Clinical and Basic Research Article

An eating behaviour—consumption frequency of certain foods in early childhood—as a predictor of behaviour problems: A 6-year follow-up study

Abstract

Objectives: Eating behaviour in early childhood serves as a foundation for future health outcomes. Diet patterns can have long-term beneficial or adverse effects on social behaviour development. Therefore, the objective of this study was to evaluate *food consumption frequency* in 1- to 6-year-olds as an eating behaviour-related predictor of behaviour problems six years later.

Methods: This longitudinal study involved 124 mother-child dyads from a project named 'Community Empowerment and Care for Wellbeing and Health Longevity' initiated in 1991 and conducting surveys every three years. We studied children aged 1–6 years in July 2011, with a follow-up assessment in August 2017. The primary exposure examined was the frequency of food items intake. The primary outcome was behaviour problems as assessed by the Strengths and Difficulties Questionnaire (SDQ).

Results: The adjusted results suggested that a higher intake of leafy green and light-coloured vegetables were significantly associated with decreased odds of conduct problems and prosocial behaviour problems in Japanese children. However, no associations were observed among fruits, milk, small fish, eggs, soybeans, seaweed, and any SDQ subscales.

Conclusion: This study shows that eating leafy green and light-coloured vegetables may have a protective effect on a child's conduct and prosocial behaviour problems. Due consideration should be given to children's eating habits in the early stages of their lives, to ensure better mental health.

KEYWORDS: child, diet, impulsive behaviour, longitudinal studies, mental health, nutrients, sugars, vegetables

Advances in Knowledge

1. This study found that eating habits in early childhood can serve as a foundation for future behavioural development.
2. Adding leafy green and light-coloured vegetables in the diet at an early age can improve prosocial behaviour and prevent behaviour problems from developing later in life.
3. Further in-depth exploration incorporating interventional studies is needed to clarify the association between eating behaviour in the early years and behaviour in later childhood, specifically how it prevents or improves behaviour problems among children.

Application to Patient Care

1. Paediatricians, nutritionists, and psychiatrists should encourage parents to add vegetables in children's diet at an early age to reap the beneficial effects on the child's mental health.

Introduction

Eating behaviour is one of the determinants of nutrient access and deficiency in early childhood. Food consumption frequency represents how often one consumes certain food items.[1] It is evident from previous research that dietary habits acquired in childhood persist throughout life, and early childhood is crucial, as this is when particular dietary habits and sedentary behaviour patterns become established.[2,3] Eating behaviour is a broad term; recent previous research focussing on the preferences of food items in early childhood reported differences in nutrient intake and unfavourable growth patterns in early childhood.[4] Food consumption frequency during this developmental stage can have long-term effects on health conditions such as coronary heart disease, diabetes, and some cancers.[5] Currently, there is a trend in the literature moving from the effects of specific nutrients to overall eating behaviour on mental health. Previous research has covered the beneficial effects of specific nutrients on cognition and behaviour.[6] Further, good dietary habits have been found to have positive effects on learning and attention and to reduce behavioural problems.[7]

Behaviour problems are becoming prevalent among children, and many such children with these problems are unidentified and untreated. Early behavioural difficulties are associated with a higher risk of persistence later in life; thus, such early behaviour requires parental attention.[8] One review study found there is a lack of evidence from short-term experimental studies for causality between diet—especially sugar intake—and behavioural problems.[9] This review emphasised the need for future studies to explore the association between diet and hyperactivity during childhood. One previous study conducted on Korean children reported fewer learning, attention, and behaviour problems among children with a higher consumption of dairy products and vegetables.[7]

Childhood is a pivotal period for the development of behaviour and cognition. Most previous studies have focussed on the associations between behaviour problems and infant breastfeeding duration or academic achievements.[10,11] One of the domains about which these studies do not provide detailed information is the association between early eating habits in terms of food consumption frequency and behaviour problems in the early years of life. A healthy diet is related to better cognitive function[12] and behavioural function.[13] Additionally, the consumption of a diet containing saccharides such as fruits and vegetables can improve the symptoms of attention deficit

hyperactivity disorder.[13] Diets with low levels of micro-nutrients and higher polyunsaturated fatty acids were found to be associated with behavioural problems such as hyperactivity and aggression.[11,14]

