

## Associations between dietary intakes of first-time fathers and their 20-month-old children are moderated by fathers' BMI, education and age

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### Abstract

Children's learning about food is considerable during their formative years, with parental influence being pivotal. Research has focused predominantly on maternal influences, with little known about the relationships between fathers' and children's diets. Greater understanding of this relationship is necessary for the design of appropriate interventions. The aim of this study was to investigate the associations between the diets of fathers and their children and the moderating effects of fathers' BMI, education and age on these associations. The diets of fathers and their first-born children ( $n$  317) in the Melbourne Infant Feeding Activity and Nutrition Trial (InFANT) Program were assessed using an FFQ and 3 × 24-h recalls, respectively. The InFANT Program is a cluster-randomised controlled trial in the setting of first-time parents groups in Victoria, Australia. Associations between father and child fruit, vegetable, non-core food and non-core drink intakes were assessed using linear regression. The extent to which these associations were mediated by maternal intake was tested. Moderation of associations by paternal BMI, education and age was assessed. Positive associations were found between fathers' and children's intake of fruit, sweet snacks and take-away foods. Paternal BMI, education and age moderated the relationships found for the intakes of fruit (BMI), vegetables (age), savoury snacks (BMI and education) and take-away foods (BMI and education). Our findings suggest that associations exist at a young age and are moderated by paternal BMI, education and age. This study highlights the importance of fathers in modelling healthy diets for their children.

**Key words:** Fathers: Diets: Young children: Moderation effects

The dietary intakes of children in developed nations have been shown to be low in fruit and vegetables (among other core foods) and high in nutrient-poor, energy-dense foods<sup>(1–3)</sup>. Evidence exists to suggest that this is the case even in young children<sup>(4–6)</sup>. In addition, evidence suggests that overweight and obesity in childhood and adolescence have adverse health consequences in adult life and that these health consequences present a significantly greater risk of disease and early mortality<sup>(7)</sup>. Differences in children's weight gain according to socio-economic indicators such as parental education or occupation<sup>(8,9)</sup> and parental BMI<sup>(10)</sup> have been recorded from very early in life. In addition, behavioural determinants of weight status have been noted to track throughout childhood into adulthood<sup>(11–13)</sup>, whereas dietary quality declines over this time<sup>(1,14)</sup>. Children's learning about food is substantial during early childhood through their observation and imitation of significant others<sup>(15–22)</sup>. The influence of parents on young

children's diets is considered central, although the majority of research concentrates on maternal influence or combines the data of both parents<sup>(23–25)</sup>.

For example, in Rasmussen *et al.*<sup>(24)</sup> review of the determinants of children's and adolescent's fruit and vegetable intake, only eleven of the ninety-eight papers included in their review included fathers. The review reported that fathers' education (as a proxy for socio-economic position (SEP)) was associated with children's fruit and vegetable intakes. Both mothers' and fathers' fruit and vegetable intakes were also reported to be associated with children's fruit and vegetable intakes. As these results reflect pooled parental data, they do not inform our understanding of the independent effects of mothers and fathers on children's dietary intakes. A further systematic review and meta-analysis by Wang *et al.*<sup>(26)</sup> on the similarities between the diets of parents and their children reported that only six of twenty-four papers included father-specific analyses. Of these

**Abbreviation:** SEP, socio-economic position.

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papers, only two reported correlations for food intake (the other four reported correlations for nutrients or energy), and of these two papers only one included children under the age of 5 years (up to 18 years). That study, by Beydoun & Wang<sup>(27)</sup>, reported that child fruit intake was associated with parental fruit intake for children aged 2–10 years.

When considering paternal influences on children's diets, Robinson *et al.*<sup>(28)</sup>, in their cross-sectional study, reported positive associations between the dietary intakes of fathers and children for fruit and grains of sixty-six Australian families, whereas Hall *et al.*<sup>(29)</sup>, in their Australian sample of fifty father-child dyads, reported moderate to strong positive correlations for dietary intakes of fruit ( $r$  0.40), cookie ( $r$  0.54) and potato chip ( $r$  0.33) intakes. Both of these studies were, however, in primary-school-aged children. In addition, Wake *et al.*<sup>(30)</sup>, in their analysis of nationally representative Longitudinal Study of Australian Children data, reported that it was the parenting behaviours and styles of fathers (and not mothers) that were associated with the BMI of their young children. Collectively, these studies suggest that fathers' eating and parenting behaviours have a moderate influence on their children's eating behaviours and subsequent health outcomes.

