

Picky eating and child weight status development

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NUTRITION AND CHILDHOOD

Picky eating and child weight status development: a longitudinal study

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Keywords

childhood eating behaviour, childhood obesity, food parenting practices, picky eating, underweight.

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Abstract

Background: Children's picky eating behaviour has been linked both to being overweight and underweight. However, the role of parenting practices in this relationship has rarely been investigated. The present study aimed to clarify the direction of the association between picky eating and weight status and to examine the moderating role of food parenting practices.

Methods: The present study comprised a longitudinal study on the effects of picky eating on child weight status within the KOALA Birth Cohort Study, the Netherlands. Mothers and their children were included in the analyses. Children's picky eating behaviour and food parenting practices were assessed at baseline (child age 5 years). Their weight status was assessed repeatedly until age 9 years. Mixed effects linear and logistic regressions were used to compare picky eaters ($n = 403$) and non-picky eaters ($n = 621$) on changes in weight status over the years.

Results: At baseline of age 5 years, picky eaters were slightly shorter, more often underweight and less often overweight than non-picky eaters, whereas energy intake in relation to body weight (kJ kg^{-1}) was similar. Picky eaters with a normal weight at baseline had no increased risk of becoming underweight during follow-up until age 9 years, and were less likely to become overweight compared to non-picky eaters. There were no interactions with food parenting practices. The parents of picky eaters more often reported pressuring their child to eat and restrict unhealthy food intake compared to parents of non-picky eaters.

Conclusions: The association between picky eating and child weight status was not influenced by parenting practices.

Introduction

Child weight problems are associated with multiple health complications in childhood and later adulthood⁽¹⁾. Results from the 2007–2010 National Health and Nutrition Examination Survey (NHANES, 2010) indicate that an estimated 3.5% of children and adolescents aged 2–19 years are underweight. Similarly, an increasing prevalence of being overweight has been established and childhood obesity has

more than doubled in children and quadrupled in adolescents in the past 30 years. In the USA, the percentage of children aged 6–11 years who were obese increased from 7% in 1980 to almost 18% in 2012⁽²⁾.

In light of the increasing prevalence of these problems among children, there is a growing interest in the eating patterns of children. One such pattern is picky or fussy eating, which is characterised by the child eating a limited amount of food, restricted intake, being unwilling to try

new foods and having strong food preferences^(3,4). In young children, this behaviour is considered to represent one of the most important influences on food consumption and thereby on body weight^(5,6). The development of food preferences is a result of the interaction between genetic predisposition and different aspects of the eating environment⁽⁷⁾. Children at young age prefer foods that are sweet and salty^(8,9) and reject those that are sour and bitter⁽¹⁰⁾.

The rate of picky eating in young children ranges between 8% and 50% in different populations. Picky eating has been related to a lower body weight^(11,12) and the reduced consumption of fruit and vegetables^(13,14). Children described as picky eaters or as having an eating problem gain less weight especially during the first 2 years of life, with 11% of these children failing to thrive⁽¹⁵⁾. A large population-based cohort study in the Netherlands among 4-year olds (approximately 5000 children) showed that young children's eating patterns are strongly associated with being underweight (13% of the children)⁽¹⁶⁾.

A few studies were conducted on the relationship between pickiness and underweight or caloric intake^(17,18). Jacobi *et al.*⁽¹⁸⁾ showed that picky eaters aged from 3.5 to 5.5 years ate fewer foods and were more likely to avoid vegetables, whereas picky girls decreased their caloric intake and exhibited more emotional problems compared to non-picky eaters. Rydell *et al.*⁽¹⁷⁾ showed that primary school picky eaters are not necessarily lighter in weight compared to non-picky eaters. Nevertheless, the relationship between picky eating and child weight status is not well understood because picky eating may also be related to being overweight. For example, because low fruit and vegetable consumption has been linked to the increased consumption of fats⁽¹⁹⁾, it may also be possible that picky eaters, who eat fewer fruit and vegetables, are consuming diets higher in fat and energy, which may put them at risk of becoming overweight in childhood⁽²⁰⁾.

