Energy and Macronutrient Intakes and Food Sources in Preschool Children: Thai NHES IV

Warapone Satheannoppakao PhD*[1], Rachada Kasemsup MD*[2], Jiraluck Nontarak MSc*[3], Pattapong Kessomboon PhD, MD*[4], Panwadee Putwatana PhD*[5], Surasak Taneepanichskul MD*[6], Rassamee Sangthong PhD, MD*[7], Suwat Chariyalertsak DrPH, MD*[8], Wichai Aekplakorn PhD, MD*[9]

*[1] Department of Nutrition, Faculty of Public Health, Mahidol University, Bangkok, Thailand
*[2] Queen Sirikit National Institute of Child Health, College of Medicine, Rangsit University, Bangkok, Thailand
*[3] National Health Examination Survey Office, Nonthaburi, Thailand
*[4] Department of Community Medicine, Faculty of Medicine, Khon Kaen University, Khon Kaen, Thailand
*[5] Department of Nursing, Faculty of Medicine, Ramathibodi Hospital, Mahidol University, Bangkok, Thailand
*[6] College of Public Health Sciences, Chulalongkorn University, Bangkok, Thailand
*[7] Epidemiology Unit, Faculty of Medicine, Prince of Songkla University, Songkhla, Thailand
*[8] Research Institute for Health Sciences, Chiang Mai University, Chiang Mai, Thailand
*[9] Department of Community Medicine, Faculty of Medicine, Ramathibodi Hospital, Mahidol University, Bangkok, Thailand

Objective: *Examine intakes of energy and macronutrients, and identify their food sources, in Thai preschool children.*
Material and Method: *Data from the Thai National Health Examination Survey (NHES) IV were used. Mothers/caregivers were interviewed regarding their children's 24-hour-dietary intake. Dietary data were analyzed for energy and macronutrients, and their food sources were investigated. Due to skewed data, Mann-Whitney U test was used to compare energy and macronutrient intake between sexes and age groups.*
Results: *Among 256 preschool children, more than 90% had protein intakes higher than the recommended level. Only 12.7 to 29.0% met the recommended intake for energy. Amounts of carbohydrate and fat consumed varied from below to above the Dietary Reference Intake (DRI) recommendation. Intakes of carbohydrate in boys and fat in girls were statistically different between age groups ($p<0.05$). Fifty to 60% of energy came from dairy products, grains and starchy products. The major carbohydrate contributors were grains and starchy products. Dairy products were the main source of protein. Important food sources of fat were dairy products for one- to three-year-old children and fat and oils for four- to five-year-old children.*
Conclusion: *Thai preschool children have inappropriate intakes of energy and macronutrients. Dairy products and grains and/or starchy products were the main sources of energy, carbohydrate, and protein. Dietary fat sources varied by age group.*

Keywords: *Macronutrient, Thai preschool children, National health survey*

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Dietary intake in early life is one of the crucial factors that affect a child's concurrent or later growth and development[1-4]. Moreover, childhood nutritional status is associated with many health conditions and chronic diseases in later life. These include hypertension, dyslipidemia[5], cancer[6], and coronary heart disease[7,8].

Even though the benefits of optimal nutritional status are recognized, malnutrition continues to increase worldwide. Overnutrition is a dominant public health problem among preschool children in developed countries[9]. Nonetheless, developing countries suffer from a double burden of malnutrition[9,10]. In Thailand, although the numbers of underweight or stunted Thai preschool children have decreased (e.g., weight-for-age less than -2 SD from 12.2% in 2003 to 4.8% in 2008 and 2009, and height-for-age less than -2 SD from 9.3 to 6.3%), undernourishment still persists. Meanwhile, the prevalence of overweight (weight-for-height more than +2 SD) has increased from 3.3 to 8.5%[11,12].

This double burden of malnutrition possibly has resulted from the weak development of the public health system, rapid socio-economic development, and changes in lifestyle and dietary pattern[13,14]. Understanding preschool children's food consumption, especially in relation to energy and macronutrients may be one way to help us solve this problem.

Correspondence to:
Aekplakorn W, Department of Community Medicine, Faculty of Medicine, Ramathibodi Hospital, Mahidol University, 270 Rama VI Road, Ratchathewi, Bangkok 10400, Thailand
Phone: +66-2-2011518, Fax: +66-2-2011930
E-mail: wichai.aek@mahidol.ac.th

The present study was developed to find out whether Thai preschool children's energy and macronutrient intake was adequate, and whether differences in sex and age groups had an effect on the amount of energy and macronutrients consumed. Even though many research studies conducted in other countries state major dietary sources of energy and macronutrients, findings from these studies might not reflect the situation in Thailand or even in Southeast Asian countries due to differences in food culture and availability. Additionally, there is little information about this age group that can guide health professionals or key government agencies to improve preschool children's eating pattern and/or dietary quality. Hence, food sources contributing energy and individual macronutrients were our concern. The present study objectives were to examine intakes of energy and macronutrients, and identify their food sources, in Thai preschool children.