A number of determinants of children's dietary intakes have been identified previously<sup>(26)</sup>, including parental education (as a proxy for SEP), BMI and age. With respect to fathers specifically, associations between paternal education and children's diets<sup>(24)</sup> and paternal BMI and children's diets<sup>(10,31)</sup> have been reported, although not in the same age group as our study. Associations between maternal age and poor child diet quality have been reported<sup>(32)</sup>, but, to our knowledge, paternal age and child diet have not been investigated. With limited data on the diets of fathers and their young children, and established relationships between children's diets and parental age, SEP and BMI<sup>(14,31,33)</sup>, the aim of this cross-sectional study was to investigate associations between the dietary intakes of fathers and their children at 20 months of age and to determine whether these associations differed on the basis of fathers' age, education (as a proxy for SEP) or BMI.

## Methods

### Study design

The Melbourne Infant Feeding Activity and Nutrition Trial (InFANT) Program was a cluster-randomised controlled trial (RCT) undertaken within pre-existing first-time parent groups and has been described in detail elsewhere<sup>(34,35)</sup>. Briefly, sixty-two first-time parent groups were selected using a two-stage random sampling design, from fourteen local government areas (across areas of all SEP) within a 60-km radius of the research centre (Deakin University in Burwood). Random allocation to either intervention or control arms occurred for groups that consented to participate. Inclusion criteria were a minimum of eight parents in the groups consenting to participate (or six parents in low-SEP area groups), and English literacy. Main carers were offered six 2-h dietitian-delivered sessions over 15 months focusing on

parental knowledge, skills and social support around infant feeding, diet, physical activity and television viewing. Control group parents received six newsletters on non-obesity-focused themes.

Exclusion criteria for this study included non-first-time parents ( $n$  14), single-parent families ( $n$  8), father as the main carer ( $n$  1), same-sex couple ( $n$  1) and families in which fathers did not complete the baseline questionnaire ( $n$  58). The sample available at baseline consisted of 460 fathers. In all, twenty-nine families were lost to follow-up, and follow-up data were missing for 114 fathers; thus, the final sample at 20 months consisted of 317 fathers (Table 1).

The Melbourne InFANT Program was approved by the Deakin University Human Research Ethics Committee and the Victorian Government Department of Human Services, Office for Children, Research Coordinating Committee. Informed written consent was obtained from all participants.

### Measurements

Dietary data from fathers involved in the Melbourne InFANT Program were collected using the validated<sup>(36)</sup> Cancer Council Victoria FFQ, an updated version of the semi-quantitative FFQ developed specifically for the Melbourne Collaborative Cohort Study<sup>(37)</sup>. The FFQ has ten response options for ninety-eight food items ranging from 'never' to 'three or more times per d'. Fathers were asked to indicate how often they had consumed each food or beverage item over the preceding 12 months. These data were converted into daily frequencies according to the Cancer Council Victoria protocol. An additional question was included in the FFQ relating to the amount of diet and non-diet soft drinks consumed (glasses per d).

Demographic and socio-economic variables included fathers' age, marital status, country of birth, main language spoken at home, employment status and education level. Weight and height were self-reported, with BMI calculated as weight (kg)/height (m<sup>2</sup>). A dichotomous age variable was created, split at the median age of the fathers in the sample (35.2 years). Paternal education was used as a proxy for SEP and was collapsed into two groups (university education *v.* non-university education). As the focus of this study was on fathers rather than on mothers, fathers' education was used as the measure of SEP. Paternal BMI was dichotomised into healthy weight and overweight/obese<sup>(31)</sup> in order to maximise power available for between-group analyses. Each food/beverage item recorded was matched to an appropriate nutrient composition and quantity, using the 2007 AUSNUT Database<sup>(39)</sup>.

