



The effects of age on associations between pre-school children's eating behaviour traits and diet quality

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ABSTRACT

Child eating behaviour traits are associated with several aspects of dietary intake of pre-school children, however the associations between child eating behaviour traits and overall dietary quality in pre-school children has not been examined. Additionally, it is unknown how these relationships vary by age. This study examines the associations between child eating behaviour traits and pre-school children's dietary quality and whether children's age moderates these associations. This study utilises cross-sectional online survey data collected from mothers ($n = 1367$) of pre-school aged children (2–5 years) from across Australia. The survey included a validated measure of four child eating behaviour traits and a validated measure of diet quality. Multiple linear regression assessed associations between child eating behaviour traits and dietary quality, including interactions between child eating behaviour traits and child age. The average age of the children was 3.3 years, with 50.2% reported as males. Enjoyment of food was positively associated with dietary quality (B coefficient: 2.51, $p < 0.001$). Food fussiness and satiety responsiveness were inversely associated with dietary quality (B coefficients: 2.59 and -2.25 , respectively, $p < 0.001$), while food responsiveness was not related to diet quality. Child age moderated associations between food fussiness and dietary quality (B coefficient: 0.38, $p = 0.025$). The difference in dietary quality between lower and higher food fussiness is most pronounced among 5-year-old children. In conclusion, this study demonstrates that it is important for future interventions aiming to improve dietary quality of pre-school children to target children with lower food enjoyment, higher food fussiness or satiety responsiveness as possible ways to improve child dietary quality. Future interventions should also have a particular focus on strategies to reduce food fussiness for older preschoolers.

1. Introduction

The dietary intake (quantity and quality of nutrients consumed) of Australian children is substandard, with only 18% of children aged 2–3 years meeting the recommended intake of vegetables (Australian Bureau of Statistics, 2022c). Additionally, pre-school children consume more than one-third of their daily kilojoules from energy-dense, nutrient-poor foods (Australian Bureau of Statistics, 2014). Poor dietary intake, characterised by low vegetable intake and high discretionary food intake, can lead to overweight and obesity. This is a significant public health concern as 1 in 4 children are reported to have overweight or obesity worldwide (Australian Institute of Health Welfare, 2022; World Health Organization, 2021). Poor dietary intake, overweight and obesity

are associated with psychosocial complications such as low self-esteem and depression (Dietz, 1998). Additionally, poor dietary intake and overweight and obesity have been shown to track into adolescence and adulthood (Drozd et al., 2021; Ogden, Carroll, Kit, & Flegal, 2012), increasing the risk of chronic diseases later in life. These diseases include cardiovascular disease, cancer, and diabetes mellitus (Lytle, Seifert, Greenstein, & McGovern, 2000). Therefore, understanding the factors that influence children's dietary intake could assist in the development of overweight and obesity preventive intervention programs early in life.

The ecological model outlines many factors that influence the dietary intake and weight of children, such as demographics, environmental factors, and social structural factors (Davison & Birch, 2001). However,

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individual eating behaviour traits (i.e., individual differences in patterns of behaviours and cognitions related to food and eating) are an additional important, potentially malleable, influence on dietary intake. Children's eating behaviour traits include food fussiness, enjoyment of food, satiety responsiveness, and food responsiveness (Wardle, Guthrie, Sanderson, & Rapoport, 2001). Previous cross-sectional studies using parent-report questionnaires of child appetitive traits have shown a range of associations between children's eating behaviour traits and particular aspects of dietary intake of pre-school children (Carnell & Wardle, 2007; Holley, Haycraft, & Farrow, 2018; Kimberley M. Mallan, Nambiar, Magarey, & Daniels, 2014; Kwon, Shim, Kang, & Paik, 2017; Putri, Chandra, & Wiradnyani, 2021; Volger et al., 2017). For example, in relation to energy intake, some studies have found that satiety responsiveness was associated with lower energy intake (Kimberley M. Mallan et al., 2014; Putri et al., 2021), while another study found that food responsiveness and enjoyment of food were associated with higher energy intake (Carnell & Wardle, 2007). In contrast, another study found no evidence of an association between food fussiness and energy intake (Kwon et al., 2017). Food fussiness has been associated with suboptimal intake of vegetables (Holley et al., 2018) and singular food groups (Volger et al., 2017). However, studies examining associations between eating behaviour traits and the dietary intake of pre-school children have yet to consider dietary quality (the overall dietary quality using key food groups together in a composite score) (Carnell & Wardle, 2007; Holley et al., 2018; Kimberley M. Mallan et al., 2014; Kwon et al., 2017; Putri et al., 2021; Volger et al., 2017). This is important as food groups and nutrients are not consumed in isolation (Kant, 1996) and overall dietary quality is a stronger predictor of health and disease (Aljuraiban et al., 2020; Asghari, Mirmiran, Yuzbashian, & Azizi, 2017).