Material and Method

Study design and participants

Data from the National Health Examination survey IV (NHES IV) were used. Methods of sampling participants for the NHES IV had been described elsewhere[15]. Briefly, multistage stratified sampling was conducted to recruit a group that was representative of the Thai population. The target population was Thais, registered on the Civil Registration system, and living in the four regions of Thailand and Bangkok. First, in each region, five provinces were randomly selected. Second, in each province, three to five districts were selected proportionally to size. Third, in each province, 13 or 14 electoral units (EU) and villages were selected from urban and rural areas, respectively. Sixty-eight EUs and 68 villages in each region were obtained. In Bangkok, 12 districts were randomly selected and five or six EUs were selected for each district. Sixty-eight EUs were selected. Consequently, total of 314 EUs and 272 villages from all regions and Bangkok were selected. Finally, in each EU or village, 8 to 10 males and females were selected by systematic sampling from six sex and age groups (males and females aged 1 to 14, 15 to 59, and over 60 years). The final sample size for the whole survey was 31,700. For the 24-hour food consumption study, a subsample of 10% from the selected samples in each EU and village for each sex and age group were randomly selected. A total sample size for the subsample was targeted at 3,170. Actually, 2,981 with additional interview for their 24-hour-food consumption information were obtained. In the present study, 256 children aged one- to five-years old were included in the study. The number of children included was in accordance with a predetermined sample size calculated based on estimated daily fat consumption in a previous national nutritional survey[11] of 26 g with standard deviation of 7.5 g and 5% level of significance. Ethical approval was obtained from the Ethics Review Committee for Research in Human Subjects, Ministry of Public Health. All preschool children's mothers/caregivers provided written informed consent for voluntary participation.

Instruments

An interviewer-administered questionnaire was used to get information on sex, age, monthly family income, region, and residential area. A 24-hour-dietary recall form was designed to obtain dietary information such as name of meals, sources of foods, details of food and beverage types, and amounts consumed.

To accurately measure food intake, a photographic food atlas including illustrations of two-dimensional portion sizes was developed. Forty-five food pictures of actual size and in Thai household portion sizes were displayed. Utensils were used to estimate portion sizes along with the photographic food atlas. These utensils consisted of a standard plastic liquid measuring cup with lip (250 cc), a set of standard measuring cups, a set of standard measuring spoons, a rice ladle, an Asian soup spoon, and a tea spoon.

Data collection

Data were collected between July 2008 and March 2009 by interviewers who had been trained on interview technique before conducting the present study for two days with a practice session of role play to standardize the technique. The eligible participants' mothers/caregivers were invited to participate in the study and then interviewed. Trained interviewers obtained each child's sociodemographic data. For collecting information on food intake, other interviewers, who were trained about a technique of dietary data collection, asked mothers/caregivers to recall types and amounts of foods their child ate during the previous day. The photographic food atlas and utensils were displayed to assist mothers/caregivers to accurately estimate the portion sizes of foods that their child ate. All food items were recorded in the 24-hour-dietary recall form.

Assessment of energy and macronutrient contents and their food sources

Food data from a single 24-hour-dietary recall were analyzed for energy and macronutrient content using INMUCAL-N version WD.2.2 software program (Institute of Nutrition, Mahidol University, Thailand). Energy and macronutrient values of subsample groups (e.g., one- to three-year-old boys, one- to three-year-old girls, four- to five-year-old boys, and four- to five-year-old girls) were descriptively compared with those recommended for Thai children aged one to five years[16].

Food sources as contributors of energy and macronutrients were then investigated. In each subsample group, all food items consumed were grouped. Obtained food groups were again analyzed for energy and macronutrients. Considered as each subgroup, total energy and macronutrients derived from each food group were summed. Then, the percentage contribution of every food group to energy and macronutrient intakes was calculated.

Statistical analyses

Data analyses were conducted by using Stata/SE 10.0 for Windows (StataCorp, College Station, TX). Descriptive statistics, including mean, SD, median, percentage, and percentile, were calculated to describe participants' characteristics, energy and macronutrient intakes, and major food sources contributing energy and macronutrients. Furthermore, the amounts of energy and macronutrients (kcal/day or g/day) consumed by individual subgroups were compared with the Thai Dietary Reference Intake (DRI) for preschool children. The Shapiro-Wilk test was utilized to test whether energy and macronutrients were normally distributed. Due to skewed data, the Mann-Whitney U test was used to examine differences in median energy and macronutrient intakes between age groups (one to three years vs. four to five years) within the same sex and between sexes within the same age group. Statistical significance was considered at $p<0.05$.