In another study, children with behaviour problems have been reported to be from homes with poor family function; low consumption of vegetables and fruits has also been reported among these families. Additionally, in this study, daughters of parents with psychological distress had lower consumption of fruits and vegetables than other children.[15] A review in the literature also reported that fathers' involvement in rearing children is associated with reduced behaviour problems.[16]

Dietary patterns in terms of food consumption frequency are known to vary among regions, and most studies regarding dietary pattern and behavioural problems have been conducted in Western countries; similar studies are needed to explore dietary patterns in Asian countries. Previous studies have been restricted to diets with a shortage of nutrients or food components. The concept of eating behaviour during childhood is an open research topic, especially regarding its effect on behavioural development. Further, little evidence has been provided regarding the association between eating behaviour in early childhood and behaviour problems later in life. Therefore, the purpose of the study was to examine the association between eating behaviour, specifically food consumption frequency in children aged 1–6 years, and their behaviour problems six years later. We hypothesised that eating behaviour in early childhood could predict behaviour problems in children later in their life.

Methods

Study design and participants

This study used the data from the 'Community Empowerment and Care for well-being and Health Longevity' (CEC) Cohort. The CEC is a longitudinal study that began in 1991 aiming to examine the factors associated with the well-being and health longevity of the residents of a suburban area in central Japan with approximately 5,000 residents. Questionnaires are distributed to all participants approximately every three years. The goal of the series of surveys is to provide information for creating health-promotion programmes to enhance the residents' quality of life. To avoid selection bias, this study utilised the questionnaire survey by introducing a complete

sampling frame. The survey was conducted by the researchers in collaboration with the municipal government, and local volunteers were assigned to distribute the questionnaires and collect them two weeks later to ensure that it was convenient for the residents to participate.

During the baseline year, 2011, 185 mothers with children aged 1–6 years responded to the survey. We excluded the data of six children from the baseline year because their mothers reported that they had mental health issues. In the 6-year follow-up, 34 of the mothers who had previously participated were no longer available (due to having moved or other similar reasons), and 21 others were dropped due to having missing values in the SDQ. Therefore, the 2017 data (the most recent year for which data was available) reported by 124 mothers for whom there was no missing information were included and analysed in the present study to examine the association between food frequency consumption and children's behaviour problems. Ethics approval for the CEC was provided by the ethics committee of the University of Tsukuba (1331-1). All participants provided written consent before participation.

Measurements

Behaviour problems

We assessed children's behaviour problems utilising the parent-reported Japanese version of the Strengths and Difficulties Questionnaire (SDQ).[17] The SDQ is a brief behavioural screening tool incorporating 25 items divided equally among five subscales; *conduct problems* (e.g. the child often loses his/her temper), *emotional symptoms* (e.g. the child has many worries or often seems worried), *hyperactivity/inattention* (e.g. the child is restless, overactive, and cannot sit still for long), *peer relationship problems* (e.g. the child is rather solitary or prefers to play alone), and *prosocial behaviour* (positive behaviours, e.g. the child is considerate of other people's feelings). Each item is scored using a three-point Likert scale (0 = not true, 1 = somewhat true, and 2 = certainly true). Scores for each item are summed to calculate subscale scores ranging from 0 to 10. Subscale scores for conduct problems, emotional symptoms, hyperactivity/inattention, and peer relationship problems are used to calculate a *total difficulties score* (the sum of 20 items) ranging from 0 to 40, and a prosocial behaviour score ranging from 0 to 10. The score for prosocial behaviour is not incorporated in the total difficulty score, as prosocial behaviour is conceptually different from psychological problems. A higher total difficulty score indicates a higher risk of

development of subsequent subscale behaviour problems. In contrast, higher scores in prosocial behaviour indicate a lower risk of developing prosocial behaviour problems.