Children's food choices are among others influenced by environmental cues and their parents' behaviour. Parents play an important role in children's eating environment and food preferences by means of their own eating behaviours, attitudes and child-feeding practices⁽¹⁸⁾. It has been suggested that parental control over child eating may be a prominent environmental influence on children's eating^(21,22). Experience of the forced consumption of certain types of food may result in long-lasting food rejection⁽²³⁾.

In a family study including measures on sibling eating behaviour, Farrow *et al.*⁽²⁴⁾ showed that parents reported using more restrictive food parenting practices with children who were fussier and desired to drink more than their siblings. Picky eating may cause concern for parents

about the adequacy of the child's diet, whereas parents are also more likely to pressure a child to eat if they perceive the latter to be underweight^(25,26). Furthermore, controlling food parenting practices in infancy may predict lower child weight at 2 years⁽²⁷⁾. In a review of 31 studies, the most frequent finding was that restricting a child from eating unhealthy or snack foods was related to a higher body mass index (BMI)/being overweight, whereas pressuring a child to eat during feeding was related to lower BMI/weight gain⁽²⁸⁾.

In addition to being adversely correlated with children's BMI⁽²⁹⁾, maternal pressure to eat has also been positively correlated with children's total fat mass⁽³⁰⁾. On the other hand, more restrictive food parenting practices have been found among parents of boys with average BMI compared to parents of boys with a high BMI⁽³¹⁾, whereas mothers of already overweight children allow their children less control over their own food and use less pressure to eat⁽³²⁾.

Moreover, it has been reported that parental control of child eating, when measured in a laboratory setting, is associated with poorer regulation, which in turn is linked with increased child weight⁽³³⁾. Similarly, restriction of unhealthy foods is often used by parents in an attempt to improve children's diets, although experimental studies have shown that restriction of a particular food may result in increased preference for⁽³⁴⁾ and intake of the restricted food^(35,36) and therefore lead to an increased risk of being overweight. However, parental control over child feeding has not been associated with child weight status⁽³⁷⁾.

Similarly, stimulation to eat healthy food has been linked with positive^(38–40) and adverse⁽⁴¹⁾ effects on child's diet and has been associated with a lower child BMI⁽⁴²⁾. Variety in the results has been reported for monitoring children's dietary intake, which is reported to be associated both with being overweight and a lower child BMI⁽⁴³⁾.

Many studies^(26,29,35,44) have investigated how parents affect children's eating behaviour. Most of the studies conducted aiming to examine the relationship between picky eating and child weight are based on correlational analyses designs. A positive association between parental restriction of unhealthy food and child weight has been established⁽²⁶⁾. However, only a few studies have examined the interaction between picky eating and feeding practices and their effect on child's weight longitudinally. Mascola *et al.*⁽⁴⁵⁾, in a prospective study of children followed from 2 to 11 years, found that picky eaters were more likely to consume a limited variety of foods, and parents of picky eaters were more likely to argue about their child's eating behaviour compared to parents of non-picky eaters. There were no differences observed with

regard to food restriction and pressure to eat. In a study of 3.5-year-old children followed up until they were 7 years old⁽⁴⁶⁾, mothers reported pickiness at all ages, whereas introduction to new food and child's dislike of the new food were positively correlated.

Because picky eating can increase the risk for both being overweight and underweight, especially through the influence of parental feeding practices, the present study aimed to disentangle these potential associations by analysing children at risk of becoming overweight or underweight. In addition, we investigated potential moderation by food parenting practices, such as restriction of unhealthy food, stimulation to eat healthy food, monitoring of eating behaviour and pressure to eat in the relationship between picky eating and the children's weight status development over the years. Children comprise the population of interest because interventions to target changes in dietary patterns in relation to weight status may be more effective at a younger age^(1,47).

Materials and methods

The KOALA (the Dutch acronym for Child, Parents and health: Lifestyle and Genetic constitution) birth cohort is a prospective birth cohort study. Healthy pregnant women were recruited from an existing cohort for a study of the aetiology of pregnancy-related pelvic girdle pain, as well as via recruitment channels from among 'alternative lifestyle' (e.g. through anthroposophist midwives and general practitioners and organic food shops)⁽⁴⁸⁾. Informed consent was provided by all of the women and approval for the study was obtained from Maastricht University/University Hospital Maastricht medical ethics committee. In total, the mothers of 2834 children completed mail-based questionnaires during pregnancy and regularly after birth.