Studies have found mixed associations between eating behaviour traits and child dietary intake (Carnell & Wardle, 2007; da Costa et al., 2022; Holley et al., 2018; Kwon et al., 2017; Kimberley M. Mallan et al., 2014; Putri et al., 2021; Volger et al., 2017). One reason for these mixed associations may be that these relationships differ according to child age. Eating behaviour traits develop and change with age via sociologically and biologically-based processes (French, Epstein, Jeffery, Blundell, & Wardle, 2012) and there is some evidence to suggest that eating behaviour traits change with age, although the evidence is limited to a small number of studies: Three studies focusing on slightly different age ranges (7–10 years (da Costa et al., 2022), 4–7 years (Ashcroft, Semmler, Carnell, Van Jaarsveld, & Wardle, 2008), and 2–15 years (Jansen et al., 2023)) have found that food responsiveness and enjoyment of food increase with age. These studies also found that satiety responsiveness and slowness in eating decreased with age (Ashcroft et al., 2008; da Costa et al., 2022; Jansen et al., 2023). Although, findings relating to child food fussiness and its interactions with age are inconsistent: food fussiness has been shown to increase during the first 6 years of life (Jansen et al., 2023), decrease between 4 and 11 years (Ashcroft et al., 2008), and remain stable between 7 and 10 years of age (da Costa et al., 2022). However, individual differences in trajectories of change have also been demonstrated. For example, one study found that some children's food fussiness continued to increase beyond the pre-school years, but this was not the case for all children (Herle et al., 2020). In contrast to these findings, another study found that several eating behaviour traits (food fussiness, enjoyment of food, food responsiveness, and satiety responsiveness) were stable over time (between ages 2 and 5 years (Farrow & Blissett, 2012)). While there are suggestions that eating behaviour traits might change with age, limited studies have examined the associations between age and child eating behaviour traits, particularly in younger children. Further, taken together with the evidence that eating behaviour traits affect dietary intake, changes in eating behaviour traits across childhood could affect dietary intakes in different ways. Some eating behaviour traits become more prominent influences on diet quality as children develop.

Several studies have demonstrated that children's eating behaviour

traits are associated with several aspects of dietary intake (Carnell & Wardle, 2007; Holley et al., 2018; Kimberley M. Mallan et al., 2014; Kwon et al., 2017; Putri et al., 2021; Volger et al., 2017). Additionally, both eating behaviour traits and dietary intake are related to age, with unhealthy dietary intake increasing as children age (Ashcroft et al., 2008; Australian Bureau of Statistics, 2022a; da Costa et al., 2022; Jansen et al., 2023). However, whether age acts as a moderator of associations between children's eating behaviour traits and child dietary intake has not been investigated. Gaining insight into how child eating behaviour traits and age interact to influence child dietary quality could enhance the development of intervention strategies. These strategies could focus on decreasing the prevalence of overweight and obesity among pre-school children by increasing vegetable intake and reducing the intake of energy-dense, nutrient-poor foods to align with the dietary guidelines. Therefore, the aim of this study is to examine the associations between pre-school children's eating behaviour traits and dietary quality. Secondly, this study aims to assess whether age moderates the associations between children's eating behaviour traits and dietary quality. Based on previous research, it is hypothesised that higher levels of enjoyment of food will be associated with higher dietary quality (Jalkanen et al., 2017; Kimberley M. Mallan et al., 2014; Putri et al., 2021). Conversely, higher levels of food fussiness, food responsiveness, and satiety responsiveness will be associated with lower dietary quality (Carnell & Wardle, 2007; da Costa et al., 2022; Holley et al., 2018; Jalkanen et al., 2017; Volger et al., 2017). Additionally, based on previous studies (Ashcroft et al., 2008; da Costa et al., 2022; Jansen et al., 2023), it is hypothesised that these associations will differ according to children's age.