Results

Of the 256 children included in the study, there were 138 (54%) boys and 118 (46%) girls. Overall mean age (SD) was 3.5 years old (1.3). The proportions of the children residing in the north, central, northeast, south and Bangkok were 32.0%, 21.9%, 21.5%, 19.9%, and 4.7%, respectively. One-third of preschool children was in family with a total income of 5,000 to less than 10,000 Baht (Table 1).

Energy and macronutrient intakes

Daily energy and macronutrient intakes were shown in Table 2. Only 12.7 to 29.0% of Thai preschool children met the recommended intake for energy (90 to 110% DRI for energy). More than 90% had protein intakes higher than the recommended values (18 and 22 g for one- to three-year-old and four- to five-year-old children, respectively)[16]. In contrast, the quantities of carbohydrate and fat consumed by preschool children were quite varied,

Table 1. Sociodemographic characteristics of 256 Thai preschool children

Sociodemographics	Boys, n (%) (total = 138 cases)	Girls, n (%) (total = 118 cases)	*p*-value
Age (years)			0.8975
Mean (SD); median	3.5 (1.2); 3.5	3.5 (1.3); 4.0	
Family monthly income			0.498
<5,000 Baht	23 (17.7)	26 (23.0)	
5,000 to <10,000 Baht	43 (33.1)	41 (36.3)	
10,000 to <15,000 Baht	26 (20.0)	16 (14.2)	
≥15,000 Baht	38 (29.2)	30 (26.5)	
Mean (SD); median	12,972.3 (14,986.5); 9,000.0	12,973.2 (14,248.6); 8,000.0	
Missing (n)	8	5	
Region			0.551
North	39 (28.3)	43 (36.4)	
Central	32 (23.2)	24 (20.3)	
Northeast	34 (24.6)	21 (17.8)	
South	27 (19.6)	24 (20.4)	
Bangkok	6 (4.3)	6 (5.1)	
Residential area			0.940
Urban	79 (57.3)	67 (56.8)	
Rural	59 (42.7)	51 (43.2)	

Table 2. Daily energy and macronutrient intakes in 256 Thai preschool children aged 1-5 years

Age group	Energy & macronutrients	Amount								% of samples ranges of Thai DRI	
		Thai DRI	Mean (SD)	Percentile							
				5	10	25	50	75	90	95	Below	Above
1-3 years												
Boys (n = 69)	Energy (kcal)	1,000.0[α]	1,039.1 (326.1)	482.0	577.7	812.7	1,025.0[a]	1,275.7	1,409.6	1,563.9	31.9	39.1
	Carbohydrate (g)	112.5-162.5[β]	129.3 (58.6)	53.4	62.4	90.4	126.6[b]	153.0	183.5	223.5	43.5	20.3
	Protein (g)	18.0[γ]	40.7 (17.5)	18.7	19.7	25.9	38.8	52.1	66.8	72.1	4.4	95.7
	Fat (g)	33.3-44.4[δ]	39.9 (17.3)	16.6	21.2	27.0	36.3	51.7	64.1	65.3	42.0	37.7
Girls (n = 55)	Energy (kcal)	1,000.0[α]	947.8 (363.2)	410.7	478.8	662.4	886.9[c]	1,240.1	1,411.7	1,643.1	52.7	32.7
	Carbohydrate (g)	112.5-162.5[β]	123.9 (54.5)	52.5	57.9	83.7	114.4	158.9	206.9	229.1	47.3	21.8
	Protein (g)	18.0[γ]	37.4 (14.5)	17.8	21.9	24.4	35.5	47.9	54.6	62.4	5.5	94.6
	Fat (g)	33.3-44.4[δ]	33.7 (15.2)	13.0	15.1	21.9	31.1[d]	47.6	55.3	58.0	58.2	29.1
4-5 years												
Boys (n = 69)	Energy (kcal)	1,300.0[α]	1,184.0 (396.6)	577.5	640.6	903.6	1,183.5[a]	1,459.1	1,696.6	1,833.0	47.8	27.5
	Carbohydrate (g)	146.3-211.3[β]	149.2 (62.3)	49.7	74.4	103.5	140.7[b]	193.8	234.2	252.2	55.1	18.8
	Protein (g)	22.0[γ]	44.3 (15.9)	26.6	27.8	34.2	42.3	51.9	62.1	74.0	2.9	97.1
	Fat (g)	36.1-50.6[δ]	45.8 (20.5)	16.5	19.0	34.3	42.8	58.6	70.4	77.0	30.4	34.8
Girls (n = 63)	Energy (kcal)	1,300.0[α]	1,123.6 (450.6)	503.5	576.8	826.1	1,046.9[c]	1,393.2	1,781.8	1,869.2	63.5	23.8
	Carbohydrate (g)	146.3-211.3[β]	142.5 (65.2)	62.9	71.2	98.4	129.4	169.5	238.7	279.5	61.9	17.5
	Protein (g)	22.0[γ]	42.1 (17.4)	18.1	23.0	29.3	42.2	50.7	64.2	71.1	9.5	90.5
	Fat (g)	36.1-50.6[δ]	43.0 (21.3)	17.3	20.6	27.2	39.6[d]	58.1	75.6	86.5	41.3	33.3