Children's dietary intakes were assessed when they were 20 months of age by trained nutritionists through a telephone-administered multi-pass 24-h recall with the primary carer (mothers in all but one case)<sup>(40,41)</sup>. Five passes were undertaken using the same methodology as undertaken in the Feeding Infants and Toddler's survey<sup>(42)</sup>. Purpose-designed booklets were provided to parents to assist in their assessment of the consumption of foods and drinks considered difficult for parents to quantify. These included examples of measures and photographs of common portion sizes adapted to age. Two or

**Table 1.** Fathers' characteristics and dietary intakes (Mean values and standard deviations; number and percentages; *n* 317)

	Mean	SD
Age (years)	35.7	4.9
BMI (kg/m <sup>2</sup> )	27.9	5.4
BMI category		
Healthy weight		
<i>n</i>	93	
%	29.3	
Overweight		
<i>n</i>	125	
%	39.4	
Obese		
<i>n</i>	70	
%	22.0	
Education level (%)		
Non-university		
<i>n</i>	177	
%	55.8	
University		
<i>n</i>	140	
%	44.1	
Country of birth (%)		
Australia		
<i>n</i>	242	
%	76.3	
Other		
<i>n</i>	66	
%	20.8	
Language spoken at home (%)		
English		
<i>n</i>	300	
%	94.6	
Other		
<i>n</i>	8	
%	2.5	
Dietary intake*		
Fruits	3.5	1.2
Vegetables	4.4	1.2
Sweet drinks (excluding juices)	0.4	0.7
Sweet drinks (juices)	0.4	0.5
Sweet snacks	1.0	0.8
Savoury snacks	0.7	0.4
Take-away food†	7.9	2.1

\* Intake was measured in g or ml per d for children and serves per d for fathers.

† Take-away foods measured in occasions for fathers.

three non-consecutive days of dietary data were collected, including one weekend day; 3 d of data were available for 97 % of the study sample. Dietary outcome variables and analyses selected for this study were based on those reported in the primary outcome paper for the InFANT study (fruit, vegetables, water, non-core drinks, non-core savoury snacks and non-core sweet snacks)<sup>(35)</sup>. The average daily intake (in g/d for children and serves per d for fathers and mothers) of fruit (excluding juice), vegetables, non-core sweet snacks (e.g. chocolate, candy, cakes), non-core savoury snacks (e.g. crisps, savoury biscuits), take-away foods and non-core sweet drinks (i.e. fruit juice, soft drinks) were calculated<sup>(35)</sup>.

### Statistical analyses

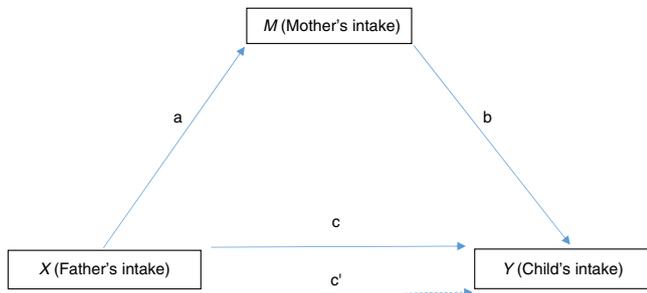
Associations between fathers' and children's fruit, vegetable, non-core snack and non-core drink intakes were assessed using linear regression analyses. All analyses were adjusted for

intervention status and the cluster-based sampling design (first-time parent groups) by using the *vce* (cluster) command in Stata (release 12; StataCorp. LP). The significance level was set at 5 %. To determine any influence of maternal intake on the associations between father and child intakes, mediation analyses (as described by MacKinnon *et al.*<sup>(43)</sup>) (Fig. 1) were conducted. Moderation by paternal age, education and BMI was assessed using regression models containing interaction terms for paternal age/education/BMI, as well as the dietary outcome variable of interest. In cases in which the coefficient of the interaction term was significantly different from zero<sup>(44)</sup>, further regression models were conducted stratified by the relevant moderator. As testing for moderation/interaction can be very sensitive to both sample size and sample distributions<sup>(45)</sup> and the purpose of moderation analysis in RCT is hypothesis generation, as well as hypothesis testing<sup>(46)</sup>, an indicative *P* value of 0.2 or below was used to indicate likely moderation and an interaction worthy of closer consideration for future studies. It should be noted that the indicative *P* value of 0.2 was not used to indicate significance, and results close to this value were still considered to be worthy of further consideration. Analyses were conducted using Stata software.