2. Methods

The present study utilises cross-sectional survey data collected from mothers of pre-school aged children from across Australia. Eligible participants were English-speaking mothers of children aged 2–5 years living in Australia. The participants were invited via paid Facebook advertisements to complete an online survey using the platform Qualtrics (Qualtrics, 2014). If participants had more than one child in the age range, they were instructed to choose one child of their choice and answer the questions relating to that child only. The survey consisted of 124 closed-ended questions relating to their child's dietary intake (14 items), parenting styles (11 items), feeding practices (37 items), child's eating behaviour traits (20 items), social desirability bias (13 items) and demographics (9 items). The survey took approximately 10–20-min to complete. Participants were offered the option to enter a random draw for one of ten vouchers worth \$50AUD. Ethical approval was granted from the Deakin University Faculty of Health Human Ethics Advisory Group (54_2018).

2.1. Outcome measure: child dietary quality

Child dietary quality was assessed using a dietary quality index (DQI) derived from a food frequency questionnaire (FFQ). This was chosen because it is based on a short FFQ which reduces participant burden and is previously validated in this population (Australian pre-school children) (Kunaratnam, Halaki, Wen, Baur, & Flood, 2017). The full details of the DQI are described elsewhere (Kunaratnam et al., 2017). Briefly, the child's usual intakes were assessed with a 13-item FFQ (Flood et al., 2014; Kunaratnam et al., 2017). The FFQ assessed the child's usual intake over a week for some items (eating breakfast, high-fat food choices, sweets/confectionary, processed meat, salty snacks, sugar-sweetened drinks, fast food, and frequency of eating meals in front of the television) and in a day for other items (water, fruit, vegetables, milk, and fruit juice). The scoring system for the DQI was based on the Australian Dietary Guidelines (National Health and Medical Research Council, 2013) and was previously validated in the Australian population for children aged 2–5 years (Kunaratnam et al., 2017). Each item of

the FFQ was scored on a Likert scale from 0 (not meeting recommendations) to 5 (meeting recommendations). The total possible score for the DQI ranged from 0 to 65, with a higher score indicating a better overall dietary quality. Given that vegetables are a food group associated with obesity as well as other health outcomes (Vernarelli, Mitchell, Hartman, & Rolls, 2011; Yannakoulia, Ntalla, Papoutsakis, Farmaki, & Dedoussis, 2010), and as child intakes are substantially below recommendations (Australian Bureau of Statistics, 2022c), the vegetable item was examined in a sensitivity analysis to understand the associations of this food group with child eating behaviour traits and vegetable intake. It was categorised into six categories; 0 serves per day, more than 0 to less than 1 serve per day, 1 to 1.5 serves per day, more than 1.5 to less than 2 serves per day, 2 to less than 3 serves per day, and 3 or more serves per day.

