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Food Neophobia and Nutritional Outcomes in Primary School-Children

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ABSTRACT

Food neophobia, unwillingness to try novel foods, is a personality trait that can influence children's food preferences and consequently their food acceptance and consumption. The purpose of this study was to determine whether children with food neophobia have poor dietary and growth outcomes compared to non-neophobic children. Subjects were 332 primary school children from 6 randomly selected schools in the district of Hulu Selangor, Selangor. Parents and children were interviewed to obtain demographic, socio-economic, food neophobia and dietary intake information. The children were also measured for weights and heights. One-way ANOVA and Chi-square procedures were utilized for statistical data analysis. Children with food neophobia had higher intakes of energy and most nutrients than average and neophilic children. However, only the mean intakes of protein($p < 0.05$), fat($p < 0.05$), vitamin A($p < 0.01$) and iron ($p < 0.01$) were significantly higher in neophobic than average or neophilic children. Compared to neophilic and average groups, a higher percentage of neophobic children met 2/3 of the RNIs for energy(85.2%), protein(98.4%) and vitamin A(72.1%). Mean percentage of carbohydrate energy was lowest($54.8 \pm 6.6\%$) while fat energy($31.8 \pm 6.2\%$) %) was highest among neophobic children. Neophobic group had the lowest percentage of children(49.2%) with carbohydrate energy >55% but highest percentage(50.8%) with fat energy >30%. For the three study groups, the mean number of servings for all food groups, except grain and cereal, did not meet the Food Pyramid recommendations. Neophobic children consumed significantly more numbers of servings from the meat group than average and neophilic groups($p < 0.01$). All study groups had relatively low mean dietary diversity scores but neophobic children had the lowest score(0.67 ± 0.73) compared to the average(0.97 ± 0.72) and neophilic(1.98 ± 0.81) groups. Significant difference in mean dietary diversity scores were only observed between neophobic and neophilic children($p < 0.05$). Higher percentages of neo-phobic children had low weight-for-height and were at-risk of overweight($p < 0.05$). Nutrition practitioners need to understand children's food preferences in their efforts to promote healthful diets for children. To improve children's eating behaviors, parents may need the guidance and support from nutritionists and dietitians that are specific to their needs and their child's situation. (*J Community Nutrition* 7(3) : 121~129, 2005)

KEY WORDS : food neophobia · dietary diversity · growth outcomes.

Introduction

Food preferences are important determinants of the nutritional quality of children's dietary intake(Domel et al. 1996 ; Fisher, Birch 1995). Research has shown that children tend to eat similar foods repeatedly, have the tendency to choose familiar foods, prefer foods that are high in sugar and fat and consume limited servings of fruits and vegetables(Birch, Fischer 1998 ; Drewnowski 1989). For many children, instead of consuming a variety of foods, fortified foods such as ready-to-eat cereals are the main sources of vitamins and minerals(Subar et al. 1998). These food consumption patterns, which are based on limited food choices, may result in intakes below the recommended levels for some nutrients. For example, lack of fruit and vegetable intakes may deprive the children of essential micronutrients and other dietary components such as fiber and phytochemicals that can be beneficial to health(Van Duyn, Pivonka 2000).

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A characteristic of some children that will influence food preferences is food neophobia which refers to an unwillingness to eat unfamiliar foods or reluctance to try novel foods (Pliner, Hobden 1992). Research findings, however, have been inconsistent in whether food neophobic children reject all unfamiliar foods or only some types of food(Cashdan 1998 ; Pliner 1994). Food neophobia is also assumed to be an adaptive trait that provides protection against foods that can be potentially harmful to health(Cooke et al. 2003 ; Pliner et al. 1993). It has also been suggested that there is an age effect of food neophobia in that the phenomenon is minimal during infancy, increases throughout early childhood and gradually decreases until adulthood(Cashdan 1994). While some have found that boys are more food neophobic than girls(Koisvisto et al. 1997), others did not find any gender differences in this personality trait(Falciglia et al. 2000 ; Wardle et al. 2005). In children, food neophobia can lead to dietary repetition and affect both food variety and the overall diet quality(Birch, Fisher 1998 ; Cooke et al. 2003 ; Falciglia et al. 2000).

There are several available instruments to assess individual differences in food neophobia. Food Neophobia Scale (FNS), a 10-item instrument was developed by Pliner and Hobden(1992) to measure food neophobia in adults. The FNS has also been used in several studies with children (Falciglia et al. 2000 ; Galloway et al. 2003 ; Zalilah, Zaidah 2005). Other measurements of food neophobia include Food Attitude Scale(FAS)(Frank, Van Der Klaauw, 1994) and a revised version of FAS or FAS-R(Raudenbush et al. 1998) which measured familiarity to food items using a 5-response scale. Recently, Loewen & Pliner(2000) developed a 10-item self-reported measure of food neophobia which was designed specifically for children.

