The Prospective Associations Between Parental Feeding Practices and Fruit & Vegetable Consumption in Young Children Aged 1 – 6 Years: A Systematic Review

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Abstract

Previous research suggests parental feeding practices potentially influence young children's consumption of fruits and vegetables. Most of this research is cross-sectional, with few studies exploring the longer-term associations. Therefore, this systematic review aims to explore the prospective associations between feeding practices and fruit and vegetable consumption in young children aged 1 – 6 years. Embase, Web of Science, MEDLINE, PsycINFO, CINAHL were searched on 16/10/2023 for prospective studies assessing feeding practices and fruit and vegetable consumption. The search returned 1597 studies, 14 of which met inclusion criteria (6 randomised controlled trials, 5 observational studies, 3 experiments). Included studies were critically appraised using the Joanna Briggs Institute tool for cohort studies and were synthesised following Cochrane guidance for a narrative synthesis. Included studies lasted an average of 77 weeks (range: 2 – 468 weeks), yielded a total of 18,137 participants (range: 24 – 12,740), and were mostly (86%) moderate/high quality. Thirteen feeding practices were explored, including four practices relating to coercive control, five relating to structure, and four relating to autonomy support. The most frequently assessed feeding practices were modelling (50% of studies), nutrition education (43% of studies), and pressure to eat (36% of studies). Eleven (79%) of the included studies reported a statistically significant association between at least one feeding practice and children fruit and/or vegetable consumption, with modelling most often having a positive effect. This review suggests that structure-based feeding practices are most consistently associated with fruit and/or vegetable consumption. However, a greater range of feeding practices need to be assessed longitudinally to better understand how they predict children's fruit and vegetable consumption over time.

Keywords: Prospective, Feeding Practices, Fruit and Vegetables, Young Children

Abbreviations: Fruit and vegetable (F&V), Odds ratio (OR)

The Prospective Associations Between Parental Feeding Practices and Fruit & Vegetable Consumption in Young Children Aged 1 – 6 Years: A Systematic Review

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1. Introduction

A strong characterisation of a healthy diet in people is their fruit and vegetable (F&V) consumption, as F&V are a good source of vitamins, minerals, and fibre; and can reduce the risk of noncommunicable diseases including cardiovascular disease and types of cancer (Aune, et al., 2017; World Health Organisation, 2020). World Health Organisation (2020) guidance outlines that people should consume at least 5 potions of F&V per day (excluding potatoes, sweet potatoes, and other starchy roots), where 1 portion is 80g for adults, or the amount that can fit into one hand for a child. In addition to the quantity and frequency of fruits and vegetables, variety of fruits and vegetables are equally as important for health and disease prevention (Conklin et al., 2014). Furthermore, some prospective studies suggest that higher F&V variety can reduce risk of diabetes and some cancers, independent of quantity (Cooper, et al., 2012; Jeurnink, 2012). Despite the known benefits of F&V, only a small percentage of young children meet F&V recommendations in western countries. For example, the most recent surveys indicate that just 14% of children aged 5-7 years meet F&V recommendations in the UK (Health Survey England, 2020); and just 20% of children aged 2-3 years and 1.5% of children aged 4-8 years meet F&V recommendations in Australia (Australian Bureau of Statistics, 2022). Therefore, stronger efforts are required to improve young children F&V consumption.

Poor F&V intake in young children is of particular concern as the dietary habits developed in the formative years (ages 1.5 – 5 years) track later into childhood and adulthood (da Costa, et al., 2024; Dubois, et al., 2022). Additionally, children typically start school around six years of age, and the variety of influences on their intakes widen. Therefore, focussing on the pre-school age group is where parents are likely to have greatest influence. Parents often use specific techniques to regulate their child's food consumption known as 'parental feeding practices' (Blissett, 2011), which have been widely studied to understand their influence on children's diets and eating behaviours (Blissett, 2011; Jarman et al., 2022; Vaughn et al., 2016). Previous research highlights the importance of parental feeding practices and their influence on children's F&V consumption (Blissett, 2011; Yee et al., 2017). Taylor et al. (2017) found that parental feeding practices explain 19.7% of the variance in children's F&V consumption. Specifically, structure-based feeding practices were most related to children's F&V consumption, explaining 15.5% of the variance, while

controlling feeding practices explained 3% of the variance (Taylor et al., 2017). However, the literature surrounding feeding practices has largely been limited by inconsistencies in terminology and definitions of the individual feeding practices, leading to confusion (Vaughn et al., 2016).

Vaughn et al. (2016) developed a content map with the fundamental constructs in feeding practices covered in the existing literature, providing clear definitions for each construct to support the field to become clearer and more consistent. This content map outlines three overarching constructs: coercive control, structure, and autonomy support, which all contain multiple sub-constructs. 'Coercive control' relates to parents applying external pressure for their child to behave according to their desires; and is made up of four subconstructs: restriction, pressure to eat, threats and bribes, and using food to control negative emotion. 'Structure' relates to how the parent organises the child's food environment, sets rules and boundaries, and supports their child to learn and maintain desired eating behaviours; and is made up of nine subconstructs: rules and limits, limited/guided choices, monitoring, meal and snack routines, modelling, food availability, food accessibility, food preparation, and unstructured practices (such as neglect and indulgence). 'Autonomy support' relates to the parent encouraging independence of their child in a food-related context; and is made up of six subconstructs: encouragement, involvement, nutrition education/knowledge, praise, reasoning, and negotiation. Definitions for each feeding practice can be found in the supplementary materials.

As feeding practices are associated with children's food intake (including F&V), it is important to understand how they impact F&V consumption in young children (Wood, et al., 2020). Previous reviews suggests that parental feeding practices such as modelling, promoting F&V availability, and encouragement are associated with better F&V consumption in young children (Blissett, 2011; Yee et al., 2017), whereas more controlling feeding practices such as pressure to eat are associated with poorer F&V consumption (Blissett, 2011; Wood, et al., 2020). However, more needs to be known in regard to how other feeding practices may be associated with F&V consumption.

Blissett (2011) also highlights that most of the research conducted in the field utilises a cross-sectional study design, leaving a need to integrate more longitudinal work into this field. Longitudinal designs allow generation of quality data from which it is possible to detail

causal pathways, which is important to further develop the understanding between feeding practices and children's eating behaviours. Furthermore, feeding practices naturally evolve and change over time leading to different eating behaviours in children which also feedback and alter the feeding practices used by the parents (Burnett et al., 2022; Russell & Russell, 2019; Taylor et al., 2017).

While previous reviews have explored the relationship between parental feeding practices and weight status (Shloim et al., 2015) and interventions to increase fruit and vegetable consumption (Hodder, et al., 2024), to date, there has been no systematic review examining the prospective research assessing parental feeding practices and children's F&V consumption. Given that the aim of nutrition research and promotion in young children is to benefit their nutrition and health in the long-term, not just the short-term, a systematic review examining the existing prospective research would benefit the field. Therefore, this systematic review aims to explore the existing prospective literature surrounding the associations between parental feeding practices and F&V consumption in young children aged 1-6 years.

2. Method

The Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) statement (Page et al., 2021) was used to guide the reporting of this systematic review to achieve a transparent and replicable review.

2.1 Eligibility Criteria

Studies were included if they met the following criteria: participants were children aged 1-6 years and their parent(s)/caregiver(s), the study included a parental feeding practice in line with Vaughn et al.'s (2016) content map, the intended outcome related to fruit and/or vegetable consumption (either quantity, variety, or frequency) of children aged 1-6 years, the study was conducted in a high income country, and the study utilised a prospective study design. No time guidelines/limits were included as criteria for deciding whether a study was prospective, but studies had to have a baseline and follow up measurement. Reports were excluded if: the feeding practices related to breastfeeding/milk-feeding/formula feeding, the study was not written in English, if the study was unpublished or a conference abstract, was

grey literature or if the study discussed diet quality but did not report F&V consumption specifically. For studies where the age range included children outside of 1-6 years, if the study did not report the results by age, the paper was excluded because it was not possible to determine which results were in the age range relevant for this review. Due to the small evidence base, studies that targeted multiple feeding practices (e.g., as part of an intervention) but did not assess/report the practices individually were still included in this review to maximise the coverage of the relevant literature surrounding feeding practices. This resulted in peer-reviewed reports to ensure the best available evidence has been reviewed for a clear synthesis. Definitions for key words can be seen in table 1.

Table 1. Definition of the PICOS-style terms and setting used for this review.

PICOS	Term	Definition
Population	Young Children	Any child aged between 1-6 years old.
Intervention / Exposure	Parental Feeding Practices	Behaviours or actions that can be performed by parents that relate to the way they feed their child/ren as detailed by Vaughn et al's. (2016) content map constructs.
Comparison	N/A	N/A
Outcome	Fruit and Vegetable Consumption	Fruit and Vegetable consumption could be related to any of the following: 1) The quantity of consumption over a given period. This could be measured in portions or grams. 2) The frequency of consumption of a fruit and/or vegetable over a given time. 3) The variety of fruits and vegetables the child consumed over a given period. This relates to the number of different fruit and/or vegetables consumed during the study period.
Study Design	Prospective	Prospective studies are studies designed in a way that start in the present and have follow up point at a point in the future (Song & Chung, 2010).
Setting	High-income Countries	A developed or high-income country relates to country that has a mature and sophisticated economy – measured by gross domestic product / income. The world bank outlines this to be $13,846 per capita (World Bank, 2023).