2.2. Exposure measure: child eating behaviour traits

Mothers were asked to rate their child's eating behaviour traits using a shortened version (to reduce participant burden) of the Children's Eating Behaviour Questionnaire (CEBQ) (Wardle et al., 2001). Four of the eight subscales were included in the survey: food fussiness, enjoyment of food, food responsiveness and satiety responsiveness. The tool has been validated in an early childhood population (1–5 years) in Australia and showed good convergent validity (all factor-item loadings were significant ($p < 0.001$)) (Kimberley M Mallan et al., 2013) and internal reliability (0.78–0.92) (Burnett, Lamb, Spence, Lacy, & Worsley, 2021). Each subscale consists of four to six items and the responses were recorded on five-point Likert scales, ranging from 1 (never) to 5 (always). The scores of the items were averaged to obtain a continuous score for each subscale, with a higher score indicating the child exhibits that eating behaviour trait more strongly.

2.3. Moderator: child age

Mothers reported their child's date of birth, which was used to calculate their age in years.

2.4. Potential confounders

Data on several demographic characteristics were collected and included as potential confounders that are likely to be related to exposure and outcome variables based on previous literature (Carnell & Wardle, 2007; Fisher, Mitchell, Smiciklas-Wright, & Birch, 2002; Gregory, Paxton, & Brozovic, 2011; Gubbels et al., 2009; Holley et al., 2018; Kimberley M. Mallan et al., 2014; Kröller & Warschburger, 2008; Patrick, Nicklas, Hughes, & Morales, 2005; Spurrier, Magarey, Golley, Curnow, & Sawyer, 2008; Vereecken, Keukelier, & Maes, 2004; Wardle, Carnell, & Cooke, 2005). Potential confounders included maternal age, child age and sex, presence of siblings in the household (yes or no), maternal country of birth (Australia/not Australia), maternal education level (four categories – high school or less, trade/certificate, undergraduate university degree or postgraduate university degree), parenting arrangements (1- or 2-parent home), and maternal social desirability. Social desirability was measured using a shortened validated version of the original Marlowe-Crowne Social Desirability Scale (ranging 0–13, 13 indicating a high social desirability score) (Crowne & Marlowe, 1960; Reynolds, 1982).

2.5. Statistical analysis

All statistical analyses were conducted using Stata 16 ("Stata Statistical Software," 2019). Pearson correlations examined associations between each of the CEBQ sub-scales. Multiple linear regression models were fitted to examine the associations between children's eating behaviour traits and dietary quality. All assumptions for multiple linear regression models were met (Burnett et al., 2021; Lumley, Diehr,

Emerson, & Chen, 2002; Schmidt & Finan, 2018). Additionally, interaction terms were included in the models to determine the moderating effect of child age on these associations, resulting in 4 interaction models. Where a statistical significance ($p < 0.05$) was observed for the interaction effect, marginal effects and graphical post-hoc assessments were conducted to understand the interaction effects ("UCLA"). The constant values of the child's ages were 2, 3, 4, and 5. The complete case sample (participants who provided complete data for all exposure variables, the moderator, confounders and the outcome) was compared to the full sample of participants to determine if data were missing completely at random (MCAR) (Burnett et al., 2021). A complete case analysis was conducted, as it was determined that data were MCAR. A sensitivity analysis, using multinomial regression, was conducted to examine the associations between child eating behaviour traits and vegetable intake.

3. Results

Of the 2260 mothers who visited the online survey webpage, 2120 were eligible to complete the survey. Of those eligible, 1827 started the survey, and 1367 provided complete data for this study. Descriptive characteristics of the participants are presented in Table 1. Half of the children were male (50.2%) and the mean age of the children was 3.3 years ($SD = 1.0$). The mean child dietary quality score was 51.9 (out of 65, range 21–64). The average eating behaviour trait scores ranged from 2.6 (food responsiveness) to 4.0 (enjoyment of food).

To determine if the CEBQ dimensions related to each other, a Pearson correlation matrix was performed, which showed a number of significant correlations. There was a strong negative correlation between enjoyment of food and food fussiness ($r = -0.10$, $p < 0.001$), and satiety responsiveness ($r = -0.58$, $p < 0.001$) (Table 2). A moderate negative correlation was shown between food responsiveness and satiety responsiveness ($r = -0.38$, $p < 0.001$). While there was a moderate

Table 1
Characteristics of participants (n = 1367).