### Results

Table 1 presents the demographic characteristics of participating fathers for this study. Mean paternal age was 35.7 years and mean BMI was 27.9 kg/m<sup>2</sup>. English was the main language spoken at home, with 78.5 % of the sample born in Australia and more fathers being non-university educated (73.8 %). There were no differences in baseline characteristics between those lost to follow-up or excluded from analyses and those retained at 20 months. Mean child age was 20 (sd 2.4) months. As there were no differences in the outcomes of interest between intervention and control groups (online Supplementary Table S1), data from each group were pooled. In analyses adjusted only for intervention status and clustering (Table 2), associations were found between fathers and children's consumption of fruit (*P*=0.001), sweet snacks (*P*=0.03) and take-away foods (*P*=0.05). After additional adjustment for mothers' intake for each food category (Table 2), the associations remained for fruit (*P*=0.008) and sweet snack intakes (*P*=0.04). Mediation analyses to assess the influence of maternal intake indicated that maternal intake partially mediated the associations between father and child consumption of fruit (mediation effect 2.64 (95 % CI 0.09, 5.17); % mediated = 22.92) and vegetables (mediation effect 3.4 (95 % CI 1.17, 5.64); % mediated = 69.51) (Table 2).

Moderation analyses were conducted for paternal BMI, age and education level as a proxy for SEP (Table 3). Positive associations were observed for fruit intake of children and fathers for all categories except overweight/obese fathers. A positive association was also observed for vegetable intake of children and older fathers. Positive associations were observed for take-away food intake of fathers and young children among University-educated, overweight/obese and younger fathers. A positive association was observed between non-university-educated fathers and their young



**Fig. 1.** Mediation model. X, Predictor variable; Y, outcome variable; M, mediator variable; a, association between predictor (X) and potential mediator (M); b, association between potential mediator (M) and outcome variable (Y); c, overall association between predictor variable (X) and outcome variable (Y); c', mediator adjusted effect of predictor variable (X) on outcome variable (Y).

children for sweet snack intake, whereas an inverse association was observed between fathers with a healthy BMI and their young children for savoury snack intake.

**Discussion**

This study provides important insights into the associations between the dietary intakes of fathers and their 20-month-old toddlers and suggests that associations exist in early childhood. To our knowledge, this has not been examined before in father–child dyads for this age group. Research has demonstrated that parents influence young children’s lifestyle behaviours through their own behaviours and eating-related parenting practices<sup>(47)</sup>, and our study adds to the small number of studies that have examined the influence of fathers specifically.

Our observation of an association between fathers’ and children’s fruit intake is consistent with the results of two separate reviews by Rasmussen *et al.*<sup>(24)</sup> and Wang *et al.*<sup>(26)</sup>. The only identified study in either review that reported dietary associations between parents and very young children was that by Beydoun & Wang<sup>(27)</sup> who reported in a US sample of 1473 households that fruit intakes were correlated between parents and their 2- to 10-year-old children<sup>(27)</sup>.

Our observation of a relationship between fathers’ and children’s sweet snack intake is consistent with results from Hall *et al.*<sup>(29)</sup> in their study of overweight fathers, in which they observed moderately strong correlations between fathers’ and children’s intakes of cookies<sup>(29)</sup>. Although their findings were observed in primary-school-aged children, it is one of only a few studies that has investigated the associations between paternal and child dietary intakes. In the current study, both fruit and sweet snack associations were maintained even when controlling for maternal intake, and although mother’s intake did partially mediate the association found for fruit this only accounted for approximately 23% the observed relationship. Previous work has demonstrated associations between the dietary intakes of both mother–father and mother–child pairs<sup>(24,28,48–51)</sup>, and thus the finding of partial mediation is not surprising. This has important implications for the design and delivery of future family-based dietary interventions.

Our analysis of paternal BMI categories presented differences in the associations between the dietary intake of fathers and their 20-month-old children depending on paternal weight status. The association between fathers’ BMI and children’s weight status has been previously reported<sup>(10,31)</sup>. Brophy *et al.*<sup>(31)</sup> reported associations between father’s BMI and children’s weight status in 11- to 13-year-olds, and Freeman *et al.*<sup>(10)</sup> reported that children with an overweight or obese father (not mother) at 4 years of age were at a higher risk of becoming obese in later childhood. Our own observations indicate that shared dietary patterns in children and their fathers may cause such associations to commence at a very early age, which is of particular concern given that the majority of pre-pubertal weight gain has been reported as occurring before the age of 5 years<sup>(52)</sup>.