Continuous SDQ scores are meaningful in epidemiological data and suitable for longitudinal studies, as they are sensitive to changes in children.[18,19] However, we categorised them into *normal* and *risk* groups based on the Japanese standard SDQ scores (a 20% cut-off percentile measured from the negative region of the spectrum). Risk groups were defined by scores of 4–10 points for the *conduct problems*, *emotional symptoms*, and *peer relationship problems* scales; 6–10 points for the *hyperactivity scale*; and 13–40 points for *total difficulty*.[20] For the *prosocial behaviour* scale, scores of 0–5 points indicate those at risk.[20] The parent-reported version of the SDQ is as efficient as a semi-structured interview technique,[18] and evidence has been provided for strong psychometric properties across several countries.[21] The reliability of the Japanese version of SDQ has been previously assessed, with reports showing the internal consistency coefficients (Cronbach's alpha) for the five subscales ranging from 0.52–0.69, and 0.77 for the total difficulty measurement. [20]

Food consumption frequency

Eating behaviour was measured using mother-reported items about children's eating frequency per week for different food items at baseline (2011). Mothers were asked 'How often does your child eat the following per week?: leafy green vegetables (e.g. spinach), light-coloured vegetables (e.g. cabbage), fruits, soybeans and soy products (e.g. tofu), milk and dairy products, eggs, fish, and seaweed'. Mothers responded using a four-point Likert scale (1 = *little*, 2 = *1–2 times per week*, 3 = *3–4 times per week*, 4 = *nearly every day*). The response alternatives were dichotomised into frequent consumption patterns and rare (infrequent) consumption patterns. Consuming a food item 3–4 times per week or more constituted *frequent consumption* and 0–2 times per week constituted *rare consumption*.[22] The quantity of food intake was not recorded; only the frequency of consumption was recorded for different food items.

Covariates

We collected data from mothers regarding demographic characteristics (age, sex, family structure, and siblings), health information (any acute illness, , having a paediatrician, and sleep pattern) and

parental care (mother's stress, father's support, and parent–child interaction). Demographic characteristics such as age (date of birth), sex (1 = boy and 2 = girl), family structure (dichotomised as if living with father and mother as a nuclear family vs living with parents and grandparents as extended family), siblings (1 = *yes* and 2 = *no*), health information (e.g. acute illness; 1 = *yes* and 2 = *no*), sleep condition (dichotomised into sufficient sleep if always and insufficient sleep if sometimes or not much; reported by respondents as 1 = *yes always*, 2 = *sometimes*, and 3 = *not much*), having a paediatrician (1 = *yes* and 2 = *no*), parental information such as mother's stress (dichotomised into always vs sometimes if response was sometimes, rarely or very little), father support (dichotomised into always proactive vs sometimes if response was sometimes or reluctant), parental interaction (dichotomised into every day if response was always and few times a week if response was 3–4 times/week, 1–2 times/week, or rarely). We chose these variables because they represented factors that could confound the relationship between eating habits and social-emotional development.

Statistical analysis

The main exposure was eating leafy green vegetables (e.g. spinach), light-coloured vegetables (e.g. cabbage), fruits, soybeans, and soy products (e.g. tofu), milk and dairy products, eggs, fish, and seaweed. Outcomes were conduct problems, emotional symptoms, hyperactivity/inattention, and the scores of the peer relationship problems subscale, prosocial behaviour scale, and total difficulty. There were three phases in our analysis. In the first phase, descriptive statistics were defined using frequencies. In the second phase, Fischer's exact test was used for the bivariate analysis to examine related factors with five aspects of the SDQ and total difficulty score. In the third phase, a multiple logistic regression model was used for a multivariable analysis and to explore the association between eating habits and social-emotional development. Only those factors were included in the regression model meeting statistical significance in Fischer's exact test. Out of the total six outcomes, conduct problems and prosocial behaviour were based on the result of Fischer's exact test. Two exposures were used in each logistic regression models: leafy green vegetables and light-coloured vegetables. We adjusted the regression models for demographic characteristics, health information and parental care based on the previous literature, both SDQ subscales were added separately. The analysis was carried out using SAS (university edition; SAS Institute, Cary, NC, USA). Statistical significance was set to $p < .05$.

