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Parental health behaviour predictors of childhood and adolescent dietary trajectories

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Abstract

Objective: To determine which parental health behaviours early in childhood most strongly predict whole-of-childhood dietary trajectories.

Design: Population-based Longitudinal Study of Australian Children (LSAC, waves 1–6; 2004–2014). Exposures were parents' fruit/vegetable consumption, alcohol, smoking and physical activity at child age 0–1 years (B Cohort) or 4–5 years (K Cohort). Outcomes, from repeated biennial short diet diaries, were group-based trajectories of (i) dietary scores and empirically derived patterns of (ii) healthful and (iii) unhealthful foods consumed, spanning ages 2–3 to 10–11 years (B Cohort) and 4–5 to 14–15 years (K Cohort). We investigated associations of baseline parental health behaviours with child dietary trajectories using multinomial logistic regression.

Setting: Australian homes.

Subjects: Of children, 4443 (87·0 %) from the B Cohort and 4620 (92·7 %) from the K Cohort were included in all trajectories. Multivariable analyses included 2719 to 2905 children and both parents.

Results: Children whose primary caregiver reported the lowest fruit/vegetable consumption had markedly higher odds of belonging to the least healthy score and pattern trajectories (K Cohort: OR = 8·7, 95 % CI 5·0, 15·1 and OR = 8·4, 95 % CI 4·8, 14·7, respectively); associations were weaker (K Cohort: OR = 2·3, 95 % CI 1·0, 5·2) for the unhealthiest pattern trajectory. Secondary caregiver fruit/vegetable associations were smaller and inconsistent. Parental alcohol, smoking and physical activity were not predictive in multivariable analyses. Results were largely replicated for the B Cohort.

Conclusions: Low primary caregiver fruit/vegetable consumption increased nearly ninefold the odds of children being in the lowest intake of healthy, but only weakly predicted unhealthy, food trajectories. Healthy and unhealthy food intake may have different determinants.

Keywords
Children
Dietary patterns
Dietary scores
Parental health behaviours
Trajectories

Poor diet is linked to a plethora of adverse health outcomes in childhood[1–3]. If easily measured parental health behaviours strongly predict children's subsequent dietary trajectories, this may lead to the development of risk prediction tools in infancy, enabling greater precision in targeting preventive intervention to families most in need.

Parental health behaviours (alcohol consumption, smoking, diet and physical activity) cluster together[4,5] and are potentially modifiable. Higher maternal alcohol consumption during pregnancy is associated with a slightly lower likelihood of 14-month-old infants following a 'health conscious' dietary pattern[6]. Maternal smoking during pregnancy or early infancy and paternal smoking during the prenatal period are predominantly associated with infants or children up to age 7 years following unhealthier diets and/or being less likely to adhere to healthier diets[6–11]. Maternal diet before pregnancy is associated with early childhood diet in 6-month- to 3-year-old children[7,12,13]. For example, maternal pre-pregnancy 'prudent' diet (comprising high consumption of fruits, vegetables, water, wholemeal bread, fish and fruit juices, and low consumption of white bread, crisps, chips, roast

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potatoes, processed meat, confectionery, cakes and biscuits) is strongly associated with children following a 'prudent' diet at 3 years of age[7]. By contrast, in cross-sectional research, maternal physical exercise is not associated with children's intake of energy-dense foods or snacking at age 4 years[14].

Unfortunately, these studies[6–14] have limitations. Their early childhood focus precludes an understanding of how parental health behaviours early in childhood may predict diet during late childhood or adolescence. Most previous studies[7–9,11–14] have considered only one parent, when it is possible that diets of each parent could contribute uniquely to prediction of children's diets. Other limitations include follow-up at a maximum of three points in time and/or measuring diet for a maximum of 5 years. It is likely that the effect of diet on health outcomes is cumulative over time[15,16], so it is important to take dietary measurements at several time points including in late childhood and/or adolescence. The Longitudinal Study of Australian Children (LSAC) overcomes these limitations. The aims of the present study were to determine which parental health behaviours early in childhood best predict children's dietary (i) score and (ii) pattern trajectories from 2–3 to 10–11 years of age, and from 4–5 to 14–15 years of age, in parallel population-representative cohorts of Australian children. We considered parents' fruit and vegetable consumption, smoking, alcohol consumption and physical activity. We hypothesised that, consistent with previous research[6–13], higher parental alcohol consumption and smoking, and lower parental fruit and vegetable consumption, would be associated with children being more likely to follow unhealthy dietary trajectories, and less likely to follow healthy dietary trajectories. We also hypothesised that, consistent with previous research[14], parental physical activity would not be associated with children's dietary trajectories.

Methods

Recruitment and sampling

The present study used data from the LSAC, collected from 2004 to 2014[17]. For the clustered sampling design[17], Australian postcodes were randomly chosen following stratification by state/territory, capital city *v.* rest of state and large *v.* small population size[17]; approximately 10 % of in-age children were then randomly chosen from each of these postcodes[17]. Sampling was from the Medicare enrolment database[17]. Medicare is Australia's universal government-funded health-care programme into which virtually all Australian children are enrolled by their first birthday. Except for some remote areas, LSAC is generally representative of the Australian population[17]. The recruited sample comprised 5107 and 4983 children from the B and K cohorts, respectively, representing 57·2 and 50·4 % uptake[17].

The Australian Institute of Family Studies Ethics Committee approved each data collection wave and families provided written informed consent. The present study drew on all six of LSAC's biennial waves from both its cohorts: the B Cohort (aged 0–1 years in 2004) and the K Cohort (aged 4–5 years at recruitment in 2004)[18]. Supplemental Fig. 1 (see online supplementary material) shows numbers and retention across the LSAC waves, and the current analytic sample.

Procedures and measures

Data collection comprised face-to-face interviews in the home with the primary caregiver (parent 1), and questionnaires completed by parent 1, parent 2 and children aged 10 years or older[19]. Parent 1 is considered the parent who best knows the study child, almost always the biological mother[20]. Retention methods included small gifts, sent yearly, between wave mail-out and online questionnaires, birthday cards and newsletters to keep contact with study families[20]. Table 1 describes exposure variables and covariates measured at baseline.

Dietary trajectory outcomes

Parents or children completed twelve to sixteen dietary questions biennially at five waves (from age 2–3 to 10–11 years) for the B Cohort and all six waves (from age 4–5 to 14–15 years) for the K Cohort (see online supplementary material, Supplemental Table 1). These questions enquired about the frequency at which the study child consumed various healthy and unhealthy food or drink items or groups of foods or drinks in the previous 24 h or yesterday. The B Cohort did not include dietary data from baseline (age 0–1 years) because a large proportion of the sample was being breast-fed or formula-fed.

