

Original Article

Nutrient intake and dietary patterns in children 2.5-5 years of age with picky eating behaviours and low weight-for-height

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Background and Objectives: Picky eating behaviours are common in young children and may adversely affect dietary intake. This study examined the adequacy of dietary patterns and nutrient intake in preschool-aged children in China and Hong Kong with picky eating behaviours and weight-for-height in the lowest quartile of the WHO Growth Standards. **Methods and Study Design:** Dietary intake was assessed using baseline 3-day food records from a multicenter, randomized trial in Chinese children (N=151) ages 2.5-5 years characterized as picky eaters by their parents and with weight-for-height $\leq 25^{\text{th}}$ percentile of the WHO Growth Standards. Nutrient intakes were calculated using validated dietary analysis software and compared with age-appropriate Chinese Recommended Nutrient Intakes (RNIs). Dietary patterns were compared with Hong Kong Food Pyramid recommendations. **Results:** Median daily energy intake was 25% lower than the age-appropriate RNI, while median intakes of calcium, iron, zinc, and vitamins C and E ranged from 52%-73% of the RNI. Vitamin D intake was only 37% of the RNI. Total fat and sodium intakes exceeded recommendations by 10% and 56%, respectively, while >16% of daily energy was derived from foods in the sweets/beverages/snack and the fats/oils groups. Almost 75% of the children met the recommended daily servings of meat/meat substitutes and nearly half met the recommendation for daily servings of fruit. Fewer met the recommendations for daily servings of vegetables (14.7%), milk/milk products (6.3%), and grains and cereals (6.3%). **Conclusions:** Young children with picky eating behaviours and low weight-for-height had suboptimal dietary patterns and were at risk for significant dietary and nutrient insufficiencies.

Key Words: picky eating, fussy eating, poor eating, preschooler, dietary intake

INTRODUCTION

Children who exhibit picky eating behaviours typically consume a limited variety of foods, eat small portions, skip meals, eat slowly, resist trying new foods, demonstrate strong food preferences and/or show little interest in food.^{1,2} Often these behaviours are short-lived and present little reason for concern.³ However, many parents report picky eating behaviours as problematic and persisting longer than two years.⁴ In some cases, these behaviours may extend well beyond the toddler years.^{1,4} Consequently, for some children, picky eating behaviours have the potential to adversely affect dietary intake and quality, weight, normal growth, and future health outcomes.⁵⁻¹¹

Observational studies^{4,6-7,12-16} indicate that picky eating

is a common problem reported by parents of young children in many different countries and regions of the world, although overall prevalence rates vary considerably depending on the child's age and how picky eating is defined and measured.^{6,17-19} In the United States (US), prevalence estimates as high as 50% have been reported in toddlers,⁶ although lower rates have been reported as

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well.¹⁷⁻¹⁸ Several studies conducted in North America have found lower intakes of energy, protein, vitamins, and minerals, as well as vegetables and fruits, among picky eaters compared with non-picky eaters.^{2,7,20}

Rates of picky eating in young children also vary considerably in China, ranging from 7%-48%.^{12,16,21} Until recently, the dietary patterns of young Chinese children with picky eating behaviours were not well characterized. Li et al¹⁶ examined dietary intake of 1,663 infants and toddlers ages 4-36 months from 8 cities in China and reported that 24% of younger picky eaters (7-12 months) avoided consuming dairy products, while nearly 50% of older picky eaters (25-36 months) avoided eating vegetables. It is unclear if the dietary patterns identified by Li and colleagues¹⁶ were associated with lower nutrient intake, as previously documented in studies of picky eating in North America.^{2,7,20} Despite several studies that have reported that picky eaters are more likely than non-picky eaters to be underweight,^{8,11,15,22} to our knowledge there are no published data on the dietary patterns and nutrient intake of picky eaters with low weight-for-height percentile in China and Hong Kong. This group is of particular interest as they may have a higher risk for nutritional inadequacies compared with normal weight picky eaters and non-picky eaters. The purpose of this study was to examine the adequacy of dietary patterns and nutrient intake in a group of preschool-aged children in China and Hong Kong who had picky eating behaviours and had weight-for-height measurements at or below the 25th percentile of the WHO Growth Standards.²³

