

## Promoting local vegetable and fruit consumption among pre-school children at a child development day care centre

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### Abstract

A quasi-experimental study aimed to improve vegetable and fruit consumption among pre-school children aged 3-5 years old enrolled at two child development day care centres. Children were divided into two groups, an intervention and comparison group. There were 43 cases in each group. The intervention group received the comprehensive program on promoting local vegetable and fruit consumption consisting of an activity series of 3 packages: awareness package, product development package, and reinforcement package, which were implemented together at the same time. The data were collected using a 24-hour dietary recall and food frequency questionnaire. The achievement of the program was analysed by comparing the amounts of vegetable and fruit consumed in the intervention and comparison groups using analysis of covariance (ANCOVA) under general estimating equations models (GEE). The results showed that intervention group consumed vegetable and fruit more than the comparison group by 1.78 serving (95% CI = 1.36 to 2.20, p-value < 0.001). It is concluded that there was increase of vegetable and fruit consumption at an early age. This program using local vegetable and fruit could be introduced to child development day care centres throughout Thailand.

### Keywords

Vegetable and fruit consumption  
Pre-school children  
Nutritional program

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### Introduction

A balanced diet with adequate intake of vegetable and fruit is important for health. Since, they are a source of antioxidants, vitamins, minerals, and other bioactive compounds as well as of fibers, and phytochemicals (World cancer research fund/American institute for cancer research, 1997). These nutrients prevent chronic diseases such as obesity, hypertension, cardiovascular disease, coronary heart disease, type 2 diabetes mellitus and several forms of cancer (World Health Organization, 2004; He *et al.*, 2007). However, large population groups worldwide, especially children, eat far less than the recommended amount of vegetable and fruit (Perez and Aranceta, 2003; Kafatos *et al.*, 2004).

According to a recent publication of the World Health Organization, to prevent chronic diseases and alleviate micronutrient deficiencies, it is suggested to consume at least 400 g (5 serving) of vegetable and fruit daily. The estimated levels of current vegetable and fruit intake vary considerably around the world ranging from less than 100 g/day in low and middle income countries, to about 450 g/day in Western Europe (World Health Organization, 2004). A Thai

health survey stated for the Northeast of Thailand that vegetable and fruit consumption for children age of 2 to 5 years consumed in average vegetable and fruit of 1.6 serving/day (about 128 g) (Health Information System Development Office, 2009). Inadequate vegetable and fruit consumption among children therefore remains an important public health challenge (Panunzio *et al.*, 2007). In an effort to increase vegetable and fruit consumption ways must be found to improve vegetable and fruit consumption which might be important for improving health and well-being, since lifelong dietary patterns are established in childhood (Centres for Disease Control and Prevention, 1996; Mikkila *et al.*, 2004) and food preferences in childhood tend to be maintained into adulthood (Wyse *et al.*, 2010).

Recent findings suggest that innovative research is necessary to broaden the traditional approach beyond increasing vegetable and fruit awareness and education. To introduce an intervention of reinforce vegetable and fruit consumption for target groups, it was necessary to identify target behaviours before providing the intervention for optimal benefits of resources used (Setalaphruk and Price, 2007; Jones *et al.*, 2010). Therefore, this study aimed to improve

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vegetable and fruit consumption among pre-school children at a child development day care centre.

## Materials and Methods

### *Recruitment of subjects*

The study was conducted at two child development day care centres of two North-eastern villages of Thailand. The protocol has been approved by Khon Kaen University Ethics Committee. One was child development day care centre which was selected as an intervention group. Another was child development day care centre which was selected as the comparison group. All eighty-six normal- and overweight-nutritional status children aged 3 to 5 years old participated in the study lived with their families. Data were collected from the participants that spent at least 80% of total period of the program. The parents were asked to sign consent agreement forms to enrol the subjects in the program and data collection. The sample size was calculated based on the primary outcome, servings of local vegetable and fruit consumption. The subjects were randomly divided into comparison and intervention groups.

### *Research Instruments*

The study used three main instruments, as following:

(a) The intervention of program: the intervention group received the local vegetable and fruit-rich program every day for 8 weeks. The program contained an activity series of 3 packages: awareness package, product development package, and reinforcement package, which were implemented together at the same time as follows.

