ORIGINAL ARTICLE

# EFFECTIVENESS OF A SCHOOL-BASED MULTICOMPONENT INTERVENTION ON NUTRITIONAL STATUS AMONG PRIMARY SCHOOL CHILDREN IN BANGKOK, THAILAND

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**Background:** Childhood obesity has become a major public health issue today. The prevalence of obesity and overweight is increasing in both adults and children. Childhood obesity in Thailand has more than doubled since the 1960s and a recent study reported that overweight and obesity in Thais is the 5th highest in Asia. The present study objective was to evaluate the effectiveness of a life-skills, multicomponent, school-based intervention on child nutritional status. **Methods:** A quasi-experimental design was conducted in two-groups (control and intervention schools) on 453 students attending grade levels 4–5 in Bangkok. Two schools were selected for control, and two schools for intervention groups. The interventions included education, diet, physical activity (PA), food-environment, school built-environment, and life-skills components. Subjects were measured at baseline and at 6 months post-treatment. **Results:** The intervention group had significant differences in overall healthy practices (+1.5 mean difference, $p$=0.048), dietary habits, physical activity, lower total cholesterol (TC) levels (-2.43 mean, $p$=0.019) and higher high density lipoprotein cholesterol (HDL-C) levels (+4.06 $p$=0.028) as compared to the control. A higher reduction of overweight individuals among the intervention group over the intervention period was observed. Physical activity and consumption of vegetables increased while consumption of high-caloric snacks and fast foods decreased in children after the intervention. **Conclusion:** This study indicated that a multidisciplinary approach in school-based interventions is most likely to be effective in preventing children from becoming overweight in the long term. More research should be conducted on school-based interventions with longer intervention periods and higher sustainability.

**Keywords:** Obesity; Life skills; Multicomponent; Physical activity; Cholesterol; LDL-C; HDL-C

**J Ayub Med Coll Abbottabad 2017;29(1):13–20**

## INTRODUCTION

The prevalence of childhood obesity is increasing worldwide[1–3], including Thailand[4]. The current data from World Health Organization (WHO) indicates that there are more than 42 million overweight children.[5] Children who are obese are at a major risk for developing serious chronic diseases, including type 2 diabetes, hypertension and stroke, cardiovascular diseases, and certain forms of cancer.[6–8] Although, the origin of obesity is complex, it relates to diet, physical activity, genetics, culture, self-perception and other environment factors.[9,10]

Obese children tend to become obese adults, and thus, the prevention of overweight in childhood is one means of preventing chronic diseases associated with obesity. School-based interventions have been identified as one of the most efficient means since schools provide a critical setting and children spend significant amounts of their time in school.[11,12] Moreover, studies indicated that interventions focusing on modifications in both diet and physical activity with emphasis on activity beyond non-curricular approaches have been more effective.[13–16]

The present study aimed to evaluate the effectiveness of a multicomponent, school-based intervention on children nutritional status.

## MATERIAL AND METHODS

The study was a quasi-experimental study, pretest-posttest design. Four primary schools in Bangkok, Thailand that previously joined the Bright and Healthy Thai Kid Project were selected based on their willingness to participate in the study. These 4 schools were coeducational, shared similar demographic characteristics for gender, number of students, family socioeconomic status (low to middle class), parental support, and school environment. Then two schools were randomly chosen to be

the intervention group and other two schools to be the control. The study population included both male and female students who were studying in grades 4–5 (aged 10–12 years). Children who had clinical problems such as comorbidities (physical disabilities) and/or learning difficulties defined by the teacher were excluded. Sample size was calculated using Cochran's formula to detect the differences between the two groups. As a result, the minimum sample size required in each group was 199. Permission from school authorities with written informed parental and child consent were required for individual children to participate in the study. The study was reviewed and approved by the Institutional Review Board, Faculty of Public Health, Mahidol University (Ethical code No. 2014-196).

The intervention was a multicomponent healthy lifestyle program that focused on the promotion of healthy eating and being physically active. The intervention was based on the principles of nutritional science and health belief model while adapted and focus on life-skills programs as a health promotion strategy. The life skills education intervention was developed with relevant curriculum, teaching materials, classes, and all sessions based on participatory approach. The program was implemented over 6-month period in an academic year.

Seven sessions on life-skills were implemented over the intervention period. The seven sessions consisted of knowing your body (nutritional assessment); obesity and its health consequences; healthy eating guidance; snacks and health including nutrition labels; physical exercise; healthy food choices; and growing vegetables. Each session consisted of 50 minutes. Sessions were led out by both the research team and the school teachers. Seven detailed lesson plans were developed to use in the 7 sessions. Three PowerPoint presentations were used, five activities were held, one gardening/planting session, and one gaming session were used throughout the program (Health & Happy Manual, 2016).

The life-skills educational component was supported by environmental changes which included: (1) School involvement, (2) School food policy, (3) School environment, and (4) Parental outreach/participatory approach through workshops.