Variable	n (%) or mean (SD)	Range
Outcome (score out of 65)		
Dietary quality	51.9 (5.9)	21.0–64.0
Exposures – Eating behaviour traits (score out of 5)		
Food fussiness	2.8 (0.9)	1.0–5.0
Enjoyment of food	4.0 (0.8)	1.25–5.0
Food responsiveness	2.6 (0.8)	1.0–5.0
Satiety responsiveness	3.0 (0.6)	1.0–5.0
Moderators		
Child's age (years)	3.3 (1.0)	2.0–5.0
2 years	366 (26.8)	
3 years	413 (30.2)	
4 years	390 (28.5)	
5 years	198 (14.5)	
Socio-demographic characteristics/confounders		
Child's sex		
Male	681 (50.2)	
Female	686 (49.8)	
Household type		
Two-parent household	1285 (94.0)	
Single-parent household	82 (6.0)	
Siblings present in the home		
Yes	973 (71.2)	
No	394 (28.8)	
Mother's country of birth		
Born in Australia	1131 (82.7)	
Born overseas	236 (17.3)	
Mother's education level		
High school or less	149 (10.9)	
Trade/certificate	233 (17.0)	
University degree (undergraduate)	628 (45.9)	
University degree (postgraduate)	357 (26.1)	
Mother's age (years)	34.6 (4.6)	19.0–54.0
Social desirability	7.1 (2.7)	0.0–13.0

Table 2
Correlation matrix of associations between the four eating behaviour trait subscales.

	Food fussiness	Enjoyment of food	Food responsiveness	Satiety responsiveness
Food fussiness	1			
Enjoyment of food	-0.65 ^a	1		
Food responsiveness	-0.10 ^a	0.41 ^a	1	
Satiety responsiveness	0.45***	-0.58 ^a	-0.38 ^a	1

^a p < 0.001.

positive correlation between food fussiness and satiety responsiveness (r = 0.45, p < 0.001) and between food responsiveness and enjoyment of food (r = 0.41, p < 0.001).

There were significant associations between all the child eating behaviour traits with child dietary quality, except for food responsiveness (Table 3). Enjoyment of food was positively associated with dietary quality, while food fussiness and satiety responsiveness were negatively associated with dietary quality.

Sensitivity analysis similarly showed that children with higher food fussiness or satiety responsiveness had a lower consumption of vegetables, whereas children with higher enjoyment of food or food responsiveness had a higher consumption of vegetables (Table 4).

Of the four models fitted (assessing age in combination with each of the four eating behaviour traits), there were significant moderating effects for one of the models (Table 5). The association between food fussiness and dietary quality was moderated by age (B -0.38, p = 0.025). The interaction effects are presented in Fig. 1.

Fig. 1 shows that average dietary quality is higher among children with lower levels of food fussiness. However, the difference in dietary quality between lower and higher food fussiness is most pronounced among 5-year-old children (p < 0.001), as shown by the steepest gradient.

4. Discussion

This study examined associations between child eating behaviour traits and diet quality, and moderation of these associations by child age. It found significant associations between three of the four measured child eating behaviour traits and dietary quality: food fussiness and satiety responsiveness were negatively associated with dietary quality. In contrast, enjoyment of food was positively associated with dietary quality. There was no association found between food responsiveness and child dietary quality. Age moderated the association between food fussiness and dietary quality, but not between satiety responsiveness, enjoyment of food or food responsiveness and dietary quality.

Food fussiness and satiety responsiveness were associated with a lower dietary quality, as expected. Previous research examining the associations between food fussiness and satiety responsiveness and dietary intake in pre-school children has examined the associations between singular food groups or energy intake (da Costa et al., 2022; Holley et al., 2018; Jalkanen et al., 2017; Kimberley M. Mallan et al., 2014; Putri et al., 2021; Volger et al., 2017), and not overall dietary quality. However, the results from previous research are broadly in line with the findings from this study. For example, previous research has

Table 3
Associations between children’s eating behaviour traits and dietary quality from separate multiple linear regression models^a.