In addition to moderation by paternal BMI, the relationships between fathers’ and children’s intakes of savoury snacks and take-away foods were also moderated by paternal education (as a proxy for SEP). Two investigations of the relationship between SEP and young children’s diets that are relevant to our findings include those by Smithers *et al.*<sup>(33)</sup> and Cameron *et al.*<sup>(14)</sup>. Smithers *et al.*<sup>(33)</sup> reported associations between children’s non-core snack intake and lower maternal education in children aged 6 months and again at 15 months. Cameron *et al.*<sup>(14)</sup> observed greater consumption of non-core snacks in 2- to 8-year-old boys whose secondary carer (90% fathers) had a lower education level. These studies suggest that parental education (as a proxy for SEP) is associated with infant diets.

The moderation effect of paternal education on take-away food intake is of interest but not unexpected. Reports by van der Horst *et al.*<sup>(53)</sup> on the associations between higher income (a common proxy for SEP) and the consumption of fast-food and take-away foods suggest that higher income was likely to be related to demanding work conditions, which in turn influenced the consumption of take-away foods. This is supported by Devine *et al.*<sup>(54)</sup> who reported that long work hours and non-standard work hours were associated with fathers’ intake of take-away foods. Our findings support those previously reported, but are of particular interest as they have not been reported with respect to fathers of children as young as those in our cohort.

We observed moderation by paternal age for vegetable intake, which, to our knowledge, has not been investigated previously. This result has similarities to those from Giovannini *et al.*<sup>(32)</sup> who reported a link between poorer infant diets and lower maternal age. That study was based on maternal rather than paternal age, with the age of younger parents in that study <30 years. Given the known dietary associations between mothers and fathers<sup>(50)</sup>, our results suggest agreement across studies for this finding.

Our investigation was novel in its focus on fathers and young children. Study strengths included the sampling of fathers from all SEP categories reflecting national data; the large proportion of fathers who completed data collection despite their partners being the point of contact for the study; and the investigation of moderation and mediation effects on the dietary relationships observed. There were some limitations to the study that should also be noted. The cross-sectional study design does not allow causation to be inferred. Dietary data were self-reported for fathers and proxy-reported for children (by mothers) and is therefore susceptible to social desirability bias. However, as it is

**Table 2.** Associations between fathers' and children's dietary intakes after adjustment for intervention status and maternal intake including assessment of mediated effect of maternal intake ( $\beta$  Coefficients\* and 95 % confidence intervals)

Food group†	Controlling for intervention status only			Controlling for intervention status and maternal intake			Mediated effect of maternal intake		Proportion mediated (%)	
	$\beta$	95 % CI		$P$	$\beta$	95 % CI		$P$		$\beta$
Fruits	11.5	4.7, 18.2	0.001	9.7	2.6, 16.7	0.008	2.64	0.09, 5.17	22.92	
Vegetables	4.9	-0.9, 10.7	0.09	3.9	-1.2, 9.2	0.13	3.4	1.17, 5.64	69.51	
Non-core sweet drinks (excluding juices)	1.4	-2.9, 5.9	0.51	1.3	-3.2, 5.8	0.55	0.28	-0.37, 0.94		
Non-core sweet drinks (juices)	-1.9	-6.0, 2.2	0.35	-2.2	-6.4, 1.9	0.29	0.31	-0.22, 0.94		
Non-core sweet snacks	1.8	0.1, 3.4	0.03	1.8	0.03, 3.6	0.04	0.13	-0.29, 0.54		
Non-core savoury snacks	-0.1	-2.3, 2.0	0.92	0.1	-2.1, 2.4	0.90	-0.27	-0.8, 0.25		
Take-away foods‡	0.6	-0.02, 1.3	0.05	0.6	-0.04, 1.3	0.06	0.08	-0.12, 0.28		

\* Coefficient values taken from stratified regression model (no interaction term included).

† Intake was measured in g or ml per d for children and serves per d for fathers.

‡ Take-away foods measured in occasions for fathers.