There are various ways of summarising diet, including dietary patterns and scores[21]. Dietary scores, often based on previous literature, sum the number or frequency of foods eaten that are considered to be beneficial or harmful to health[21]. Alternatively, empirically derived dietary patterns provide insight into which foods are consumed together, and are not restricted by needing to align with dietary guidelines or disease[21]. Supplemental Figs 2–4 (see online supplementary material) show the six outcome variables (three per cohort), which were previously published childhood trajectories of overall dietary scores, 'healthy' dietary patterns and 'unhealthy' dietary patterns for both the B and K cohorts, separately[22]. Dietary data for the B Cohort were collected over 8 years at five waves and dietary data for the K Cohort were collected over 10 years at six waves. The methods of deriving these trajectories are described in detail in a prior publication[22] but briefly reiterated below.

We derived dietary scores (ranging from 0 to 14, with 14 being healthiest) for each child at each wave, based predominantly on the 2013 Australian Dietary Guidelines[23]. Scores summed the child's frequency of seven categories

Table 1 Measures for the parental behaviour exposures and covariates

Variable	Measure and additional information
Exposures	
P1 fruit and vegetable consumption, P2 fruit and vegetable consumption	First, we generated separate scores for P1 fruit consumption, P2 fruit consumption, P1 vegetable consumption and P2 vegetable consumption, in line with 2013 Australian Dietary Guidelines[23]. The 2013 Australian Dietary Guidelines[23] recommend 2 servings of fruit daily for men and women, between 5 and 6 servings of vegetables and legumes/beans daily for men, and between 5 and 7½ servings of vegetables and legumes/beans daily for women. Therefore, in line with these guidelines, for fruit consumption, we allocated 0 points for <1 serving/d, 1 point for 1 serving/d and 2 points for ≥2 servings/d, then multiplied the total score for fruit consumption by 2·5 to give equal weighting to fruit and vegetable consumption in our scoring system. For vegetable consumption, we allocated 0 points for <1 serving/d, 1 point for 1 serving/d, 2 points for 2 servings/d, 3 points for 3 servings/d, 4 points for 4 servings/d and 5 points for ≥5 servings/d. We then combined scores for fruit and vegetable consumption to give total scores for P1 fruit and vegetable consumption, and for P2 fruit and vegetable consumption, ranging from 0 to 10. We combined fruit and vegetable intakes in both parents to gain a more holistic picture of parent diet and reduce chance findings. Combining fruit and vegetable intakes also reflects: (i) that diet is complex, comprising intakes of foods that correlate with one another[35] and do not operate alone[21]; and (ii) dietary patterns may also predict the risk of disease better than individual foods[21]
P1 average daily alcohol consumption, P2 average daily alcohol consumption	We classified P1 and P2 average daily alcohol consumption into four categories: 'none', and '1 or 2', '3 or 4' and '≥5' for how many standard drinks each parent has on a typical day when they are consuming alcohol
P1 smoking, P2 smoking	We classified P1 and P2 smoking into five categories: 'never' and 'former' smokers, and '<5 cigarettes/d', '6–10 cigarettes/d' and '≥11 cigarettes/d' for the number of cigarettes P1 or P2 usually smokes in one day. For multinomial regression analyses, we classified P1 or P2 smoking into four categories: 'never', 'former', '≤10 cigarettes/d' and '≥11 cigarettes/d'
P1 physical activity, P2 physical activity	P1 and P2 were each asked approximately how many days per week they do moderate or vigorous physical activity (like walking briskly, riding a bike, gardening, tennis, swimming, running) for least 30 min. We classified P1 and P2 physical activity into four categories: '0', '1 to 2', '3 to 4' and '5 to 7' d/week
Covariates	
P1 age, P2 age	The age last birthday for P1 and P2 was recorded. We classified P1 and P2 ages as '<25', '25–29', '30–34' and '≥35' years for P1 in wave 1 of the B Cohort; and as '<30', '30–34', '35–39' and '≥40' years for P2 in wave 1 of the B Cohort, and for P1 and P2 in wave 1 of the K Cohort
Child Indigenous status	Parent 1 was asked whether the study child was of Aboriginal or Torres Strait Islander origin. We dichotomised Indigenous status into: 'yes' for children who were of Aboriginal and/or Torres Strait Islander origin; and 'no' for children who were neither
Child language other than English spoken at home	P1 was asked whether the study child speaks a language other than English at home. Similar to Renzaho *et al.*[36], we grouped languages into two categories: 'English only' and 'Other language'
Socio-economic position	A composite variable that averaged information on parental occupational status and educational attainment, and annual family income, described previously[37]. We separated socio-economic position into quintiles, also using sampling weights from wave 1
SEIFA neighbourhood disadvantage	This measure is based on the census-derived Australian Bureau of Statistics' Index of Relative Socio-economic Disadvantage, described previously[38]. We classified SEIFA neighbourhood disadvantage as quintiles, also using sampling weights from wave 1

P1, parent 1; P2, parent 2; SEIFA, Socio-Economic Indexes for Areas.

of foods or drinks consumed during the last 24 h: water, vegetables, fruits and milk products or alternatives (all positively coded); and sweetened drinks, fatty foods and sugary foods (negatively coded).

Dietary patterns were derived using exploratory factor analyses with all twelve to sixteen food or drink items at each wave (listed in the online supplementary material, Supplemental Table 1)[24]. Each wave in each cohort yielded comparable 'healthy' and 'unhealthy' factors or patterns. The 'healthy' pattern was characterised by frequent consumption of cooked vegetables, raw vegetables or salad and fresh fruits in all waves, and water in most waves, each with high factor loadings of 0·3 or higher, reflecting these as foods or drinks that stand out most in the 'healthy' factor[25]. In contrast, the 'unhealthy' pattern was characterised by frequent consumption of savoury snacks and sweetened drinks in all waves; hamburgers, sausages or sausage rolls, meat pies, hot dogs, hot chips and fruit juice in most waves (each with high factor loadings of 0·3 or higher); and a high negative factor loading (below −0·3) for water consumption in six out of eleven waves. We then used regression scoring to derive dietary pattern scores for the unhealthy and the healthy factors separately, for each child.

Trajectories of dietary scores, 'healthy' patterns and 'unhealthy' patterns were derived using group-based trajectory modelling with the 'traj' plug-in in the statistical software package Stata/IC version 14.1[26]. This generated trajectories showing how overall dietary scores, the study child's frequency of 'healthy' food consumption (spanning low to high) from each wave and the study child's frequency of 'unhealthy' food consumption (again spanning low to high) from each wave changed with age. Each of the three outcome variables per cohort consisted of four trajectories. To be included in the relevant trajectories, children needed dietary data from at least two waves (see

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online supplementary material, Supplemental Fig. 1). The four categories for each of the overall dietary score and 'healthy' pattern trajectories were 'always healthy', 'becoming less healthy', 'moderately healthy' and 'never healthy'. The four categories for the 'unhealthy' pattern dietary trajectories were 'never unhealthy', 'becoming unhealthy', 'moderately unhealthy' and 'always unhealthy'.