Exclusions

In total, 20 children were excluded from the analyses, including 11 children with congenital defects (Down's syndrome and other congenital diseases), as well as children with metabolic disorders likely to affect their body weight ($n = 4$) and also families who were lost to follow-up or suffered perinatal deaths ($n = 5$). This resulted in an initial sample of 2814 mothers and their children.

Child picky eating, food parenting practices and energy intake at baseline

Mothers were asked to complete a questionnaire regarding their children's eating style ($n = 2037$) when their children were 5 years of age. Mothers responded on a

five-point Likert scale ranging from 'strongly agree' to 'strongly disagree' with respect to whether they agreed to the following statements about their children's eating behaviour: 'My child's diet consist of only few foods', 'My child is unwilling to eat many of the food I serve' and 'My child is picky or fussy about what s/he eats'⁽²⁵⁾. Three subscales from the Child Feeding Questionnaire⁽⁴⁹⁾, which has been shown to have good validity and internal reliability⁽²⁵⁾, were used to measure parental feeding practices: pressure to eat (i.e. parents' tendency to pressure their child to consume more food), restriction (i.e. the extent to which parents attempt to restrict their child's intake during meals) and monitoring (i.e. the degree to which parents monitor their child's fat intake). Additionally, a fourth subscale developed by Gubbels *et al.*⁽⁵⁰⁾ was used: stimulation (i.e. the degree to which parents stimulate their child's healthy food intake). Cronbach's α values for all scales were as follows; picky eating: 0.74; pressure to eat: 0.50; restriction: 0.63; monitoring: 0.85; stimulation: 0.50.

The child's energy intake was estimated from a parent-reported food-frequency questionnaire at age 5 years, previously validated in 4–6-year-olds with the doubly-labelled water method⁽⁵¹⁾.

Outcome measurements

Child weight and height were based on parental reporting when children were 5 years old (baseline) and in follow-up questionnaires at time points with a mean age of 7, 8 and 9 years, respectively. Parents were asked to measure weight (kg) and height (cm), with the child wearing light clothes and no shoes, and to report the exact date of measurement. These measures were used to derive children's BMI [weight (kg)/height (m²)]. Children were classified as underweight, normal and overweight/obese^(52,53).

Maternal characteristics

The questionnaires included questions about the mother's age with respect to pregnancy for the present child, level of education and hours of employment, as well as height and weight information taken before pregnancy for the calculation of BMI scores. Mothers' BMI (kg m⁻²) before pregnancy was classified according to the WHO standard guidelines as: underweight (<18.5 kg m⁻²), normal weight (18.5–24.99 kg m⁻²), overweight (≥ 25 kg m⁻²) or obese (≥ 30 kg m⁻²).

Statistical analysis

Because we were primarily interested in distinguishing between children who were picky eaters compared to

those who were not picky eaters, a quartile split was used for the analysis. Children in the highest ($n = 403$) and lowest ($n = 621$) quartile of the eating style questionnaire were compared with regard to several characteristics. In the analyses, these 1024 children were included and the measurements on children's picky eating were based on maternal reports in when the child was aged 5 years. Therefore, picky eating behaviour at age 5 years was set as the baseline time, with 40% being categorised as picky eaters.

In logistic regression analyses, picky eating (the predictor variable) and BMI (the outcome variable) were both treated as categorical variables based on the classifications of underweight and overweight, as well as picky eaters and non-picky eaters. In addition, BMI was analysed as a continuous outcome variable in linear regression. The adjustment variables were child's age, gender, baseline BMI (at age 5 years) and mothers' pre-pregnancy BMI.

These regression analyses were performed in the following groups of baseline weight status: (i) children at risk of becoming underweight: normal weight status below median at baseline (BMI above the International Obesity Task Force cut-off for being underweight but below the median for age and gender) and (ii) children at risk of becoming overweight: normal weight above median (BMI below the International Obesity Task Force cut-off for being overweight but above the median for age and gender). Longitudinal mixed (random and fixed) effects regression models with BMI at age 7, 8 and 9 years as outcome were used for all analyses. Random effects terms included the slope of the association between picky eating and the random intercept of the natural log of the odds of being overweight or underweight over time (in logistic regression) and the slope and intercept of BMI scores over time (in linear regression), whereas fixed-effects terms included all baseline covariates. Interactions between picky eating and the four food parenting practices were tested by sequentially including product terms (picky eating \times parenting practices) in the regression models. Interactions with time were also tested in the models.