2.2 Search Strategy

The protocol for this review was registered on PROSPERO. An electronic database search was conducted on CINAHL (EBSCOhost), Embase (Ovid), Medline (Ovid), PsycINFO (ProQuest), and Web of Science (Core Collection, BIOSIS Citation Index, KCI-Korean Journal Database, MEDLINE®, Preprint Citation Index, ProQuest™ Dissertations & Theses Citation Index, SciELO Citation Index). Final searches were performed and extracted on 16th October 2023. Databases were filtered to only show reports written in English. Search strings followed a PICOS-style strategy with key terms detailed in Table 1 (see supplemental materials for full search), and no date restrictions were applied. Duplicates were removed automatically via the systematic review software Covidence, and studies were selected via a screening process involving two reviewers (LP and HP) doing both title and abstract screening and full text screening independently and then comparing results. Any differences or disagreements that could not be agreed were settled by a third reviewer (MJ). To minimise duplication, no independent searches for grey literature were done as Web of Science and Medline (Ovid) include grey literature in the search results.

2.3 Data Synthesis

A narrative synthesis approach was selected to synthesise the included data to understand the prospective associations between parental feeding practices and F&V consumption in young children. The synthesis followed the Cochrane Consumers and Communication Review Group guidance on conducting narrative synthesis to avoid biased conclusions (Popay, et al., 2006). The included results were grouped by feeding practice to make clear comparisons and answer the research question effectively. Other variables extracted were participant demographic characteristics, study design, and characteristics. To present the results, a study summary table is provided (see table 2). The data from the included studies (as agreed between all three reviewers) was extracted by the lead reviewer (LP) and 10% were double checked by a second reviewer (MJ) to minimise any risk of bias.

2.4 Critical Appraisal

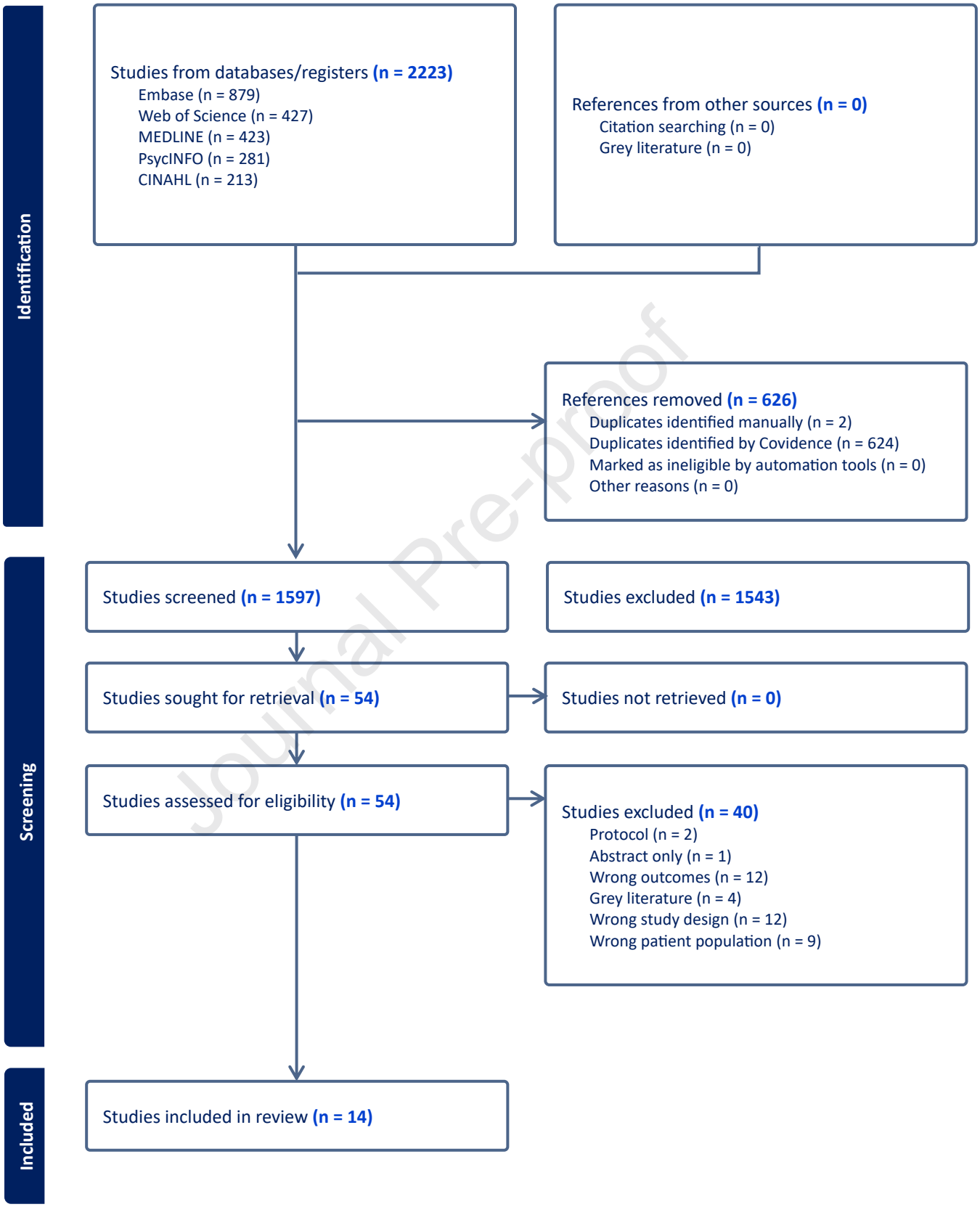
The Joanna Briggs Institute Critical Appraisal for Cohort Studies (Joanna Briggs Institute, 2023) was used to critically appraise the included studies by two reviewers (LP and HP) and any disagreements were settled by a third reviewer (MJ). The tool consisted of eleven questions that were appropriate for the included studies and assessed whether the

reviewed study had included a key piece of information, if it is unclear, or not applicable. Items assess whether: 1) the two groups were similar and recruited from the same population, 2) the exposures measured similarly to assign people to both exposed and unexposed groups, 3) the exposure was measured in a valid and reliable way, 4) confounding factors were identified, 5) strategies to deal with confounding factors were stated, 6) the participants were free of outcome at the start of the study, 7) the outcomes were measured in a valid and reliable way, 8) the follow up time was reported and sufficient to be long enough for outcomes to occur, 9) the follow up was complete, and if not, reasons to loss of follow up was described and explored, 10) strategies to address incomplete follow up were utilized, and 11) an appropriate statistical analysis was used. From this an overall appraisal was determined for the study. Item 6 was removed due to it not being possible to be 'free from' F&V consumption at baseline. An overall appraisal percentage was calculated based on the number of items recorded as 'yes' (> 70% = high quality, 50 - 70% = moderate quality, and < 50% = low quality).

3 Results

The initial search identified 2223 records, of which 626 were duplicates (which were removed by the Covidence duplication finder or by hand). This left 1597 title and abstracts to be screened, of which 54 full texts were agreed to be assessed for eligibility. Fourteen studies met the inclusion criteria and were included in this review (see figure 1 for PRISMA flow diagram). A summary of included studies can be found in supplemental materials.

160 *Figure 1. PRISMA flow diagram.*



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3.1 Study Characteristics

The included studies yielded a total of 18,137 children aged 1-6 years, with sample sizes ranging from 24 – 12,740 children. Children were relatively equally split by sex, with 9,100 (50.2%) males and 8,640 (47.6%) females, leaving 397 (2.2%) children with unknown sex from two studies (Beinert et al., 2017; Ostbye et al., 2012). All studies included at least one parent and all, but three studies reported the sex of the parent (Cravener et al., 2015; Holley et al., 2016; Owen et al., 2018). Parent samples were dominated by mothers, with 17,861 (98.5%) reported mothers and 140 (0.8%) reported fathers. Studies, on average, lasted 77 weeks and ranged from 2 – 468 weeks. Three studies were shorter studies lasting 2 – 5 weeks (Cravener et al., 2015; Holley et al., 2016; Warkentin et al., 2020), six lasted 12 – 52 weeks (De Bock et al., 2012; Edelson et al., 2016; Gregory et al., 2011; Haire-Joshu et al., 2008; Ostbye et al., 2012; Owen et al., 2018), and five lasted longer than 52 weeks (Beinert et al., 2017; Gingras et al., 2020; Oliveira et al., 2015; Weinfield et al., 2020; Wolfenden et al., 2014). Six of the included studies utilised a randomised controlled trial study design (Beinert, et al., 2017; Cravener, et al., 2015; De Bock, et al., 2011; Haire-Joshu, et al., 2008; Ostbye, et al., 2012; Wolfenden, et al., 2014), five observational designs (Edelson, et al., 2016; Gingras, et al., 2020; Gregory, et al., 2011; Oliveira, et al., 2015; Weinfield, et al., 2020), and three experiment study designs (Holley, et al., 2016; Owen, et al., 2018; Warkentin, et al., 2020).