As this personality trait may contribute to limited food choices, children with food neophobia are at risk of having less varied and inadequate diets. The purpose of this study was to determine the differences in dietary and growth outcomes among school children according to their willingness to try unfamiliar or new foods. We hypothesized that children with food neophobia would have lower intakes of energy and nutrients, inadequate servings from all food groups, lack dietary diversity and poor growth status compared to children who were more willing to try unfamiliar or new foods.

Materials and Methods

1. Subjects

Subjects were school children in Primary 2 and 3(7 - 9 years old) from 6 randomly selected national schools in Hulu Selangor, a district in the state of Selangor, Malaysia. All children(n=882) were given printed information on the research for their parents. Participation in the research was voluntary and parents were requested to sign the consent forms if they agreed to participate in the research. The final sample consisted of 332 children with 158 and 174 boys and girls, respectively. The research protocol was approved by the Ethics Committee of Faculty Medicine and Health Sciences, University Putra Malaysia and Ministry of Education of Malaysia. Data collection was carried out from September 2002 to May 2003.

2. Measurements

1) Food neophobia scale

Food Neophobia Scale(FNS) consists of 10 items with a 7-point rating scale. The score ranges from 10 to 70 with the highest score indicate a high degree of food neophobia. FNS has been shown to have high internal consistency(α = 0.88) and test-retest reliability(r = 0.8 to 0.9)(Pliner & Hobden 1992). In our previous study, some of the words in the items were modified for suitability in the Malaysian culture and the instrument yielded a good internal consistency of α = 0.71(Zalilah, Zaidah 2005). The internal consistency of the instrument for the present sample was α = 0.74. Using the scale, children who were unwilling to try new foods(food neophobia), children with average willingness to try new foods(average) and children who were very willing to try new foods(food neophilia) are defined as children with scores greater than 1.0 standard deviation(SD) above the mean, within 1.0 SD above or below the mean and greater than 1.0 SD below the mean of the study sample, respectively (Falciglia et al. 2000).

2) Dietary intake

Dietary data was obtained for 1 weekday and 1 weekend by trained graduate students in the community nutrition program at University Putra Malaysia using the 24-hour dietary recall method. Face-to-face interviews were conducted with both the childcare giver(e.g. parents) and the children. The childcare givers were requested to provide dietary information when the children were not in school, while the children were asked to recall the foods that they consumed during school hours. Common household measurements(e.g. cups, spoons, ladles, plates) were utilized to facilitate the dietary recall. In cases where children had difficulty to recall the food consumed during school hours, the children were asked to show the types of food consumed that were available in the school canteens or at the nearby shops or hawkers' stalls. All dietary recalls were reviewed for accuracy and completeness.

The energy and nutrient intakes from the two days 24-hour recalls were calculated using Nutrical software which utilized the Malaysian Food Database(Tee et al. 1997). The average value of energy and nutrient intakes over the two days was taken for final analyses. The value was then compared to the Recommended Nutrient Intakes for Malaysia (RNIs)(NCCFN 2005). Percentage of energy from macronutrients(carbohydrate, fat and protein) was calculated and compared to the recommended distribution: carbohydrate (55 - 70%), protein(10 - 15%) and fat(20 - 30%)(NCCFN 2005). The number of servings for each food group (grain and cereal, fruit, vegetable, meat and milk) was calculated based on the Food Pyramid for children(Bright Start Nutrition 2000). The calculation for dietary diversity score (DDS) was adapted from Kant et al.(1993) and Drewnowski et al.(1996) in which 1 point was given to each food group if the minimum recommended number of servings(grain and cereal - 6 ; vegetables - 2 ; fruits - 2 ; meat - 2 ; milk - 2) were consumed. The DDS ranges from 0 to 5 with a score of 0 indicates no minimum number of servings for the five food groups was met while increasing scores reflect increased dietary diversity.

3) Growth parameters

Weights and heights of the children were measured using SECA digital weighing scale and SECA body meter, respectively. The measurements were recorded to the nearest 0.1kg for weight and 0.1cm for height. The average of two measurements of weight and height were used to calculate the z scores for height-for-age and weight-for-height. The z scores were then used to categorize the children into these categories(WHO 1983) - low height-for-age(<- 1SD), normal height-for-age(> -1SD), low weight-for-height(< -1 SD), normal weight-for-height(-1 SD to 2 SD) and high weight-for-height or at-risk of overweight(>2 SD)

4) Data analysis

All data were analyzed using Statistical Package for the Social Sciences version 11.0(SPSS Inc, Chicago, USA). The differences in continuous dependent variables among groups (neophobic, average and neophilic) were analyzed using One-way ANOVA. Associations between categorical data and the three study groups were assessed using the Chi-square(χ^2) procedure. Bonferroni post-hoc test identified statistically significant mean difference among the groups. Significance level was set at $p < 0.05$.