Awareness package (8 weeks): Project activities were conducted as giving knowledge on the kinds of vegetable and fruit, cooking main course of food with vegetables, vegetable and fruit party, and growing and treating vegetables. The team of researchers instructed the children for 2 hours once a week, by exposing them to posters, songs, poems, and stories about vegetable and fruit. The elderly club in the community was involved in providing knowledge and wisdom about cooking from local vegetable and fruit or telling the tales to encourage them to eat more vegetable and fruit. The activity was conducted for 2 hours/session, once a week, and continued for 8 weeks.

The researchers provided teachers knowledge and communication techniques on vegetable and fruit for 20-30 minutes/week for 8 weeks through such recreational activities as viewing cartoons, singing a song, painting, playing photo cards,

playing games, listening to stories, and discussing on vegetable and fruit, etc. The teachers led children to participate in discussion on benefits of vegetable and fruit consumption. Demonstration and practice of gardening activities were also organized. The teachers and the researchers encouraged children to grow vegetables and took them to the vegetable plots in community for 30 minutes/session, once a week for 8 weeks. The children were educated about nutrition by the researchers, focusing on promotion of vegetable and fruit consumption, for 2 hours/session, once a week, and continued for 8 weeks. Children tried the cooked vegetable and had lunch together. The elderly club in the community involved in passing on knowledge and wisdom about the cooking or the story about the local vegetable and fruit for 2 hours/session, once a week, and continued for 8 weeks.

Product development package (8 weeks): Our preliminary study showed that most of children (approximately 80%) tended to refuse vegetable consumption mainly due to their unfavourable textures, appearances, tastes and flavours. Special attention was given to create various vegetable and fruit recipes by the children's parents, teachers and researchers. In Thailand, chemical and microbial contamination vegetables and fruits have been reportedly present (Wanwimolruk *et al.*, 2016). Therefore, for safety, washing vegetables before consumption is advisable as this helps reduce the level of pesticide residues in our daily intake (Wanwimolruk *et al.*, 2015). All vegetables and fruits were washed thoroughly with flowing tap water and immersed in 1% sodium chloride for 10 minutes. This method can reduce microbial and pesticide contamination (Takeuchi and Frank, 2001; Lozowicka *et al.*, 2016).

In addition, the children also participated in creating and trying their own menus. The activities were based on traditional food patterns in the Northeast of Thailand including steamed, boiled, fried, grilled vegetable and fruit as well as vegetable soups. In this way, with the ready-to-eat forms, we could encourage them to take more vegetable and fruit. In details, we offered cut-up pieces of fruits or vegetables at snack times and made them easy-to-access ensuring that the fruit was visible by storing it in a fruit bowl.

The researchers collaborated with teachers and parents for creating menus which has beautifying tasty, good texture and were accepted by the pre-school children. The menus were formulated by applying the resources available in their local and basing on suitable menu for lifestyle of Northeast

people of Thailand. The cookers of the intervention group were daily provided menus and raw materials by the researchers at 7 a.m. for 8 weeks. The teachers daily prepared the menu courses of lunch at 10.00 - 11.00 a.m. for the pre-school children. The children were provided the formulated menus for 8 weeks.

A reinforcement package (8 weeks): The teachers and parents learned lessons given by the researchers in order to promote and reinforce vegetable and fruit consumption of the children for 2 weeks (3 hours/week). The teachers promoted and reinforced the children to consume vegetable and fruit at lunch meals for 8 weeks. The parents promoted and reinforced their children to consume vegetable and fruit by describing benefits of vegetable and fruit on their health. Both the parents and their children collaborated to prepare or cook diets supplemented with local vegetable and fruit. They were supported to carefully prepare food for their children by asking them to involve with selecting vegetable and fruit, cooking, growing and taking care of the vegetable and fruit gardens.

The program was conducted with the participation from teachers, parent, cookers, peers, and community groceries (restricted on selling sweets and candies to pre-school children) and controlled by the researchers.