The feeding practices covered in this review were well spread across the three main constructs of Vaughn et al. (2016) content map. The included studies measured: four subconstructs of feeding practices relating to coercive control (restriction, pressure to eat, food rewards, and non-food rewards), four subconstructs relating to structure-based feeding practices (modelling, availability, routines, and monitoring), and four subconstructs relating to autonomy support (nutrition education, involvement, reasoning, and encouragement). Of these feeding practices, modelling was most frequently assessed (in 50% of studies), followed by nutrition education (in 43% of studies), and pressure to eat (in 36% of studies). See figure 2 for breakdown of feeding practices assessed.

Most studies reported the outcomes of F&V consumption separately. Nine (64%) studies included fruit consumption as an outcome, eleven (79%) included vegetable consumption as an outcome measure, and five (36%) studies included combined F&V consumption as a

single outcome measure. The frequency of F&V consumption was the most common method of assessment by servings/portions per day (7/14 studies); three studies assessed quantity of F&V intake, two of which measured intake in grams per day, and the other measured in kcals per day; and two (14%) measured percentage increases of the proportion of children consuming more than one (Oliveira et al., 2015) or five F&V per day (Ostbye et al., 2012). The remaining two studies calculated scores to represent how well participants were meeting F&V recommendations.

3.2 Critical Appraisal

The critical appraisal scores for the selected studies are presented in the supplemental materials. Eight studies were judged to be high quality (Cravener et al., 2015; De Bock et al., 2012; Gingras et al., 2020; ; Haire-Joshu et al., 2008; Ostbye et al., 2012; Owen et al., 2018; Weinfield et al., 2020; Wolfenden et al., 2014), four were judged to be moderate quality (Edelson et al., 2016; Gregory et al., 2011; Oliveira et al., 2015; Warkentin et al., 2020;), and two were judged to be low quality (Beinert et al., 2017; Holley et al., 2016). Collective strengths included using participants recruited from the same population and separated groups to be similar in age, sex, household income, and education (14/14 studies); outcomes were measured in a valid and reliable way (14/14 studies); and an appropriate statistical analysis was utilised (14/14 studies). Collective weaknesses include that just nine (64%) studies specifically measured all the included feeding practices independently, and the other five (36%) studies did not objectively measure individual feeding practices but targeted them collectively as part of the implemented intervention. Secondly, just six (43%) studies had relatively complete data (defined as a drop out of no more than 20% of the participants). While higher dropout rates are expected in longitudinal research utilising observational designs, just three (50%) of these six specified and utilised a strategy to deal with the incomplete data.

Table 2. Study Summary Table.

Authors	**Country**	**Design**	**Duration** ***(weeks)***	**Participants (*Sample size, age range, sample characteristics*)**	**Feeding Practice / Fruit & Vegetable Intake Measures**	**Outcome**
(Beinert et al., 2017)	Norway	Randomised Control Trial	72 weeks	104 parents of children aged 4 – 6 months at baseline. 71 parents at 1st timepoint when children aged 15 months. 64 parents at 2nd timepoint when children aged 24 months. Parents were aged 25 – 39 years at baseline, 84% were educated to at least college/university level, and 98% were married/cohabiting, all but 2 sets of participants (both mothers) recruited both father and mother.	Nutrition education included in intervention but not assessed. Food Frequency Questionnaire at ages 6, 15, and 24 months assessed consumption of different fruit and vegetables per day.	Fruit consumption (times per day) steadily increased in both intervention (baseline = 1.02, 15 months = 1.66, 24 months 2.2) and control (baseline = 0.93, 15 months 1.7, 24 months = 2.69) from baseline to 24 months. However, none of these differences were significant ($p > 0.05$). Vegetable consumption (times per day) was not measured at baseline. From 15 months to 24 months, there was again a steady, but not statistically significant ($p > 0.05$), increase in the intervention group (15 months = 1.79, 24 months = 1.95), but not the control group (15

						months = 2.2, 24 months = 1.93).
(Cravener et al., 2015)	USA	Randomised Control Trial	4 weeks	24 children aged 3-5 years and their parents. 12 children were male, 12 were female. 91.7% of the sample were of white ethnicity.	Non-food rewards (stickers and games for prize at the end of study) as part of intervention. Intervention group received vegetables (Broccoli, Peppers, Carrots, Cauliflower, Snap Peas, and Celery) packaged with favourite cartoon characters of children and sticker incentives, and control group had plainly packaged vegetables with no incentives. Vegetable intake (quantity) assessed at baseline, week 2, week 3, and follow-up.	The control group overall vegetable intake was 42.9g at baseline, 28.1g at week 2, 28.9 g at week 3, and 29g at follow up. The treatment groups overall vegetable intake was 28.3g at baseline, 50g at week 2, 37.2g at week 3, and 37.1g at follow up. Children in the treatment group increased vegetable intake by over 100% between week 2 and baseline ($p < 0.01$) and follow up ($p < 0.05$), which was statistically significant. This difference, however, was not sustained into week 3 ($p > 0.05$) or follow up ($p > 0.05$).
(De Bock et al., 2011)	Germany	Cluster Randomised Trial	24 weeks	348 preschool children aged 3 - 6 years and their mothers. 53.1% of the children were male, and 21.2% of mothers were	15, 2-hour sessions, once weekly for 6-months. 5 sessions included parents and targeted modelling behaviour and nutrition education. Other sessions involved just children and	At baseline, 60% of children consumed recommended two portions (200g) of fruits per day. There was an increase from baseline to follow up of 0.22 points

				educated to a university/college level.	targeted their nutrition education and involvement in making meals. Fruit and vegetable intake measured at baseline, 6 months, and 12 months (the waiting list control arm were also measured 6 months before intervention start). Assessed frequency of fruit and vegetable portions (size of child's hand) consumed per day. Accounted for confounding variables including age, gender, SES, and immigrant background.	for fruit consumption frequency with statistical significance ($p < 0.001$). At baseline, 34.6% of children consumed recommended two portions (200g) of vegetables per day. There was an increase from baseline to follow up of 0.15 points for vegetable consumption frequency ($p < 0.05$).
(Edelson, et al., 2016)	USA	Observational	12 weeks	60 families with a child aged 17 – 31 months. 96.6% of parents were mothers, 51.6% of children were male, 66.7% of mothers were educated to college/university level, 81.6% were of Caucasian ethnicity, and 68.3% of parents had a household income of $50,000 of more.	Recorded feeding practices by observational coding and looked for practices including pressure, reasoning, food-reward, non-food reward, and modelling. 3 x 24-hour dietary recall interviews were done to assess servings of fruit and vegetable intake (quantity).	Parents most often used pressure, reasoning, and modelling. Across the three dietary recalls, for novel fruit / vegetable meal reasoning was used 7x as often, food as a reward twice as often, modelling 5x as often. Pressure to eat was weakly correlated with fruit intake ($r = 0.3$, $p <$ 0.05) at main meals, but still achieved statistical

			significance. However, was not statistically significantly related as a new food (r = -0.2, p > 0.05). Reasoning was weakly correlated with fruit consumption at main meals (r = 0.3, p < 0.05) with statistical significance, but not as a new food (r = 0.2, p > 0.05). Food as a reward was not statistically significantly related to fruit intake as a new food (r = 0.2, p > 0.05), and there was not enough data as a main meal. Modelling was weakly correlated with fruit consumption at main meals (r = 0.3, p < 0.05) with statistical significance, but not as a new food (r = -0.2, p > 0.05). Pressure to eat was moderately associated with vegetable intake as a new food (r = 0.7, p < 0.05). There was not enough data to analyse vegetable intake at main meals. Reasoning was moderately correlated

						with vegetable intake at both main meals ($r = 0.4$, $p < 0.05$) and as a new food ($r = 0.6$, $p < 0.05$), both with statistical significance. Food as a reward was moderately correlated with vegetable intake as a new food ($r = 0.4$, $p < 0.05$) with statistical significance. There was not enough data as a main meal. Modelling was moderately correlated with vegetable intake at main meals ($r = 0.4$, $p < 0.05$) with statistical significance, but not as a new food ($r = -0.2$, $p > 0.05$).
(Gingras, et al., 2020)	USA	Observational	468 weeks	1172 children and their mothers followed from birth and sent annual questionnaires. Data assessed when children are 6 months, in early childhood (mean age = 3.2 years), and in mid-childhood (mean age = 7.9 years). 1172 mothers and their d aged 6 months at	Child Feeding Questionnaire measured Restriction, and Pressure to eat as feeding practices. Measured fruit and vegetable frequency of consumption via a food frequency questionnaire. Covariates were also assessed which included: age, education, marital	Linear regression analysis indicates that neither pressure to eat (β −0.15 points; 95%CI −0.41, 0.11) or restriction (β 0.31 points; 95%CI −0.18, 0.81) were significantly associated with fruit and vegetable intake at mid-childhood follow up timepoint.