Results

In total, data of 124 children aged 1–6 years was used in the study; 67 (54.1%) were boys, and 57 (45.9%) were girls. Of the participants, 99 (78.3%) had siblings, and 83 (67.1 %) lived with their extended families. In addition, 59 (47.6%) of mothers in the dyads were stressed, and only 30 (24.2%) of fathers supported mothers in childcare. Other relevant demographic information is presented in Table 1.

Regarding the bivariate association of participant's characteristics and behaviour problems, children with conduct behaviour risk were significantly associated with mother's stress ($p < .01$), acute illness ($p = 0.04$), and having a paediatrician ($p = 0.03$). Prosocial behaviour was found to be significantly associated with sex ($p = 0.01$) and parent–child interaction ($p < 0.01$) (Table 2). Regarding the other demographic characteristics (age, family type, siblings, sleep, and father's support) association with behaviour problems were not evident in our study.

The bivariate analysis between the food consumption frequency and behaviour problem revealed a significant association between conduct behaviour and frequency of consumption of leafy green ($p < 0.01$) and light-coloured vegetables ($p < 0.01$). Additionally, we also found a significant association between prosocial behaviour and frequency of consumption of leafy green ($p < 0.01$) and light-coloured vegetables ($p < 0.01$) (Table 3). Regarding the frequency consumption of milk, fruits, soybean and soy products, eggs, small fish, and seaweed, no significant association was revealed in the bivariate analysis.

Logistic regression was conducted for two outcomes that showed significant results in the bivariate analysis. Table 4 and Table 5 show the multivariable regression analysis results of both unadjusted and adjusted models (adjusted for age, sex, family type, siblings, any acute illness, having a paediatrician, sleep pattern, mother's stress, father's support, and parent–child interaction) for the conduct problems and prosocial behaviour problems subscales. Tables 4 and 5 show that children with frequent consumption of leafy green vegetables have 0.12-fold lower odds of conduct behaviour problem and 0.23-fold lower odds of prosocial behaviour problems than children consuming leafy green vegetables rarely. Additionally, children with frequent consumption of light-coloured vegetables have 0.19-fold lower odds of conduct behaviour problem and 0.19-fold lower odds of prosocial behaviour problems than children consuming rarely.

There was strong evidence for associations among frequent consumption of leafy green vegetables, light-coloured vegetables, and SDQ subscales (conduct problems and prosocial behaviour). Children frequently consuming leafy green and light-coloured vegetables showed a decreased risk of conduct and prosocial behaviour problems, both before and after adjustment. There were no associations between other food groups and any SDQ subscales.

Discussion

This study examined the association between eating habits in early childhood (1–6 years) and behaviour problems six years later in a sample of children from a suburban area in central Japan. The hypothesis that eating behaviour in early childhood would be associated with the behaviour problem was partially supported. Of the different food groups, only leafy green vegetables and light-coloured vegetables were associated with factors of behavioural development, such as problems with conduct and prosocial behaviour. The results showed that children who frequently consumed leafy green vegetables and light-coloured vegetables in the early years of their lives showed lower odds for conduct and prosocial behaviour problems. To our knowledge, this relationship has not been shown earlier in early childhood in Japan.

Few studies have explored the relationship between behavioural development and food consumption frequency in early childhood. A recent Australian study showed that children who have behavioural problems and lower prosocial behaviours are from poorly functioning households consumed fewer fruits and vegetables.[15] This is consistent with our results regarding vegetable intake. However, in our study, no association was found between fruit intake and behaviour problems.