**1. School involvement:** Upon the agreement by the school to participate in the study, the researcher and team discussed current obesity problems within school and present ways to help reduce the problem through a school-based and participatory approach program. A health-promotion book developed by our nutritionist team were given to the school as a guideline to understand major topics study were implemented in the school, which includes the following: 1) Why should we be healthy? 2) How do we know our health status? 3) Ways to help make one another (friends) healthy? 4) Skills to be discipline (health conscious). 5) Knowledge and skills for health. 6) Self-sufficient for health. 7) Nutritional status.

Baseline characteristics of the students and their nutritional status were presented to the school administrators and teachers to undermine further actions during the intervention period.

**2. School-food policy:** In all the intervention schools, all of food sold in schools were monitored and changed to meet the guidelines. Schools were asked not to sell carbonated drinks in the intervention schools. Beverages were requested to be limited to 100% juice, water, and low-fat milk. Intervention schools with vending machines that provide soda, chips, and candies were asked to be removed. Vendors were asked to provide healthier food choices to children.

**3. School environment:** Teachers in the intervention schools were asked to set their classroom to allow more physical activity. Clearer markings and zonal markings were used in the intervention schools. Although, it is not within the school's authority to ask vendors around the school to stop selling unhealthy food, teachers and administrators requested vendors to sell more healthy food, giving students more choices. School staffs and students were given a health promotion comic book with games to encourage, enforce, and stimulate healthy choices with the school public. The comic book included quantity and nutritional values for common food a person eats in order to assess one's diet.

**4. Parental participation:** Two times 1-hr workshop was scheduled to meet the family members. Family members were reached through home and school association meetings, report card, parental education meeting, and monthly nutrition/physical activity workshops. The workshops were arranged in schools ground to presents findings of the baseline nutritional status and present a platform for discussing and educating parents about the importance of making healthy food choices. Healthy handbooks (ISBN 978-974-11-0756-8) were given to parents. Parents and students were encouraged to purchase healthy snacks, be less

sedentary, be more physical active, and eat more fruits and vegetables. Parents were discouraged from buying sweets and unhealthy snacks for their children.

Baseline measurements were collected in the beginning of the school year and post measurements were collected after 6 months. Primary outcomes included dietary habits, physical activity, and sedentary behaviour. The secondary outcomes included the nutritional status and blood lipid profiles. Standard calibrated weighing scales and stadiometers were used to determine weight and height. A digital standardized weighing scale SECA scale model 750 was used to measure the weight of the child.

Weight was measured to the nearest 0.1 kg. Height was measured by Microtoise (standardized portable stadiometer), which measures to the nearest 0.1 cm. Measurements of weight and height strictly followed the CDC Atlanta guidelines for measuring children. Nutritional status was calculated by the Institute of Nutrition Research, Mahidol University (INMU) Thai Growth Program as weight-for-height z-scores. A self-administered questionnaire for data collection was developed and adapted from previous validated standard questionnaire used in research targeting adolescents.

The questionnaire was piloted at a different school with similar school characteristics among 34 subjects. Reliability of 0.82 was tested and expert validity was conducted. The questionnaire was administered in the classroom in the presence of the research team. Students' knowledge, attitude, and practice on diet, physical activity and other related issues were measured through 69 items.

Three milliliters of venous blood was collected from each participant in the morning after 10–12 hours of overnight fasting. Breakfast was provided for the children after blood collection. Blood samples were kept in an ice-box (4 °C) and sent to the Office of Public Health and Environmental Technology Services (OPHETS) laboratory, Faculty of Public Health, Mahidol University for analysis of lipid profiles including TC, triglyceride(TG), HDL-C and low density lipoprotein cholesterol (LDL-C) by the enzymatic method (Beckman Coulter, AU680).

All anthropometric data were analysed using SPSS-17. Descriptive statistics of continuous variables was presented as frequencies, percentage distribution, and means ± standard deviation (SD), while median was used to test data with non-normal distribution. Categorical variable was presented as absolute and relative frequencies. Student *t*-tests and Chi-square tests for baseline characteristics were used to compare intervention and control groups at baseline and post-treatment. Outcome measures at follow were entered as dependent variables and intervention vs control as independent variables. Student's independent t-test was used to evaluate the significance of mean differences after the intervention period between the intervention and control groups. Students' paired *t*- test was used to evaluate the significant of changes within group at baseline and intervention. Chi-square test was used to test for significant differences for categorical data. The mean difference between the two groups was used to determine the absolute intervention effect. General linear models were used to analyse nutritional status and blood lipid profiles of the respondents. All analysis used a 95% confidence interval (CI), and a *p*-value of less than 0.05 to be considered statistically significant.

## RESULTS

Baseline characteristic of the children were shown in Table-1. Among the 490 children who provided consent, 452 were assessed at baseline (Figure-1). The sample consisted of 53.5% females. Participants had a mean age of 9.7 years in the intervention and 10.0 years in the control groups. There were 59.6% of grade 5 students. There was a higher prevalence of overweight/obese children (19.7%) in the control group as compared to the intervention (16.6%) group. However, there was no significant difference between the intervention and control groups at baseline.