Results

1. Sample characteristics

Table 1 shows the comparison on age, household size, household income, income per capita and gender among neophobic, average and neophilic children. None of the examined variables was significant among the study groups.

2. Energy and nutrient intakes

In general, the average energy and nutrient intakes of the study sample were adequate except for calcium and vitamin C. Neophobic children tend to have higher intakes of energy and most nutrients than average and neophilic children(Ta-

Table 1. Demographic and socioeconomic characteristics of study sample

Characteristics	Neophobic(n = 61)	Average(n = 214)	Neophilic(n = 57)	F or χ^2 value
		Mean(standard deviation)		
Age(months)	104.74(6.79)	107.26(7.06)	107.37(7.20)	3.26
Household size	6.51(1.70)	6.36(1.86)	6.30(2.07)	0.22
Household income(RM)	1926(1131)	1923(1407)	1950(1307)	0.09
Income per capita(RM)	322(223)	323(251)	346(267)	0.20
Gender *n(%)*				2.064
Male	34(21.5)	97(61.4)	27(17.1)	
Female	27(15.5)	117(67.2)	30(17.3)	

*** : $p < 0.001$, USD1 : RM3.8

Table 2. Energy and selected nutrient intakes for neophobic, average and neophilic children

Measure	Neophobic (n = 61)	Average (n = 214)	Neophilic (n = 57)	F value
	Mean(standard deviation)			
Energy(kcal)	1380 (263.91)	1285 (285.10)	1332 (306.84)	2.82
(% RNI)	(81.77)	(76.82)	(79.57)	
Protein(g)	51.09 (18.61)	45.12 (16.79)	46.57 (17.79)	4.83*[a,b]
(% RNI)	(159.67)	(141.00)	(145.54)	
Carbohydrate (g)	187.42 (34.34)	181.47 (39.39)	189.62 (34.61)	1.37
Fat(g)	47.59 (13.47)	42.39 (14.27)	43.59 (17.33)	5.97*[a, b]
Thiamin(mg)	0.61 (0.22)	0.57 (0.22)	0.61 (0.26)	1.80
(% RNI)	(68.22)	(62.79)	(68.31)	
Riboflavin(mg)	0.93 (0.50)	0.84 (0.33)	0.90 (0.41)	1.71
(% RNI)	(103.76)	(93.29)	(99.92)	
Niacin(mg)	8.75 (3.37)	7.92 (3.67)	8.17 (3.68)	1.25
(% RNI)	(72.91)	(66.00)	(68.05)	
Vitamin A(ug)*[a]	459.74 (244.24)	368.28 (175.52)	431.47 (252.16)	5.81**[a]
(% RNI)	(91.95)	(73.65)	(86.29)	
Vitamin C(mg)	17.19 (12.35)	20.87 (34.53)	25.45 (27.19)	1.09
(% RNI)	(49.12)	(59.64)	(72.70)	
Calcium(mg)	265.26 (104.35)	249.33 (119.37)	266.85 (146.65)	0.71
(% RNI)	(37.89)	(35.62)	(38.12)	
Iron(mg)*[a]	9.82 (5.34)	8.04 (3.55)	9.34 (4.65)	5.53**[a]
(% RNI)	(109.13)	(89.37)	(103.78)	

*: p <0.05, **: p <0.01
[a]Significant mean difference between Neophobic and Average children
[b]Significant mean difference between Neophobic and Neophilic children
RNI : Recommended nutrient intake

Table 3. Distribution of children according to the recommended nutrient intake(RNI) for energy and selected nutrients

Measure	Neophobic (n = 61)	Average (n = 214)	Neophilic (n = 57)	χ^2 value
		n(%)		
Energy				6.36*
< 2/3	9(14.8)	63(29.4)	19(33.3)	
≥ 2/3	52(85. 2)	151(70.6)	38(66.7)	
Protein				6.61*
< 2/3	1(1.6)	9(4.2)	5(8.8)	
≥ 2/3	60(98.4)	205(95.8)	52(91.2)	
Thiamin				1.49
< 2/3	32(52.5)	130(60.7)	32(56.1)	
≥ 2/3	29(47.5)	84(39.3)	25(43.9)	
Riboflavin				0.74
< 2/3	12(19.7)	49(22.9)	15(26.3)	
≥ 2/3	49(80.3)	165(77.1)	42(73.7)	
Niacin				0.43
< 2/3	31(50.8)	118(55.1)	32(56.1)	
≥ 2/3	30(49.2)	96(44.9)	25(43.9)	
Vitamin A				7.76*
< 2/3	17(27.9)	102(47.7)	23(40.4)	
≥ 2/3	44(72.1)	112(52.3)	34(59.6)	
Vitamin C				0.75
< 2/3	48(78.7)	169(79.0)	42(73.7)	
≥ 2/3	13(21.3)	45(21.0)	15(26.3)	
Calcium				7.04*
< 2/3	60(98.4)	204(95.3)	51(89.5)	
≥ 2/3	1(1.6)	10(4.7)	6(10.5)	
Iron				4.62
< 2/3	49(80.3)	149(69.6)	46(80.7)	
≥ 2/3	12(19.7)	65(30.4)	11(19.3)	

