V, Hunter S: **Barriers to inclusion and successful engagement of parents in mainstream services.** York: Joseph Rowntree Foundation; 2007.
70. Wolman J, Skelly E, Kolotourou M, Lawson M, Sacher P: **Tackling toddler obesity through a pilot community-based family intervention.** *Community Pract* 2008, **81**(1):28-31.

71. Lamb-Parker F, Piotrkowski CS, Baker AJL, Kessler-Sklar S, Clark B, Peay L: **Understanding barriers to parent involvement in Head Start: a research-community partnership.** *Early Child Res Q* 2001, **16**:35-51.
72. Eakin EG, Reeves MM, Lawler SP, Oldenburg B, Del Mar C, Wilkie K, Spencer A, Battistutta D, Graves N: **The Logan Healthy Living Program: a cluster randomized trial of a telephone-delivered physical activity and dietary behavior intervention for primary care patients with type 2 diabetes or hypertension from a socially disadvantaged community--rationale, design and recruitment.** *Contemp Clin Trials* 2008, **29**(3):439-454.
73. Ossip-Klein DJ, McIntosh S: **Quitlines in North America: evidence base and applications.** *Am J Med Sci* 2003, **326**(4):201-205.
74. NSW Department of Health: **"Let's take a moment" quit smoking brief intervention - a guide for all health professionals.** Sydney: NSW Health; 2005.
75. O'Hara BJ, Phongsavan P, Venugopal K, Bauman AE: **Characteristics of participants in Australia's Get Healthy telephone-based lifestyle information and coaching service: reaching disadvantaged communities and those most at need.** *Health Educ Res* 2011, **26**(6):1097-1106.
76. Vetter N: **Health promotion--quo vadis now?** *J Public Health* 2005, **27**:239-240.
77. McIntyre S: **The social patterning of exercise behaviours: the role of personal and local resources.** *Br J Sports Med* 2000, **34**(6):6.
78. O'Hara BJ, Bauman AE, King EL, Phongsavan P: **Process evaluation of the advertising campaign for the NSW Get Healthy Information and Coaching Service.** *Health Promot J Aust* 2011, **22**(1):68-71.
79. Wolfenden L, Bell C, Wiggers J, Butler M, James E, Chipperfield K: **Engaging parents in child obesity prevention: Support preferences of parents.** *J Paediatr Child Health* 2012, **48**(2):E4-6.
80. Miller CL, Wakefield M, Roberts L: **Uptake and effectiveness of the Australian telephone Quitline service in the context of a mass media campaign.** *Tob Control* 2003, **12**:ii53-ii58.

81. Tzelepis F, Paul CL, Walsh RA, Wiggers J, Knight J, Lecathelinais C, Daly J, Neil A, Girgis A: **Telephone recruitment into a randomized controlled trial of quitline support.** *Am J Prev Med* 2009, **37**(4):324-329.
82. Wolfenden L, Paul CL, Tzelepis F, Freund M, Wiggers J, Gillham K: **Acceptability of proactive telephone recruitment to a telephone support service to encourage healthy eating, physical activity and weight loss.** *Aust N Z J Public Health* In press.
83. McBride CM, Rimer BK: **Using the telephone to improve health behavior and health service delivery.** *Patient Educ Couns* 1999, **37**:3-18