(b) A 24-hour dietary recall questionnaires (24-HR) was used to measure the quantity of children's daily vegetable and fruit consumption for 3 days (2 weekdays and 1 weekend day consecutively), by asking the parents through a self-administered questionnaire about children's vegetable and fruit consumption within a 24-hour period. The questionnaire was used 3 times i.e., before intervention, after intervention and at the end of intervention.

(c) Food frequency consumption (FFQ): FFQ was used for assessing the child's vegetable and fruit consumption. The FFQ questionnaire was consisted of 2 parts. One was a list of individual food or local vegetable and fruit groups. Two was a 7-item frequency questionnaire of vegetable and fruit consumption. The 7-item frequency questionnaire was consisted of none, 1-2 times/week, 3-4 times/week, and 5-7 times/week. The score of the vegetable and fruit frequency consumption were ranged of 0 to 28. The FFQ questionnaire was repeated 3 times i.e., before intervention, after intervention and at the end of intervention. The researchers conducted this process by interviewing the parent to recall how often the child selects particular foods the assessment referred back for 7 days.

#### *Data analysis*

All statistical analyses were performed with

STATA (version 10 or Previous) statistical software. Inferential statistics was use to evaluate the efficacy of a program on promoting vegetable and fruit consumption of pre-school children attending child development day care centre. The primary outcome was analysed by comparing mean differences serving of vegetable and fruit between 2 groups applying an analysis of covariance (ANCOVA) under general estimating equations models (GEE).

The study would have 90% power to detect a difference of 1.5 serving between the intervention and comparison groups with respect to the primary outcome (improved local vegetable and fruit consumption at a two-sided significance level of 0.05). Analysis was performed on data from serving of children's local vegetable and fruit consumption measurements at baseline, and at the end of the study. Subject variables of the two groups were balanced by adjusting covariates of gender, age, dietary behaviour, parent's education, family income, availability, and accessibility of vegetable and fruit. We carefully selected the two schools that had similar geographical characteristics and management systems. We also preliminarily surveyed background information of the caregivers. Both of the subjects child development day care centres had some common contexts in terms of centre management, centre structure, and teaching-learning management, which were administered by the local administration. That is, the child development day care centres are run by the local government organizations, which are empowered by the Ministry of Defense. This means that they share similarity in a number of respects, including the syllabus, the number of childcare takers, and the administration budget. In addition, the childcare takers have been trained appropriately and they are yearly evaluated about their proper conduct by the office of education. Last but not least, the list of local vegetables showed that both schools had no different sources and types of food. This study was approved by the Khon Kaen University Ethics Committee for human research, before conducting on the 19 April 2012. An informed consent form was obtain from all parents (reference no. HE552009).

#### **Results**

This study investigated the effectiveness of the comprehensive program to promote local vegetable and fruit consumption of pre-school children attending the child development day care centre. We promoted local vegetable and fruit consumption for 8 weeks with a 12-week followed-up. The impact of the program on local vegetable and fruit consumption

Table 1. Baseline characteristics of the comparison and intervention groups (n=86)

Factors	Comparison group (n=43)		Intervention group (n=43)	
	numbers	(%)	numbers	(%)
Sex				
Male	22	51.16	23	53.49
Female	21	48.84	20	46.51
Age				
3 year	13	30.23	5	11.63
4 year	12	27.91	22	51.16
5 year	18	41.86	16	37.21
Family monthly income (Baht)				
<5,000	5	11.63	9	20.93
5,001 – 10,000	17	39.53	17	39.53
10,001 – 15,000	15	34.88	12	27.91
>15,000	6	13.96	5	11.63
Family size (person)				
1-3	1	2.33	4	9.30
4-6	31	72.09	32	74.42
>7	11	25.58	7	16.28
Weight baseline (Kg)				
Mean $\pm$ SD	14.71 $\pm$ 2.03		15.53 $\pm$ 3.29	
Min - max	15.50 - 20.00		12.00 - 27.50	
Height baseline (cms)				
Mean $\pm$ SD	94.36 $\pm$ 5.71		99.33 $\pm$ 5.59	
Min - max	85.00 - 106.00		86.50 - 110.50	
Kind of food consumed by a child				
Isarn food	33	76.74	35	81.40
Thai food	10	23.26	8	18.60
Nutritional status baseline				
Normal (-1.5 S.D. to + 1.5 SD)	31	72.09	40	93.02
Rotund (+1.5 S.D. to + 2 SD)	6	13.95	0	0.00
Overweight (+ 2 SD to + 3 SD)	4	9.30	1	2.33
Obese (above + 3 SD)	2	4.65	2	4.65
Adequate consumption of food per day				
Vegetable; 3 rice-serving spoons				
Sufficient	14	32.56	12	27.91
Insufficient	29	67.44	31	72.09
Fruit; 2 serving				
Sufficient	25	58.14	19	44.19
Insufficient	18	41.86	24	55.81
Pre-school children vegetable and fruit consumption				
Neither	1	2.33	2	4.65
Both	32	74.42	32	74.42
Fruit only	7	16.28	9	20.93
Vegetable only	3	6.98	0	0.00
Child consume vegetable				
Yes	33	76.74	26	60.47
No	10	23.26	17	39.53
Fruit consumption of pre-school children				
Yes	39	90.70	43	100.00
No	4	9.30	0	0.00