*: p <0.05

ble 2). The mean intakes of protein($F = 4.83$, $p < 0.05$), fat ($F = 5.97$, $p < 0.05$), vitamin A($F = 5.81$, $p < 0.01$) and iron($F = 5.53$, $p < 0.01$) were significantly higher in neophobic than average or neophilic children.

Table 3 shows the number and percentage of children in each group meeting at last two thirds of the RNIs. Compared to neophilic and average groups, a higher percentage of neophobic children met 2/3 of the RNIs for energy(85.2%) ($\chi^2 = 6.36$, $p < 0.05$), protein(98.4%)($\chi^2 = 6.61$, $p < 0.05$) and vitamin A(72.1%)($\chi^2 = 7.76$, $p < 0.05$). On the other hand, neophobic group had the least percentage of children meeting 2/3 of the RNIs for calcium ($\chi^2 = 7.04$, $p < 0.05$).

The mean percentage of carbohydrate energy was lowest (54.8%) while fat energy(31.8%) was highest among neophobic children(Table 4). However, mean significant difference for fat energy($F = 3.03$, $p < 0.05$) and carbohydrate energy($F = 3.07$, $p < 0.05$) was only observed between the neophobic and neophilic groups. Neophobic group had the lowest percentage of children(49.2%) with carbohydrate energy >55% but highest percentage(50.8%) with fat energy >30%.

3. Number of servings from food groups and dietary diversity

Table 5 shows the mean number of Food Pyramid servings consumed by children from neophobic, neophilic and average groups. Significant mean difference was only ob-

Table 4. Mean and distribution of percentage energy contribution from macronutrients for neophobic, average and neophilic children

Measure	Neophobic (n = 61)	Average (n = 214)	Neophilic (n = 57)	F value
		Mean(standard deviation)		
Carbohydrate(%)	54.85(6.57)	57.07(7.44)	58.05(7.97)	3.07*[a]
<55% n(%)	31(50.8)	90(42.1)	20(35.1)	
≥ 55% n(%)	30(49.2)	124(57.9)	37(64.9)	
		(χ^2 = 6.03*)		
Protein(%)	14.54(3.39)	13.82(3.49)	13.72(3.32)	1.28
< 10% n(%)	5(8.2)	22(10.3)	8(14.0)	
≥ 10% n(%)	56(91.8)	192(89.7)	49(86.0)	
		(χ^2 = 1.31)		
Fat (%)	31.82(6.16)	29.30(5.94)	28.67(6.84)	3.03*[a]
< 30% n(%)	30(49.2)	117(54.7)	34(59.6)	
≥ 30% n(%)	31(50.8)	97(45.3)	23(40.4)	
		(χ^2 = 6.31*)		

* : p <0.05
[a]Significant mean difference between Neophobic and Neophilic children

served for number of servings consumed from the meat group with neophobic children consumed significantly more than the average and neophilic groups(F = 4.94, p < 0.01). In addition, neophobic group had the highest percentage of children (42.6%) meeting the minimum number of servings (>2) for the meat group. Except for grain and cereal group (6.13 + 1.62), the mean number of servings from fruit (0.29 + 1.62), vegetable(0.30 + 0.35), meat(1.51 + 0.73) and milk (0.12 + 0.28) for the study sample as a whole did not meet the Food Pyramid recommendations. All study groups had relatively low mean dietary diversity scores with neophobic children had the lowest score(0.67 + 0.73) compared to the average(0.97 + 0.72) and neophilic(1.98 + 0.81) groups. A significant difference in mean dietary diversity score(p < 0.05) was only observed between neophobic and neophilic children.