Child eating behaviour traits	B (95% CI)	p-value
Food fussiness	-2.59 (-2.93, -2.26)	<0.001
Enjoyment of food	2.51 (2.13, 2.89)	<0.001
Food responsiveness	0.34 (-0.07, 0.75)	0.107
Satiety responsiveness	-2.25 (-2.73, -1.77)	<0.001

^a Models adjusted for maternal age, maternal country of birth, maternal education level, child age and sex, presence of siblings in the household, parenting arrangements and social desirability.

Table 4
Multinomial regression models examining associations between satiety responsiveness, enjoyment of food and vegetable intake^a.

	Satiety responsiveness B (95% CI)	Enjoyment of food B (95% CI)	Food responsiveness	Food fussiness
Vegetable intake				
0 serves per day	Not reported	Not reported	Not reported	Not reported
More than 0 to less than 1 serve per day	Base outcome	Base outcome	Base outcome	Base outcome
1 to 1.5 serves per day	-0.72 (-0.95, -0.49)***	0.93 (0.74, 1.12)***	0.26 (0.07, 0.44)**	-1.17 (-1.36, -0.98)***
More than 1.5 to less than 2 serves per day	Not reported	Not reported	Not reported	Not reported
2 to less than 3 serves per day	-1.31 (-1.59, -1.04)***	1.25 (1.02, 1.48)***	0.25 (0.05, 0.46)*	-1.68 (-1.92, -1.45)***
3 or more serves per day	-1.51 (-1.90, -1.12)***	1.80 (1.42, 2.17)***	0.24 (-0.06, 0.54)	-2.41 (-2.79, -2.03)***

**p < 0.01.

***p < 0.001.

*p < 0.05.

^a Models adjusted for maternal age, maternal country of birth, maternal education level, child sex, presence of siblings in the household, parenting arrangements and social desirability.

found that high satiety responsiveness is associated with low energy and low vegetable intake (Jalkanen et al., 2017; Kimberley M. Mallan et al., 2014; Putri et al., 2021), which is in line with the observed lower scores on a diet quality index (because there are fewer serves of healthy foods consumed). High food fussiness has been associated with low vegetable intake and other singular food groups (Holley et al., 2018; Volger et al., 2017). Additionally, the results from the sensitivity analysis support this, as children in this study who have higher satiety responsiveness or higher food fussiness have a lower intake of vegetables. This may be because children are exhibiting higher satiety responsiveness towards all foods, including healthy foods, lowering their overall dietary quality. Another explanation might be that parents are responding to children who eat less due to high satiety responsiveness with feeding practices that focus more on quantity than diet quality. Additionally, the results from the correlation matrix show a positive correlation between satiety responsiveness and food fussiness which suggests that parents may be misinterpreting items relating to satiety responsiveness such as ‘my child gets full up easily’ to relate to food fussiness, rather than the child’s ability to recognise their own fullness cues. Future studies should consider this when selecting measures for child eating behaviour traits (Russell, Burnett, Lee, Russell, & Jansen, 2023).

Enjoyment of food was associated with a higher dietary quality. This is supported by previous research that found enjoyment of food is

Table 5

Multiple Linear regression models of the associations between the child eating behaviour traits and dietary quality, moderated by age^a.

	B (95% CI)	p-value
Model 1		
Food fussiness	-1.33 (-2.49, -0.18)	0.023
Age	1.02 (0.04, 1.99)	0.041
Food fussiness x Age	-0.38 (-0.72, -0.05)	0.025
Model 2		
Enjoyment of food	2.40 (1.13, 3.68)	<0.001
Age	-0.35 (-1.86, -1.17)	0.653
Enjoyment of food x Age	0.03 (-0.34, 0.41)	0.860
Model 3		
Food responsiveness	0.83 (-0.54, 2.20)	0.233
Age	0.18 (-0.90, 1.25)	0.746
Food responsiveness x Age	-0.15 (-0.55, 0.25)	0.459
Model 4		
Satiety responsiveness	-2.01 (-3.65, -0.37)	0.017
Age	-0.07 (-1.51, 1.38)	0.928
Satiety responsiveness x Age	-0.07 (-0.54, 0.39)	0.759

^a Models adjusted for maternal age, maternal country of birth, maternal education level, child sex, presence of siblings in the household, parenting arrangements and social desirability.