DRI = Dietary Reference Intake

[α] Acceptable ranges of Thai DRI for energy in the present study were determined at 900.0-1,100.0 kcal (90-110% DRI for energy) for 1-3 year old age group and at 1,170.0-1,430.0 kcal (90-110% DRI for energy) for 4-5 year old age group.

[β] Quantity of carbohydrate (g/day) was calculated from energy from carbohydrate (45-65% of total energy[16]).

[γ] Recommended quantity of protein is calculated from body weight (kg) multiplied by protein daily requirement (g/1 kg body weight/day). Protein requirements for children aged 1-3 years and 4-5 years are 1.4 and 1.2 g/1 kg body weight/d, respectively(16). When estimated body weights of Thai children aged 1-3 years and 4-5 years are 13 and 18 kg, respectively, daily protein needs are equal to 18 and 22 g.

[δ] Quantity of fat (g/day) is calculated from energy from fat (30-40% and 25-35% of total energy for children aged 1-3 years and 4-18 years, respectively[16]).

[a, b, c, d] The same letter was used to indicate median differences between age groups (1-3 years, 4-5 years), $p<0.05$.

No differences in energy and macronutrient intakes between boys and girls in the same age group.

ranging from below to above the intake reference values[16]. It was found that approximately half and one fifth of all children had carbohydrate intakes below and above the Thai DRI, respectively. Two fifths consumed less than the recommended intakes for fat, while one third consumed more than the recommendation. Median intakes of energy and carbohydrate in boys and energy and fat in girls were statistically different between age groups (one to three years vs. four to five years) (all $p<0.05$). No differences in energy and macronutrient intakes between sexes in the same age group were found ($p>0.05$).

Food sources of energy and macronutrients

Food sources contributing energy and macronutrients differed according to age group and sex in Fig. 1-4. Overall, a key contributor of energy for boys and girls one to three years was dairy products, but for those aged four to five years, grains and starchy products became a core energy contributor. Notably, energy from sweets, snacks and beverages as well as sugars and honey progressively increased with the age.

A major carbohydrate contributor for Thai preschool children was grains and starchy products (providing 45.4 to 51.7% of carbohydrate), followed by dairy products. Sweets, snacks and beverages, as high calorie, low nutrient-dense food sources, became the third greatest carbohydrate contributors for almost all subgroups, except for girls one to three years. Dairy products were a fundamental protein source for one- to three-year-old children and provided one third of protein consumed. However, consumption of dairy

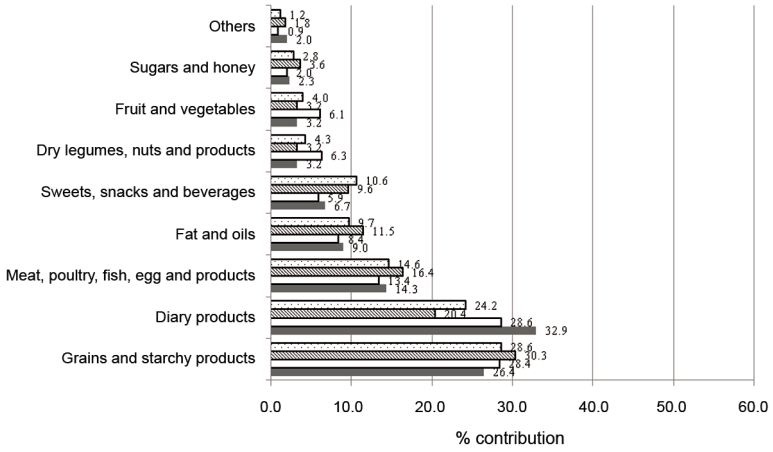

Fig. 1 Food sources of energy in 256 preschool children aged 1-5 years; ■ 1-3 year old boys, □ 1-3 year old girls, ▨ 4-5 year old boys, ⁘ 4-5 year old girls.

