

# Prevalence and determinants of sufficient fruit and vegetable consumption among primary school children in Nakhon Pathom, Thailand

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**BACKGROUND/OBJECTIVES:** Low consumption of fruit and vegetable is frequently viewed as an important contributor to obesity risk. With increasing childhood obesity and relatively low fruit and vegetable consumption among Thai children, there is a need to identify the determinants of the intake to promote fruit and vegetable consumption effectively.

**SUBJECTS/METHODS:** This cross-sectional study was conducted at two conveniently selected primary schools in Nakhon Pathom. A total of 609 students (grade 4-6) completed questionnaires on personal and environmental factors. Adequate fruit and vegetable intakes were defined as a minimum of three servings of fruit or vegetable daily, and adequate total intake as at least 6 serves of fruit and vegetable daily. Data were analyzed using descriptive statistics, the chi-square test, and multiple logistic regression.

**RESULTS:** The proportion of children with a sufficient fruit and/or vegetable intakes was low. Covariates of child's personal and environmental factors showed significant associations with sufficient intakes of fruit and/or vegetable ( $P < 0.05$ ). Logistic regression analyses showed that the following factors were positively related to sufficient intake of vegetable; lower grade, a positive attitude toward vegetable, and fruit availability at home; and that greater maternal education, a positive child's attitude toward vegetable, and fruit availability at home were significantly associated with sufficient consumption of fruits and total fruit and vegetable intake.

**CONCLUSIONS:** The present study showed that personal factors like attitude toward vegetables and socio-environmental factors, such as, greater availability of fruits were significantly associated with sufficient fruit and vegetable consumption. The importance of environmental and personal factors to successful nutrition highlights the importance of involving parents and schools.

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**Keywords:** Fruit, vegetables, self efficacy, child

## INTRODUCTION

Thailand has experienced great economic and social improvements since the 1980s [1]. Greater financial support for widespread community-based programs, including nutrition programs [2,3], aimed at promoting nutrition and health for preschool and school aged children, and an agriculture for school lunch program aimed at increasing fruit and vegetable consumption [4] have led to impressive declines in numbers of underweight children and children with stunted growth since 1987 [5]. On the other hand, as has been found in many low-and middle-income countries experiencing nutrition transition [6,7], economic improvements have led to other public health challenges like overweightedness and obesity [6,7]. Thailand now has one of the highest adult obesity rates in Asia [8], and is rapidly catching up with the West [8], and a similar pattern

has been reported for childhood obesity [9]. Furthermore, the consumption of fruit and vegetable in Thailand is low regardless of age [10,11], and this has been linked with obesity risk [12-14]. The Thai National Health Examination Survey III showed the proportion of participants aged  $\geq 15$  years that consumed the recommended amounts of total fruit and vegetable ( $\geq 5$  servings/day) was only 27% [10] and that mean daily fruit and vegetable consumptions were 268 grams for men and 283 grams for women [11].

Health behaviors like food habits are established in childhood and tend to be retained throughout adult life [15]. Thus preventative strategies should be developed and implemented during childhood, during which health behaviors are easier to change [16]. One of the proposed actions for health behavior change includes increasing fruit and vegetable consumption. To design effective interventions, it is critical that factors related

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to fruit and vegetable consumption be understood. Many health behavioral theories highlight the importance of personal and environmental factors in the development of behaviors [17]. In the context of fruit and vegetable consumption, personal factors, such as, self-efficacy and outcome expectancy, have been well studied. A review study showed that while one in five papers showed a positive association between outcome expectancy and fruit and vegetable consumption, most studies on the association between fruit and vegetable consumption and self-efficacy showed a positive association [18]. Another personal factor, that is, attitude toward fruit and vegetable consumption, has also been positively identified in the majority of studies [18]. In terms of environmental factors, home availability is considered to be the most important socio-environmental indicator of fruit and vegetable intake [19-22]. Furthermore, a recent study reported that a supportive home environment predicted vegetable intake among Australian children aged 9-13 years [23]. Although the above-mentioned factors regarding fruit and vegetable consumption have been well studied, almost all studies were undertaken in developed countries [22] and few in South-east Asia. Thus, in the present study, we aimed at identifying personal and socio-environmental determinants of sufficient fruit and vegetable intake among primary schoolchildren in Nakhon Pathom, Thailand.