Statistical analysis

All analyses used Stata/IC version 14.2 and employed survey methods, using cross-sectional sampling weights from wave 1 of each cohort. These methods account for the multistage and clustered sampling design, and non-response[20]. We described the baseline characteristics of the total sample using percentages for categorical variables, or means and standard deviations for continuous variables. To determine whether there was an under- or over-representation of particular subgroups in our analyses, we also described the baseline characteristics of participants included in and not included in all trajectories using percentages for categorical variables, or means and standard deviations for continuous variables. We estimated associations between parental health behaviours in wave 1 and subsequent child dietary trajectories using univariable and multivariable multinomial logistic regression analyses. The exposures considered in multivariable analyses were parent 1 and 2 fruit and vegetable consumption, average daily alcohol consumption, smoking and physical activity in the same model, along with the following covariates: family socio-economic position, neighbourhood disadvantage, study child Indigenous status, study child language other than English spoken at home, parent 1 age and parent 2 age. Due to missing parent 2 data for single-parent families, we conducted sensitivity analyses including data from only the primary caregiver in the multivariable models. We also conducted sensitivity analyses which additionally included child sex as a covariate. For exposure variables with at least three categories, we derived overall *P* values for the combination of all non-reference exposure categories (compared with the reference category), for each non-reference dietary trajectory, using the Wald test.

Results

Sample characteristics

Supplemental Fig. 1 (see online supplementary material) shows the numbers of children participating at each wave of LSAC; 3537 (71·0 %) and 3764 (73·7 %) children from the B and K cohorts, respectively, remained in the study after the most recent wave of data collection (wave 6). Table 2 shows the baseline characteristics of the samples of children from the B and K cohorts for whom there were and were not outcome data (dietary trajectories), 4443 (87·0 %) and 4620 (92·7 %), respectively. Children with dietary trajectory data were similar in age to those without, and more likely to have parents who had never smoked. The proportion of boys was similar among children with and without dietary trajectory data. Of the children, 2719 to 2905 had data on all variables from both parents so were included in multivariable analyses. Sensitivity analyses included 3605 to 3668 children with full data from parent 1 only.

Associations between parental health behaviours and dietary score trajectory outcomes

In univariable analyses, the lowest levels of parental fruit and vegetable consumption and parent 1 physical activity, and the highest levels of parental alcohol consumption and parental smoking, were generally associated with children being in all three less healthy dietary score trajectories rather than the healthiest in both cohorts (see online supplementary material, Supplemental Table 2). In multivariable analyses, which included all parental health behaviours and covariates in the same model, only the lowest level of parent 1 fruit and vegetable consumption remained strongly associated with children belonging to all three less healthy dietary score trajectories (Table 3). For example, in the K Cohort, lowest *v.* highest parent 1 fruit and vegetable consumption was associated with ninefold relative odds of children following the 'never healthy' trajectory from age 4–5 to 14–15 years (OR = 8·7; 95 % CI 5·0, 15·1 in reference to 'always healthy'; Table 3). This association was in the same direction but smaller (OR = 4·4; 95 % CI 2·6, 7·5) in the B Cohort (ages 2–3 to 10–11 years; Table 3). The lowest parent 2 fruit and vegetable consumption also remained predictive of the 'becoming less healthy' and 'moderately healthy' trajectories in the B Cohort, and all three of the least healthy trajectories in the K Cohort, although less strongly than for parent 1. Sensitivity analyses, which excluded all parent 2 variables, yielded similar results (available from corresponding author on request). Sensitivity analyses that additionally included child sex yielded similar results (available from corresponding author on request).

Associations between parental health behaviours and 'healthy' pattern trajectory outcomes

When we alternatively considered trajectories of children's consumption of 'healthy' foods, we observed similar relationships to those for dietary scores in univariable analyses (see online supplementary material, Supplemental Table 3). In multivariable analyses, only the lowest parent 1 fruit and vegetable consumption remained strongly associated with children following the three trajectories with the least healthy patterns, in both cohorts (Table 4). Associations were comparable to or higher than those for the dietary score trajectory outcomes, with odds eight- to ninefold higher for children with the lowest relative to the highest level of parent 1 fruit and vegetable consumption, in both cohorts (Table 4). Additionally, the

Table 2 Baseline characteristics* of the sample, by cohort: Longitudinal Study of Australian Children (LSAC; 2004–2014)