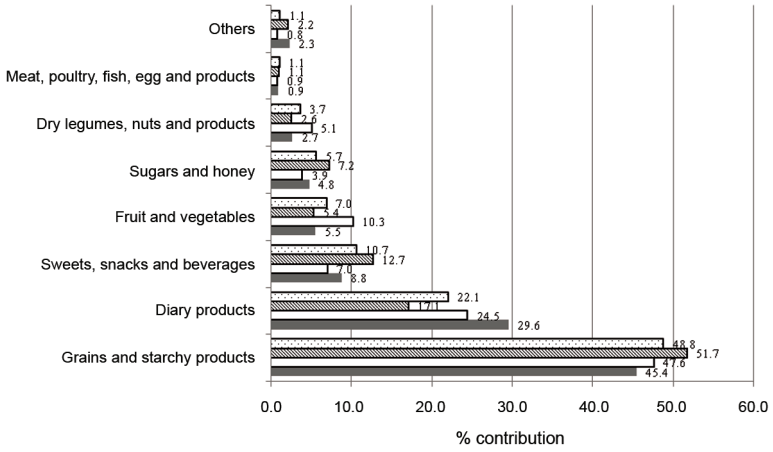

Fig. 2 Food sources of carbohydrate in 256 preschool children aged 1-5 years; ■ 1-3 year old boys, □ 1-3 year old girls, ▨ 4-5 year old boys, ⁘ 4-5 year old girls.

products decreased in the four- to five-year-old group. The predominant food source of protein changed from dairy products to meat, poultry, and related products. Regarding the main sources of dietary fat, dairy products were the main food source of fat (contributing 33.4 to 36.8%) in one- to three-year-old children. Whereas, four- to five-year-old children consumed fat and oils more frequently than dairy products, fat and oils then accounted for 28.9 to 33.4% of fat intake in this age group.

Discussion

In the present study, we set acceptable ranges of Thai DRI for energy at 900 to 1,100 kcal or 90 to 110% DRI for one- to three-years-olds and 1,170 to 1,430 kcal or 90 to 110% DRI for four- to five-years-olds. On the whole, the preschool children who participated in the present study, except girls aged four- to five-years-old, met the recommended energy needs (1,039.1 (326.1) kcal or 103.9% DRI for energy for one- to three-year-old boys, 947.8 (363.2) kcal or 94.8% DRI for one- to three-year-old girls, 1,184.0 (396.6) kcal or 91.1% DRI for four- to five-year-old boys and 1,123.6 (450.6) kcal or 86.4% DRI for four- to five-year-old girls). Yet, mean energy intakes here were lower than that of American children (1,471.0 kcal for two- to three-year-olds and 1,802.0 kcal for four- to eight-year-olds)[17], and Vietnamese preschool children (1,647.0 kcal for four- to five-year-old boys and 1,560.0 for four- to five-year-old girls)[18]. Roughly 70 to 87% of Thai preschool children did not achieve the

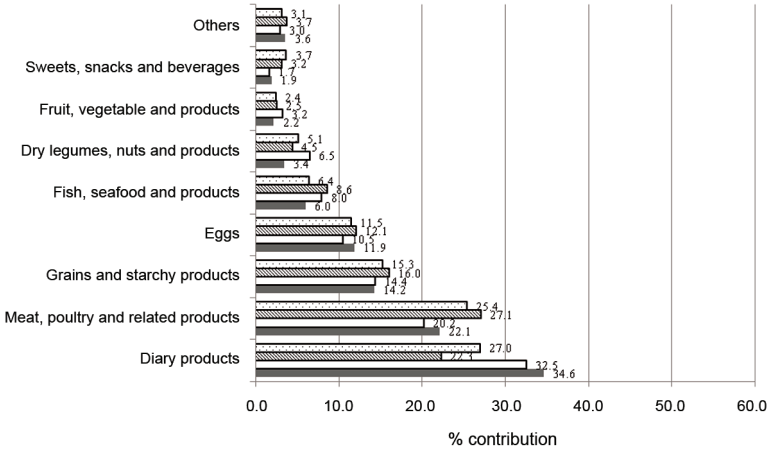

Fig. 3 Food sources of protein in 256 preschool children aged 1-5 years; ■ 1-3 year old boys, □ 1-3 year old girls, ▨ 4-5 year old boys, ⁘ 4-5 year old girls.