of pre-school children was given below:

#### *Demographic characteristics of intervention group and comparison group at baseline*

The proportion of boys slightly exceeded those of girls for the intervention as well as the comparison group. The overwhelming majority of children aged 3 to 4 years. All of them lived with their parents and other family members (average of 4-6 persons). The average income varied between 5,000 and 10,000 baht.

Most of the pre-school children were healthy. The average weight of the children was 15 kilograms, and their average height was 100 centimetres (Table 1). The nutritional status of most of the children was normal. The main dietary pattern of the children consisted of local North-eastern (Isarn) food. In the beginning of the project, the children consumed insufficient amounts of vegetables and one fourth of them consumed no vegetable at all. Similarly, almost half of the children rarely ate fruits.

Behaviours of vegetable and fruit consumption differed between the comparison and the intervention groups. The number of children in the comparison group eating vegetables was higher when compared

with the intervention group. However, the number of children eating fruits in the intervention group was more than the comparison group. In the comparison group, 4 children did not eat fruits at all, but all children in the intervention group used to eat fruits (Table 1).

#### *The promoting local vegetable and fruit consumption program increased amount of vegetable and fruit consumption in pre-school children attending child development day care centre*

The amount of vegetable and fruit consumption per day in the intervention and comparison groups: before the experiment, after the intervention, and 12 weeks follow-up found that; At baseline, comparison group had  $1.96 \pm 1.48$  vegetable and fruit serving per day vs.  $2.61 \pm 1.16$  serving per day in the intervention group. Thus, we adjusted other covariates at baseline as shown in Table 1. After 8-week intervention, comparison group had  $1.99 \pm 1.26$  serving per day, which was not significantly different from baseline. On the other hand, the intervention group consumed vegetable and fruit  $4.15 \pm 1.37$  serving per day with the adjust difference of ANCOVA at 2.06 serving (95% CI = 1.48 to 2.64). We then analysed data at

Table 2. Comparison of the mean difference of the amount of vegetable and fruit consumption of pre-school children per day between the comparison group (n=43) and the intervention group (n=43)

Variable	Comparison group (n=43)			Intervention group (n=43)			Adjust Difference (ANCOVA)	Mean Difference* (GEE) (95%CI)	p-value	
	Baseline	After intervention	12 weeks follow-up	Baseline	After intervention	12 weeks follow-up				
Amount of vegetable and fruit (Serving)	1.96±1.46	1.99±1.26	1.90±1.40	2.61±1.16	4.15±1.37	4.43±1.48	2.06 (1.48-2.64)	1.22 (0.55-1.89)	1.78 (1.36-2.20)	< 0.001

Note: Values expressed are means ± S.D. of the amount of vegetable and fruit consumption of pre-school

\*refers to overall mean of outcome post intervention. Mean differences obtained from ANCOVA which were adjusted for the corresponding outcome's baseline measurements and using control as the reference group and adjusted other covariates

Table 3. Comparison of the mean difference of vegetable and fruit frequency consumption of pre-school children per day between the comparison group and the intervention group (n = 86)