In a final step, energy intake was added to the regression model to evaluate whether the effect of picky eating on BMI development was explained by differences in energy intake at baseline. In all analyses, $P < 0.05$ was considered statistically significant. The analyses were performed using STATA, version 12⁽⁵⁴⁾.

Results

In Table 1, picky eaters and non-picky eaters were compared with respect to several child and maternal characteristics. There were no differences between the two

groups regarding maternal pre-pregnancy BMI status, age, hours of employment and education. The parents of picky eaters were more likely to pressure their child to eat and restrict unhealthy food intake ($P < 0.001$) compared to parents of non-picky eaters. On the other hand, the parents of non-picky eaters were more likely ($P < 0.001$) to use stimulation to eat healthy food as a feeding practice compared to mothers of picky eaters. Correlational analyses between picky eating and weight among children who do not fall in the two extreme quartiles (picky eaters versus non-picky eaters) were not significant, nor were the correlations between picky eating and each of the food parenting practices. A significant negative correlation was observed between pressure to eat and weight ($r = -0.13$, $P \leq 0.01$). These results suggest that the association between picky eating and weight status is more profound in the two extreme quartiles (high and low) and not as much in the middle groups. Pressure to eat is negatively associated with weight even at the 'middle' classes of picky eating.

Picky eaters were more likely to be male compared to non-picky eaters ($P = 0.04$) (Table 1). Picky eaters were shorter than non-picky eaters (height = 111.1 cm versus 112.6 cm, $P < 0.001$), slightly lighter for height than non-picky eaters (BMI = 15.13 kg/m² versus 15.35 kg/m², $P = 0.02$) and more often underweight (23% versus 18%, $P = 0.02$) and less often overweight (6% versus 10%, $P = 0.02$). The energy intake per kg body weight was similar in picky eaters and non-picky eaters (329.4 kJ kg⁻¹ per day versus 323.9 kJ kg⁻¹ per day, $P = 0.25$).

Table 2 depicts the change in BMI from baseline until age 9 years, comparing picky with non-picky eaters in linear regression models. Both the unadjusted and adjusted models of the linear regression analyses showed no significant associations between picky eating and weight status change. The interactions of picky eating with food parenting practices were not statistically significant, nor were the interactions with time.

The results from the logistic regression models in Table 3 suggest that, after adjusting for important covariates, picky eaters were less likely to become overweight (adjusted odds ratio = 0.21, 95% confidence interval = 0.06–0.76, $P = 0.02$) compared to non-picky eaters. Similar to the linear regression models, the interactions of picky eating with food parenting practices were not statistically significant, nor were the interactions with time. When energy intake was included in the model, we observed that the association between picky eating and overweight totally disappeared (adjusted odds ratio = 0.89, 95% confidence interval = 0.49–2.00, $P = 0.99$), which indicates that energy intake may confound the relationship between the reduced risk of overweight and picky eating.

Table 1 Mean (SD) and frequencies of mother's characteristics by picky eaters and non-picky eaters at 5 years

Maternal characteristics	Picky eaters (N = 403)		Non picky eaters (N = 621)		P-values	ANOVA
	Mean	SD	Mean	SD		
BMI before pregnancy	23.75	3.78	23.95	4.31	0.46	–
Age at pregnancy	32.42	3.53	32.18	3.88	0.31	–
	N	%	N	%	P-values	χ^2
BMI before pregnancy (based on WHO categories)						
Underweight (<18.5 kg m ⁻²)	9	2.24	9	1.46	0.73	1.29
Normal (18.5–24.99 kg m ⁻²)	277	68.91	423	68.78		
Overweight (25–29.99 kg m ⁻²)	82	20.40	123	20.00		
Obese (≥ 30 kg m ⁻²)	34	8.46	60	9.76		
Hours of employment						
0–16	92	29.30	138	29.36	0.30	2.39
17–24	159	50.64	217	46.17		
25–40+	63	20.06	115	24.47		
Education						
Low	31	7.69	53	8.56	0.31	3.56
Medium	146	36.23	227	36.67		
High	176	43.67	241	38.93		
Age (in categories)						
20–30 years	115	28.61	209	33.66	0.09	2.87
31–50 years	287	71.39	412	66.34		

ANOVA, analysis of variance; BMI, body mass index.