4. Growth parameters

There was no significant mean difference for height-for-

Table 5. Number of servings from food pyramid and diet quality score for neophobic, average and neophilic children

Measure	Neophobic(n = 61)	Average(n = 214)	Neophilic(n = 57)	F value
		Mean(standard deviation)		
Grain & cereals	6.09(1.40)	6.06(1.70)	6.44(1.54)	1.23
< 6 servings n(%)	28(45.9)	107(50.0)	19(33.3)	
≥ 6 servings n(%)	33(54.1)	107(50.0)	38(66.7)	
		(χ^2 = 5.04)		
Fruits	0.27(0.42)	0.26(0.45)	0.41(0.72)	2.03
< 2 servings n(%)	61(100.0)	212(99.1)	53(93.0)	
≥ 2 servings n(%)	0(0.0)	2(0.9)	4(7.0)	
			(χ^2 = 10.76**)	
Vegetables	0.22(0.18)	0.31(0.39)	0.35(0.34)	1.96
< 2 servings n(%)	61(100.0)	213(99.5)	57(100.0)	
≥ 2 servings n(%)	0(0.0)	1(0.5)	0(0.0)	
		(χ^2 = 0.55)		
Meat	1.78(0.64)	1.46(0.71)	1.44(0.84)	4.94**[a,b]
< 2 servings n(%)	35(57.4)	160(74.8)	40(70.2)	
≥ 2 servings n(%)	26(42.6)	54(25.2)	17(29.8)	
			(χ^2 = 6.95*)	
Milk & dairy	0.10(0.25)	0.13(0.29)	0.11(0.29)	0.33
< 2 servings n(%)	61(100.0)	214(100.0)	56(98.2)	
≥ 2 servings n(%)	0(0.0)	0(0.0)	1(1.8)	
		(χ^2 = 4.84)		
Diet diversity score	0.67(0.73)	0.97(0.72)	1.98(0.81)	4.29*[b]

* : p<0.05, ** : p<0.01
Food guide pyramid for children(Bright Start Nutrition, 2000) - grain & cereal 6 - 10 ; vegetables 2 ; fruits 2 ; meat 2 - 3 ; milk 2 ; Dietary diversity 0 - 5.
[a]Significant mean difference between Neophobic & Average children
[b]Significant mean difference between Neophobic & Neophilic children

Table 6. Growth status of neophobic, average and neophilic children

Measure	Neophobic(n = 61)	Average(n = 214)	Neophilic(n = 57)	F value
		Mean(standard deviation)		
Height-for-age(z-score)	- 0.88(1.11)	- 1.15(1.10)	- 1.04(1.31)	1.40
< - 1 SD *n(%)*	27(44.3)	124(57.9)	28(49.1)	
≥ - 1 SD *n(%)*	34(55.7)	90(42.1)	29(50.9)	
		(χ^2 = 4.21)		
Weight-for-height(z-score)	- 0.07(1.66)	- 0.16(1.51)	0.38(1.04)	2.57
< - 1 SD *n(%)*	22(36.1)	69(32.2)	14(24.6)	
- 1 SD to 2 SD *n(%)*	26(42.6)	123(57.5)	32(56.1)	
>2 SD *n(%)*	13(21.3)	22(10.3)	11(19.3)	
		(χ^2 = 10.90*)		

* : p <0.05

age and weight-for-height z scores among the three study groups(Table 6). However, there were higher percentages of neophobic children who were in the category of low weight-for-height(36.1%) and at-risk of overweight(21.3%) than neophilic and average groups(χ^2=10.90, $p < 0.05$).

Discussion

Falciglia and colleagues(2000) found that total fat intake did not differ significantly among neophobic, neophilic and average children. However, consumption of saturated fat was highest in neophobic children despite no difference in the intakes of meat and dairy products. On the other hand, Cooke et al.(2003) reported that meat consumption decreased at higher levels of food neophobia but no association was observed between food neophobia and intakes of sweet, fatty snacks and eggs. Although we were not able to determine saturated fat intake in the children's diets, our findings showed that children with food neophobia had significantly higher total fat intake than both the neophilic and average children. Also, significantly more neophobic children compared to the other groups had fat intake more than the recommended level (>30%). The differences in total fat intake could be due to higher consumption of meat group, high-fat foods within the food groups or foods at the upper most of the Food Pyramid by the neophobic children. Further investigation into the relationship between food neophobia and intakes of foods high in fat and types of fat is required as diets that are high in fat, particularly that of saturated fat, could have adverse health implications in children.