METHODS

This study examined dietary intake data collected at baseline from a multicenter, randomized, controlled trial²⁴ in 153 children 2.5-5 years of age who were characterized as picky eaters by their parents and had weight-for-height measurements $\leq 25^{\text{th}}$ percentile of the WHO Child Growth Standards.²³ The children were identified as picky eaters based on their parents' reports of common picky eating behaviours (e.g., child consumes a limited number of foods, is unwilling to try new foods, eats slowly, lacks interest in eating, and/or does not eat enough). Detailed methods and outcomes from the interventional study have been reported previously.²⁴ Briefly, data were collected between February and December 2010 in the People's Republic of China (Xinhua Hospital; Nanjing Maternity and Child Health Care Hospital, Jinan Children's Hospital and Wuxi People's Hospital) and Hong Kong (Prince of Wales Hospital). The study was approved by each institution's ethics committee (EC) [primary committee: Ethics Committee of Xinhua Hospital affiliated to Shanghai Jiaotong University School of Medicine, EC approval number NO.038 (2009)]. Written informed consent was obtained from parents prior to the start of the study. The study was registered at ClinicalTrials.gov (NCT01823302).

Of the 153 randomized children, 151 parents or caregivers completed a baseline 3-day food record (2 weekdays; 1 weekend day) and were included in the analysis. Details of food, drinks and dietary supplements, including brand names and amount consumed, were recorded by parents, caregivers or preschool teachers. Meals eaten at

preschool were validated against the preschool menu and recipes were collected for all multi-ingredient dishes. To minimize recording and portion-size errors, detailed instructions were provided along with a Dietary Nutrition Survey Guide²⁵ containing pictures of 180 common foods in typical household containers. All dietary intake data were calculated by trained study personnel using the Nutrition Data System for Research (Database version 2009; © 2009 Regents of the University of Minnesota dietary analysis program). The US foods database was utilized due to the lack of a comparable Chinese nutrient and food group database. Median daily nutrient intakes were calculated and compared with age- and sex-appropriate Chinese Recommended Nutrient Intakes (RNIs).²⁶ For the nutrient analysis, the child's exact age was used for comparison, whereas for the analysis of dietary patterns, the food group intake was compared to the lower end of the Hong Kong Food Pyramid recommended range for children 3-6 years of age. Only a few children (16.6%) were between 2.5 and 3 years of age, therefore, comparison to the lower end of the recommended range for children 1-3 years of age was considered inappropriate for these subjects. Dietary intake was also evaluated in comparison with food group recommendations in the Hong Kong Food Pyramid.²⁷ This guideline was selected for comparison because the recommendations in the Chinese Food Guide Pagoda do not include quantitative recommendations for food group intake in children 2.5-5 years of age.

RESULTS

Study population

The mean (standard deviation, SD) age of the 153 children enrolled in the clinical trial was 3.8 (0.7) years, with a range of 2.5-4.9 years. Slightly more than half of the subjects were girls ($n=83$; 54.2%). Mean weight of the group was 13.5 (1.8) kg; mean height was 98.9 (6.8) cm. Mean weight-for-height percentile was 11 (7.4). Nearly 80% ($n=122$) of the children attended preschool and approximately 47% ($n=71$) of mothers and 51% ($n=78$) of fathers attended some college.

Nutrient intake

Median daily intakes of selected nutrients are shown in Table 1. Overall median energy intake was slightly less than 1,000 kilocalories/day, which is 25% lower than the age-appropriate Chinese RNI. In contrast, the proportion of total energy intake from fat was 33%, exceeding the recommended intake by nearly 10%. Median protein intake was within the age-appropriate Chinese RNIs. Among micronutrients, median vitamin D intake was only 37% of the Chinese RNI, while median intakes of calcium, iron, zinc and vitamin C were each $< 2/3$ of their respective RNI values. In contrast, median sodium intake was 56% higher than recommended. Other nutrients with median intakes above RNI values included phosphorous, potassium, magnesium, selenium, folic acid, vitamin B-6 and vitamin B-12.

Dietary patterns

On average, grains and cereals contributed approximately 1/3 of the children's daily energy intake (Figure 1) and this food group was the largest contributor of kilocalories