Table 2 Mean (SD) of food parenting practices by picky eaters and non-picky eaters at 5 years

Food parenting practices	Picky eaters (N = 403)		Non picky eaters (N = 621)		P-values	ANOVA
	Mean	SD	Mean	SD		
Pressure to eat (range 1–5)	3.54	0.74	3.17	0.78	<0.001	PE > nPE
Restriction unhealthy intake (range 1–5)	3.42	0.60	3.18	0.60	<0.001	PE > nPE
Monitoring of fat intake (range 1–5)	4.39	0.55	4.43	0.56	0.24	–
Stimulation to eat healthy foods (range 1–5)	4.54	0.49	4.67	0.46	<0.001	nPE > PE

ANOVA, analysis of variance; PE, picky eating.

Discussion

The present study aimed to investigate the association between young children's picky eating and weight status taking into account the moderating effect of parental feeding practices. The results showed that picky eaters are more likely to be underweight and less likely to be overweight at age 5 years compared to non-picky eaters. Moreover, if picky eaters have a normal weight at age 5 years, they are less likely to become overweight later in childhood compared to non-picky eaters. After controlling for total energy

intake as a confounder and potential mediator, the effect of picky eating on child weight status was not mediated by energy intake.

Food likes and dislikes play an important role in food choices. Fussy eating can influence children's dietary intake. Gubbels *et al.* (55) have reported on the significant interaction between parental restriction and eating style (i.e. reluctant and slow eating) with respect to influencing sweets, chocolate and vegetable intake and on the interaction between picky eating and feeding practices with respect to influencing sugar intake (50). Faith *et al.* (43)

Table 3 Mean (SD) and frequencies of child characteristics by picky eaters and non-picky eaters at 5 years

Child characteristics	Picky eaters (N = 403)		Non picky eaters (N = 621)		P-values	χ^2
	N	%	N	%		
Gender						
Male	232	42.26	317	36.00	0.04	4.18
Female	171	57.74	304	64.00		
BMI categories at baseline						
Underweight	86	22.87	104	17.75	0.02	7.92
Normal	269	71.54	425	72.53		
Overweight/Obese	21	5.59	57	9.73		
	Mean	SD	Mean	SD	P-values	ANOVA
BMI	15.14	1.37	15.36	1.40	0.02	5.79
Height (cm)	111.14	6.15	112.58	6.06	<0.001	12.77
Energy intake per kg body weight (kJ kg ⁻¹ per day)	329.38	73.98	323.88	70.97	0.25	–

ANOVA, analysis of variance; PE, Picky eating; BMI, body mass index.

Table 4 Change in body mass index (BMI) from baseline comparing picky with non-picky eaters

	Difference in BMI change at follow-up	
	Unadjusted Beta (95% CI)	Adjusted [‡] Beta (95% CI)
Children at risk of becoming underweight		
Low-normal weight status at baseline*, n		
Non-picky eaters (n = 119)	(reference)	(reference)
Picky eaters (n = 180)	+0.03 (-0.16; +0.23)	+0.05 (-0.11; +0.22)
Children at risk of becoming overweight		
High-normal weight status at baseline [†] , n		
Non-picky eaters (n = 150)	(reference)	(reference)
Picky eaters (n = 245)	-0.09 (-0.29; +0.11)	-0.08 (-0.25; +0.10)

Beta, regression coefficient from linear regression analysis representing the difference in BMI points between picky and non-picky eaters, with 95% confidence interval (CI).

*Low-normal weight status: normal BMI below median for age and gender.

[†]High-normal weight status: normal BMI above median for age and gender.