We showed that the energy and nutrient intakes of food neophobic children were generally higher than those of average and neophilic children. In addition, more of the neophobic children achieved 2/3 of RNI for energy and most nutrients(except calcium and iron) than the other groups. However, the mean energy and most nutrients(except for protein, riboflavin, iron) of neophobic, neophilic and average children were less than the recommended levels. Perhaps, for all of these children(and more so for the neophobic group), the energy and nutrient intakes were from limited food sources as evidenced by the inadequate mean number of servings for most food groups and poor dietary diversity score. For example, the consumption of modified and refined grain products(e.g. fried rice and mee, local cakes, pastries and quick breads) and processed meats(nugget, hot dog, beef patties) among these children could contribute to adequate grain and cereal and meat groups, energy, and protein. However, the consumption of these food types could also increase the total fat intake and lower intakes of other nutrients(e.g. thiamin, niacin, iron). Subar et al.(1998) reported that among children in the United States, fortified foods, rather than foods which are naturally high in nutrients and other dietary components, are the main sources of nutrients for children. Similarly, Falciglia et al.(2000) showed that when ready-to-eat cereal was removed from the dietary analysis, fewer children met 2/3 of the RDA/DRI recommendations for nutrients such as vitamins A, C, B6 and folate, iron, fiber and zinc. Similar to other Asian countries, Malaysia is also experiencing nutritional transition in which changes in food intakes and patterns(e.g. higher consumption of refined grains, animal source foods, added sugar and fats and lower consumption of fruits and vegetables, eating out) and decreased physical activity have led to increasing prevalence of diet-related health problems among adults and children(Ismail, 2002 ; Ministry of Healthy 1999 ; Tee, 1999).

Several studies have reported that higher levels of food neophobia in children are associated with lower consumption of fruits and vegetables as these foods are considered to be less familiar food groups among children(Cooke et al. 2003 ; Galloway et al. 2003 ; Wardle et al. 2005). In the present study, we did not observe any significant difference in fruit and vegetable intake between neophobic and non-neophobic children, which may be attributed to the overall low intake of fruits and vegetables by the study sample. Nevertheless, the low fruit and vegetable intakes among these children should be highlighted as increasing the variety of fruit and vegetable consumption in children does not only provide them with nutritive and non-nutritive substances for optimal health but also results in decreasing fat intake and consequently maintenance of healthy weight(Dwyer 2000 ; Munoz et al. 1997).

Food neophobic children have been found to have lower Healthy Eating Index(HEI) scores than average and neophilic children(Falciglia et al. 2000). Lack of food variety and high intake of saturated fats were the major contributors to the decreased diet quality in these children. In our study, all the study groups had relatively low mean dietary diversity scores, but food neophobic children(0.76 + 0.73) had the lowest mean dietary diversity score compared to average(0.97 + 0.72) and neophilic(1.87 + 0.81) groups. The lack of dietary diversity in the children's diets and especially among neophobic children could be explained by the limited food choices as sources of energy and nutrients. Lack of dietary diversity combined with higher intake of fat in the diets of children with food neophobia may put them at higher risks of poor health and nutrition.

Previous studies have investigated the relationship between food neophobia and dietary intakes but none has looked at the association between this personality trait and growth outcomes(Cooke et al. 2003 ; Falciglia et al. 2000 ; Galloway et al. 2003 ; Wardle et al. 2005). In the present study, we showed that more of the neophobic children had low weight-for-height and were at-risk of overweight compared to neophilic and average groups. Although poor diet quality (e.g. high dietary fat and low carbohydrate intakes and lack dietary diversity) of neophobic children could be one of the many plausible explanations for this observation, further investigation is certainly required. Perhaps, other factors such as physical activity and health status may be implicated in the relationship between food neophobia and growth outcomes observed among these children.

Children's refusal to try novel foods or foods which are familiar to the family members may contribute to parental concerns about the quantity and quality of foods consumed by the child. There are, however, various strategies reported in the literature to increase children's preferences and acceptance of new or unfamiliar foods. Research evidences have shown that five to ten exposures may be required to increase liking of new foods and subsequently food acceptance by children(Birch, Marlin 1982 ; Birch et al. 1987). Children's observations of eating behaviors of other people including their parents, siblings and peers can increase their preferences and intakes of foods(Birch 1980 ; Cooke et al. 2004 ; Fisher et al. 2002 ; Oliveria et al. 1992). In other words, modeling is an effective method to encourage children to accept foods. Presentation of new foods with foods or flavors that are familiar to the children can also make the food more acceptable(Pliner, Stallberg-White 2000). For example, vegetables are cooked in gravy or sauce that is familiar and liked by children. Finally, food availability and accessibility at homes and schools can contribute to children's likings for and consumption of food(Domel et al. 1993 ; Hearn et al. 1998). Parents should make available a variety fruits and vegetables at home, or schools should be encouraged to serve healthy food choices.

There are limitations in this present study that could influence the study findings. Besides unwillingness to try new foods, there are other factors(e.g. health status, physical activity level, dieting behaviors, food availability and accessibility) which were not investigated in this study that could influence the dietary intakes and growth status of the children. The use of food neophobia scale from a different culture may contribute to response bias among the subjects. Although the internal consistency for this instrument reported in this study and a previous study(Zalilah, Zaidah 2005) is more than 0.7, the translation of the items into languages(Malay and Indian) appropriate for the children may result in misinterpretation of the items. Consequently, this could affect the categorization of the children according to their willingness to try new foods. Despite these limitations, the findings of this study could contribute to the literature on the potential role of food neophobia in child health and nutrition.