	Total sample				Included in all trajectories				Not included in all trajectories			
	B (0–1 years)		K (4–5 years)		B (0–1 years)		K (4–5 years)		B (0–1 years)		K (4–5 years)	
Demographic variable	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*
Child age (years)		5107		4983		4443		4620		664		363
Mean	0·7		4·8		0·7		4·8		0·7		4·8	
SD	0·2		0·2		0·2		0·2		0·2		0·2	
Child sex (% male)	51·1	5107	51·2	4983	51·3	4443	51·5	4620	50·1	664	48·1	363
Indigenous status (% Indigenous)	4·9	5107	3·9	4981	4·0	4443	3·6	4618	10·7	664	7·4	363
Child language other than English spoken at home (% English only)	88·9	5008	87·6	4893	90·2	4366	88·2	4541	80·0	643	79·3	352
P1 age (years)		5106		4981		4443		4618		663		363
Mean	31·0		34·6		31·3		34·7		29·1		33·3	
SD	5·7		5·5		5·5		5·5		6·5		6·3	
P2 age (years)		4569		4237		4050		3969		520		268
Mean	33·8		37·4		34·0		37·4		32·2		36·8	
SD	6·1		6·2		6·0		6·1		6·7		7·2	
SEP (%)		5089		4963		4431		4605		658		358
Quintile 1 (highest SEP)	20·0		20·0		21·5		20·8		10·1		9·0	
Quintile 2	20·0		20·0		21·3		20·6		11·4		12·6	
Quintile 3	20·0		20·0		20·5		20·2		16·8		17·6	
Quintile 4	20·0		20·0		19·7		19·5		21·9		26·7	
Quintile 5 (lowest SEP)	20·0		20·0		17·1		18·9		39·8		34·1	
SEIFA neighbourhood disadvantage (%)		5107		4983		4443		4620		664		363
Quintile 1 (least disadvantaged)	19·2		18·1		19·8		18·4		15·1		13·9	
Quintile 2	17·0		18·0		17·4		18·0		14·2		17·9	
Quintile 3	20·3		19·8		20·1		19·8		21·4		20·1	
Quintile 4	21·0		20·7		20·8		20·9		22·3		17·2	
Quintile 5 (most disadvantaged)	22·6		23·4		21·9		22·8		27·0		31·0	
P1 fruit/vegetable consumption score (%)		4237		4163		3842		3951		395		212
0–2·5	18·5		16·6		18·1		16·5		22·7		18·6	
3–5	28·2		28·7		28·4		28·7		26·5		29·8	
5·5–7·5	32·4		32·6		32·7		32·7		28·8		32·3	
8–10	20·9		22·1		20·8		22·2		22·1		19·3	
P2 fruit/vegetable consumption score (%)		3507		3261		3248		3146		259		115
0–2·5	28·1		25·8		27·9		25·7		31·0		27·5	
3–5	27·9		28·3		28·1		28·2		25·0		30·0	
5·5–7·5	27·8		28·5		28·3		28·6		21·2		24·5	
8–10	16·3		17·5		15·7		17·5		22·8		18·0	
P1 average alcohol consumption (drinks/d; %)		4102		3998		3723		3799		379		199
None	20·6		18·8		19·2		18·0		34·2		33·0	
1 or 2	57·4		53·3		59·6		54·1		35·2		37·3	
3 or 4	15·3		19·9		15·0		20·2		17·6		15·3	
≥5	6·8		8·1		6·2		7·7		13·0		14·5	
P2 average alcohol consumption (drinks/d; %)		3416		3180		3167		3067		249		113
None	9·0		10·9		8·5		10·6		15·1		20·3	
1 or 2	42·2		43·2		42·9		43·2		33·1		45·1	
3 or 4	30·8		28·2		30·8		28·5		30·7		19·8	
≥5	18·1		17·7		17·9		17·8		21·1		14·9	
P1 smoking (%)		4225		4134		3833		3925		392		209
Never	52·8		51·5		53·6		51·8		44·5		44·5	
Former	24·4		23·3		25·2		23·9		15·9		12·9	
<5 cigarettes/d	6·6		6·9		6·0		6·7		12·4		9·8	
6–10 cigarettes/d	7·8		8·0		7·1		7·7		15·1		13·2	
≥11 cigarettes/d	8·4		10·4		8·1		9·9		12·0		19·6	
P2 smoking (%)		3486		3148		3233		3036		252		111
Never	52·5		50·9		53·6		51·4		38·0		37·0	
Former	19·5		23·2		19·6		23·4		18·4		17·5	
<5 cigarettes/d	7·9		5·4		7·4		5·4		13·6		6·9	
6–10 cigarettes/d	5·7		5·4		5·4		5·1		9·6		12·5	
≥11 cigarettes/d	14·5		15·1		14·0		14·7		20·4		26·1	
P1 physical activity (d/week; %)		4254		4168		3855		3956		398		212
5–7	16·5		18·0		15·9		17·9		22·8		20·0	
3–4	29·6		31·4		29·4		31·4		30·8		33·0	
1–2	38·0		36·8		38·9		37·0		30·0		33·9	
0	15·9		13·8		15·8		13·8		16·5		13·1	
P2 physical activity (d/week; %)		3522		3253		3262		3138		260		114
5–7	25·5		25·7		25·3		25·6		27·1		29·3	
3–4	26·4		26·8		26·2		27·0		29·0		23·6	
1–2	35·1		33·9		35·7		34·1		28·1		30·3	
0	13·0		13·6		12·8		13·4		15·8		16·9	

B, wave 1 of the B Cohort; K, wave 1 of the K Cohort; P1, parent 1; P2, parent 2; SEP, socio-economic position; SEIFA, Socio-Economic Indexes for Areas.
*All estimates are weighted.

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Table 3 Multinomial multivariable* logistic regression analyses, showing associations between parental health behaviours and overall dietary score trajectories, for both cohorts (B Cohort, *n* 2905; K Cohort, *n* 2719): Longitudinal Study of Australian Children (LSAC; 2004–2014)†,‡