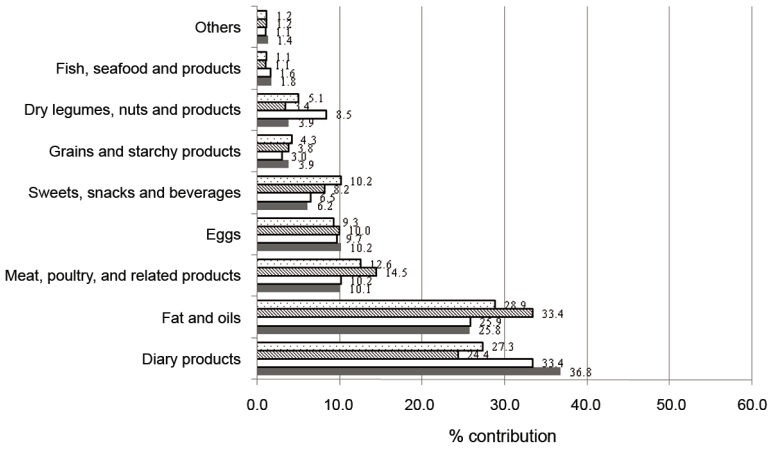

Fig. 4 Food sources of fat in 256 preschool children aged 1-5 years; ■ 1-3 year old boys, □ 1-3 year old girls, ▨ 4-5 year old boys, ⁘ 4-5 year old girls.

recommendation for energy daily intake (900 to 1,100 kcal), as shown in Table 2. Perhaps, the energy intakes of these preschool children moderately reflect the double burden of malnutrition in Thailand.

According to dietary macronutrient analysis, the majority of preschool children consumed protein in excess of the Thai DRI. Interestingly, protein intakes were at least two times greater than the Thai DRI in half of one- to five-year-old. The protein intake of this sample group was also slightly larger than that surveyed in 2003; the median intake of protein in one- to five-year-old children was 34.8 g/day in 2003[11], compared with 35.5 and 38.8 g/day for one- to three-year-old girls and boys, respectively and 42.2 and 42.3 g/day for four- to five-year-old girls and boys, respectively in the present dataset. Nevertheless, when compared to the amount of protein consumed by preschool children in other countries, the protein intake of Thai preschool children was lower. For example, in the U.S., data from the National Health and Nutrition Examination Survey (NHANES), 2003 and 2004, revealed that American children aged two to three years and four to eight years had median protein intakes equal to 53.4 and 65.0 g/day, respectively[19]. Huynh et al[18] reported that the average protein intakes of four- to five-year-old Vietnamese boys and girls were 75.7 and 72.1 g/day, respectively. Even though our preschool children ate less protein than those in the aforementioned countries, they consumed an amount that was in excess of the Thai DRI for protein intake in this age group. The impact of a high protein intake in early childhood on the subsequent development of adiposity is controversial[20-22]. An appropriate amount of protein should be consumed, in order to strike a balance between growth and development and renal solute load.

When the average intakes of carbohydrate and fat were analyzed, overall, our preschool children met the reference values for carbohydrate and fat. However, compared to children residing in other countries, Thai preschool children consumed less carbohydrate, but more fat. For example, according to a population-based study in Rio de Janeiro by Salles-Costa et al[23], 229 Brazilian children aged one and a half to two and a half years consumed, on average, 168 g of carbohydrate, and 32 g of fat daily. In contrast, our study, one- to three-year-old Thai children consumed 123.9 to 129.3 g of carbohydrate and 33.7 to 39.9 g of fat, on average, per day. For four- to five-year-old Thai children, average intakes ranged from 142.5 to 149.2 g for carbohydrate and 43.0 to 45.8 g for fat. Again, carbohydrate intakes were lower but fat intakes were higher, than those reported for children of the same age in other countries. For instance, the average carbohydrate intakes of four- to five-year-old Vietnamese boys and girls were 248.2 and 234.0 g/day, respectively, and the average fat intakes were 39.3 and 37.5 g/day for boys and girls[18]. Once percentiles of carbohydrate and fat intake were considered, only a small number of preschool children could meet their recommendations. Hence, carbohydrate and fat intakes were problematic among our preschool group.

In addition, statistical differences in macronutrient intake between boys and girls in any age group were not found here. This is contrary to the findings of Huynh et al[18], who reported that Vietnamese boys consumed larger amounts of protein and fat than girls. They hypothesized that this might have been linked with the cultural preference for a boy over a girl leading to a sex-related difference in dietary pattern[18]. When comparing macronutrient quantities consumed by preschool children of the same sex, four- to five-year-old children were more likely to have higher macronutrient intakes than one- to three-year-old children. Nonetheless, in terms of sex-related difference in dietary pattern, only carbohydrate intake in boys and fat intake in girls were significantly greater. Further work is required to examine disparities in certain macronutrient intakes between sexes and across age groups.