[‡]Adjusted for age, gender, child baseline BMI, maternal pre-pregnancy BMI.

suggested that pressure to eat at age 5 years negatively predicted child weight at age 7 years. Therefore, there is an indication that parenting practices can influence the child's eating styles and their weight status. Galloway

Table 5 Risk of becoming underweight or overweight comparing picky with non-picky eaters

	Unadjusted OR (95% CI)	Adjusted [‡] OR (95% CI)
Children at risk of becoming underweight		
Low-normal weight status at baseline*, n		
Non-picky eaters (n = 119)	1.0 (reference)	1.0 (reference)
Picky eaters (n = 180)	0.91 (0.43–1.89)	0.95 (0.47–1.94)
Children at risk of becoming overweight		
High-normal weight status at baseline [†] , n		
Non-picky eaters (n = 150)	1.0 (reference)	1.0 (reference)
Picky eaters (n = 245)	0.37 (0.09–1.34)	0.21 (0.06–0.76)

OR, odds ratio from logistic regression analysis (longitudinal mixed models with weight status at age 7, 8 and 9 years as outcome), with 95% confidence interval (CI); bold: $P < 0.05$.

*Low-normal weight status: normal body mass index (BMI) below median for age and gender.

[†]High-normal weight status: normal BMI above median for age and gender.

[‡]Adjusted for age, gender, child baseline BMI, maternal pre-pregnancy BMI.

et al. ⁽²⁵⁾ found that picky eaters do not consume food high in energy, which may eventually lead to being overweight. Picky eating has been associated with both being underweight or overweight; however, the results obtained in the present study suggest that picky eaters are less likely to gain excess weight. Picky eaters had a reduced likelihood of becoming overweight compared to normal eaters irrespective of the effect of the maternal feeding practices. Galloway *et al.* ⁽²⁵⁾ found that picky girls, who

tended to consume less total energy, had lower body fat and were less likely to be overweight. Although picky eating may compromise children's nutrient intake in environments where food may be limited, our findings suggest that, in current industrialised environments, where a variety of palatable, energy-dense foods are readily available, picky eating may be less problematic than previously considered. The finding that picky eaters are less likely to become overweight diverges from previous studies, which reported no differences in growth and weight status of picky toddlers and preschool children^(3,46). Possibly, the persistence of picky eating behaviour over time has long-term effects on weight status that are not evident until the children are older than 9 years.

The lack of an interaction between picky eating and parental feeding practices on children's weight status development might suggest that there are other possible explanations for the observed association. One possible explanation for the lack of an interaction between parental feeding practices and picky eating may be that facilitation and influence of eating behaviour patterns by parents within the family attenuates when the child becomes older. Furthermore, experimental research has found that toddlers and preschool aged children were more likely to accept a new food if an adult was eating the same food than they were if the food was simply presented to them⁽⁵⁶⁾. The children in the present study were 5 years of age when their parents recorded their food preferences and therefore the children may have passed that stage at which they could still be influenced by their parents' feeding practices or the parents may be exercising more tolerant feeding practices. Another reason may be that the feeding practices implemented by the parents may be responsive to children's eating habits for a specific time point. Democratic or authoritarian feeding styles, which are related to child weight⁽⁵⁷⁾, may represent more stable characteristics of parental behaviour compared to feeding practices.

It has been suggested that children may have an innate preference for sweets and fatty foods and could be naturally picky eaters⁽⁵⁸⁾. In the present study, however, the results showed that picky eaters may not necessarily be more predisposed to prefer high energy foods compared to non-picky eaters. In addition, energy intake was similar between picky eaters and non-picky eaters, even though the mothers of picky eaters were more restrictive compared to mothers of non-picky eaters. However, in our analyses, we showed that energy intake was an important covariate in the association between picky eating and weight status at age 9 years. This may suggest that energy intake influences the outcome at a later time point, or that high restriction levels are not sufficiently

adequate to moderate the result. However, data on energy intake at later time points were not available, and so it was not possible to investigate whether energy intake had any influence on the outcome. We nevertheless examined the effect of time on the outcome and found that there was no influence.