Variable	Comparison group (n=43)			Intervention group (n=43)			Adjust Difference (ANCOVA)	Mean Difference* (GEE) (95%CI)	p-value	
	Baseline	After	12 weeks follow-up	Baseline	After	12 weeks follow-up				
Vegetable and fruit frequency (Score)	16.00± 4.70	16.55± 4.70	15.76± 5.74	18.02± 4.00	22.33± 4.22	23.56± 3.43	4.52 (2.67 to 6.38)	4.19 (2.40 to 5.98)	5.19 (3.55 to 6.84)	< 0.001

Note: Values expressed are means ± S.D. of vegetable and fruit frequency consumption of pre-school children per day

\*refers to overall mean of outcome post intervention. Mean differences obtained from ANCOVA which were adjusted for the corresponding outcome's baseline measurements and using control as the reference group and adjusted other covariates.

12-week follow-up and found that the comparison group had 1.90 ± 1.40 vegetable and fruit serving per day while the intervention group had the amount average of vegetable and fruit consumption 4.43 ± 1.48 serving per day with the adjust difference of ANCOVA at 1.22 serving (95% CI = 0.55 to 1.89). Overall, we compared the difference of the average of vegetable and fruit consumption in pre-school children in the comparison group and intervention group at baseline, after 8-week intervention, and at the 12-week follow-up, post treatment adjusted to baseline. An analysis of covariance, post treatment adjusted to baseline (ANCOVA) under general estimating equations models (GEE) showed that, after the whole 20 weeks of experiment, the intervention group had significantly higher amount of average vegetable and fruit consumption than the comparison group 1.78 serving (95% CI = 1.36 to 2.20, p-value < 0.001) (Table 2).

*The program increased frequency of vegetable and fruit consumption in pre-school children attending child development day care centre*

Before the experiment, most of pre-school children (44.19%) in the comparison group had a low frequency of vegetable and fruit consumption level. Meanwhile, 39.53% and 16.28% of the children had moderate and high frequency of vegetable and fruit consumption levels, respectively (average 16.00 ± 4.70/28.00 points, Table 3 and 4). In the intervention group, most subjects (65.12%) had moderate frequency of vegetable and fruit consumption level (18.02 ± 4.00/28.00, Table 3 and 4). After 8-week intervention, majority (46.51%) of subjects in the comparison group still had a low level with the average frequency (16.55 ± 4.70). In contrast, most of subjects (58.14%) in the intervention group had a high frequency of vegetable and fruit consumption level (average frequency 22.33 ± 4.22/28.00).

At the 12-week follow-up, most of the children (44.19%) in the comparison group still had a

Table 4. Differences in frequency of vegetable and fruit consumption level between comparison group and intervention group

Level of vegetable and fruit frequency	Comparison group (n=43)						Intervention group (n=43)					
	Baseline		After intervention		12 weeks follow-up		Baseline		After intervention		12 weeks follow-up	
	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)
High	7	16.28	11	25.58	7	16.28	7	16.28	25	58.14	33	76.74
Moderate	17	39.53	12	27.91	17	39.53	28	65.12	16	37.21	9	20.93
Low	19	44.19	20	46.51	19	44.19	8	18.60	2	4.65	1	2.33

low level with the average frequency of  $15.76 \pm 5.74/28.00$ . This data suggests that the frequency of vegetable and fruit consumption of fruits of pre-school children in the comparison group was not different in the 3 periods. Meanwhile, most of subjects in the intervention group (76.74%) had a high level in the frequency of vegetable and fruit consumption with the average frequency of  $23.56 \pm 3.43/28.00$ . We then used an analysis of covariance with post treatment adjusted to baseline (ANCOVA) under general estimating equations models (GEE) and found that the average point of the frequency of vegetable and fruit consumption in the intervention group was higher in than the comparison group (5.19 point, 95% CI = 3.55 to 6.84, p-value < 0.001) (Table 3). The frequency of vegetable and fruit consumption for the intervention group increased from 16.28% at baseline to 76.74% at the end of the program (Table 4).