				baseline, and followed up at 3.2 years Mothers were aged between 27 and 37, 74.1% of mothers were educated to college/university level, 70.9% where of white ethnicity, 94.4% were married/cohabiting, 49.7% of children were female.	status, household income, height, and pre-pregnancy weight and BMI.	
(Gregory, et al., 2011)	Australia	Observational	52 weeks	60 mothers of children aged 1 years. 60 mothers of children of children aged 1 years, of which 32 were male. Mothers were aged between 29 and 38 years, and 75% were educated to university/college level.	Child Feeding Questionnaire measured practices including pressure to eat, Restriction, Modelling. Food Availability also measured separately. Frequency of food consumption of fruits and vegetables measured with Child Food Frequency Questionnaire.	Pressure to eat was weakly correlated with fruit consumption at year 1 ($r = 0.33$, $p < 0.01$) with statistical significance but not year 2 ($r = -0.10$, $p > 0.05$). Restriction was not statistically significant in its correlation to fruit consumption at either year 1 ($r = -0.03$, $p > 0.05$) or year 2 ($r = -0.14$, $p > 0.05$). Modelling was weakly correlated with fruit consumption at year 1 ($r = 0.39$, $p < 0.01$) and year 2 ($r = 0.27$, $p < 0.05$), both with statistical significance. Food availability was moderately correlated with fruit consumption at

			year 1 ($r = 0.42$, $p < 0.01$), and weakly associated at year 2 ($r = 0.30$, $p < 0.05$), both with statistical significance. Frequency of fruit consumption at 2 years was predicted by lower use of pressure to eat at year 1 ($\beta = -0.28$, $p < 0.05$). Pressure to eat approached statistical significance with a weak correlation with vegetable consumption at year 1 ($r = -0.23$, $p < 0.10$), but was statistically significant at year 2 ($r = -0.27$, $p < 0.05$). Restriction was not statistically significant in its correlation to vegetable consumption at either year 1 ($r = -0.16$, $p > 0.05$) or year 2 ($r = -0.04$, $p > 0.05$). Modelling was moderately correlated to vegetable consumption at year 1 ($r = 0.45$, $p < 0.01$) and year 2 ($r = 0.51$, $p < 0.01$) both with statistical significance. Food availability was

			moderately associated with statistical significance with vegetable consumption at year 1 ($r = 0.51$, $p < 0.01$) and year 2 ($r = 0.45$, $p < 0.01$). Child frequency of vegetable consumption at 2 years was significantly predicted by more frequent use of modelling ($\beta = 0.34$, $p < 0.01$), and approached significance for less frequent use of pressure to eat ($\beta = -0.21$, $p = 0.058$).

(Haire-Joshu, et al., 2008)	USA	Randomised Cohort Design	Average time between baseline and follow up was 28 weeks (range 24 – 44 weeks).	1306 parents with a child aged between 1 and 6 years, 678 of which were male. 98.5% of parents were female, 22.8% were educated to university/college level, 82.7% were of white ethnicity, 72.6% were married/cohabiting, and 29.8% had an annual household income of more than $50,000.	Intervention targeted and assessed nutrition knowledge, modelling, non- coercive practices, and fruit and vegetable availability through asking parent questions. Food Frequency Questionnaire assessed fruit and vegetable intake	Intervention improved fruit intake (mean servings = 0.14, p < 0.05) for parents, both with statistical significance. Fruit servings increased in normal weight children (mean servings = 0.25, p < 0.05) with statistical significance, but not in overweight children (mean servings -0.06, p > 0.05). There was no statistically significant intervention effect on vegetable

consumption (mean servings 0.04, $p > 0.05$). Vegetable servings increased in normal weight children (mean servings = 0.10, $p =$ 0.60) and approached statistical significance. However, this was not the case in overweight children (mean servings = -0.02, $p > 0.05$). Intervention improved combined fruit and vegetable intake (mean servings = 0.20, $p <$ 0.05) for parents, with statistical significance. The intervention improved combined fruit and vegetable intake in normal weight children (mean servings = 0.35, p < 0.05) with statistical significance, but not in overweight children (mean servings = -0.10, $p > 0.05$). Parent fruit and vegetable intake change ($\beta = 0.50$, $p <$ 0.001), fruit and vegetable availability ($\beta = 0.10$, $p < 0.01$), and fruit and vegetable knowledge ($\beta = 0.21$, $p <$

						0.001) all predicted positive changes on children's fruit and vegetable consumption.
(Holley, et al., 2016)	UK	Experimental	2 weeks	90 parents of children aged 2 - 4 years, 38 of which were male. Parents age ranged from 22 – 46 years, '–	'Four experimental groups: Condition 1 tested repeated exposure (offered daily), condition 2 tested modelling and repeated exposure, condition 3 tested rewards and repeated exposure, and condition 4 where all techniques were used. CFPQ used and assessed Pressure to eat, Environment, encouragement, and nutrition education. Calculated quantity of disliked vegetable consumption pre-and post- intervention.	No correlations between encouragement (r = 0.10), modelling (r = 0.11), pressure to eat (r = -0.02), teaching about nutrition (r = -0.10) and consumption of disliked vegetable were statistically significant (p > 0.05). Only the environment was weakly correlated with disliked vegetable consumption (r = 0.17, p = 0.06), but just approached significance.
(Oliveira, et al., 2015)	Portugal, UK, and France	Observational	192 weeks	Generation XXI, Portugal: 4227 mothers and their children aged 4 – 5 years at final follow up, 2166 of which were male. 72% of mothers were aged 25 – 35, and 31% of mothers were	Compared to 3-day food records when the children were 4-6 months, 12-15 months, 24 months, and 48- 60 months. As part of their 'irregular eating' assessment, it relates to the lack of mealtime routines and was reported from the perception of the mother.	Association between difficulties in establishing a daily routine and high fruit intake (>1 serving per day) was statistically significant at 24 months in the ALSPAC cohort (OR 0.84, 95% CI 0.72 to 0.98, p < 0.05), and at 48-60 months in the

				educated to a university / college level. . ALSPAC, UK: 7620 mothers and their children aged 4 – 5 years at final follow up, 3962 of which were male. 74% of mothers were aged 25 – 35 years, and 39% were educated to a university / college level. EDEN, France: 893 mothers and their children aged 4 - 5 years at final follow up, 472 of which were male. 76% of mothers were aged 25 – 35 years, and 60% were educated to university / college level.	Food Frequency Questionnaire measured fruit and vegetable intake.	Generation XXI (OR 0.53, 95% CI 0.41 to 0.67, p < 0.05) and ASLPAC cohorts (OR 0.77, 95% CI 0.67 to 0.88, p < 0.05). Association between difficulties in establishing a daily routine and high vegetable intake (>1 serving per day) was statistically significant at 24 months in the ALSPAC cohort (OR 0.56, 95% CI 0.48 to 0.66, p < 0.05), and at 48-60 months in the Generation XXI (OR 0.48, 95% CI 0.36 to 0.66, p < 0.05) and ASLPAC cohorts (OR 0.43, 95% CI 0.38 to 0.50, p < 0.05).
(Ostbye, et al., 2012)	USA	Randomised Control Trial	32 weeks	392 mother-child dyads. Children aged 2-5 years, . 35.8% of mothers were aged 30 – 35 years, 68.3% were educated to a university / college level, 76.8% were of	Intervention arm received 8 monthly interactive kits which included feeding practices (incentives, mealtime routines, supportive home environment, and modelling). Parental Feeding Style	No difference between intervention arm and control group in fruit and vegetable intake in children (p = 0.16) at follow up. Slight differences in fruit and vegetable intake, but non statistically

				white ethnicity, 92.1% were married/cohabiting, and 56.8% had an annual household income of $60,000 or more.	Questionnaire implemented and assessed rewards, emotional feeding, controlling practices, and encouragement. Family Meals Questionnaire also assessed TV viewing, and food availability. 24-hour dietary recalls were administered to measure fruit and vegetable intake in young children.	significant (p > 0.05). Fruit and vegetable availability slightly improved fruit and vegetable intake in the intervention group (0.13 vs 0.05, p = 0.09), approaching statistical significance. Modelling in the intervention group increased the percentage of children eating 5 or more servings of fruit and vegetable consumption by 8.4% in the intervention, compared to 0% in the control arm, p < 0.05).
(Owen, et al., 2018)	UK	Experimental	12 weeks	127 children aged 21-24 months and their parents. 48% of children were male, 83.5% were of White British ethnicity. 55% of parents were educated to university/college level, 73.2% were married, and 48.8% had an annual household	Intervention tested nutrition education and through a book of target fruit or vegetable. Repeated exposure of target vegetable was also part of intervention Child Food Frequency Questionnaire to measure fruit and vegetable intake.	Intake of target fruit found no main effects of Time (p > 0.05), Group (p > 0.05), or Group × Time interaction (p > 0.05). There were, therefore, no long-term effects of either taste exposure or visual familiarization on children's consumption of their target fruit. Group differences were seen in children's consumption of the target vegetable from baseline

		income of more than £50,000.	to follow-up. There was a main effect of Time ($p < 0.01$) and Group x Time interaction ($p < 0.05$), but not Group ($p > 0.05$). Only the Vegetable Book group showed a significant increase in intake of the target vegetable (Vegetable Book: $F(1,26) = 14.03$, $p < 0.001$; Fruit Book: $F(1,21) = 3.47$, $p > 0.05$; Control: $F(1, 28) = 0.02$, $p > 0.05$). Planned contrasts confirmed that the Vegetable Book group showed a larger increase in vegetable intake than children in the Control group ($p < 0.01$), while the difference between the Vegetable and Fruit Book groups bordered on significance ($p = 0.055$). The analysis of total fruit intake revealed a main effect of Time ($p < 0.01$), reflecting a decline in intake from baseline to follow-up ($p < 0.01$). There was no effect of Group ($p > 0.05$), or Group × Time interaction