## SUBJECTS AND METHODS

### *Study design and participants*

This cross-sectional study was conducted in two conveniently selected primary schools in Nakhon Pathom, Thailand in Feb 2015. One school was run by a municipal government and the other was a general public school run by the Office of the Basic Education Commission of the Ministry of Education. Prior to undertaking this study, the study design and purpose were discussed with the director of each school and their approvals were obtained. Three classes from the 4th or 5th grades and two classes from the 6th grade were randomly selected by cluster sampling. All students in the selected classes were requested to complete a self-administered, written questionnaire with support from a trained research team, during school time in a classroom (609 students, response rate = 100%). Sample size was estimated using a 95% confidence interval, an acceptable error of 4%, and a sufficient fruit and vegetable intake proportion of 30% [10]. The sample size was increased by 20% to allow for incorrectly completed questionnaires, the required sample size was 605. Questionnaires for parents were distributed and collected by teachers. Students' parents or caregivers were invited to participate by letter and completed the questionnaire at home (response rate = 88%).

### *Ethical consideration*

The study was conducted according to the tenets of the Declaration of Helsinki and all procedures involving human subjects were approved by the Human Research Ethics Committee of Mahidol University, Thailand (approval no.: 2015/033.2701). Written informed consent was obtained from all children and parents after the study objectives had been explained and they had been assured of confidentiality and told that they could

terminate participation at any time without prejudice. All data were treated anonymously using study identification numbers.

### *Fruit and vegetable consumption*

Fruit and vegetable consumption was assessed by two questions, adapted from the Child Nutrition Questionnaire (CNQ), developed in the "Eat well be active" [24]: 'How many serves of fruits do you usually eat in a day? [1 serve = 1 medium piece, 2 small pieces of fruit (e.g., mandarins or apricots), or 1 cup of diced pieces]', and 'How many serves of vegetables do you usually eat in a day? (1 serve = 1 cup of salad vegetable, 1/2 a cup of cooked vegetable, or 1 medium potato)'. The response options provided were 'do not eat, less than 1 serve/day, 1-2 serves/day, 3-5 serves/day, or more than 5 serves/day'. Although the use of such questions to measure daily fruit and vegetable consumption would not be expected to provide an accurate measure of usual intake, many studies have shown the use of such questions to assess fruit and vegetable consumption effectively identifies those at risk of low fruit and vegetable intake and is useful for monitoring population intakes because of low subject burden [25-27].

Suggested daily fruit and vegetable intakes and portion sizes vary between countries, and no universally accepted recommendation has been made regarding adequate intakes of fruit, vegetables, or total fruit and vegetable, respectively. According to Thailand's nutrition Flag [28], 4 rice-serving spoons of vegetable and 3 portions of fruit are recommended for children aged 6-13 years. Thus, we defined a minimum of 3 servings per day as adequate intakes for fruit and for vegetable, because a recent study showed low consumption of vegetable among Thai people aged  $\geq 15$  years [10]. For total fruit and vegetable, at least 6 serves of fruit and vegetable per day were defined as sufficient.

### *Personal factors*

#### *Self-efficacy and outcome expectancy*

This study adapted questions on outcome expectancy and self-efficacy from questionnaires developed and validated in other studies. Positive outcome expectancy to measures beliefs about consequences of eating fruit and vegetable by pre-adolescents was developed in the "Power Play! School Idea and Resource Kit Survey", which contains 9 items [29]. Self-efficacy to measure a person's confidence of eating fruit and vegetable at breakfast, lunch, dinner, and for snacks was developed as part of the Gimme 5 study, and contains 13 questions [30]. Outcome expectancy and self-efficacy were measured on a 5-point Likert scale ranging from totally disagree to totally agree. In the present study, Cronbach's alpha was 0.86 for self-efficacy and 0.88 for outcome expectancy and in the original sample these were 0.89-0.90 and 0.66-0.77, respectively [31].