## Discussion

The present study shows that the comprehensive program on promoting local vegetable and fruit consumption significantly increases amount and frequency of local vegetable and fruit consumption among pre-school children at a child development day care center. Previous quasi-experimental studies in children have set the goal standard servings of vegetable and fruit consumption ranged between 0.5-1 serving/day (Steptoe *et al.*, 2003; Kitchen *et al.*, 2009). The reasons of this significant finding might be due to the comprehensiveness of the program itself i.e., the novel program has been developed based on all factors affecting consumption behaviours. The influential factors were considered, revised, and incorporated into the program through a series of various activities—encouragement of awareness, nutritional education, vegetable and fruit food formulations, cooking demonstration, entertaining activities (singing, comics, games as well as real planting and gardening). In the studies by Sirikulchayanonta *et al.* (2010) they used food experience, multimedia and role models for promoting vegetable and fruit consumption in children. This data suggest that parent and community involvement

is of importance for vegetable and fruit promotion. Of note, in European countries, students in boarding school are generally served by vegetable and fruit with awareness and reinforcement promotion by teachers and staff (Perez and Aranceta, 2003; Kafatos *et al.*, 2004; Panunzio *et al.*, 2007; Te Velde *et al.*, 2008; Kitchen *et al.*, 2009; Tak *et al.*, 2009; Savage *et al.*, 2012; Upton *et al.*, 2013). To our knowledge, the present study is first to apply the comprehensive methods to improve vegetable and fruit consumption behaviour of pre-school children. In addition, this program is relatively cheaper than others since we can adjust local vegetable and fruit components in accordance with seasonal availability. Community reinforcement is also important for the program development (Te Velde *et al.*, 2008). We designed the program in such a way that local groceries refrain from selling sweets, candies, and sodas to the children. The program included nutritional education to local grocery owners, local elderly club, parents, and community leaders.

Even though this study is successful to reach 4.15 servings/day of vegetable and fruit consumption, this value is still below World Health Organization recommendation standard (5 servings/day). Malnutrition is still a health problem for Thai children—excessive energy consumption and nutrient imbalance are among the most common nutritional problems (Setalaphruk and Price, 2007; Shawn and tKatherine, 2008). A superior carbohydrate, fat, and oil consumption ratio over vegetable and fruit causes overweight nutritional status during childhood (Shawn and tKatherine, 2008; Sirikulchayanonta *et al.*, 2010). However, literature shows that none of studies could achieve this standard level (Marie *et al.*, 2011; Savage *et al.*, 2012). This failure of achievement is probably due to the fact that the intervention period was too short (Steptoe *et al.*, 2003; Tak *et al.*, 2009; Wyse *et al.*, 2010). Additional research requires a longer period (at least a year) to monitor the vegetable and fruit consumption behaviour of pre-school children attending child development day care centre. However, the limited factor was that the school time was only 5 months/semester and we could not extend the follow up period due to their relocation during the summer break. Other studies

that were successful to follow up in longer periods needed top-down cooperation at the government plan level (World Health Organization, 2004; Centres for Disease Control and Prevention, 2005; Kitchen *et al.*, 2009).

This study produced results which corroborate the findings of a great deal of the previous work in this field. Our findings show improvement of vegetable and fruit consumption regarding greater amount of vegetable and fruit (Table 2) (Panunzio *et al.*, 2007; Jakubikova *et al.*, 2011; Savage *et al.*, 2012; Upton *et al.*, 2013) and higher frequency of vegetable and fruit consumption (Wyse *et al.*, 2010; Jakubikova *et al.*, 2011; Savage *et al.*, 2012), but amount of vegetable and fruit in subjects fell short of World Health Organization recommendations (Table 3) (World Health Organization, 2003; Tak *et al.*, 2009; Jakubikova *et al.*, 2011; Savage *et al.*, 2012; Upton *et al.*, 2013). The finding also indicated that there was higher frequency of vegetable and fruit consumption in pre-school children (Tak *et al.*, 2009; Wyse *et al.*, 2010).