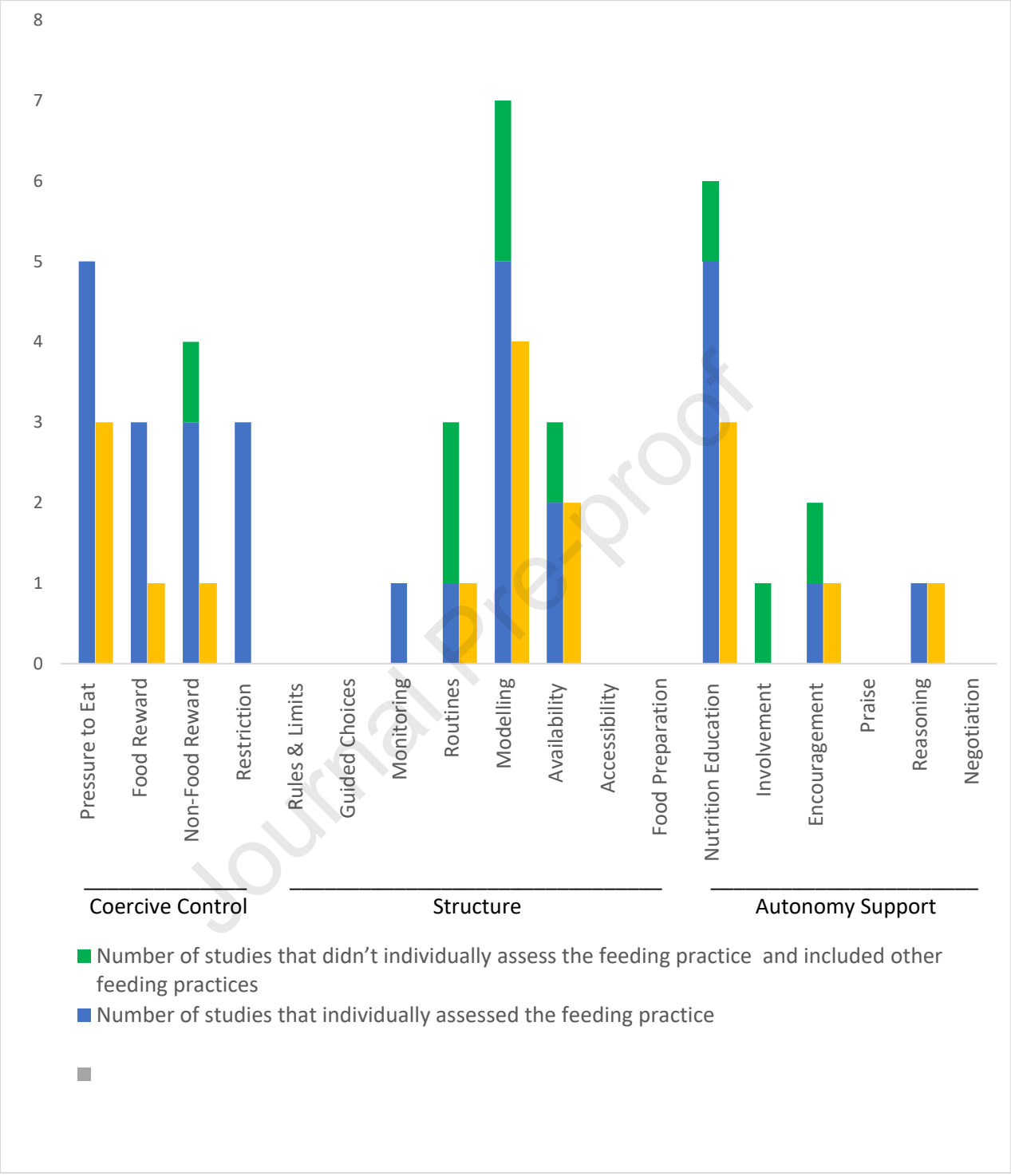
						(p > 0.05). A similar pattern was seen in the analysis of children's total vegetable intake, although the effect of Time did not reach significance, (p > 0.05). Again, there was no effect of Group (p > 0.05), or Group × Time interaction (p > 0.05).
(Warkentin, et al., 2020)	UK	Experimental	5 weeks	70 children aged 3 - 5 years and theirmothers. 52.9% of children were male. Mothers were aged 31 – 50 years, 45.9% were educated to university/college level, 77.1% were of White ethnicity, and 89.2% were married.	Feeding practices measured by Child Feeding Questionnaires including Restriction, Monitoring, and Pressure to Eat; and Parental Feeding Style Questionnaire measured prompts. Standardised lunches given and calculated mean intakes of each food group including fruits and vegetables.	Neither restriction or monitoring were significantly correlated with fruit and vegetable intake. Pressure to eat and prompts however were. Pressure to eat was weakly correlated with fruit and vegetable consumption (r = -0.25, p < 0.05), with statistical significance. Prompting to eat was also weakly correlated to fruit and vegetable consumption (r = -0.26, p < 0.05), with statistical significance. Pressure to eat scores were also associated with lower intake of fruits and vegetables (β = −3.80 kcal, crude model only (p < 0.05). Pressure

						to eat lost significance after adjusting for child age, sex, and parent age and education (β = -3.36 95% CI -7.01, 0.29). Prompting to eat however, was statistically significant in its association with fruit and vegetable consumption (β = -9.84 95% CI -18.60, -1.09) in the crude model, and after adjusting for all confounders (β = -10.93 95% CI -20.80, -1.07).
(Weinfield, et al., 2020)	USA	Observational	104 weeks	1250 children aged from birth to 24 months and their mothers. 50.7% of children were male. 50% of mothers were older than 26 years at the child's birth, 44.1% were educated to a university / college level, 34.4% were of white ethnicity, 37.5% were married, and 28.7% were above130% of the poverty level ($31,005)	Intervention (Special Supplemental Nutrition Program for Women, Infants, and Children) worked with parents to increase their nutrition education. Healthy Eating Index scores assessed by 24-hour dietary recall assessed fruit and vegetable intake.	There was a statistically significant difference in total vegetable consumption against the three duration groups (low intermediate, and high) at follow up ($p < 0.01$). Low participation resulted in a total vegetable score of 2.3, 2.4 for intermediate participation, and 2.6 for high participation. Total fruit on the other hand did not have a statistically significant difference in consumption against the

						duration groups (low, intermediate, and high) at follow up ($p > 0.05$). Low participation resulted in a total vegetable score of 4.5, 4.8 for intermediate participation, and 4.7 for high participation.
(Wolfenden, et al., 2014)	Australia	Randomised Control Trial	76 weeks	394 arents and their children aged 3 - 5 years. 48.4% of children were female. Parents were aged between 29 and 40 years, 95.9% were female, 47.2% were educated to a university/college level, and 41.4% had an annual household income of more than $100,000.	Intervention: four 30-minute contacts as well as a guidebook. Intervention aimed to increase availability of fruit and vegetables, encourage supportive family eating routines, and promote parent role modelling of fruit and vegetable. Food intake assessed by Children's Dietary Questionnaire. Reports frequency and variety of fruits and vegetables.	At the 12-mo follow-up, fruit and vegetable intake was significantly higher among children in the intervention group (β = 1.61 95% CI 0.88 to 2.33, $p < 0.001$). The effect remained significant when baseline data were substituted for missing data at follow-up (β = 1.25 95% CI 0.64 to 1.86, $p < 0.001$). To contextualize this difference, analysis of postintervention differences between groups at 12 months found that children in the intervention group consumed significantly more servings of fruit (mean SEM: 2.86, compared with 2.43; $p < 0.01$) and vegetables

				(2.95 compared with 2.47; $p < 0.01$). At the 18-mo follow-up, there were no significant differences between groups in the fruit and vegetable intake ($\beta = 0.51$ 95% CI -0.17 to 1.18, $p > 0.05$). However, there were significant postintervention differences in the mean number of child servings of fruit (2.91 compared with 2.42; $p < 0.001$) and vegetables (2.98 compared with 2.55; $p < 0.01$), favouring children in the intervention group.

Figure 2. Breakdown of feeding practices assessed in the included studies.



3.3 Outcomes

3.3.1 Coercive Control

3.3.1.1 Pressure to Eat

Two studies assessed the association between pressure to eat and subsequent fruit consumption (Edelson et al., 2016; Gregory et al., 2011), with both reporting weak but

significant positive correlations (r = 0.3 – 0.33) between pressure to eat and frequency of servings of fruit per day. While this may seem that pressure to eat has a positive effect on fruit consumption, the observational study by Edelson et al. (2016) was conducted over a short time frame (12 weeks), and was only significant for fruit consumption at main meals, but not as a new food the child had never tasted before (r = -0.2, p > 0.05). Additionally, results from the observational study by Gregory et al. (2011) highlight that by the follow up assessment (2 years), the relationship had become non-significant and showed a weak negative correlation (r = -0.10, p > 0.05). This is further supported where Gregory et al. (2011) demonstrated that fruit consumption at follow up was predicted by less use of pressure to eat at baseline (β = -0.28, p < 0.05).

Three studies assessed the association between pressure to eat and subsequent vegetable consumption (Edelson et al., 2016; Gregory et al., 2011; Holley et al., 2016), two of which demonstrated a statistically significant relationship (Edelson et al., 2016; Gregory et al., 2011). In the 12-week observational study (Edelson et al., 2016), a strong positive correlation was found between pressure to eat and vegetable consumption (r = 0.7, p < 0.05). It is important to note that this finding was observed for vegetable intake as a new food and that not enough data was collected for vegetables at main meals. Similar to fruit consumption, observations by Gregory et al. (2011) highlight a weak negative relationship between pressure to eat and vegetable consumption at follow up (r = -0.27, p < 0.05).