Food sources of energy and macronutrients seemed to differ among subgroups. More or less 50 to 60% of energy was derived from dairy products, and grains and starchy and products. The top one food source of energy varied according to age. This was consistent with data from NHANES 2005 and 2006, which showed that whole milk was the primary source of energy for two to three-year-old American children, but grain desserts were the first energy source for four- to eight-year-old children[17]. Distinctly, in the current study the older children were likely to get energy from food sources which were often referred to as being energy-dense but nutrient-poor, for example sweets, snacks, and beverages. As for carbohydrate, its first two contributors were grains and starchy products and dairy products for all subgroups. When investigated in depth, most preschool children consumed refined grains and starchy products rather than non-refined varieties. In addition, except for girls one to three years, sweets, snacks, and beverages were the third biggest carbohydrate contributors, while fruit and vegetables ranked fourth. Notably, in four- to five-year-olds, the contribution of sweets, snacks and beverages to

carbohydrate intakes was higher than that in one- to three-year-olds. It is known that sweets, snacks, and beverages mostly supply not only large amounts of energy, refined starch and sugar, but also salt (sodium), and fat. Moreover, negligible amounts of essential micronutrients are found in sweets, snacks and beverages. This food group is frequently chosen over fruit and vegetables, thus displacing micronutrients and other nutrients such as fibers and phytochemicals that are good for health.

For one- to three-year-old children, one third of protein intake was derived from dairy products. When dairy products were examined more closely, plain milk was often selected (about 47% of the total amount of dairy products consumed), followed closely by flavored milk and milk products (about 38%), the latter of which provides additional sugar. Interestingly, dairy consumption altered with advancing age. It was found that the primary protein source for four- to five-year-old children was meat, poultry and related products. Regarding the food source of protein, four- to five-year-old children consumed cooked meat and poultry more often than processed meat and poultry products and animal organs. A group of grains and starchy products was the third largest contributor to protein intakes, followed by eggs in fourth place.

Dairy products, not only being key protein contributors, were also major sources of fat in one- to three-year-old children. Among four- to five-year-old children, fat and oils were the main sources of dietary fat, supplying 28.9 to 33.4% per day. From in depth examining a 24-hour dietary recall data, vegetable oil was mainly chosen for cooking foods for four- to five-year-old children; it formed approximately 80% of the total amount of fat and oils consumed, followed by coconut milk (17%) and animal fat (3%).

The existence of under- and over-nutrition in Thai preschool children potentially results from not only household food availability, but also from the feeding practice of mothers/caregivers or child eating habits. Fildes et al[24] studied the determinants of food preferences among children. One out of two determinants is related to early exposure to foods, which is able to develop children's preference for foods. Inappropriate dietary intake can lead to an improper intake of essential nutrients, especially macronutrients. Mothers/caregivers are the key target group, in whom the health professional team can put the effort to promote optimal nutritional status and healthful eating habits of their children. Effective nutrition education programs and new strategies should be developed and continuously implemented within different contexts of Thai communities. These programs must be coordinated with the capacity building of healthy feeding practices. Furthermore, periodic monitoring of Thai preschool children's food consumption and nutrient intake is needed.

Limitations of the present study involved using a single 24-hour-dietary recall. Only one recall may not reflect the habitual diet of individuals; however, it is adequate for estimating dietary intakes of a large population group. A second 24-hour-dietary recall should be done to assess participants' usual and adequate nutrient intakes[25]. Thus, for a future study, a first 24-hour-dietary recall followed by a second 24-hour-dietary recall in a subset, or multipass 24-hour-dietary recall, should be conducted. The second limitation was related to Dietary Reference Intakes of Thais or Thai DRIs. To estimate an inadequate intake within a group, Estimated Average Requirements (EARs) should be applied[26]. Due to limited quantities of food and dietary research studies in Thais, the existing Thai DRIs are incomplete. Most of the EARs have not been determined yet, and Acceptable Macronutrient Distribution Ranges (AMDRs) have still not been established. To make the picture clear, under the limited interpretation of energy and macronutrient adequacy, we presented energy and macronutrient data in mean, SD, and percentile. The last limitation was linked to the small number (n = 256) of participants.

For the future NHES, a study related to energy and macronutrient intakes of Thai preschool children with a larger sample size is needed to confirm these findings. Remarkably, Thailand is now concentrate on preventing obesity and overweight in Thai preschool children[12]. However, undernourished children exist, even though it is only a small number when compared to the overnourished children. Nevertheless, this problem cannot be disregarded. The development of national strategy and policy has to be carried out. Additionally, to fight the double burden of malnutrition, collaboration from food companies and industries is required.

In conclusion, Thai preschool children's energy and macronutrient intake may reflect the double burden of malnutrition. Macronutrient sources differed according to subgroups. Nutrition education programs should be provided which emphasize healthy feeding practices and motivate mothers/caregivers to promote optimal nutritional status and healthy eating in the next generation.

What is already known on this topic?