Adult twin studies and, more recently, twin children studies⁽⁵⁹⁾ have suggested that eating behaviours similar to picky eating (e.g. food neophobia) are broadly genetically influenced. It may be that picky eaters also have a specific genetically influenced pattern of eating behaviour that is not shared by non-picky eaters. In the present study, approximately 40% of the children fell into the highest quartile for picky eating. Picky eating is a common problem during childhood, ranging from 8% to 50% of children in different samples^(3,4,13,44). The large variations in the prevalence seen in previous samples may be a result of differences in the ages of children included in the studies and in the duration of picky eating required for a case. A large prevalence of picky eating (30%) was observed at some point during an 18-month long study in children aged from 2.5 to 4 years, whereas only 5% were picky eaters across longer time intervals⁽¹³⁾. Therefore, the large prevalence of picky eating in our sample may suggest that the average age of 5 years of the children in our sample may be an important time point for the development of picky eating. However, we should not underestimate the fact that, in previous studies, different assessments and measurements of picky eating have been used, which may lead to variation in the results.

Several other studies have established a relationship between picky eating and children being underweight. Carruth *et al.*⁽⁴⁴⁾ found that infants who were picky eaters consumed less total energy and fat than non-picky eaters. Similarly, another study⁽⁶⁰⁾ found that picky eaters at 5 years of age were under-consuming some macronutrients and were consuming fewer total fats, less energy and protein compared to non-picky eaters.

The findings of the present study should also be interpreted in light of its strengths and limitations. A strength of the present study is that a multi-item measure for parental-reported picky eating was used, whereas one-item questionnaires were often used in other studies^(18,45).

In addition, the group analyses with children at risk of becoming underweight or overweight enabled us to estimate the effect of pick eating on becoming over- and underweight with proper control of baseline weight status.

Some limitations of the present study should also be taken into account. Picky eating has been inconsistently measured in different studies with a lack of standard criteria for defining pickiness⁽⁶¹⁾. The large heterogeneity of

assessment methods and definitions used in previous studies suggested that fussy/picky eating is a complex phenomenon and that there is the need for a more reliable measure⁽⁶¹⁾. Previous studies reporting food pickiness being related to other problematic eating behaviour^(3,62) also suggest that picky eating may be better captured in a behavioural pattern that takes into account many eating behaviours, as well as the unwillingness to eat specific types of food. On that account, the Children's Eating Behaviour Questionnaire (CEBQ) is one of the most comprehensive existing questionnaires used to assess children's eating behaviour, such as fussy eating, together with a variety of behaviours, such as food avoidance or food approach.

Some studies simply use a parental description of picky eating⁽⁴⁴⁾. Sleddens *et al.*⁽⁵⁾, using four scales from the CEBQ with children aged 6–7 years, found that satiety responsiveness and slowness in eating were associated with a lower BMI, although food fussiness and emotional undereating were not associated with BMI. Moreover, it should also be noted that the effect sizes are small, indicating that the amount of variance in weight status explained by picky eating may be limited. This may partly be attributed to the fact that picky eating is a difficult concept to assess, and there is no consensus about the proper way to measure it. In the present study, we tried to limit the influence of this factor by selecting a multi-item questionnaire with good reliability.

In addition, the generalisation of these results to the wider population of Dutch children should be performed cautiously because parents with an 'alternative' healthy lifestyle were over-represented in the sample. However, in the analyses, there was no influence of the recruitment method observed.

Discrepancy in the measurement and conceptualisation of food parenting practices may also partially account for inconsistent cross-sectional findings. The use of parental reporting on children's eating behaviour rather than a behavioural measure could be seen not only as a limitation, but also as a strength. Parents in a questionnaire study can observe their children's eating behaviour where they can appraise habitual behaviour, as opposed to one-off behaviours in a laboratory setting. In a similar way, parental reporting of children's weight and height was found to be reasonably valid for classifying overweight children in large epidemiological studies^(63,64) and a previous report from the KOALA cohort⁽⁶⁵⁾.

Conclusions

In sum, in the present study, we found that picky eaters who had normal weight at age 5 years were more likely to be underweight and less likely to be overweight compared to non-picky eaters during follow-up until age

9 years. These findings suggest that picky eaters are not necessarily consuming food higher in energy compared to non-picky eaters.

Conflict of interests, source of funding and authorship

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EA, AR, SK, AJ, JG, ES and CT contributed to the conception, design and interpretation of the data and drafting of the manuscript. SK, JG, ES and CT contributed to the acquisition of the data. All authors critically revised the manuscript for important intellectual content, agreed to be accountable for all aspects of the work and approved the final manuscript submitted for publication.

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