Two studies assessed the association between pressure to eat and combined F&V consumption (Gingras et al., 2020; Warkentin et al., 2020), with one showing a statistically significant relationship (Warkentin et al., 2020). The findings from this 5-week experimental study indicated that pressure to eat was negatively associated with combined F&V consumption (r = -0.25, p < 0.05), with the child consuming an equivalent of 3.8 calories fewer from F&V per day, which is arguably within the margin of measurement error. This association however, lost significance after being adjusted for child age, sex, parent age, and parent education (β = -3.36 95% CI - 7.01, 0.29).

3.3.1.2 Food Rewards

One study assessed the association between the use of food rewards (i.e., offering chocolate if the child eats their broccoli) and subsequent fruit consumption (Edelson et al.,

2016), but did not demonstrate statistical significance. Two studies assessed the association between food rewards and subsequent vegetable consumption (Edelson et al., 2016; Holley et al., 2016), with one association statistically significant (Edelson, et al., 2016). In the observational study, Edelson et al. (2016) reported that food rewards and daily vegetable portions had a positive moderate correlation ($r= 0.4$ $p < 0.05$). However, this was only found when measuring the amount of vegetables consumed as a new food, because not enough data was collected regarding consumption of vegetables at main meals. One study assessed the association between food rewards and combined F&V consumption (Ostbye et al., 2012) but it was not statistically significant.

3.3.1.3 Non-food Rewards

One study assessed the association between the use of non-food rewards and subsequent fruit consumption (Edelson et al., 2016), finding no association. Three studies assessed the association between non-food rewards and subsequent vegetable consumption (Cravener et al., 2015; Edelson et al., 2016; Holley et al., 2016), one finding an association. Cravener et al. (2015) conducted a randomised control trial over 4 weeks and reported that non-food rewards (stickers) increased vegetable consumption by 21.7g per day when stickers were introduced, but this level of increase was not sustained by the end of the study 2 weeks later (albeit there remained an 8.8g per day increase compared to baseline). One study assessed the association between non-food rewards and combined F&V consumption (Ostbye et al., 2012), showing no association.

3.3.1.4 Restriction

One study assessed the association between the use of restriction and each of subsequent fruit and vegetable consumption individually (Gregory et al., 2011), and two studies assessed the association between restriction and combined F&V consumption (Gingras et al., 2020; Warkentin et al., 2020), but none showed statistically significant associations.

3.3.2 Structure

3.3.2.1 Modelling

Five studies assessed the association between modelling and subsequent fruit consumption (De Bock et al., 2012; Edelson et al., 2016; Gregory et al., 2011; Haire-Joshu et al., 2008; Wolfenden et al., 2014), all of which demonstrated statistically significant positive effects. Two of these five (Edelson et al., 2016; Gregory et al., 2011) were observational studies which indicated a weak to moderate association between modelling and fruit consumption (range: $r = 0.27$ to 0.39). Findings by Edelson et al. (2016) suggest that there was only a relationship between modelling and fruit consumption at main meals but not fruit consumption as a new food ($r = -0.2$, $p > 0.05$). Two of these five were randomised trials (De Bock et al., 2012; Haire-Joshu et al., 2008), where fruit servings increased between 0.22 and 0.25 servings per day ($p < 0.05$). Haire-Joshu et al. (2008) noted that their reported statistically significant finding was only in children who were 'normal' weight, as in children who were overweight there was no difference in fruit consumption (-0.06 servings of fruit per day). Finally, Wolfenden et al. (2014) conducted a 76-week randomised control trial, where the intervention aimed to increase modelling, availability, and routines. They found no immediate post-intervention treatment effect on F&V intake, however, there was a statistically significant effect at the 12-month follow up, where the intervention group consumed 0.43 more servings per day than at baseline. This again slightly increased a further 0.07 servings per day at the 18-month follow up.

Of the six studies which assessed the association between modelling and subsequent vegetable consumption, four demonstrated a significant positive influence (De Bock et al., 2012; Edelson et al., 2016; Gregory et al., 2011; Wolfenden et al., 2014), and two found no association (Haire-Joshu et al., 2008; Holley et al., 2016). There were two observational studies (Edelson et al., 2016; Gregory et al., 2011) which demonstrated moderate positive correlations between modelling and vegetable consumption (range: $r = 0.4$ to 0.51). Findings by Edelson et al. (2016) suggest that there was only a relationship between modelling and vegetable consumption at main meals but not vegetable consumption as a new food ($r = -0.2$, $p > 0.05$). Furthermore, Gregory et al., (2011) observed that vegetable servings per day were significantly predicted by more frequent use of modelling throughout the study ($\beta = 0.34$, $p < 0.01$). Two of the studies that showed statistical significance were randomised trials (De Bock et al., 2012; Wolfenden et al., 2014). De Bock et al. (2012) reported that children consumed 0.15 more servings of vegetables per day in their intervention group, after an

intervention aiming to increase modelling, nutrition education, and involvement. Similar to fruit consumption, Wolfenden et al. (2014) reported no difference between the intervention and control groups in treatment effect on vegetable consumption. At the 12 month follow up, children in the intervention group (with the intervention targeting modelling, availability, and routines) consumed an average of 0.48 more servings of vegetables than at baseline. This increase was sustained (0.43 servings per day increase) at the 18 month follow up compared to baseline.

Two of the included studies assessed the association between modelling and combined F&V consumption (Haire-Joshu et al., 2008; Ostbye et al., 2012). Both were randomised trials and showed a statistically significant result. Haire-Joshu et al. (2008) reported that combined F&V consumption increased 0.35 servings per day in normal weight children. There was no statistically significant difference in overweight children (-0.10 servings per day, $p > 0.05$). Ostbye et al. (2012) on the other hand reports that while there was no significant difference ($p = 0.16$) in F&V intake at follow up between intervention and control group, modelling led to an 8.4% increase in the number of children consuming 5 or more fruits and vegetables per day in the intervention group.

3.3.2.2 Food Availability

Three of the included studies assessed the association between food availability and subsequent fruit consumption (Gregory et al., 2011; Haire-Joshu et al., 2008; Wolfenden et al., 2014), and all demonstrated statistical significance. Gregory et al. (2011) conducted an observational study and reported a moderate positive correlation ($r = 0.42$) between fruit availability and number of fruit servings consumed per day. This association remained statistically significant but got weaker at follow up 1 year later ($r = 0.30$). The other two studies were randomised trials that saw increases in number of fruit servings consumed per day (range = 0.25 to 0.49). Nevertheless, Haire-Joshu reported that this increase in fruit consumption was only present in children who were 'normal' weight, and not children who were overweight (change in mean servings per day = -0.06, $p > 0.05$).

Three of the included studies (Gregory et al., 2011); Haire-Joshu et al., 2008; Wolfenden et al., 2014) assessed the association between availability and subsequent vegetable consumption, two of which were statistically significant (Gregory et al., 2011; Wolfenden et

al., 2014). Gregory et al. (2011) conducted an observational study and reported a moderate correlation at baseline ($r = 0.51$, $p < 0.01$) and at follow up 1 year later ($r = 0.45$, $p < 0.01$). Wolfenden et al. (2014) however, reported no difference between intervention and control groups in treatment effect for F&V consumption, where the intervention aimed to increase availability, routines, and modelling. Vegetable consumption did increase in the intervention group by 0.48 servings per day at 12-month follow up than at baseline compared to the control arm, and a sustained increase (0.43 servings per day) at the 18-month follow up.

One study assessed the association between food availability and combined F&V consumption (Haire-Joshu et al., 2008). Haire-Joshu et al. (2008) conducted a randomised cohort design and found that the intervention increased F&V servings per day by 0.35 in children who were 'normal' weight, but not children who were overweight (serving per day change = -0.10, $p > 0.05$).

3.3.2.3 Routines

Two studies assessed mealtime routines and its association with fruit consumption (Oliveira et al., 2015; Wolfenden et al., 2014). Oliveira et al. (2015) conducted a 192-week observational study across Portugal, UK, and France. Their findings suggest there was a statistically significant association between daily routines and fruit consumption at 24 months (OR 0.84 95% CI 0.72 to 0.98) and at 48-60 months (ranges: OR 0.53 to 0.77 95% 0.41 to 0.88). Supporting this, Wolfenden et al.'s (2014) randomised control trial which aimed to increase routines, modelling, and availability suggested there was no difference between intervention and control groups. At the 12 month follow up children in the intervention group consumed 0.43 more servings of fruit than at baseline. At 18 months, this had again increased slightly to 0.49 more servings of fruit per day compared to baseline. Whilst Wolfenden et al. (2014) aimed to increase routines, modelling, and availability, they did not assess these practices to see changes across the trial.

Two studies assessed the association between routines and vegetable consumption (Oliveira et al., 2015; Wolfenden et al., 2014). Oliveira et al. (2015) reported a statistically significant association between daily routines and vegetable consumption at 24 months (OR 0.56 95% CI 0.48 to 0.66) and at 48-60 months (ranges: OR 0.43 to 0.48 95% 0.36 to 0.66). Wolfenden et al.'s (2014) findings suggest there to be no difference between intervention

and control. But at 12 months, children in the intervention group consumed 0.48 more servings of vegetables than at baseline. At 18 months, this was sustained as a 0.43 vegetable serving per day than at baseline. One randomised control trial assessed mealtime routines and its association to combined F&V consumption (Ostbye et al., 2012), which did not reach statistical significance.