	B Cohort trajectories									K Cohort trajectories								
	'Becoming less healthy'			'Moderately healthy'			'Never healthy'			'Becoming less healthy'			'Moderately healthy'			'Never healthy'		
Parental health behaviour	OR	95 % CI	*P*§	OR	95 % CI	*P*§	OR	95 % CI	*P*§	OR	95 % CI	*P*§	OR	95 % CI	*P*§	OR	95 % CI	*P*§
P1 fruit/vegetable consumption score																		
8–10	Ref.	–	–	Ref.	–	–	Ref.	–	–	Ref.	–	–	Ref.	–	–	Ref.	–	–
5·5–7·5	1·4	1·1, 1·9	0·01	1·5	1·1, 2·0	<0·001	1·1	0·7, 1·9	<0·001	1·3	1·0, 1·7	<0·001	1·4	1·0, 1·9	<0·001	1·5	0·9, 2·4	<0·001
3–5	1·5	1·1, 2·0		1·6	1·2, 2·3		2·4	1·4, 4·0		2·1	1·6, 2·7		2·5	1·8, 3·4		4·2	2·5, 6·8	
0–2·5	1·9	1·3, 2·8		3·1	2·2, 4·5		4·4	2·6, 7·5		2·2	1·5, 3·0		3·9	2·6, 5·9		8·7	5·0, 15·1	
P2 fruit/vegetable consumption score																		
8–10	Ref.	–	–	Ref.	–	–	Ref.	–	–	Ref.	–	–	Ref.	–	–	Ref.	–	–
5·5–7·5	1·1	0·8, 1·5	0·22	1·0	0·7, 1·4	0·02	0·9	0·4, 1·7	0·05	1·2	0·9, 1·6	<0·001	1·2	0·9, 1·7	0·001	1·8	1·0, 3·3	<0·001
3–5	1·1	0·7, 1·5		1·3	1·0, 1·9		1·4	0·8, 2·6		1·7	1·3, 2·3		1·7	1·2, 2·3		3·1	1·6, 5·8	
0–2·5	1·4	1·0, 2·0		1·4	1·0, 2·0		1·6	0·9, 3·0		2·0	1·4, 2·6		2·0	1·4, 2·8		4·8	2·6, 9·1	
P1 average alcohol consumption (drinks/d)																		
1 or 2	Ref.	–	–	Ref.	–	–	Ref.	–	–	Ref.	–	–	Ref.	–	–	Ref.	–	–
None	1·2	0·9, 1·7	0·37	1·1	0·8, 1·4	0·62	1·2	0·8, 2·0	0·59	1·0	0·7, 1·3	0·30	1·2	0·8, 1·7	0·40	1·3	0·8, 2·1	0·33
3 or 4	0·8	0·6, 1·2		1·2	0·9, 1·6		1·1	0·7, 1·8		1·2	0·9, 1·5		1·2	0·9, 1·7		1·4	1·0, 2·1	
≥5	1·2	0·7, 2·0		1·3	0·8, 2·1		1·4	0·8, 2·6		0·7	0·4, 1·2		1·4	0·8, 2·5		1·2	0·6, 2·3	
P2 average alcohol consumption (drinks/d)																		
1 or 2	Ref.	–	–	Ref.	–	–	Ref.	–	–	Ref.	–	–	Ref.	–	–	Ref.	–	–
None	1·1	0·7, 1·8	0·46	1·3	0·9, 2·0	0·02	1·2	0·6, 2·6	<0·001	1·3	0·8, 1·9	0·45	1·3	0·8, 2·0	0·33	1·3	0·7, 2·4	0·07
3 or 4	1·1	0·9, 1·5		1·0	0·7, 1·2		0·7	0·5, 1·1		1·1	0·9, 1·4		1·2	0·9, 1·5		0·9	0·6, 1·4	
≥5	1·3	0·9, 1·8		1·5	1·1, 1·9		1·8	1·2, 2·6		1·2	0·9, 1·6		1·3	0·9, 1·8		1·6	1·1, 2·4	
P1 smoking (cigarettes/d)																		
Never	Ref.	–	–	Ref.	–	–	Ref.	–	–	Ref.	–	–	Ref.	–	–	Ref.	–	–
Former	1·1	0·9, 1·5	0·77	0·9	0·7, 1·2	0·19	0·9	0·6, 1·3	0·56	1·1	0·9, 1·4	0·18	0·8	0·6, 1·0	0·15	0·8	0·6, 1·2	0·03
≤10	1·1	0·7, 1·6		1·2	0·9, 1·7		1·0	0·5, 1·7		1·5	1·0, 2·2		1·2	0·8, 1·8		1·1	0·7, 1·9	
≥11	1·0	0·5, 1·7		1·4	0·9, 2·2		1·4	0·7, 2·6		1·4	0·8, 2·3		1·1	0·6, 1·8		2·1	1·2, 3·7	
P2 smoking (cigarettes/d)																		
Never	Ref.	–	–	Ref.	–	–	Ref.	–	–	Ref.	–	–	Ref.	–	–	Ref.	–	–
Former	0·9	0·7, 1·2	0·45	0·9	0·7, 1·2	0·46	0·7	0·5, 1·1	0·007	0·9	0·7, 1·1	0·64	0·9	0·7, 1·2	0·80	0·7	0·5, 1·1	0·18
≤10	0·9	0·6, 1·3		0·8	0·6, 1·1		0·6	0·3, 1·1		1·1	0·7, 1·5		0·9	0·6, 1·3		0·7	0·4, 1·2	
≥11	0·7	0·5, 1·1		0·9	0·7, 1·3		1·5	0·9, 2·5		1·0	0·7, 1·5		1·1	0·7, 1·6		1·0	0·6, 1·7	
P1 physical activity (d/week)																		
5–7	Ref.	–	–	Ref.	–	–	Ref.	–	–	Ref.	–	–	Ref.	–	–	Ref.	–	–
3–4	1·1	0·8, 1·6	0·45	1·0	0·7, 1·4	0·01	1·0	0·6, 1·8	0·14	1·2	0·9, 1·6	0·77	1·3	0·9, 1·8	0·66	1·2	0·7, 1·9	0·40
1–2	1·1	0·8, 1·6		1·1	0·8, 1·5		1·5	0·9, 2·5		1·1	0·8, 1·5		1·2	0·8, 1·7		1·3	0·8, 2·0	
0	1·4	0·9, 2·1		1·6	1·1, 2·3		1·5	0·8, 2·8		1·2	0·8, 1·7		1·1	0·8, 1·7		1·6	0·9, 2·8	
P2 physical activity (d/week)																		
5–7	Ref.	–	–	Ref.	–	–	Ref.	–	–	Ref.	–	–	Ref.	–	–	Ref.	–	–
3–4	1·0	0·7, 1·3	0·88	0·9	0·7, 1·2	0·23	1·1	0·7, 1·8	0·25	1·0	0·8, 1·3	0·29	1·4	1·0, 1·9	0·02	1·4	0·9, 2·2	0·20
1–2	1·0	0·8, 1·4		1·2	0·9, 1·5		0·9	0·6, 1·5		1·3	0·9, 1·7		1·7	1·2, 2·3		1·5	1·0, 2·2	
0	1·1	0·7, 1·5		1·0	0·7, 1·5		1·5	0·9, 2·6		1·2	0·8, 1·7		1·6	1·1, 2·3		1·1	0·7, 1·9	

P1, parent 1; P2, parent 2; Ref., reference category; SEIFA, Socio-Economic Indexes for Areas.
*The model included all parental health behaviours and P1 age, P2 age, study child Indigenous status, study child language other than English spoken at home, socio-economic position and SEIFA neighbourhood disadvantage as covariates.
†'Always healthy' trajectory = reference category for both cohorts.
‡All estimates are weighted.
§*P* value from Wald test for variables with more than two categories.

Table 4 Multinomial multivariable* logistic regression analyses, showing associations between parental health behaviours and 'healthy' pattern trajectories, for both cohorts (B Cohort, *n* 2903; K Cohort, *n* 2719): Longitudinal Study of Australian Children (LSAC; 2004–2014)†,‡