Sources of energy and macronutrient intakes in Thai children are mainly from protein and carbohydrate, but the proportions are unknown.

What this study adds?

More than 90% had protein intakes higher than the recommended values (18 and 22 g for one- to three-year-old and four- to five-year-old children, respectively). About 50 to 60% of energy came from dairy products and grains and starchy products. The major carbohydrate contributors were grains and starchy products, while dairy products were the main source of protein.

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Authors' contributions

Aekplakorn W, Chariyalertsak S, Sangthong R, Taneepanichskul S, Putwatana P, and Kessomboon P contributed to the design of the NHES IV and data collection. Satheannoppakao W designed dietary assessment tools in NHES IV, formulated the concept for this manuscript, and wrote the first draft. Satheannoppakao W and Kasemsup R analyzed and interpreted dietary data. Nontarak J performed statistical analyses. Aekplakorn W tailored the manuscript. All authors critically reviewed the manuscript and approved the final version.

Potential conflicts of interest

None.

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การได้รับพลังงานและสารอาหารหลัก และแหล่งอาหารในเด็กก่อนวัยเรียน: การสำรวจสุขภาพประชาชนไทยโดยการตรวจร่างกายครั้งที่ 4

วราภรณ์ เสถียรนพเก้า, รัชดา เกษมทรัพย์, จิราลักษณ์ นนทรักษ์, ปัตพงษ์ เกษสมบูรณ์, พรรณวดี พุธวัฒนะ, สุรศักดิ์ ฐานีพานิชสกุล, รัศมี สังข์ทอง, สุวัฒน์ จริยาเลิศศักดิ์, วิชัย เอกพลากร

วัตถุประสงค์: *เพื่อศึกษาการบริโภคพลังงานและสารอาหารหลัก และระบุแหล่งอาหารของพลังงานและสารอาหารหลักในเด็กไทยก่อนวัยเรียน*

วัสดุและวิธีการ: *การศึกษาเชิงภาคตัดขวางนี้เป็นส่วนหนึ่งของการสำรวจสุขภาพประชาชนไทยโดยการตรวจร่างกายครั้งที่ 4 ซึ่งคัดเลือกตัวแทนของประชาชนไทยอาศัยใน 4 ภาค และกรุงเทพมหานคร มารดา/ผู้ดูแลถูกสัมภาษณ์เกี่ยวกับการบริโภคอาหารใน 24 ชั่วโมงที่ผ่านมาของเด็ก ข้อมูลอาหารนำมาวิเคราะห์พลังงานและสารอาหารหลัก รวมถึงแหล่งอาหารของพลังงานและสารอาหารหลัก จากการเบ้ของข้อมูล Mann-Whitney U test ใช้วิเคราะห์เปรียบเทียบการได้รับพลังงานและสารอาหารหลักระหว่างเพศและกลุ่มอายุ*

ผลการศึกษา: *จากเด็กก่อนวัยเรียนจำนวน 256 คน มากกว่าร้อยละ 90 บริโภคโปรตีนสูงกว่าระดับที่แนะนำให้บริโภค เพียงร้อยละ 12.7 ถึง 29.0 ได้รับพลังงานตามข้อแนะนำการบริโภค ปริมาณของคาร์โบไฮเดรตและไขมันที่บริโภคผันแปรตั้งแต่ต่ำกว่าจนถึงสูงกว่าปริมาณสารอาหารอ้างอิงที่ควรได้รับประจำวัน การบริโภคคาร์โบไฮเดรตในเด็กชายและไขมันในเด็กหญิงมีความแตกต่างอย่างมีนัยสำคัญทางสถิติระหว่างกลุ่มอายุ ($p<0.05$) ประมาณร้อยละ 50-60 ของพลังงานได้จากการกินผลิตภัณฑ์จากนมและธัญพืชและผลิตภัณฑ์จากแป้ง แหล่งอาหารหลักของคาร์โบไฮเดรตคือ ธัญพืชและผลิตภัณฑ์จากแป้ง ขณะที่ผลิตภัณฑ์จากนมเป็นแหล่งหลักของโปรตีน แหล่งสำคัญของไขมันคือ ผลิตภัณฑ์จากนมสำหรับเด็กอายุ 1-3 ปี และไขมันและน้ำมัน สำหรับเด็กอายุ 4-5 ปี*

สรุป: *เด็กไทยก่อนวัยเรียนได้รับพลังงานและสารอาหารหลักไม่เหมาะสม ผลิตภัณฑ์จากนม และธัญพืชและ/หรือผลิตภัณฑ์จากแป้งเป็นแหล่งสำคัญของพลังงาน คาร์โบไฮเดรต และโปรตีน แหล่งของไขมันจากอาหารผันแปรตามกลุ่มอายุ*