#### *Attitude towards fruit and vegetable*

Questions on child's attitude toward fruit and vegetable were adapted from CNQ, which was developed for the Australian obesity prevention project [24]. Items for fruits were; i) makes me feel healthy; ii) tastes good; iii) easy snack; and iv) I like the taste of new fruits. Items for vegetables were; i) makes me

feel healthy; ii) tastes good; iii) I like the taste of new vegetables; and iv) vegetables are easy to prepare. The responses were scored using a Likert scale, which ranged from strongly disagree to strongly agree, from 1 to 5 points. In the present study, Cronbach's alpha was 0.59 for fruits and 0.67 for vegetables and in the original study Cronbach's alpha was 0.75 for vegetables [23].

#### Socio-environmental factors

##### Supportive environment for eating fruit and vegetable

Questions were adapted from CNQ [24]. The items were; i) vegetables are usually served at dinner; ii) fruits are available to eat at home; iii) parents and iv) teachers encourage fruit and vegetable consumption. Responses were scored using a Likert scale, which ranged from strongly disagree to strongly agree, from 1 to 5 points (Cronbach's alpha was 0.60 in the present study).

##### Home availability

Home availabilities of fruit and vegetable were assessed using two questions, which were also adapted from Hearn *et al.* [21]. The questions were 'Do you have fruits to eat at home?' and 'Do you have vegetables to eat at home?' The responses were 'never, sometimes, always, and I do not know.'

##### Other variables

Family information, such as, monthly household income, maternal education, and number of children in households were obtained from parents. Household incomes were recorded using a six-category scale starting at < 10,000 baht then 10,001-20,000 baht followed by incrementation by 10,000 baht to > 50,001 baht. Monthly household incomes were classified as ≤ 10,000, 10,001-20,000, and > 20,000 baht. In addition, self-reported maternal education level (no formal education, primary, secondary, college, university, and others) was classified as primary or less, secondary, or college or higher. Parents were also asked open-ended question about numbers of children in their household and these responses were classified as one or more than one.

#### Data analysis

Descriptive statistics were used to analyze proportions or mean general characteristics of participants. Because the consumption behaviors of fruit and vegetable differ [19], three outcome variables were used: sufficient intake of fruits (3 serves/day), vegetables (3 serves/day), and sufficient intake of fruit and vegetable (6 serves/day). Continuous predictor variables, such as, child's personal factors, and supportive environment regarding fruit and vegetable consumption were categorized into tertiles. Associations between outcome variables and covariates were assessed using the chi-square test. In order to identify factors associated with sufficient fruit and/or vegetable consumption, odds ratios were estimated using multiple logistic regression analysis, which was used to select the best contributors among covariates. All analyses were conducted using the SAS version 9.3 (SAS Institute Inc., Cary, NC, USA).

## RESULTS

### General characteristics of participants

Of the 609 students that participated in this study, 54.4% were girls and overall average participant age was  $10.9 \pm 0.93$  years (range from 9 to 13 years) (Table 1). About 41% of students were living in households with high incomes and with mothers

**Table 1.** Socio-demographic characteristics of the study subjects

	Total (n = 609)	
	n	% or Mean ± SD
Gender		
Girls	331	54.4
Boys	278	45.6
Child's grade		
4th	222	36.5
5th	227	37.3
6th	160	26.3
Household monthly income (baht)		
≤ 10,000	118	22.7
10,001-20,000	190	36.5
> 20,000	212	40.8
Education of mother		
Primary or less	115	23.8
Secondary	173	35.7
College or higher	196	40.5
Number of children in household		
2+	377	72.8
1	141	27.2
Fruit and vegetable consumption		
Fruit		
Do not eat	13	2.1
< 1 serve/day	70	11.5
1-2 serves/day	219	36.0
3-5 serves/day	172	28.2
> 5 serves/day	135	22.2
Vegetable		
Do not eat	37	6.1
< 1 serve/day	105	17.3
1-2 serves/day	258	42.4
3-5 serves/day	138	22.7
> 5 serves/day	70	11.5
Child's personal factors		
Child's attitude towards fruits (4-20 scores)	585	16.2 ± 2.6
Child's attitude towards vegetables (4-20 scores)	597	16.3 ± 2.5
Self-efficacy for FV (13-65 scores)	563	46.5 ± 9.6
Outcome expectancy for FV (9-45 scores)	595	33.4 ± 7.1
Socio-environmental factors		
Fruit availability in home		
Never/don't know	130	21.4
Sometimes	173	28.4
Always	306	50.3
Vegetable availability in home		
Never/don't know	131	21.5
Sometimes	173	28.4
Always	305	50.1
Supportive environment of FV (4-20 scores)	594	16.4 ± 2.5

FV: fruit and vegetable.