Table 1. Daily nutrient intake

Nutrient	Median intake (Q1, Q3)	Chinese RNI [†]	Intake as percentage of Chinese RNI [‡] median (Q1, Q3)
Total energy (kcal/day)	996 (837, 1,120)	1,150-1,450	75 (62, 86)
Protein (g/day)	43 (35, 51)	40-50	94 (74, 113)
Total fat (% total kcal)	33 (28, 37)	30-35	110 (95, 122)
Calcium (mg/day)	429 (340, 561)	600-800	63 (49, 83)
Phosphorus (mg/day)	681 (522, 795)	450-500	141 (112, 171)
Iron (mg/day)	7.5 (5.8, 9.4)	12	63 (49, 78)
Zinc (mg/day)	5.4 (4.4, 6.3)	9-12	52 (42, 64)
Sodium (mg/day)	1,138 (888, 1,436)	650-900	156 (117, 193)
Potassium (mg/day)	1,221 (949, 1,531)	1,000-1,500	105 (76, 138)
Magnesium (mg/day)	136 (99, 163)	100-150	110 (83, 145)
Selenium (μ g/day)	78 (61, 95)	20-25	346 (273, 437)
Vitamin A (μ g/day)	436 (298, 708)	500-600	82 (55, 130)
Vitamin D (μ g/day)	3.7 (2.6, 4.8)	10	37 (26, 48)
Vitamin E (mg/day)	3.2 (2.4, 4.6)	4-5	73 (52, 99)
Vitamin C (mg/day)	39 (25, 60)	60-70	60 (39, 98)
Folic acid, (μ g DFE/day)	252 (197, 311)	150-200	148 (115, 188)
Vitamin B-6 (mg/day)	0.8 (0.6, 1.0)	0.5-0.6	147 (115, 188)
Vitamin B-12 (μ g/day)	2.4 (1.8, 3.4)	0.9-1.2	240 (174, 326)
Choline (mg/day)	215 (164, 266)	200-250	99 (75, 121)

DFE: dietary folate equivalent; kcal: kilocalorie; Q1: lower quartile; Q3: upper quartile; RNI: Recommended Nutrient Intake.

[†]Range is provided for RNIs that vary by sex and age.

[‡]Each subject's average daily intake was compared with appropriate sex- and age-group RNIs; median percentage of RNI is reported.

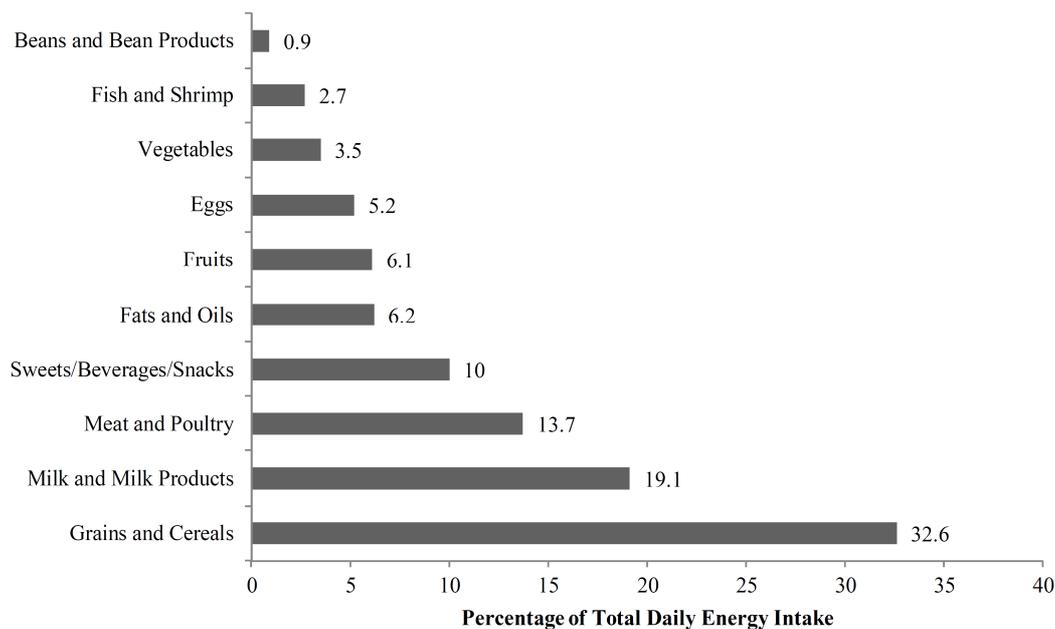


Figure 1. Percentage of total daily energy intake from select food groups in children ages 2.5-5 years with picky eating behaviours and weight-for-height $\leq 25^{\text{th}}$ percentile (WHO Growth Standards)