3.3.2.4 Monitoring

Only one study assessed the association between monitoring and vegetable consumption but did not demonstrate a significant relationship (Warkentin et al., 2020).

3.3.3 Autonomy Support

3.3.3.1 Nutrition Education

Five studies assessed the association between nutrition education and subsequent fruit consumption (Beinert et al., 2017; De Bock et al., 2012; Haire-Joshu et al., 2008; Owen et al., 2018; Weinfield et al., 2020), but just two demonstrated statistical significance (De Bock et al., 2012; Haire-Joshu et al., 2008). Both these studies were randomised trials that aimed to increase nutrition education of the parents, or the parents and the child, (as well as other feeding practices including modelling, involvement, and availability) and found that fruit consumption increased between 0.22 and 0.25 servings per day between baseline and follow up (between 24 and 28 weeks). De bock et al. (2012) targeted nutrition education in both children and their parents, and Haire-Joshu et al. (2008) targeted the education just at the parents.

Six studies (Beinert et al., 2017; De Bock et al., 2012; Haire-Joshu et al., 2008; Holley et al., 2016; Owen et al., 2018; Weinfield et al., 2020) assessed the association between nutrition education and the subsequent vegetable consumption, with three demonstrating statistical significance (De Bock et al., 2012, Owen et al., 2018, Weinfield et al., 2020). Nutrition education was targeted at either just the child (Owen et al., 2018), just the parent (Weinfield et al., 2020), or both (De Bock et al., 2012). Across the three studies, vegetable servings consumed per day increased between 0.15 and 0.26. The findings from the observational study by Weinfield et al. (2020) highlighted a significant difference in total vegetable consumption between the three intervention duration groups (low intermediate, and high) at follow up ($p < 0.01$), where higher duration of participation resulted in greater

vegetable consumption (low participation = 2.3, intermediate participation = 2.4, high participation = 2.6). However, the studies by Beinert et al. (2017), Weinfield et al. (2020), and De Bock et al. (2012) did not assess nutrition education specifically, so it was not possible to know if the knowledge of the parent and/or child actually increased because of the intervention. Owen et al., (2018) who targeted just children's nutrition knowledge in an experimental study, found that their vegetable book intervention (a picture book with a 'farm to fork' narrative, explaining how a vegetable grows, is sold, what it looks like, and how it is prepared and served) increased target vegetable consumption by 0.26 servings per day.

One study assessed the association between nutrition education for parents and combined F&V consumption (Haire-Joshu et al., 2008). The intervention increased combined F&V intake in children by 0.35 servings per day in children who were 'normal' weight, but not in children who were overweight (-0.10, $p > 0.05$), and F&V knowledge ($\beta = 0.21$, $p < 0.001$) predicted the positive changes on children's F&V consumption through mediation analysis.

3.3.3.2 Encouragement

One study assessed the association between encouragement and subsequent fruit consumption (Owen et al., 2018), but did not reach statistical significance. Two studies (Holley et al., 2016, Owen et al., 2018) assessed the association between encouragement and subsequent vegetable consumption, with one finding an association (Owen et al., 2018). Owen et al. (2018) conducted a 12-week experimental study and found that vegetable intake increased by 0.41 servings per day post intervention (2-weeks from baseline), but then reduced to 0.27 servings per day at follow up (12-weeks after baseline). Only the vegetable book saw an increase in consumption of target vegetable. One study assessed the association between encouragement and combined F&V consumption but was not statistically significant (Ostbye et al., 2012).

3.3.3.3 Involvement

One study explored the association between involvement and subsequent fruit consumption and subsequent vegetable consumption (De Bock et al., 2012). Results indicate that fruit consumption increased 0.22 servings per day and vegetable consumption increased 0.15 servings per day from baseline because of the intervention that involved

children in meal preparation. However, it was not clear that the feeding practice of involvement increased because of the intervention.

3.3.3.4 Reasoning

One study assessed the association between the use of reasoning and subsequent fruit consumption and subsequent vegetable consumption (Edelson et al., 2016). This observational study suggested that reasoning was weakly correlated with fruit consumption at main meals ($r = 0.3$, $p < 0.05$), but not as a new food ($r = 0.2$, $p > 0.05$); and that reasoning was moderately correlated with vegetable intake at both main meals ($r = 0.4$, $p < 0.05$) and as a new food ($r = 0.6$, $p < 0.05$).

4 Discussion

The purpose of this review was to explore the prospective associations between parental feeding practices and F&V consumption in young children. The main findings from this review indicate that most feeding practices were more frequently associated with vegetable consumption than fruit consumption. Specifically, structure-based feeding practices (modelling, availability, and routines) were most frequently positively associated with young children's F&V consumption, while coercive controlling feeding practices were conflicting in the association with F&V consumption over time. For example, pressure to eat indicated a positive association with F&V consumption in the studies with shorter time to follow up, but a negative/insignificant association in the longer studies. In contrast, autonomy supportive practices were not well covered, thus their associations with F&V consumption are inconclusive. A conclusions table can be found in the supplemental materials.

4.1 Coercive Control

The findings from this systematic review support previous cross-sectional findings highlighting statistically significant associations between pressure to eat, food rewards, and non-food rewards and fruit and/or vegetable consumption (Galloway, et al., 2006; Wardle, et al., 2005; Yee, et al., 2017). However, contrary to previous cross-sectional findings (Galloway et al., 2006), the prospective data show that the use of restrictive feeding practices was not associated with fruit and/or vegetable consumption. Whilst other work demonstrates the potentially problematic effect of the use of restriction on other eating behaviour outcomes

(e.g., an exacerbation of desire to eat restricted food; Fisher & Birch, 1999), these findings suggest that restriction neither positively nor negatively influences fruit and/or vegetable consumption in the longer term.

Findings regarding the relationships between pressure to eat and fruit and/or vegetable consumption were mixed. Pressure to eat was associated with both increased and decreased F&V consumption, with typically stronger associations between pressure to eat and vegetable rather than fruit consumption. The differences in the direction of the relationships appear to be based on the length of study. Shorter studies (lasting < 12 weeks) generally indicated positive associations, whereas the higher quality, longer studies (lasting around a year) demonstrated negative associations with vegetable consumption. Therefore, parents who apply more pressure to their children to eat fruit and/or vegetable may have a positive influence in the shorter-term, but over time may lead to less consumption. This evidence helps explain parents continued use of pressuring practices: their initial use of the feeding practice, often in response to children's fussy eating, is reinforced by the child's immediate consumption of the desired food, but over time, the strategy loses its effectiveness and is actually associated with greater increases in fussy eating (Jansen, et al., 2017).

The relationships between F&V consumption and the use of rewards, either food or non-food, were mixed. Both appear to be positively associated with only vegetable consumption, but not fruit consumption. Out of the three studies which assessed the relationship between food rewards and F&V consumption, food rewards were positively associated with vegetable consumption in just one 12-week long study. No longer-term study assessed the influence of food rewards on vegetable consumption. Like pressure to eat, it is hypothesised that using food rewards can create a negative relationship with food for the child such that the food used as a reward becomes more attractive and the food that must be eaten to obtain the reward becomes less accepted. However, this literature is typically focused on overconsumption or discretionary food intake rather than F&V consumption (Bante, et al., 2008; Nansel, et al., 2016). There is insufficient data which examines these relationships longitudinally to determine any specific positive or negative effects on F&V consumption.

Of the four studies that assessed the relationship between non-food rewards and F&V consumption, one reported a positive association. While this study was rated high quality, the positive effect of non-food rewards was only present during the week the reward was

given. After this, the children's vegetable consumption returned to a similar rate as reported at baseline, indicating the positive influence may not be sustained over time. While using non-food rewards is hypothesised to be a positive alternative to using food-rewards (Morrill, et al., 2016), there is limited evidence that examines the sustained effects of non-food rewards on F&V consumption.

4.2 Structure

The findings from this review support previous findings that structure-related feeding practices (modelling and availability) are most strongly associated with fruit and/or vegetable consumption (Blanchette & Brug, 2005; Blissett, 2011; Yee, et al., 2017). Contrary to previous cross-sectional findings (Monroe-Lord, et al., 2022), the data from the included studies suggest that monitoring was not associated with either fruit or vegetable consumption. Whilst other work demonstrates that monitoring can lead to increased F&V consumption in the short-term (McGowan, et al., 2012), findings from this review suggest that monitoring was not associated with either fruit and/or vegetable in the longer term. This could be due to monitoring and children's dietary behaviour having a curvilinear relationship; where monitoring can have positive effects to a certain point, but too much monitoring can lead to negative effects (Mellin, et al., 2002; Vaughn et al., 2016).