Summary and Conclusions

As food neophobia may put children at risk of limited food choices, we hypothesized that food neophobic children would have lower energy and nutrient intakes, inadequate consumption of food group servings, lack of dietary diversity and consequently compromised growth status. However, our findings showed that compared to neophilic and average groups, neophobic group had significantly higher mean intakes of nutrients such as protein, fat, vitamin A and iron. In addition, significantly more food neophobic children achieved 2/3 of RNI for energy, protein and vitamin A and less 2/3 for calcium. Food neophobic children had significantly lower mean carbohydrate energy and highest fat energy than the other groups. Approximately 50% of children with food neophobia did not meet the recommended carbohydrate energy of > 55% and fat energy < 30%. Except for meat group, the mean number of servings for grain and cereal, fruit, vegetable and milk groups were comparable in the 3 study groups. However, in all study groups, only the number of serving for grain and cereal group was achieved. All study groups had low mean dietary diversity scores but the neophobic group had the lowest mean dietary diversity score. Our study showed that the limited food sources as evidenced by the inadequate number of servings from most food groups and poor dietary diversity scores may be a possible explanation for the patterns of energy and nutrient intakes among the children in this study. The relationship may be more pronounced among neophobic children compared to children in the other study groups, thus explaining the dietary findings observed in the former group. Children with food neophobia were more likely to have low weight-for-height and be at-risk of overweight than the other two groups. Besides dietary intakes, other factors(e.g. physical activity) are worth investigation to provide possible explanations for the observation of food neophobia and growth outcomes.

To promote healthful diets for children, nutrition practitioners should focus not only on the external environment (e.g. food marketing and advertising, weight concerns and dieting, food availability and accessibility) but also the social context of eating(e.g. child feeding practices) and personality traits(e.g. food neophobia, pickiness) that can affect children's food preferences(Birch, Fisher 1998 ; Hill 2002). Understanding food neophobia in children and its association with poor diet quality such as lack of food variety, inadequate intakes of fruit and vegetables and high dietary fat intake and with poor growth outcomes may assist nutritionists and dietitians in the planning of appropriate nutrition interventions to improve health and nutrition of children. For example, interventions to increase fruit and vegetable consumption among children should also target on improving parents' eating behaviors and child feeding practices as these strategies may enhance children's preferences and acceptance of these food groups. Thus, to improve children's food preferences and acceptance, parents may need the guidance and support from nutritionists and dietitians that can be tailored to their needs and their child's situation.

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References

Birch LL(1980) : Effects of peer models' food choices and eating behaviors on preschoolers' food preferences. *Child Dev* 51 : 489-496

Birch LL, Marlin DW(1982) : I don't like it ; I never tried it : Effects of exposure to food on two-year old children's food preferences. *Appetite* 4 : 353-360

Birch LL, McPhee L, Shoba BC, Pirok E, Steinberg L(1987) : What kind of exposure reduces children's food neophobia? *Appetite* 9 : 171-178

Birch LL, Fisher JO(1998) : Development of eating behaviors among children and adolescents. *Pediatrics* 101 : 539-549

Bright Start Nutrition(2000) : Food Guide Pyramid for Children (2 − 11yrs). http:/www.nutriweb.org.my

Cashdan E(1994) : A sensitive period for learning about food. *Human Nature* 5 : 279-291

Cashdan E(1998) : Adaptiveness of food learning and food aversions in children. *Soc Sci Information* 37 : 613-632

Cooke L, Wardle J, Gibson EL(2003) : Relationship between parental report of food neophobia and everyday food consumption in 2-6-year-old children. *Appetite* 41 : 205-206

Cooke L, Wardle J, Gibson EL, Sapochnik M, Sheiham A, Lawson M(2004) : Demographic, familial and trait predictors of fruit and vegetable consumption by preschool children. *Public Health Nutr* 7 : 295-302

Domel SB, Baranowski T, Davis H, Leonard SB, Riley P, Baranowski J(1993) : Measuring fruit and vegetable preferences among 4th and 5th grade students. *Prev Med* 22 : 866-879

Domel SB, Thomson WO, Davis HC, Baranowski T, Leonard SB, Baranowski J(1996) : Psychosocial predictors of fruit and vegetable consumption among elementary school children. *Health Edu Res* 11：299-308

Drewnowski A(1989)：Sensory preferences for fat and sugar in adolescence and adult life. *Ann NY Acad Sci* 561：243-250

Drewnowski A, Henderson SA, Shore AB, Fishler C, Preziosi P, Hercberg S(1996)：Diet quality and dietary diversity in France：implications for the French paradox. *J Am Diet Assoc* 96：663-669

Dwyer J(2000)：Should dietary fat recommendations for children be changed? *J Am Diet Assoc* 100：36-37.