in the children's diets. Nonetheless, only 6.3% of children in this study met the recommended intake of grains and cereals, as defined by the Hong Kong Food Pyramid (Table 2). When combined, the meat and meat substitute groups (i.e., meat and poultry, fish and shrimp, eggs, beans and bean products) contributed approximately 23% of daily energy intake, and nearly 3/4 of the children met the Hong Kong Food Pyramid recommendation for meat and other protein sources. Whereas milk and milk products contributed 19% of daily energy, only 6.3% of the children consumed the recommended intake of 480 mL/day. Approximately 16% of the children's daily energy intake came from foods in the fats and oils and

sweets, beverages and snack foods categories. Although fruits contributed only 6% of total energy, a substantial proportion of children (47%) met the Hong Kong Food Pyramid recommendation for fruit consumption and the median daily intake of fruit exceeded the recommended amount. In contrast, only 14.7% of children met the Hong Kong Food Pyramid recommendation for vegetable consumption and the median amount consumed was approximately 50% below the recommended level.

DISCUSSION

Limited data are available on the dietary practices and nutrient intake of young children with picky eating be-

Table 2. Daily consumption of food groups

Food group	Median daily intake (Q1, Q3)	Hong Kong Food Pyramid Recommendation	Number (%) of children who met food pyramid recommendation
Grains and cereals (g)	193 (144, 255)	400-600 g	9 (6.3)
Vegetables (g)	79 (48, 128)	152-228 g	21 (14.7)
Fruits (g)	97 (57, 154)	80 g	67 (46.9)
Meat and meat substitutes (g)		76-114 g	105 (73.4)
Meat and poultry	65 (37, 95)		
Fish and shrimp	22 (10, 38)		
Eggs	30 (16, 53)		
Beans and bean products	13 (7, 21)		
Milk and milk products (mL)	166 (101, 282)	480 mL	9 (6.3)
Fats and oils (g)	7 (3, 16)	Eat less	NA
Sweets, beverages, and snack foods (g)	33 (15, 56)	Eat less	NA

Q1: lower quartile; Q3: upper quartile.

behaviours who fall into the lower percentiles of weight-for-height. The present study, which examined baseline dietary records from a group of children with picky eating behaviours and weight-for-height $\leq 25^{\text{th}}$ percentile who were enrolled in a randomized trial, provides new insight on potential unmet nutritional needs in this unique pediatric population. Intake of protein among children in this study was at the recommended level, which is consistent with previous studies in picky eaters in the US^{2,28} and Canada.⁷ In contrast, a cross-sectional study²⁹ that evaluated the dietary intake of 911 healthy Chinese children (aged 3-7 years) using a single 24-hour dietary recall found a lower intake of protein among picky eaters compared with non-picky eaters.

In the present study overall energy intake was 25% lower than recommended for this population. Similarly, a study in Canadian preschool children (ages 2.5-4.5 years)⁷ found that those considered to be picky eaters consumed fewer kilocalories/day than non-picky eaters. These findings are in contrast to previous studies^{6,28} of US toddlers with picky eating behaviours who were not selected on the basis of their weight, which have reported that energy intake either met or exceeded age-appropriate recommended intakes. A study conducted in Finland³⁰ in older children (5 years of age) also found comparable energy intake between poor eaters and a non-poor-eater comparison group when intake was adjusted for weight. Similarly, energy intake among Chinese preschoolers described by their parents as somewhat or always picky eaters did not differ from that of non-picky eaters.²⁹ These results indicate that in some populations of young children, energy intake can be affected negatively by picky eating behaviours and should be considered a reasonable concern for parents and caregivers to share with their child's healthcare provider.

Intake of certain micronutrients was another area of concern for the children in the present study. Vitamin D intake was especially low, with a median intake of only 37% of the Chinese RNI. Carruth et al²⁸ previously reported inadequate intake of zinc and vitamins D and E among young children in the US with picky eating behaviours, although intake of other micronutrients was either close to or higher than recommended levels. Another study in young picky eaters in the US⁶ reported adequate mean intake for all micronutrients evaluated.⁶ In a study

of preschool children in Hong Kong who were not selected for picky eating, mean vitamin D intake was 60% of the Chinese RNI.³¹ Calcium and iron intakes in these children were also below RNI levels, but to a lesser extent (88% and 94% of the RNI, respectively) than observed in the present study (63% of the RNI for both nutrients). The consistent finding of low vitamin D intake in studies of children with picky eating behaviours is particularly concerning given that 1,25-dihydroxyvitamin D functions as a hormone and plays an important role in metabolism and bone mineralization. However, vitamin D₃ (cholecalciferol) is also produced by humans after exposure to sunlight. Thus, although findings suggest a possible need for supplementation in those children with the lowest intake levels, a true vitamin D deficiency can only be confirmed by examining serum 25-hydroxyvitamin D (25OHD) concentrations.²⁹