Findings concerning the prospective relationships between modelling and F&V consumption were positive in this review. Modelling was the most frequently studied feeding practice and was also the most frequently associated with fruit and/or vegetable consumption, with 6 of the 7 studies reporting significant associations (the one study that did not find a significant association was rated low quality). Typically, modelling was slightly more strongly related with vegetable consumption than fruit consumption, supporting previous research (Mazza, et al., 2022; McIver et al., 2021). A high-quality study suggests that increased vegetable consumption at the 1-year follow up was predicted by more frequent use of modelling by parents at baseline. Modelling being more strongly related to vegetable consumption than fruit consumption may be expected as parents are likely to more frequently model vegetable consumption because vegetables are more likely to be present in main meals (which are often eaten with parents); whereas young children often consume fruits as snacks (independent from their parents), so there may be less opportunity for parental modelling of fruit consumption (Draxten, et al., 2014; Litterbach, et al., 2017).

Like modelling, availability had strong positive associations with later fruit and/or vegetable consumption, with all three studies reporting positive relationships. Availability had the strongest associations with F&V consumption found in this review, supporting previous findings (Blanchette & Brugg, 2005). With modelling and availability being most consistently positively associated with F&V consumption, it is important for future longitudinal research to have an emphasis on these feeding practices when looking to increase F&V consumption in young children. However, the included studies used self-report assessments of availability, where it would be expected that parents who self-report high availability, also self-report high intake of F&V. Therefore, other availability assessment methods, such as stock inventories, which give an objective quantitative assessment of the availability of specific foods in the household, may be a more robust measure for use in further studies.

Parental creation of regular routines for their children's eating was positively associated with fruit and/or vegetable consumption in 2 of the 3 studies, supporting previous cross-sectional findings (Wyse, et al., 2011). However, the one study that did not find a statistically significant association was the only study rated high quality, and the two which reported significant associations were deemed moderate quality. From these two studies, one classified 'high' F&V consumption as more than one serving per day (when the recommendation is five per day); and the other also included increasing availability and modelling as part of an intervention but did not independently measure the target feeding practices. Therefore, it was not possible to know whether parental use of routines had an influence on the children's F&V consumption, or if it was a result from improvements in modelling and/or availability (which are strong predictors of F&V consumption). Further investigation of the impact of parental routines is warranted in future research.

Given the strength and consistency of evidence from this review and previous cross-sectional studies, future interventions should incorporate structure-based feeding practices (particularly modelling) to maximise the chance of increasing F&V consumption in young children.

4.3 Autonomy Support

The findings from this review further highlight that autonomy supportive feeding practices, nutrition education aside, have not been well assessed in their associations with

fruit and/or vegetable consumption (Vaughn, et al., 2016). Only nutrition education had more than two studies exploring the associations with fruit and/or vegetable consumption. From the limited evidence base, nutrition education, child involvement, encouragement, and reasoning were all positively associated with fruit and/or vegetable consumption, supporting previous cross-sectional findings (Inhulsen, et al., 2017; McGowan et al, 2012; Shim, et al., 2016).

Findings regarding the relationship between nutrition education and fruit and/or vegetable consumption were mostly positive. Out of the six studies that assessed the relationship between nutrition education and F&V consumption, just two found no association (both of which were rated low quality). The other four stronger studies, all reported a significant association with vegetable consumption and two found no association with fruit consumption. A potential explanation for this could be that children's preference for fruit is greater than that of vegetables (Johnson, 2016), so acceptance of fruit into the diet is driven by liking. In contrast, providing children with knowledge about the nutrition of vegetables may encourage some children to eat more vegetables. However, previous research suggests that education-based interventions are not effective on their own in creating sustained behaviour change despite knowledge being important (Arlinghaus & Johnston, 2017). Therefore, combining nutrition education with other feeding practices may be most useful in creating sustained increases in F&V consumption in young children.

The relationships between reasoning and child involvement and F&V consumption appear to be positive from the limited available evidence. Just one study explored the associations between involvement and F&V consumption, and one explored the associations between reasoning and F&V consumption, with both studies indicating positive associations, supporting previous cross-sectional findings (Mazza, et al., 2022; Zeinstra, et al., 2010). The one study that explored involvement was rated moderate quality and included modelling and nutrition education for both parents and children in their intervention. These feeding practices were not individually assessed, so again it was not possible to know which feeding practice was responsible for the increase in consumption. Regarding use of reasoning, a moderate association was found between vegetable consumption at both main meals and for vegetables new to the child. This suggests reasoning may be more strongly related to

vegetable consumption than fruit consumption in young children, but more research is needed.

The relationship between parental use of encouragement and F&V consumption was mixed. Of the two studies which assessed this relationship, only one found a significant association with fruit and/or vegetable consumption in line with previous cross-sectional findings (Inhulsen, et al., 2017; McGowan et al, 2012; Shim, et al., 2016). While Vaughn et al. (2016) provides a definition of encouragement as 'ways in which parents try to inspire their children to adopt healthy eating habits', there is still a lot of difficulty with understanding this construct. For example, understanding where the line is drawn between encouragement and pressure to eat is complex as these constructs are similar in nature. Assertive and intrusive prompts may relate more closely to pressure to eat, but encouragement is intended to be more gentle prompts and suggestions. However, there is uncertainty when encouragement in this way is done repeatedly if this then turns to pressure with its potentially negative long-term outcomes. Indeed, it may be the emotional tone of the communication, or the child's interpretation of it, rather than the frequency, which determines the borderline between pressure and encouragement.

4.4 Limitations

The critical appraisal of the included studies highlighted several limitations of the available evidence for this review. Firstly, three of the included studies incorporated more than one feeding practice in their intervention but did not assess the feeding practices individually to determine if they increased or decreased throughout the intervention. Similarly, two of the included studies assessed nutrition education as part of their intervention but did not assess if knowledge increased. This meant that it was not possible to know which practices may have been responsible or even if the practice was responsible for any reported increase in fruit and/or vegetable consumption. Secondly, less than half of the included studies had relatively complete data (classified as less than a 20% drop out rate in accordance with JBI definition). While higher drop-out rates are to be expected with longitudinal research, just half of the studies with incomplete data utilised a strategy to deal with the incomplete data. This means that three of the studies could be at an increased risk of bias as more engaged families will have completed the study / intervention, and therefore may have been more likely to have a more positive outcome. Thirdly, there were many

inconsistencies in dietary assessment and reporting of F&V consumption, making it difficult to draw conclusions from the limited evidence surrounding feeding practices and F&V consumption. Lastly, only 0.8% of the participants across the included studies were the fathers of the children. Understanding other caregiver feeding practices is important to identify differences between caregivers and how this can influence F&V consumption.

This review also has some limitations. Firstly, as part of the inclusion criteria, the included studies had to be written in English. This meant relevant studies may have been excluded that could have provided further evidence in the associations between certain feeding practices and fruit and/or vegetable consumption. Secondly, as heterogeneity of design and outcome measures precluded meta-analysis and meta-regression, it was difficult to quantify the strength or importance of the relationships between feeding practices and fruit and/or vegetable consumption in young children. Thirdly, the findings for each feeding practice in this review is based on a small number of studies, one to three in most instances, and three of the included studies were shorter than six weeks. This makes it difficult to draw robust conclusions from such a small evidence base. Lastly, this review only considered feeding practices, when there are many other factors at play that can influence children's F&V consumption. Previous research suggests that feeding practices account for approximately 20% of the variance in F&V consumption in young children (Taylor, et al., 2017), demonstrating that other factors explain the remaining variance, such as the child and parent characteristics, the child's eating behaviours, parent's own food consumption, and wider determinants at the household level and within the wider environment (Jarman, et al., 2022).

4.5 Implications and Future Recommendations

The findings in the review highlight how different feeding practices may influence longer term fruit and/or vegetable consumption in the limited studies available. This can be applied to guiding future intervention design, to identify which feeding practices would be best to positively influence fruit and/or vegetable consumption. Taken as a whole, the current evidence suggests that future interventions should largely target structure-based feeding practices, specifically modelling and availability, as these are most frequently associated with positive influences on F&V consumption; and educate parents on the potential negative consequences of feeding practices such as pressure to eat. This review also highlights the

need to integrate more longitudinal work in the field. While it is useful to understand which feeding practices can increase fruit and/or vegetable consumption quickly, it is important to know what the effects of these practices are over time. For example, whilst pressure to eat seems to positively influence F&V consumption in the short-term, it can lead to negative influences in the long-term. Longitudinal designs, with adequate measurement of both feeding practices and F&V intake at baseline and follow-up, will also allow demonstration of causal pathways between feeding practices and dietary outcomes. Future work should be conducted exploring these long-term associations as well as examining the other feeding practices which have not been assessed longitudinally so far.

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6 CRediT Authorship Contribution Statement

Luke Pullar: Conceptualisation, Methodology, Formal Analysis, Investigation, Resources, Data Curation, Writing – Original Draft, Visualization, Project Administration. **Megan Jarman**: Validation, Writing – Review & Editing, Supervision. **Alison Spence**: Conceptualisation, Writing – Review & Editing, Supervision. **Hannah Povall**: Validation, Investigation. **Alissa Burnett**: Conceptualisation, Supervision. **Jacqueline Blissett**: Conceptualisation, Writing – Review & Editing, Supervision.

7 Ethical Statement

This review utilized secondary data published in peer-reviewed journal articles so did not require ethical approval. The protocol for this review was registered on PROSPERO (registration number = CRD42023470042).

8 Data Availability

Data can be made available on request.

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Ethical Statement

This review utilized secondary data published in peer-reviewed journal articles so did not require ethical approval. The protocol for this review was registered on PROSPERO (registration number = CRD42023470042).

Declaration of Competing Interest

None.