This study sought to examine the effects early childhood eating behaviours have on social behaviour development, filling a gap in the literature from previous research, which focussed on adolescents.[22] Peacock et al. demonstrated a ‘junk pattern’ and non-milk extrinsic sugar are associated with total difficulty scores and low prosocial behaviour scores.[23] However, these associations were attenuated substantially following adjustment. In this study, we did not observe any associations between any food items and total difficulty scores. Fish intake is associated with omega-3 fatty acids, and an early study in Japan and a later review showed that having a high number of behaviour problems is associated with low total omega-3 fatty acid intake.[24,25,26]

However, a study conducted in Australia found no association between fatty acids and Attention-deficit/Hyperactivity disorder symptoms.[27] Further, a randomised controlled trial showed no improvement in children with aggression and disruptive behaviour with fish oil treatment.[28] We can relate these findings to our results, in that we did not find any association between a low intake of fish and behaviour problems. This result could have occurred because the age group measured at baseline was 1–6 years, and the frequency of fish intake was lower in our total sample than it would be with older participants.

This study extended findings demonstrating an association between vegetable intake and behaviour problems in childhood significantly. The mechanism behind this relationship is not yet clear; however, a possible mechanism may be connected to the function of dopamine in maintaining attention and controlling impulsive behaviour.[29] Vitamins B6 and C act as coenzymes involved in the production of dopamine,[12] and vegetables are a source of Vitamin B6 and vitamin C. The primary strength of the study was the collection of detailed data from a large prospective cohort in central Japan. The collection of data on chronic disease status during the baseline year helped us exclude children with mental illness. Moreover, it enabled us to investigate 'new cases' of behavioural problems. In addition, the wealth of data collected throughout the cohort permitted us to adjust for several potential confounders.

A potential limitation of the study was that only one suburban community from central Japan was included in the study; therefore, a more comprehensive geographical survey should be conducted to generalise the results. We utilised parentally completed SDQ scores, which could have led to parents underestimating behavioural problems, which would have decreased the likelihood of associations with other food items. Another limitation is that several potential factors that previous studies noted to be associated with behaviour problems, such as the family's socioeconomic status, parents' educational level, and the mother's well-being were not included in the questionnaire. We aimed to clarify which food item consumed at the baseline year is associated with behaviour development; therefore, we did not assess eating behaviour as a time-varying covariate. Further detailed investigations are required to explore changes in eating behaviour and behaviour development.

It is possible that using food frequency questionnaires to determine underlying eating behaviour may not be an appropriate method for this particular outcome. Using the quantitative analysis for

each food item could have provided further associations. However, a validation study showed that a food frequency questionnaire could identify those with high and low food intake and showed a moderate capability for ranking individuals by food intake.[30] Neurodevelopmental disorders, such as conduct disorders, are moderately heritable with different genetic factors; it was out of scope for our study. In the future, genetic factors and biological and environmental factors should be considered together to explore the causality.

However, the results of this study showed that eating vegetables in early childhood were related to reduced odds of behaviour problems, primarily conduct behaviour and prosocial behaviour problem. Increased behaviour problems in children is a serious public health issue. Therefore, healthy eating patterns in early life and introducing more vegetables to the diet could ensure optimal mental and behavioural performance later in life.

Conclusion

Keeping the aforementioned admonition in mind, our findings are consistent with those showing associations between diet and mental health, offering evidence indicating that a diet rich in vegetables could prevent behaviour problems in children. Given the considerable pressure of increasing behaviour problems in children, determining whether the introduction of vegetables in the diet could prevent behaviour problems is of principal public health importance. More research is warranted to examine this relationship and should incorporate some interventional studies to determine whether dietary habits could prevent or improve behaviour problems in children.