Limited data are available for comparison of nutrient intake in the present study population with intake in the general population of toddlers in China. Xue et al³⁰ assessed the dietary intake of a large cohort of Chinese preschool children from a wide geographical region and differing socioeconomic levels and reported that picky eaters consumed less iron and zinc than non-picky eaters, but the investigators did not report on vitamin D intake. Findings from another single 24-hour dietary recall administered in a cross-sectional study of 1,409 infants and toddlers from 8 cities in China indicated that an estimated 1/3 of toddlers in China consume less than recommended levels of several vitamins (thiamin, vitamin B₆, vitamin C) and minerals (calcium, magnesium).³³ In contrast, US preschoolers have been shown to consume adequate amounts of these micronutrients³⁴ suggesting that important differences exist in the typical nutrient intake between preschoolers in China and those in the US. Picky eating behaviours may further amplify these differences in nutrient intake between Chinese and US toddlers, particularly for those nutrients consumed at less-than-recommended levels. Further studies are needed to explore this possibility.

The children in the present study consumed a substantial amount of energy (16%) from foods in the fats and oils group and the sweets, beverages and snack foods group. It is likely that these foods contributed to the higher-than-recommended fat and sodium intakes observed in

this study. Recently, Lee and colleagues³⁵ reported frequent consumption of “red light” foods (e.g., chips, soft drinks, sweets, cakes, fried foods) in a study of over 4,500 preschool children in Hong Kong. For example, in the 7 days preceding the survey, nearly 50% of the preschoolers had consumed sweets 3 or more times and 35% had eaten cakes 3 or more times. Moreover, the investigators noted that the proportion of Hong Kong preschool children meeting recommended intakes of protein, fresh fruit, and vegetables was significantly lower among children consuming high levels of these energy-dense, nutrient-poor foods. While a high proportion (70%) of the Hong Kong preschoolers met the recommendation for grains and cereals, only 46%, 39%, 35% and 19% met the recommended intakes for fruits, meats and meat substitutes, milk and milk products and vegetables, respectively.³⁵ With the exception of meat and meat substitutes and fruits, the present study in children with picky eating behaviours in China and Hong Kong found much lower rates of children who met the Hong Kong Food Pyramid recommendations, suggesting that suboptimal dietary patterns that are common in the general Hong Kong preschool population may be even more prevalent in children with picky eating behaviours and low weight-for-height. It is notable that intake of milk and milk products contributed 19% of daily energy in the present study, yet only 6% of the children consumed the recommended amount. This finding suggests that in the current group of children, consumption of milk and milk products did not appear to negatively influence appetite or replace other food groups, as others have reported previously.³⁶

Overall, compared with prior studies in other populations of young children with picky eating behaviors,^{6,28-30} the present study found a greater number of nutrients and food groups that were consumed in less-than-recommended amounts. Geographic location and cultural food practices are obvious factors contributing to differences in dietary intake between study populations; perinatal factors such as birth weight and gestational age at birth may also contribute to differences in weight status along with dietary intake.³⁶ In addition, dietary intake was assessed with a US-food-based dietary analysis software program, which may affect the validity of the assessment in a Chinese population. Finally, children in the current study were recruited from clinical pediatric practices based on parents’ reports of picky eating and the child’s weight-for-height percentile. It is possible that children whose parents discuss their concerns about picky eating with their children’s health care providers have more significant nutritional risks than those who are identified as picky eaters in community or school-based samples.

In conclusion, in China and Hong Kong, children who were described by their caregivers as having picky eating behaviors and who were in the lowest quartile of weight-for-height consumed on average less than the recommended age-appropriate Chinese RNI for total energy, but consumed more than the recommended proportion of kilocalories from fat. In addition, median micronutrient intake among children with picky eating behaviors was below the Chinese RNI for a number of key nutrients including calcium, iron, zinc, vitamin C and vitamin E, and was especially low in vitamin D. When

compared with the Hong Kong Food Pyramid, children with picky eating behaviors commonly consumed less than recommended amounts of all food groups, but relatively high levels of sweets and fats. Regular consumption of a dietary pattern that differs considerably from the Hong Kong Food Pyramid may result in chronic insufficient intake of energy and micronutrients. Additional research is needed to further characterize the eating habits of children with picky eating behaviors, particularly those in lower weight percentiles, and to assess any related long-term health or developmental consequences.

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