	B Cohort trajectories									K Cohort trajectories								
	'Becoming less healthy'			'Moderately healthy'			'Never healthy'			'Becoming less healthy'			'Moderately healthy'			'Never healthy'		
Parental health behaviour	OR	95 % CI	*P*§	OR	95 % CI	*P*§	OR	95 % CI	*P*§	OR	95 % CI	*P*§	OR	95 % CI	*P*§	OR	95 % CI	*P*§
P1 fruit/vegetable consumption score																		
8–10	Ref.	–	–	Ref.	–	–	Ref.	–	–	Ref.	–	–	Ref.	–	–	Ref.	–	–
5·5–7·5	1·8	1·2, 2·7	<0·001	1·4	1·1, 1·8	<0·001	1·9	1·1, 3·2	<0·001	1·1	0·9, 1·5	<0·001	1·1	0·8, 1·6	<0·001	1·6	0·9, 2·7	<0·001
3–5	2·5	1·7, 3·8		2·5	1·9, 3·3		3·3	1·9, 5·8		1·7	1·3, 2·2		2·1	1·4, 3·0		3·4	2·0, 5·8	
0–2·5	1·8	1·0, 3·0		3·9	2·7, 5·5		8·8	4·9, 16·0		2·2	1·5, 3·2		4·7	3·0, 7·3		8·4	4·8, 14·7	
P2 fruit/vegetable consumption score																		
8–10	Ref.	–	–	Ref.	–	–	Ref.	–	–	Ref.	–	–	Ref.	–	–	Ref.	–	–
5·5–7·5	1·2	0·8, 1·8	0·09	1·0	0·8, 1·3	0·01	1·0	0·5, 1·9	<0·001	1·5	1·2, 2·0	<0·001	1·4	1·0, 2·1	<0·001	2·2	1·3, 3·8	<0·001
3–5	0·8	0·5, 1·3		1·3	0·9, 1·8		2·5	1·5, 4·4		2·2	1·6, 3·0		2·0	1·3, 3·0		3·3	1·8, 6·1	
0–2·5	1·3	0·9, 2·0		1·5	1·1, 2·0		2·5	1·4, 4·6		2·2	1·6, 2·9		2·6	1·8, 3·7		4·5	2·5, 7·9	
P1 average alcohol consumption (drinks/d)																		
1 or 2	Ref.	–	–	Ref.	–	–	Ref.	–	–	Ref.	–	–	Ref.	–	–	Ref.	–	–
None	1·6	1·1, 2·3	0·03	1·1	0·8, 1·4	0·93	1·5	1·0, 2·4	0·27	0·9	0·7, 1·2	0·30	1·2	0·8, 1·8	0·76	1·3	0·8, 2·1	0·44
3 or 4	1·6	1·1, 2·4		1·1	0·8, 1·4		1·0	0·6, 1·6		1·2	0·9, 1·6		1·1	0·8, 1·5		1·4	0·9, 2·0	
≥5	1·0	0·5, 2·0		0·9	0·6, 1·5		1·3	0·8, 2·3		1·2	0·8, 2·0		1·2	0·7, 2·1		1·4	0·7, 2·6	
P2 average alcohol consumption (drinks/d)																		
1 or 2	Ref.	–	–	Ref.	–	–	Ref.	–	–	Ref.	–	–	Ref.	–	–	Ref.	–	–
None	0·6	0·3, 1·1	0·21	0·8	0·6, 1·2	0·70	1·3	0·6, 2·5	0·23	1·2	0·8, 1·7	0·33	0·9	0·5, 1·4	0·89	0·9	0·5, 1·9	0·71
3 or 4	1·0	0·7, 1·3		1·0	0·8, 1·2		1·0	0·7, 1·4		1·0	0·8, 1·3		1·0	0·8, 1·4		1·1	0·8, 1·6	
≥5	0·8	0·5, 1·1		1·1	0·8, 1·4		1·5	1·0, 2·1		1·3	1·0, 1·6		1·1	0·8, 1·5		1·3	0·8, 1·9	
P1 smoking (cigarettes/d)																		
Never	Ref.	–	–	Ref.	–	–	Ref.	–	–	Ref.	–	–	Ref.	–	–	Ref.	–	–
Former	1·3	1·0, 1·7	0·08	1·1	0·9, 1·4	0·58	1·0	0·7, 1·4	0·69	1·2	0·9, 1·5	0·58	0·9	0·6, 1·2	0·35	0·8	0·5, 1·2	0·62
≤10	0·8	0·5, 1·3		1·0	0·7, 1·4		0·9	0·5, 1·6		1·2	0·9, 1·7		0·7	0·4, 1·1		0·9	0·5, 1·5	
≥11	1·5	0·9, 2·7		0·9	0·6, 1·4		1·3	0·7, 2·4		1·0	0·7, 1·6		0·7	0·4, 1·2		1·1	0·7, 2·0	
P2 smoking (cigarettes/d)																		
Never	Ref.	–	–	Ref.	–	–	Ref.	–	–	Ref.	–	–	Ref.	–	–	Ref.	–	–
Former	1·1	0·8, 1·5	0·86	1·1	0·8, 1·3	0·52	0·7	0·5, 1·1	0·32	0·9	0·7, 1·1	0·18	0·9	0·6, 1·2	0·71	0·7	0·4, 1·0	0·03
≤10	1·0	0·6, 1·5		0·9	0·6, 1·1		0·6	0·4, 1·1		1·2	0·9, 1·7		1·1	0·7, 1·6		0·7	0·4, 1·2	
≥11	1·1	0·7, 1·8		1·1	0·8, 1·5		0·9	0·5, 1·5		0·9	0·6, 1·2		1·0	0·7, 1·5		1·4	0·9, 2·2	
P1 physical activity (d/week)																		
5–7	Ref.	–	–	Ref.	–	–	Ref.	–	–	Ref.	–	–	Ref.	–	–	Ref.	–	–
3–4	1·5	0·9, 2·4	0·15	1·0	0·7, 1·3	0·14	0·9	0·5, 1·5	0·02	1·3	0·9, 1·7	0·42	1·1	0·8, 1·6	0·58	0·9	0·5, 1·4	0·32
1–2	1·4	0·9, 2·2		1·0	0·8, 1·3		1·3	0·8, 2·2		1·3	0·9, 1·7		1·3	0·9, 1·9		1·2	0·7, 2·0	
0	1·9	1·1, 3·2		1·3	1·0, 1·8		1·8	1·0, 3·1		1·3	0·9, 1·8		1·1	0·7, 1·7		1·3	0·7, 2·2	
P2 physical activity (d/week)																		
5–7	Ref.	–	–	Ref.	–	–	Ref.	–	–	Ref.	–	–	Ref.	–	–	Ref.	–	–
3–4	0·9	0·6, 1·3	0·96	1·1	0·8, 1·3	0·66	1·1	0·7, 1·7	0·95	1·1	0·9, 1·5	0·65	1·4	1·0, 1·9	0·15	1·5	1·0, 2·4	0·03
1–2	0·9	0·6, 1·4		0·9	0·7, 1·2		1·1	0·8, 1·6		1·2	0·9, 1·5		1·1	0·8, 1·6		1·7	1·2, 2·5	
0	0·9	0·6, 1·5		0·9	0·6, 1·2		1·1	0·6, 1·8		1·1	0·8, 1·6		1·4	0·9, 2·1		1·5	0·9, 2·6	

P1, parent 1; P2, parent 2; Ref., reference category; SEIFA, Socio-Economic Indexes for Areas.
*The model included all parental health behaviours and P1 age, P2 age, study child Indigenous status, study child language other than English spoken at home, socio-economic position and SEIFA neighbourhood disadvantage as covariates.
†'Always healthy' trajectory = reference category for both cohorts.
‡All estimates are weighted.
§*P* value from Wald test for variables with more than two categories.

lowest parent 2 fruit and vegetable consumption also remained predictive of the 'moderately healthy' and 'never healthy' trajectories in the B Cohort, and all three of the least healthy trajectories in the K Cohort, although less strongly than for parent 1. Sensitivity analyses that additionally included child sex yielded similar results (available from corresponding author on request).

Associations between parental health behaviours and 'unhealthy' pattern trajectory outcomes

Finally, when we examined trajectories showing how children's frequency of 'unhealthy' food consumption changed with age, our findings reverse mirrored those for dietary score and 'healthy' pattern trajectories in univariable analyses (see online supplementary material, Supplemental Table 4). In multivariable analyses, the lowest level of parent 1 fruit and vegetable consumption remained strongly associated with children belonging to the 'moderately unhealthy' and 'always unhealthy' trajectories in the B Cohort, and all three of the unhealthiest pattern trajectories in the K Cohort (Table 5). However, associations were weaker than for dietary score and 'healthy' pattern trajectories. The lowest parent 2 fruit and vegetable consumption also remained predictive of the 'moderately unhealthy' trajectory in the K Cohort, although less strongly than for parent 1. In sensitivity analyses excluding parent 2, results remained similar. However, the highest level of parent 1 smoking was also strongly associated with children belonging to all three of the unhealthiest pattern trajectories in the B Cohort, and the 'moderately unhealthy' and 'always unhealthy' trajectories in the K Cohort (available from corresponding author on request). Sensitivity analyses that additionally included child sex yielded similar results (available from corresponding author on request).