**Table 2.** Proportions of children (n = 609) satisfying criteria for sufficient intakes of fruit and/or vegetable (serves/day)

	Sufficient vegetable intake			Sufficient fruit intake			Sufficient total FV intake		
	< 3	≥ 3	P-value	< 3	≥ 3	P-value	< 6	≥ 6	P-value
	n (%)	n (%)		n (%)	n (%)		n (%)	n (%)	
<b>Child's gender</b>									
Girls	216 (65.3)	115 (34.7)	0.7622	159 (48.0)	172 (52.0)	0.4029	205 (61.9)	126 (38.1)	0.2505
Boys	184 (66.4)	93 (33.6)		143 (51.4)	135 (48.6)		184 (66.4)	93 (33.6)	
<b>Grade</b>									
4th	134 (60.4)	88 (39.6)	0.0766	105 (47.3)	117 (52.7)	0.4453	133 (59.9)	89 (40.1)	0.1393
5th	153 (67.4)	74 (32.6)		111 (48.9)	116 (51.1)		145 (63.9)	82 (36.1)	
6th	113 (71.1)	46 (28.9)		86 (53.8)	74 (46.3)		111 (69.8)	48 (30.2)	
<b>Household income (monthly)</b>									
≤ 10,000	78 (66.1)	40 (33.9)	0.7093	64 (54.2)	54 (45.8)	0.4486	77 (65.3)	41 (34.8)	0.7664
10,001-20,000	123 (65.1)	66 (34.9)		97 (51.1)	93 (49.0)		126 (66.7)	63 (33.3)	
> 20,000	146 (68.9)	66 (31.1)		100 (47.2)	112 (52.8)		134 (63.2)	78 (36.8)	
<b>Maternal education</b>									
Primary-	82 (71.9)	32 (28.1)	0.1393	64 (55.7)	51 (44.4)	0.0283	78 (68.4)	36 (31.6)	0.2227
Secondary	106 (61.3)	67 (38.7)		95 (54.9)	78 (45.1)		115 (66.5)	58 (33.5)	
College+	134 (68.4)	62 (31.6)		84 (42.9)	112 (57.1)		117 (59.7)	79 (40.3)	
<b>Number of children in household</b>									
2+	248 (66.0)	128 (34.0)	0.3590	190 (50.4)	187 (49.6)	0.8788	244 (64.9)	132 (35.1)	0.7077
1	99 (70.2)	42 (29.8)		70 (49.7)	71 (50.4)		89 (63.1)	52 (36.9)	
<b>Child's attitude towards fruits</b>									
1st tertile (4-15) <sup>1)</sup>	157 (73.4)	57 (26.6)	0.0002	132 (61.7)	82 (38.3)	< 0.0001	160 (74.8)	54 (25.2)	< 0.0001
2nd tertile (16-17)	111 (68.5)	51 (31.5)		80 (49.1)	83 (50.9)		106 (65.4)	56 (34.6)	
3rd tertile (18-20)	116 (55.0)	95 (45.0)		79 (37.4)	132 (62.6)		110 (52.1)	101 (47.9)	
<b>Child's attitude towards vegetables</b>									