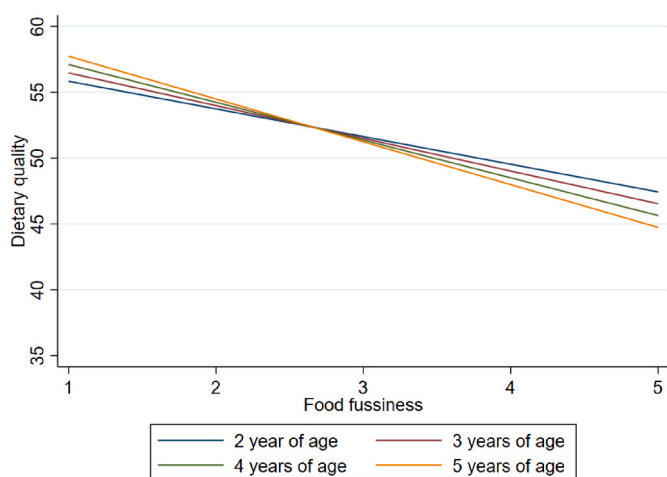


Fig. 1. Associations between food fussiness and dietary quality stratified by age.

associated with a high energy and vegetable intake (Carnell & Wardle, 2007; Jalkanen et al., 2017), which suggests that children with higher enjoyment of food are consuming more total volume of food, including of healthy foods. This was also evident from the results of the sensitivity analysis, as children with a higher enjoyment of food consumed more serves of vegetables. However, it is important to note that enjoyment of food may be affected by the food environment (Leyva et al., 2020). If children are in an environment with exposure to unhealthy foods, then they are likely to have a lower dietary quality as they tend to enjoy eating a range of foods. Additionally, it is important to note that enjoyment of food and food responsiveness were positively correlated. It has been noted that the CEBQ does not have a strong theoretical foundation (Russell et al., 2023), as many constructs are related and intertwined. Therefore, the overlap of constructs in the CEBQ may explain the lack of significant association between food responsiveness and dietary quality.

These findings indicate the importance of future interventions including child eating behaviour traits to improve child dietary intake, as previous research has suggested that child eating behaviour traits

may be modifiable (Daniels et al., 2009; Ruggiero, Hohman, Birch, Paul, & Savage, 2021). Previous interventions addressing poor dietary intake among pre-school children have primarily targeted parents and their feeding practices, with varying success (Laws, Adam, Esdaile, Love, & Campbell, 2022). If an intervention were to reduce food fussiness, for example, this may increase vegetable consumption and variety of intake, which would increase the child's overall dietary quality. Future interventions should not only consider targeting child eating behaviour traits, but also incorporate educating parents on how best to respond to different child eating behaviour traits. For example, it should be emphasised to a parent of a child with high enjoyment of food the importance of limiting discretionary foods and providing a healthy food environment to promote healthy overall dietary quality.

The current study provides novel information regarding the examination of age as a moderator of associations between pre-school children's food fussiness and dietary quality. The results suggest that older children who have higher levels of food fussiness need further support to achieve a high dietary quality, compared to younger children. This may be particularly important in this age group, as previous studies have found that food fussiness increases in the pre-school years before declining after age 4 to 6 (Ashcroft et al., 2008; Jansen et al., 2023), however some children's food fussiness will continue to increase beyond this age (Herle et al., 2020). If food fussiness does continue beyond the pre-school age years, the results suggest that the effect on dietary quality will become more prominent, therefore it is important to intervene early to prevent further declines in diet quality. This is important for future intervention programs aimed at supporting parents of pre-school children to appropriately respond to their children's challenging eating behaviour traits, especially at different ages, to optimise healthy dietary intake. Age did not moderate any other associations, future research should investigate these interactions over a larger age range, as previous research has shown that some eating behaviour traits change more in middle childhood (Ashcroft et al., 2008; da Costa et al., 2022; Jansen et al., 2023).