Discussion

Principal findings

Using prospective data from both parents, we found that fruit and vegetable consumption of the primary caregiver, usually the biological mother, during infancy or early childhood was a powerful predictor of diet across the entire childhood life course through to mid-adolescence. Specifically, children whose primary caregivers consumed the lowest levels of fruits and vegetables had up to nine times the odds of following a trajectory of low dietary scores and a trajectory characterised by the lowest frequency of healthy foods. The primary caregiver's fruit and vegetable consumption was much less predictive of children's consumption of unhealthy foods. Parental smoking, alcohol consumption and physical activity were not predictive of children's diet. Our findings replicated strongly across both cohorts.

Strengths and weaknesses

A major and unusual strength of the present study was that diet was measured frequently and prospectively over a long period spanning infancy through to the mid-teen years. We considered the same health behaviours in both parents, allowing us to determine whether consideration of both parents adds greatly to prediction, as well as whether effect sizes differ between the primary caregiver and other parent. Our findings were replicated uniquely across two cohorts of children. This replication increased reliability and our confidence in these results[27], and allowed us to generalise across a wider span of childhood than would otherwise have been possible.

The main limitation was the brevity of the available measures, all of which were self- or parent-reported. Parents reported their consumption of fruits and vegetables but not of unhealthy foods; therefore, we could not obtain an overall picture of parental diet, which would be ideal because people tend to eat foods in dietary patterns. While the children's dietary measure was both more detailed and strengthened by its repetition across five to six waves, the self- or parent-reported format is open to inaccurate reporting[28] and/or recall[29] of diet. The items reported were none the less limited; for example, we did not consider children's consumption of legumes or whole grains. If both children and parents reported healthier diets than they actually consumed, our large associations could in fact be underestimates of true associations in the population. For parent alcohol, we could not consider possible impacts of frequency of consumption or variation in day-to-day alcohol intake. A further potential limitation of our study is that some participants were under-represented in our analyses (e.g. those of low socio-economic position and with high levels of parental smoking). This under-representation of particular subgroups is likely to have resulted in an underestimation of the true associations in the population. Nevertheless, applying survey weights would have partially accounted for this limitation. Finally, another drawback is that because this research is observational, causality cannot be established.

Strengths and weaknesses in relation to other studies

Compared with previous research[7–9,11–14], our study provides a broader view over a longer time horizon of how multiple health behaviours from both parents are associated with dietary trajectories throughout childhood and adolescence. Like previous studies, we show that maternal diet[7,12,13], but not physical exercise[14], is associated with early childhood diet, and we confirm univariable associations of maternal smoking with unhealthier diets[11] and of maternal non-smoking with healthier diets[7,10]. However, our multivariable findings differ from previous studies indicating that parental alcohol consumption and smoking predict child diet[6–11].

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Table 5 Multinomial multivariable* logistic regression analyses, showing associations between parental health behaviours and 'unhealthy' pattern trajectories, for both cohorts (B Cohort, *n* 2903; K Cohort, *n* 2719): Longitudinal Study of Australian Children (LSAC; 2004–2014)†,‡

	B Cohort trajectories									K Cohort trajectories								
	'Becoming unhealthy'			'Moderately unhealthy'			'Always unhealthy'			'Becoming unhealthy'			'Moderately unhealthy'			'Always unhealthy'		
Parental health behaviour	OR	95 % CI	*P*§	OR	95 % CI	*P*§	OR	95 % CI	*P*§	OR	95 % CI	*P*§	OR	95 % CI	*P*§	OR	95 % CI	*P*§
P1 fruit/vegetable consumption score																		
8–10	Ref.	–	–	Ref.	–	–	Ref.	–	–	Ref.	–	–	Ref.	–	–	Ref.	–	–
5·5–7·5	1·2	0·6, 2·3	0·64	1·4	1·0, 1·9	0·01	1·5	0·6, 3·6	0·06	1·8	1·2, 2·7	<0·001	1·1	0·8, 1·5	<0·001	1·2	0·5, 2·7	0·18
3–5	1·2	0·6, 2·3		1·2	0·8, 1·6		2·0	0·8, 5·1		2·4	1·6, 3·8		1·6	1·1, 2·2		1·2	0·5, 3·1	
0–2·5	0·8	0·3, 1·9		1·7	1·2, 2·5		3·3	1·2, 9·1		2·7	1·7, 4·2		2·1	1·4, 3·2		2·3	1·0, 5·2	
P2 fruit/vegetable consumption score																		
8–10	Ref.	–	–	Ref.	–	–	Ref.	–	–	Ref.	–	–	Ref.	–	–	Ref.	–	–
5·5–7·5	1·2	0·6, 2·8	0·05	0·9	0·7, 1·3	0·51	1·5	0·5, 4·1	0·38	1·0	0·6, 1·5	0·09	1·1	0·8, 1·6	0·06	0·7	0·2, 2·4	0·13
3–5	2·0	1·0, 3·9		1·1	0·8, 1·6		2·2	0·8, 6·0		1·3	0·8, 2·0		1·4	0·9, 2·0		2·1	0·7, 5·7	
0–2·5	1·1	0·5, 2·3		1·1	0·8, 1·5		1·5	0·5, 4·4		1·5	0·9, 2·3		1·6	1·1, 2·2		2·2	0·8, 6·1	
P1 average alcohol consumption (drinks/d)																		
1 or 2	Ref.	–	–	Ref.	–	–	Ref.	–	–	Ref.	–	–	Ref.	–	–	Ref.	–	–
None	1·2	0·6, 2·2	0·11	0·9	0·7, 1·3	0·96	0·9	0·5, 1·7	0·47	1·1	0·7, 1·7	0·88	1·0	0·7, 1·4	0·98	1·7	0·6, 5·1	0·59
3 or 4	1·2	0·6, 2·2		1·0	0·8, 1·4		1·6	0·8, 3·0		1·1	0·8, 1·6		0·9	0·7, 1·2		1·6	0·8, 3·3	
≥5	2·3	1·2, 4·3		1·1	0·7, 1·8		0·9	0·4, 2·5		1·1	0·6, 1·9		0·9	0·6, 1·6		1·5	0·4, 5·1	
P2 average alcohol consumption (drinks/d)																		
1 or 2	Ref.	–	–	Ref.	–	–	Ref.	–	–	Ref.	–	–	Ref.	–	–	Ref.	–	–
None	1·1	0·5, 2·4	0·94	0·9	0·6, 1·5	0·47	2·3	0·9, 5·5	0·16	0·5	0·3, 0·9	0·08	1·4	1·0, 2·2	0·22	0·4	0·1, 1·3	0·39
3 or 4	0·9	0·5, 1·6		0·9	0·7, 1·2		1·3	0·7, 2·5		0·8	0·6, 1·2		0·9	0·7, 1·2		0·7	0·3, 1·4	
≥5	1·1	0·6, 2·0		1·2	0·9, 1·6		2·1	1·0, 4·3		1·0	0·7, 1·4		1·0	0·7, 1·3		0·7	0·3, 1·5	
P1 smoking (cigarettes/d)																		
Never	Ref.	–	–	Ref.	–	–	Ref.	–	–	Ref.	–	–	Ref.	–	–	Ref.	–	–
Former	1·2	0·7, 2·1	0·06	1·0	0·8, 1·4	0·01	1·0	0·5, 1·7	0·41	1·1	0·8, 1·5	0·48	0·8	0·6, 1·2	0·03	0·9	0·4, 2·0	0·79
≤10	1·3	0·6, 2·8		1·7	1·2, 2·4		1·5	0·7, 3·1		1·3	0·9, 2·0		1·5	1·0, 2·1		0·8	0·3, 2·2	
≥11	3·0	1·4, 6·6		1·6	1·1, 2·6		1·9	0·8, 4·6		0·9	0·4, 1·8		1·6	1·0, 2·4		1·5	0·5, 4·3	
P2 smoking (cigarettes/d)																		
Never	Ref.	–	–	Ref.	–	–	Ref.	–	–	Ref.	–	–	Ref.	–	–	Ref.	–	–
Former	1·2	0·6, 2·2	0·88	0·8	0·6, 1·1	0·04	0·7	0·3, 1·5	0·01	1·2	0·8, 1·6	0·67	0·7	0·5, 1·0	0·01	1·1	0·5, 2·3	0·46
≤10	1·3	0·7, 2·5		0·6	0·4, 0·9		0·4	0·2, 0·9		0·9	0·5, 1·4		0·7	0·5, 1·1		0·3	0·1, 1·6	
≥11	1·2	0·6, 2·4		1·0	0·7, 1·4		1·7	0·9, 3·2		1·0	0·6, 1·5		1·2	0·8, 1·7		1·2	0·5, 3·0	
P1 physical activity (d/week)																		
5–7	Ref.	–	–	Ref.	–	–	Ref.	–	–	Ref.	–	–	Ref.	–	–	Ref.	–	–
3–4	0·9	0·4, 1·8	0·81	0·9	0·6, 1·3	0·009	0·9	0·4, 1·9	0·46	1·2	0·8, 1·8	0·75	1·0	0·7, 1·4	0·97	0·9	0·3, 2·2	0·60
1–2	0·9	0·5, 1·8		1·2	0·8, 1·6		1·3	0·6, 2·8		1·0	0·7, 1·5		0·9	0·7, 1·3		1·2	0·5, 2·9	
0	1·2	0·5, 3·0		1·6	1·1, 2·3		1·5	0·6, 3·8		1·2	0·7, 1·9		0·9	0·6, 1·4		0·8	0·3, 2·4	
P2 physical activity (d/week)																		
5–7	Ref.	–	–	Ref.	–	–	Ref.	–	–	Ref.	–	–	Ref.	–	–	Ref.	–	–
3–4	1·0	0·6, 1·7	0·33	0·9	0·7, 1·2	0·77	0·8	0·4, 1·6	0·19	1·0	0·7, 1·4	0·79	1·3	0·9, 1·7	0·22	1·0	0·5, 2·3	0·79
1–2	0·6	0·4, 1·2		0·9	0·7, 1·2		0·8	0·4, 1·7		1·1	0·8, 1·5		1·0	0·8, 1·4		0·8	0·3, 1·7	
0	0·6	0·3, 1·3		0·8	0·6, 1·2		1·6	0·8, 3·3		0·9	0·5, 1·4		0·9	0·6, 1·2		0·7	0·3, 1·8	