1st tertile (4-15) <sup>1)</sup>	149 (78.8)	40 (21.2)	< 0.0001	118 (62.4)	71 (37.6)	< 0.0001	153 (81.0)	36 (19.1)	< 0.0001
2nd tertile (16-17)	134 (66.3)	68 (33.7)		104 (51.2)	99 (48.8)		127 (62.9)	75 (37.1)	
3rd tertile (18-20)	108 (52.7)	97 (47.3)		74 (36.1)	131 (63.9)		101 (49.3)	104 (50.7)	
<b>Outcome expectancy for FV</b>									
1st tertile (9-31) <sup>1)</sup>	149 (73.0)	55 (27.0)	0.0114	114 (55.9)	90 (44.1)	0.0214	142 (69.6)	62 (30.4)	0.0172
2nd tertile (32-36)	117 (66.1)	60 (33.9)		93 (52.3)	85 (47.8)		118 (66.7)	59 (33.3)	
3rd tertile (37-45)	126 (59.2)	87 (40.9)		91 (42.7)	122 (57.3)		121 (56.8)	92 (43.2)	
<b>Self-efficacy for FV</b>									
1st tertile (13-42) <sup>1)</sup>	136 (74.3)	47 (25.7)	0.0004	101 (55.2)	82 (44.8)	0.0002	133 (72.7)	50 (27.3)	0.0002
2nd tertile (43-51)	132 (67.7)	63 (32.3)		107 (54.6)	89 (45.4)		127 (65.1)	68 (34.9)	
3rd tertile (52-65)	101 (54.9)	83 (45.1)		67 (36.4)	117 (63.6)		96 (52.2)	88 (47.8)	
<b>Supportive environment of FV</b>									
1st tertile (4-15) <sup>1)</sup>	140 (78.7)	38 (21.4)	< 0.0001	112 (62.6)	67 (37.4)	< 0.0001	128 (77.5)	40 (22.5)	< 0.0001
2nd tertile (16-17)	131 (66.8)	65 (33.2)		106 (54.1)	90 (45.9)		130 (66.3)	66 (33.7)	
3rd tertile (18-20)	118 (53.9)	101 (46.1)		74 (33.8)	145 (66.2)		109 (49.8)	110 (50.2)	
<b>Fruit availability in home</b>									
Never/don't know	97 (75.2)	32 (24.8)	0.0127	86 (66.2)	44 (33.9)	< 0.0001	99 (76.7)	30 (23.3)	< 0.0001
Sometimes	117 (67.6)	56 (32.4)		102 (59.0)	71 (41.0)		122 (70.5)	51 (29.5)	
Always	186 (60.8)	120 (39.2)		114 (37.3)	192 (62.8)		168 (54.9)	138 (45.1)	
<b>Vegetable availability in home</b>									
Never/don't know	98 (75.4)	32 (24.6)	0.0051	77 (58.8)	54 (41.2)	0.0007	92 (70.8)	38 (29.2)	0.0053
Sometimes	119 (68.8)	54 (31.2)		97 (56.1)	76 (43.9)		121 (69.9)	52 (30.1)	
Always	183 (60.0)	122 (40.0)		128 (42.0)	177 (58.0)		176 (57.7)	129 (42.3)	