This study is limited in that it is cross-sectional and does not allow for investigation of temporal ordering in the associations examined. Previous research has shown that eating behaviour traits change over time (Ashcroft et al., 2008; da Costa et al., 2022; Jansen et al., 2023), therefore, future research should examine if child eating behaviour traits not only interact with age, but how eating behaviour traits change within children and affect their associations with dietary quality over time. Additionally, the findings of this study may not be generalisable to the wider population, as this study was based on a convenience sample, many of the participants came from highly educated backgrounds (72%), and the proportion of participants born outside of Australia (17.4%) was less than the general population (29%) (Australian Bureau of Statistics, 2022b). Therefore, the findings need to be confirmed in future studies. Furthermore, this study did not include a measure of children's body weight, future studies should consider including this measure to include as a confounder of the associations. Finally, as this was secondary analysis, retrospective sample size calculations are not recommended, therefore the power achieved is unknown (Gerard, Smith, & Weerakkody, 1998; Hoenig & Heisey, 2001). Strengths of this study include the large sample size, and the use of validated scales of eating behaviour traits and dietary quality (Kunaratnam et al., 2017; Wardle et al., 2001). Additionally, this is the first study to examine the associations between eating behaviour traits and overall dietary quality in pre-school children; previous studies have examined singular items or energy intake (Carnell & Wardle, 2007; Holley et al., 2018; Kimberley M. Mallan et al., 2014; Kwon et al., 2017; Putri et al., 2021; Volger et al., 2017). Finally, this study included a measure of social desirability bias as a confounder to account for mothers over or under reporting their children's eating behaviour traits and dietary intake.

5. Conclusion

This study found that pre-school children's eating behaviour traits, namely enjoyment of food, food fussiness and satiety responsiveness, are associated with overall dietary quality. Further, child age moderated the association between food fussiness and dietary quality, with fussiness having a larger, negative impact upon the diet quality of older, compared to younger children. The results show that older children who have higher levels of food fussiness may need additional support to achieve high dietary quality, compared to younger children. Future interventions aimed at preventing poor dietary quality among pre-school children should include eating behaviour traits as a focus, particularly strategies to reduce food fussiness for older preschoolers, as well as prevent food fussiness for younger preschoolers.

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Data code and availability

The data that support the findings of this study are available from the corresponding author, (A.J.B), upon reasonable request.

Ethical Statement for Solid State Ionics

Hereby, I Alissa J Burnett consciously assure that for the manuscript "Associations between pre-school children's eating behaviour traits and dietary quality and the moderation of age on these associations." the following is fulfilled:

- 1) This material is the authors' own original work, which has not been previously published elsewhere.
- 2) The paper is not currently being considered for publication elsewhere.
- 3) The paper reflects the authors' own research and analysis in a truthful and complete manner.
- 4) The paper properly credits the meaningful contributions of co-authors and co-researchers.
- 5) The results are appropriately placed in the context of prior and existing research.
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I agree with the above statements and declare that this submission follows the policies of Solid State Ionics as outlined in the Guide for Authors and in the Ethical Statement.

CRediT authorship contribution statement

Alissa J. Burnett: Writing – review & editing, Writing – original draft, Project administration, Methodology, Formal analysis, Data curation, Conceptualization. **Catherine G. Russell:** Writing – review & editing. **Claire Farrow:** Writing – review & editing. **Alison C. Spence:**

Writing – review & editing. **Anthony Worsley:** Writing – review & editing. **Kathleen E. Lacy:** Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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N/A.

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