P1, parent 1; P2, parent 2; Ref., reference category; SEIFA, Socio-Economic Indexes for Areas.
*The model included all parental health behaviours and P1 age, P2 age, study child Indigenous status, study child language other than English spoken at home, socio-economic position and SEIFA neighbourhood disadvantage as covariates.
†'Never unhealthy' trajectory = reference category for both cohorts.
‡All estimates are weighted.
§*P* value from Wald test for variables with more than two categories.

These discrepancies could reflect other studies making different choices of covariates, including a greater subset of food and drink items, being conducted in different geographic locations, measuring exposures at different time points, and/or being conducted over a shorter time period than our study[6–11]. It is also possible that the use of stepwise regression procedures[6,8,10] may have increased type I error rates in some studies, leading to false conclusions of associations between parental health behaviours and child diet[30].

Meaning of the study for clinicians and policy makers

Our study highlights the importance of parental fruit and vegetable consumption on children's diets. Health promotion efforts to educate and facilitate parents to invest in a healthy diet for themselves and their families have already been met with some success. For example, targeting weekly nutrition workshops to parents and 2–4-year-old children improved children's diets[31], while a nutrition education programme, targeted to both parents and children separately, increased pre-school children's consumption of milk and vegetables[32]. While none of these trials has reported long-term follow-up, our study underscores the potentially lasting value of such interventions by virtue of the very large associations between primary caregiver fruit and vegetable consumption and dietary trajectories across different measures and cohorts from early childhood through to at least 15 years of age. As discussed above, potential measurement error may mean that both parents and children reported healthier diets than they consumed. Thus, the relative odds of following the least healthy dietary trajectories for children whose parents reported the lowest fruit and vegetable consumption may be even higher than our study showed. Given the lack of associations we observed between parental smoking, alcohol consumption and physical activity, and children's dietary trajectories, it is likely that some factors aside from parental influences may also play a role in food selection by children. These influences might operate outside the home environment, for example at childcare, pre-school or school.

Unanswered questions and future research

Future longitudinal research should obtain a broader picture both of parents' and children's diets, including intakes of both healthy and unhealthy foods, using more comprehensive dietary measurement tools such as computerised 24 h dietary recalls[33]. This research could bring greater clarity to what determines children's intake of healthy foods compared with what determines their intake of unhealthy foods. These determinants may well differ, given that Anderson *et al.*'s study of American pre-school children[34] showed a surprising lack of congruence between the healthy and unhealthy aspects of their diets. Thus, interventions focusing solely on increasing healthy foods may not simultaneously decrease unhealthy food patterns. We recommend further research that considers longitudinal variation in elements of these dietary patterns. It could also be valuable to develop and test the utility of a prediction tool, based on parental fruit and vegetable consumption, which pinpoints families in greatest need of tailored dietary interventions.

Conclusion

In conclusion, low primary caregiver fruit/vegetable consumption strongly predicted the lowest intake of healthy, but only weakly predicted unhealthy, food trajectories throughout childhood. These findings suggest that healthy and unhealthy patterns of food intake throughout childhood may differ in their early-life determinants. Secondary caregiver, usually paternal, fruit/vegetable associations were inconsistent, and alcohol consumption, smoking and physical activity did not predict children's dietary trajectories. These findings could help develop short predictive tools to target interventions that improve intake of healthful foods for children. Other approaches may be needed to identify which toddlers and young children are likely to develop patterns of unhealthful dietary intakes.

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Supplementary material

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