FV: fruit and vegetable.

Values are number (percentages) and P-values were determined using the chi-square test.

<sup>1)</sup>Values were ordered and then divided into three proportions and represented with a range (min-max).

educated to a college or a higher educational level. The proportions of children that reported at least 3 servings of fruit and

of vegetable daily were low (34% for vegetables and 50% for fruits).

**Table 3.** Determinants related to sufficient intakes of fruit and/or vegetable (serves/day) among the primary schoolchildren (n = 609)

	n	Sufficient vegetable (≥ 3 serves/day)	Sufficient fruit (≥ 3 serves/day)	Sufficient total FV (≥ 6 serves/day)
		aOR (95% CI)	aOR (95% CI)	aOR (95% CI)
<b>Child's gender</b>				
Girls	331	1.00	1.00	1.00
Boys	278	1.055 (0.655-1.699)	1.505 (0.96-2.361)	1.062 (0.665-1.696)
<b>Grade</b>				
6th	160	1.00	1.00	1.00
5th	227	1.898 (0.908-3.966)	2.129 (1.025-4.418)	1.875 (0.907-3.878)
4th	222	1.948 (1.093-3.469)	1.162 (0.688-1.963)	1.561 (0.885-2.751)
<b>Household income (monthly)</b>				
≤ 10,000	118	1.00	1.00	1.00
10,001-20,000	190	1.161 (0.621-2.169)	1.054 (0.585-1.898)	0.772 (0.417-1.429)
> 20,000	212	0.832 (0.424-1.631)	0.827 (0.439-1.557)	0.697 (0.359-1.354)
<b>Maternal education</b>				
Primary-	115	1.00	1.00	1.00
Secondary	173	1.708 (0.903-3.231)	1.134 (0.636-2.022)	1.308 (0.699-2.444)
College+	196	1.443 (0.737-2.828)	1.983 (1.069-3.678)	1.938 (1.001-3.753)
<b>Number of children in household</b>				
2+	377	1.00	1.00	1.00
1	141	0.669 (0.396-1.129)	1.152 (0.712-1.864)	1.279 (0.776-2.109)
<b>Child's attitude towards fruits</b>				
1st tertile (4-15) <sup>1)</sup>	214	1.00	1.00	1.00
2nd tertile (16-17)	163	0.589 (0.312-1.111)	0.933 (0.532-1.636)	0.808 (0.438-1.494)
3rd tertile (18-20)	211	0.967 (0.508-1.841)	1.145 (0.624-2.099)	1.121 (0.592-2.123)
<b>Child's attitude towards vegetables</b>				
1st tertile (4-15) <sup>1)</sup>	189	1.00	1.00	1.00
2nd tertile (16-17)	203	1.76 (0.918-3.371)	1.308 (0.744-2.302)	2.248 (1.183-4.273)
3rd tertile (18-20)	205	2.353 (1.152-4.805)	1.919 (1.002-3.674)	3.317 (1.632-6.741)
<b>Outcome expectancy for FV</b>				
1st tertile (9-31) <sup>1)</sup>	204	1.00	1.00	1.00
2nd tertile (32-36)	178	1.058 (0.582-1.922)	0.801 (0.465-1.382)	0.733 (0.406-1.324)
3rd tertile (37-45)	213	1.352 (0.739-2.472)	1.142 (0.65-2.007)	1.070 (0.592-1.934)
<b>Self-efficacy for eating FV</b>				
1st tertile (13-42) <sup>1)</sup>	183	1.00	1.00	1.00
2nd tertile (43-51)	196	1.194 (0.661-2.156)	1.002 (0.58-1.73)	1.171 (0.652-2.105)
3rd tertile (52-65)	184	0.84 (0.436-1.619)	1.022 (0.552-1.891)	0.955 (0.501-1.818)
<b>Supportive environment for FV</b>				
1st tertile (4-15) <sup>1)</sup>	179	1.00	1.00	1.00
2nd tertile (16-17)	196	1.113 (0.57-2.174)	1.049 (0.585-1.881)	1.147 (0.601-2.191)
3rd tertile (18-20)	219	1.779 (0.874-3.623)	1.579 (0.819-3.043)	1.399 (0.697-2.810)
<b>Fruit availability in home</b>				
No/rarely	130	1.00	1.00	1.00
Sometimes	173	1.72 (0.592-5.001)	2.855 (1.04-7.838)	1.872 (0.653-5.367)
Always	306	2.528 (1.027-6.219)	3.881 (1.633-9.222)	2.917 (1.202-7.076)
<b>Vegetable availability in home</b>				
No/rarely	131	1.00	1.00	1.00
Sometimes	173	0.833 (0.312-2.223)	0.571 (0.231-1.414)	0.463 (0.176-1.219)
Always	305	0.93 (0.398-2.169)	0.675 (0.306-1.49)	0.548 (0.238-1.257)
<b>Goodness of fit<sup>2)</sup></b>				
		9.7251	5.599	8.534
<b>P-value<sup>2)</sup></b>				
		0.2849	0.692	0.383

FV, fruit and vegetable; aOR, adjusted odds ratio; CI, confidence interval.

aOR and CI values were obtained by multivariate analysis adjusted for each of the variables shown the Table.

<sup>1)</sup> Values were ordered and then divided into three proportions and represented with a range (min-max).<sup>2)</sup> Hosmer and Lemeshow goodness-of-fit test and P-value.

#### *Bivariate associations between independent factors and sufficient intake of fruit and/or vegetable*

Bivariate associations between demographic, personal, and environmental variables and sufficient intakes of fruit and/or vegetable are shown in Table 2. Of the demographic factors, only maternal education showed a significant association ( $P < 0.05$ ). On the other hand, covariates of personal and environmental factors all showed significant associations with sufficient intakes of fruit and/or vegetable ( $P < 0.05$ ).

#### *Determinants of sufficient intakes of fruit and/or vegetable*

Factors found to be related to sufficient intakes of fruit and/or vegetable by multiple logistic regression analysis are presented in Table 3. Children of lower grade, children with a positive attitude toward vegetables, and home fruit availability were positively and significantly associated with sufficient vegetable consumption, and children with a higher maternal education level, a positive attitude toward vegetables, and home fruit availability were positively and significantly associated with sufficient fruit and total fruit and vegetable consumption.