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385 **Table 1**. Participant demographics at the baseline year

Items	No	Rate (%)
Age		
1–3 years	63	50.8
4–6 years	61	49.2
Sex		
Boys	67	54.1
Girls	57	45.9
Family type		
Nuclear family	41	32.9
Extended family	83	67.1
Siblings		
No	25	20.2
Yes	99	79.8
Acute illness		
Yes	13	10.5
No	111	89.5
Enough sleep		
Always	108	87.2
Sometimes	16	12.9
Having a paediatrician		
Yes	83	66.9
No	41	33.1
Mother's stress		
Yes	59	47.6
No	65	52.4
Father's support		
Yes	30	24.2
No	94	75.8
Parent–child interaction		
Everyday	91	73.4
Few times a week	33	26.6
Total	124	100

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Table 2. Associations between demographic characteristics and behaviour problems 6 years later

Demographic variables	Category	Conduct problem					Prosocial behaviour				
		Normal group		Risk group		*p*	Normal group		Risk group		*P*
		n	%	n	%		n	%	n	%	
Sex	Boys	43	64.2	24	35.8	0.14	30	44.8	37	55.2	0.01
	Girls	35	61.4	22	38.6		36	63.2	21	36.8	
Acute Illness	Yes	5	38.5	8	61.5	0.04	9	69.2	4	30.8	0.11
	No	73	65.8	38	34.2		57	51.4	54	48.6	
Having a paediatrician	Yes	47	56.6	36	43.4	0.03	41	49.4	42	50.6	0.07
	No	31	75.6	10	24.4		25	60.9	16	39.1	
Mother's stress	Yes	32	52.3	27	45.7	0.02	32	54.3	27	45.7	0.13
	No	46	70.7	19	29.3		34	52.3	31	47.7	
Parent–child interaction	Everyday	60	65.9	31	34.1	0.08	56	61.6	35	38.4	< .01
	Few times a week	18	54.5	15	45.5		10	30.3	23	69.7	

Notes. Results determine using Fischer's exact test. *P*-values of < .05 were considered significant.

Table 3. Association between food consumption frequency and behaviour problems six years later

Food items	Category	Conduct problems				Prosocial behaviour				*P*
		Normal group		Risk group		Normal group		Risk group		
		n	%	n	%	n	%	n	%	
Leafy vegetables	Frequently	72	70.6	30	29.4	63	58.8	42	41.2	< .01
	Rare	6	27.2	16	72.7	6	27.3	16	72.7	
Light-coloured vegetables	Frequently	72	68.6	33	31.4	62	59.1	43	40.9	< .01
	Rare	6	31.6	13	68.4	4	21.1	15	78.9	

Note. Results of Fischer's exact test. P-values of < .05 were considered significant.

Table 4. Odds of conduct problems by eating vegetables: Results of multiple logistic regression

Food items	Unadjusted OR		*P*	Adjusted OR[a]		*P*
	OR	95% CI		OR	95% CI	
Leafy green vegetables	0.15	0.05–0.43	<.001	0.12	0.04–0.41	< .001
Light-coloured vegetables	0.21	0.07–0.61	<.001	0.19	0.06–0.61	.005

Abbreviations: OR, odds ratio; CI, Confidence interval

[a]Adjusted for demographic characteristics (age, sex, family type, siblings), health information (any acute illness, having a paediatrician, and sleep pattern), and parental care (mother's stress, father's support, and parent–child interaction).

Table 5. Odds of prosocial behaviour problems by eating vegetables: Results of multiple logistic regression

Food items	Unadjusted OR		*P*	Adjusted OR[a]		*P*
	OR	95% CI		OR	95% CI	
Leafy green vegetables	0.26	0.09–0.72	.01	0.23	0.07–0.74	.01
Light-coloured vegetables	0.18	0.05–0.59	< .01	0.19	0.05–0.69	.01

Abbreviations: OR, odds ratio; CI, Confidence interval

[a]Adjusted for Demographic characteristics (age, sex, family type, siblings), Health information (any acute illness, having a paediatrician, and sleep pattern) and parental care (mother's stress, father's support, and parent–child interaction).