The promoting programs of the local vegetable and fruit consumption may be applied to child development day care centres in all regions of Thailand by introducing locally or seasonally available vegetables or fruit and some new menu with vegetable and fruit were perhaps created. Food appearance affects to stimulate children's appetite, so their foods should be satisfied with taste, smell, texture, colour, and size. Moreover, Media influences on pre-school vegetable and fruit consumption, which the pre-school children are interested in, eager to learn and can spend their time as long as possible, are personal media, especially outsiders (elders, local farmers, cooks, etc.). Moreover, Studies should focus on the direct and indirect influences of vegetable and fruit consumption among pre-school children and how to integrate into the educational system of Thailand.

However, it is necessary for relevant food providers to take food safety and threat from pesticide into serious consideration. The problem of pesticide residues in vegetables and fruits is a big concern to consumers because of its negative health and environmental impacts (Buakham *et al.*, 2012; Wanwimolruk *et al.*, 2016). In fact, Thailand relies heavily on the use of pesticides to protect crops and increase yields. Thailand was ranked third out of 15 Asian countries in pesticide use per unit area and fourth in annual pesticide use. This is due to the widespread use of pesticides in agriculture. The most popular classes of pesticides imported into Thailand are herbicides, followed by insecticides and

fungicides. It increased environmental contamination and the intensive use of pesticides certainly has consequences for human health. There is a largely uncontrolled use of pesticides on the Thai people and limited ways to improve pesticide management in Thailand. This exposure may have a greater impact on the growth and development of children than adults exposed to similar concentrations (Panuwet *et al.*, 2012; Saphamrer and Nata, 2014; Tawatsin *et al.*, 2015). Types of pesticides detected in the vegetables either from Thai local markets or supermarkets were similar. Examples of vegetables popularly consumed in Thailand and possessing potential toxicity are Chinese kale, pakchoi and morning glory. The incidence of detected pesticides was 100% (local markets) and 99% (supermarkets) for the Chinese kale; 98% (local markets) and 100% (supermarkets) for the pakchoi; and 99% (local markets) and 97% (supermarkets) for the morning glory samples. The pesticides detected exceeded their maximum residue limits (MRL) at a rate of 48% (local markets) and 35% (supermarkets) for the Chinese kale; 71% (local markets) and 55% (supermarkets) for the pakchoi, and 42% (local markets) and 49% (supermarkets) for the morning glory (Wanwimolruk *et al.*, 2016). This evidence indicates that the relevant food providers should take stringent precautions to ensure that pesticide residues in children food are kept to a minimum. Good cleaning practice can help reduce the pesticide residues from raw materials. Many cleaning practices were reported. For example, residue pesticides on the cucumbers and strawberries can be cleaned by 10% acetic acid aqueous (Kin and Hult, 2010). 52% of pesticide residues (i.e. tolylfluanid) can be removed when the apples are cleaned with running tap water for 15 min (Rasmussen *et al.*, 2003). Five percentage of soda salt solution can remove 26.90 % of pesticide residues (i.e. dimethoate) from Chinese cabbage (Yu-shan *et al.*, 2013). Washing Chinese kale under running water for 2 min can reduce 55% of pesticide residues (i.e. profenofos) (Wanwimolruk *et al.*, 2015). Soaking fruits in tap water for 15 min and soaking in 0.1% edible vinegar for 15 min followed by rinsing with running tap water for 2 min can remove 64.82-67.03% of pesticide residues (i.e. chlorantraniliprole) from cowpea fruits (Chen *et al.*, 2015). These could provide guides of food safety for reducing pesticide residuals in vegetables and fruits. In the present study, we suggested that the consumers should avoid pesticides by selecting food from reliable sources, eating seasonal vegetables and fruits; and self-seeding crops.

## Conclusion

This comprehensive program on promoting local vegetable and fruit consumption not only increase the amount of vegetable and fruit consumption but also improve the frequency level of vegetable and fruit consumption of pre-school children attending child development day care centre. Regarding the program effectiveness, the intervention group has taken vegetable and fruit more than the control group under statistical significance (1.78 portion serving; 95% CI = 1.36 to 2.20, p-value <0.001). Such as small cucumbers, morning glories, white greens, rambutans, apples and oranges. These results suggest that comprehensive program on promoting local vegetable and fruit consumption could be applied to child development day care centre.

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