## DISCUSSION

In this cross-sectional analysis of fruit and vegetable consumption among Thai primary schoolchildren from Grades 4 to 6, relatively low proportions of the students consumed sufficient fruit and/or vegetable. Factors positively related with sufficient intake of vegetables were lower grade, a positive child's attitude toward vegetables, and home fruit availability. Furthermore, higher maternal education level, child's attitude toward vegetables, and home fruit availability were found to be significantly associated with sufficient fruit and total fruit and vegetable consumption. Our findings highlight the importance of the roles of parents and schools in terms of creating a supportive environment by increasing the availability of fruits and improving children's attitudes toward vegetables.

Low consumption of fruit and vegetable by children seems to be common in developing [32] and developed countries [22,33]. A recent study in Southeast Asian adolescents (aged 13-15 years) showed the proportion of adolescents consuming inadequate amounts of fruit and vegetable ( $< 5$  servings/day) was 76.3% overall and 67.1% in Thailand [32]. These findings are supported by the present study, which also showed a high prevalence of insufficient fruit and vegetable consumption ( $< 6$  serves/day, 64%). Furthermore, in a previous study, the proportion of children that consumed sufficient vegetables was found to be lower than that for fruit [34]. Generally, older children are less likely to meet recommended fruit and vegetable intakes and girls are more likely to consume more fruit and vegetable than boys, which is also in line with our findings, despite a lack of statistical significance. Thus, interventions to promote fruit and vegetable intake should be aimed at younger children [35].

Personal factors are key drivers of decisions regarding healthy food choices [36]. The regression model devised during the present study explained around 12% of variance in fruit and vegetable consumption, but personal variables explained half of total variance. In previous studies, self-efficacy was shown

to be one of the strongest predictors of children's consumption among personal factors [23,37,38]. Despite no association in our regression model, bivariate associations of personal factors, such as, self-efficacy, outcome expectancy, and attitudes toward vegetables and fruits showed significant associations with fruit and vegetable consumption. This findings is supported by previous studies, which reported positive attitudes toward fruit and vegetable and self-efficacy significantly predicted fruit intake in both genders [23,38]. In the present study, child's attitude toward vegetables, but not toward fruits, was found to strongly predict fruit intakes and total fruit and vegetable intakes by regression analysis. Generally, children seem to have better attitudes toward fruits than vegetables [37], which is also consistent with our findings. Because fruits are readily available in Thailand, these findings indicate efforts to increase fruit and vegetable consumption should be focused on improving attitudes toward vegetables.

Children learn from their experiences of foods in their homes, and thus, supportive physical and social environments are important in terms of forming attitudes and self-efficacy for healthy eating [23]. It has been reported that home availability of fruit and vegetable is the most important determinant of fruit and vegetable consumption among children [18,20-23,37, 39,40] due to a direct effect on fruit and vegetable consumption and the indirect effects of parental example [41]. One study conducted in Iceland reported fruit and vegetable availability at home seems to be a more important determinant of vegetable consumption by children than of fruit consumption [22]. However, in the present study, fruit availability rather than vegetable availability at home seemed to be the more important determinant of both fruit and vegetable intake. It should be noted that environmental factors, which are generally self-reported by children, reflect children's perceptions of environment factors. As Zarnowiecki *et al.* [23] suggested, perceptions of the home environment are more likely to influence healthy food intake significantly in children, and thus, fruit and vegetable consumption is likely to be increased by making fruit and vegetable more visible and available [22].

Vegetables are ingredients of many Thai dishes, such as, soups and stir-fried foods, and generally require more cooking skills and preparation time than fruits, which adds to the availability/accessibility of fruits. This is supported by a qualitative study on Iranian adolescents, which reported most students ate fruits daily at home, but that vegetables were less available because of the preparation required [42]. Therefore, parents play a significant role in determining fruit and vegetable consumption by children because they directly shape the physical and social environment [20]. The present study also shows maternal education is positively associated with fruit intake and total fruit and/or vegetable intake. This agrees in part with the findings of a Polish study [39], which found parental education influenced fruit, but not vegetable, consumption. Mothers educated to a higher level are more likely to pay attention to healthy dietary habits and contribute to fruit and vegetable consumption, particularly fruit consumption, because children readily eat fruits, fruit preparation is easier, and fruit is a well-known healthy dietary component [39].