**Table 3.** Fathers' and children's dietary intakes\* according to paternal BMI, education and age† ( $\beta$  Coefficients and 95 % confidence intervals)

	Fruits		Vegetables		Sweet drinks excluding juices		Sweet drinks (juices)		Sweet snacks		Savoury snacks		Take-away foods‡	
	$\beta$	95 % CI	$\beta$	95 % CI	$\beta$	95 % CI	$\beta$	95 % CI	$\beta$	95 % CI	$\beta$	95 % CI	$\beta$	95 % CI
Fathers' BMI														
Healthy weight	22.3	8.8, 35.8	6.2	-2.6, 15.1	0.2	-0.6, 1.1	-7.7	-23.4, 7.9	1.0	-2.3, 4.4	-4.6	-8.0, -1.2	-0.5	-2.1, 1.1
Overweight/obese	5.9	-2.2, 14.0	4.4	-4.0, 13.0	1.6	-3.9, 7.3	-0.4	-4.2, 3.3	2.1	-0.1, 4.3	2.2	-0.4, 4.8	1.0	0.3, 1.7
Interaction ( $P$ )	0.06		0.9		0.48		0.35		0.43		0.003		0.08	
Fathers' education														
University	13.3	2.6, 23.9	6.6	-3.2, 16.4	-1.4	-3.4, 0.4	-2.5	-8.2, 3.1	1.4	-2.0, 4.9	-1.9	-3.9, 0.01	1.2	0.3, 2.0
Non-university	9.4	0.1, 18.7	3.3	-6.0, 12.7	2.9	-2.5, 8.3	-0.3	-8.0, 7.3	1.9	0.00, 3.9	1.3	-2.2, 5.0	0.3	-0.6, 1.2
Interaction ( $P$ )	0.57		0.63		0.59		0.24		0.85		0.09		0.14	
Fathers' age														
<35.2 years	16.5	4.7, 28.3	-0.25	-9.1, 8.6	1.6	-2.2, 5.5	-3.1	-8.8, 2.5	0.8	-1.6, 3.4	0.7	-1.6, 3.1	1.1	0.03, 2.1
≥35.2 years	7.9	1.2, 14.7	9.5	1.9, 17.2	1.3	-3.9, 6.6	-0.8	-5.8, 4.0	2.3	-0.06, 4.7	-1.1	-5.1, 2.8	0.4	-0.4, 1.2
Interaction ( $P$ )	0.21		0.11		0.89		0.48		0.42		0.44		0.28	

\* Intake was measured in g or ml per d for children and serves per d for fathers.

† All variables adjusted for intervention status and clustering. Model includes term for interaction between BMI, education or age and the dietary variable of interest in order to test for moderation.

‡ Take-away foods measured in occasions for fathers.

the association between father and child data that is the focus, associations should still be apparent even in the presence of a bias towards socially desirable reporting. The FFQ used for collection of these data has been previously validated<sup>(36,55)</sup>, but it is nonetheless an inferior method of dietary assessment in comparison with the best practice 3 × 24-h dietary recalls used to assess infant's diets in this study. It is also acknowledged that the use of two different methods for parental and child dietary intakes may pose some limitations when investigating dietary associations. Finally, the study focused on first-time fathers, and the results might not be generalisable to fathers with more than one child.

### Conclusion

Our results show associations between fathers' and children's fruit, sweet snack and take-away food intakes at 20 months of age. Our results also demonstrate that paternal BMI, education and age moderate these associations. Although the associations

between mothers and children's diets are well established, these findings highlight the potentially important role that fathers' diets may have in determining child dietary intakes. Family-based interventions that evaluate the impact of specifically targeting fathers are recommended to help elucidate the role of fathers. That paternal BMI, education and age moderated these associations suggests fathers who are younger, overweight and from low-SEP backgrounds may have a stronger influence on their children's diets than their counterpart fathers. Future research on child diet could include examination of paternal, as well as maternal, factors. The use of longitudinal designs that allow determination of how dietary associations between fathers and their children may change over time are warranted.

### Supplementary material

For supplementary material/s referred to in this article, please visit <http://dx.doi.org/doi:10.1017/S0007114515002755>

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The authors' contributions were as follows: A. D. W. drafted and edited the manuscript, contributed to the interpretation of the results and had primary responsibility for the final content. A. J. C. guided the statistical analysis, contributed to the interpretation of the results and edited the manuscript. K. D. H. designed and led the Melbourne InFANT Program and edited the manuscript. D. C. contributed to the interpretation of the results and edited the manuscript. K. J. C. was the principal investigator on the Melbourne InFANT Program. She designed and led that study, conducted the dietary data collection, contributed to the interpretation of the results and edited the manuscript. All authors read and approved the final manuscript.

There are no conflicts of interest.

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