Falciglia GA, Couch SC, Gribble LS, Pabst SM, Frank R(2000)：Food neophobia in childhood affects dietary variety. *J Am Diet Assoc* 100：1474-1481

Fisher JO, Birch LL(1995)：3-5 year-old children's fat preferences and fat consumption are related to parental adiposity. *J Am Diet Assoc* 95：759-764

Fisher JO, Mitchell DC, Smiciklas-Wright H & Birch LL(2002)：Parental influences on young girls' fruit and vegetable, micronutrient and fat intakes. *J Am Diet Assoc* 102：58-64.

Frank RA, Van Der Klaauw N(1994)：The relationship of sensory and personality factors to individual differences in reported food preferences. *Appetite* 22：101-123

Galloway AT, Lee Y, Birch LL(2003)：Predictors and consequences of food neophobia and pickiness in young girls. *J Am Diet Assoc* 103：692-698

Hearn MD, Baranowski T, Baranowski J, Doyle C, Smith M, Lin LS, Resnicow K(1998)：Environmental influences on dietary behavior among children：Availability and accessibility of fruit and vegetables enable consumption. *J Health Edu* 29：26-32

Ismail MN(2002)：The nutrition and health transition in Malaysia. *Publ Hlt Nutr* 5(1A)：191-195

Kant AK, Schatzkin A, Harris TB, Ziegler RG, Block G(1993)：Dietary diversity and subsequent mortality in the First National Health and Nutrition Examination Survey Epidemiologic Follow-up Study. *Am J Clin Nutr* 57：434-440

Koivisto-Hursti UK, Sjoden PO(1997)：Food and general neophobia and their relationship with self-reported food choice：Familial resemblance in Swedish families with children ages 7-17 years. *Appetite* 29：89-103

Loewen R, Pliner P(2000)：The Food Situations Questionnaire：A measure of children's willingness to try novel foods in stimulating and non-stimulating situations, *Appetite* 35：239-250

Ministry of Health(1999)：Malaysia's Health 1999-Technical Report of the Director-general of Health Malaysia. Kuala Lumpur：Ministry of Health

Munoz KA, Krebs-Smith SM, Ballard-Barbash R, Cleveland LE (1997)：Food intakes of US children and adolescents compared with recommendations. *Pediatrics* 100：323-329

NCCFN(2005)：Recommended nutrient intakes for Malaysia. Putrajaya: Ministry of Health

Oliveria SA, Ellison RC, Moore LL, Gillman MW, Garrahie EJ, Singer MR(1992)：Parent-child relationships in nutrient intake：the Framingham Children'S Study. *Am J Clin Nutr* 56：593-598.

Pliner P, Hobden K(1992)：Development of a scale to measure the trait of food neophobia in humans. *Appetite* 19：105-120

Pliner P, Pelchat M, Grabski M(1993)：Reduction of neophobia in humans by exposure to novel foods. *Appetite* 20：111-123

Pliner P(1994)：Development of measures of food neophobia in children. *Appetite* 23：147-163

Pliner P, Stallberg-White C(2000)：'Pass the ketchup please'：Familiar flavors increase children's willingness to taste novel foods. *Appetite* 34：95-103

Raudenbush B, Schroth F, Reilley SP, Frank RA(1998)：Food neophobia, odor evaluation and exploratory sniffing behavior. *Appetite* 31：171-183

Subar AF, Krebs-Smith SM, Cook A, Kahle LL(1998)：Dietary sources of nutrients among US children 1989-1991. *Pediatrics* 102：913-923

Tee ES, Ismail MN, Nasir MA, Khatijah I(1997)：Nutrient composition of Malaysian foods(4th edition) Kuala Lumpur：Institute Medical Research.

Tee ES(1999)：Nutrition of Malaysians: where are we heading? *Mal J Nutr* 5：87-109

Van Duyn MAS, Pivonka E(2000)：Overview of the health benefits of fruit and vegetable consumption for the dietetics professional：Selected literature. *J Am Diet Assoc* 100：1511-1521

Wardle J, Carnell S, Cooke L(2005)：Parental control over feeding and children's fruit and vegetable：How are they related? *J Am Diet Assoc* 105：227-232

World Health Organization(1983)：Measuring Change in Nutritional Status. Geneva：WHO.

Zalilah MS, Zaidah MY(2005)：Correlate of children's eating attitude test scores among primary school children. *Perc Motor Skills* 100：463-472