The present study implies the school environment is

important as it shows the impact of school policy on fruit and vegetable intake. Both schools involved in our study restricted the sale of carbonated drinks. Nevertheless, in both schools fruit and vegetable availability was limited in terms of supply and diversity, which has been shown to hinder fruit and vegetable consumption of children [43]. One successful fruit and vegetable promotion program held in Thailand, a free school-based fruit program, involved the provision of whole or sliced fruits to school children; similar programs have been described in Bolivia and Venezuela [44]. We suggest this be reconsidered as a school-based fruit and vegetable promotion program. In addition, one school in the present study ran a vegetable farm to supply vegetables for school meals and educational purposes, and this could in turn improve children's attitudes toward vegetables and increase vegetable consumption. These activities imply the need for multicomponent intervention [45] incorporating personal and environmental strategies to increase fruit and vegetable consumption [46], for example, the use of taste testing games [47], improving fruit and vegetable availability at homes and schools [37,48], and cooking experimentation, for example, cutting up vegetables into smaller pieces to increase their appeal.

Certain limitations of the present study warrant consideration. First, because Thai students were selected from only two primary schools in a semi-urban area of Nakhon Pathom province, caution should be exercised when generalizing our findings. Second, the study involved a cross-sectional survey and short-term, self-reported assessments, which contribute to measurement errors and are prone to imprecise estimates because of the reliance placed on children's memory. Third, the accuracy of the method used to estimate fruit and vegetable intake is debatable. Further study is needed to test the validities of estimation tools in Thai children, particularly in light of the concerns raised about the use of questionnaires developed in Australia [24]. The use of short food-related questions to measure daily fruit and vegetable consumption is also debatable. Although the performance of such questionnaires may not be less than perfect for determining usual intake, many studies have shown such questionnaires provide an effective means of identifying people at risk of low fruit and vegetable intake and for monitoring population intakes because of low subject burden [25-27]. Furthermore, fruit and vegetable intakes as determined using short questions have been positively associated with responses to other questions in the CNQ designed to assess fruit and vegetable consumption in children, which provides some evidence of construct validity. The following is an example of such a question; 'Please indicate if you ate this fruit yesterday, by ticking the box that applies to you, for each fruit and vegetable (22 fruits and 29 vegetables)'. For this question correlation coefficients were significant ( $r = 0.266$ ,  $P < 0.001$  for vegetables and  $r = 0.204$ ,  $P < 0.001$  for fruits). Nevertheless, given the limitation associated with estimating fruit and vegetable intakes, consideration should be given to the above-mentioned issues when interpreting the findings of this study. Fourth, the social desirability of responses may have introduced bias during data collection, and thus, we suggest identified associations be used to generate hypotheses for testing in future studies. Other environmental factors associated with peers, schools, neighborhoods, and media need to be

explored by large scale prospective study.

The present study suggests that interventions involving parent participation and encouraging parents to create a supportive home environment by making fruit and vegetable readily available may increase fruit and vegetable consumption by children. To provide a supportive home environment, the consumption of fruit and vegetable, but particularly of vegetables, should be promoted among parents as well as children [39]. Moreover, in order to reinforce the healthy eating habits of children, dietary education should be continued at schools [39]. Therefore, we recommend that interventions be based on environment policy-based designs at the family and school levels. Such interventions may support the development of more positive attitudes and habitual behaviors and self-efficacy among children [19]. Since fruit and vegetable intakes appear to decrease with age, interventions to promote increasing their intake should be especially aimed at younger children on a large scale [35].

In conclusion, this study shows that both personal factors, like attitude to vegetables, and socio-environmental factors, such as, the availability of fruits at home, are strongly associated with sufficient fruit and vegetable intakes. Our findings highlight the importance of the roles of parents and schools in terms of creating supportive environments by ensuring the availabilities of fruits and by enhancing children's attitudes to vegetables.

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## CONFLICT OF INTEREST

The authors declare no potential conflicts of interests.

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