Table-2 displays the primary outcomes among the intervention and control groups after the intervention. There was more significant difference in changes between baseline and post-treatment in overall knowledge on diet and PA in the intervention group than the control (1.75, $p$=0.001). It was revealed that the intervention group had more positive attitude towards diet and PA after intervention than the control, but no significant difference. However overall practice scores in diet and physical activity were not improved in both groups, changes in mean differences at baseline and post-intervention in the control group was reported significantly more negative than the intervention (1.50, $p$=0.048).

It was reported that intervention group

had more healthy food choices, higher amount of vegetable consumption but still less than recommended daily intake, decreased intake of sugary food and sweetened beverages as compared to the control group (data available on http://library.car.chula.ac.th).

There were an increase in physical activity (+0.06 hr/day) and reduced sedentary behaviour (0.51 hr/day) in the intervention group. However, data revealed that both intervention and control groups fell short of the recommended 8–10 hours of sleep per day.

Table-3 displays the secondary outcomes between the intervention and control groups after the intervention. Regarding nutritional status, it was shown that there was a greater reduction in the prevalence of overweight/obesity in the intervention group (-2.71%, $p$=0.55) as compared to the control (-2.16%), however it was not significant difference.

Statistically different decreased in total cholesterol levels (3.84, $p$=0.019) and increase in HDL-C levels (2.23, $p$=0.028) were observed in the intervention as compared to control. The data indicated a positive change in the intervention group for all variables as compared to control.

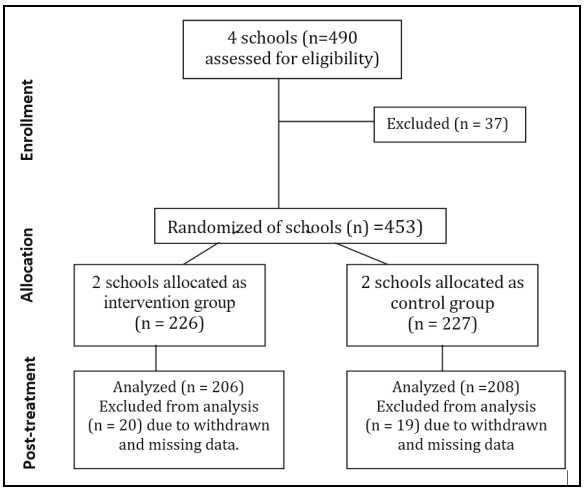


**Figure-1: Recruitment process of participants.**

**Table-1: General characteristics and nutritional status at baseline of the intervention and control groups.**

| Dietary Practice | Intervention | | Control | | *p*-value* |
|---|---|---|---|---|---|
| | Number | Percent | Number | Percent | |
| **Gender** | | | | | |
| Male | 117 | 49.6 | 111 | 43.7 | 0.303 |
| Female | 119 | 50.4 | 143 | 56.3 | |
| **Age (years)** | | | | | |
| 8 | 1 | 0.4 | 0 | 0 | |
| 9 | 85 | 36 | 61 | 24.2 | |
| 10 | 125 | 53 | 137 | 54.4 | |
| 11 | 25 | 10.6 | 53 | 21 | |
| 12 | 0 | 0.4 | 1 | 0.4 | |
| Mean | 9.73 | | 10.00 | | **0.636 |
| **Educational level** | | | | | |
| Grade 4 | 106 | 44.9 | 92 | 36.2 | 0.055 |
| Grade 5 | 130 | 55.1 | 162 | 63.8 | |
| **Daily allowance** | | | | | |
| <50 baht | 138 | 61.3 | 129 | 56.8 | 0.449 |
| 50-100 baht | 77 | 34.2 | 92 | 40.5 | |
| 101-200 baht | 8 | 3.6 | 5 | 2.2 | |
| >200 bath | 2 | 0.9 | 1 | 0.4 | |
| **Self-perception of weight** | | | | | |
| Underweight | 42 | 18.8 | 44 | 19.4 | 0.704 |
| Normal | 116 | 51.8 | 109 | 48 | |
| Overweight/Obese | 66 | 29.5 | 74 | 32.6 | |
| | | | | | |
| **Nutritional Status** | | | | | |
| Underweight | 4 | 1.8 | 7 | 3.1 | 0.356 |
| Normal | 179 | 79.2 | 171 | 75.3 | |
| Overweight/Obese | 43 | 19.0 | 49 | 21.6 | |

*$p$-value <0.05 was calculated with Pearson Chi-Square. ** $p$-value of mean age was calculated with independent $t$-test.

**Table-2: Primary outcomes among intervention and control groups after intervention.**

| Variable | Intervention | Control | Changes | *p*-value* |
|---|---|---|---|---|
| **Overall Knowledge** | | | | |
| Baseline | 17.13 (3.91) | 18.45 (3.77) | | 0.001 |
| After 6 months | 21.24 (4.13) | 20.81 (2.85) | | 0.059 |
| Difference | 4.11 | 2.36 | 1.75 | **0.001** |
| **Overall Attitude** | | | | |
| Baseline | 14.77 (1.87) | 15.12(1.67) | | 0.032 |
| After 6 months | 16.03 (2.46) | 16.11 (2.49) | | 0.722 |
| Difference | 1.26 | 0.99 | 0.27 | 0.275 |
| **Diet Practice** | | | | |
| Baseline | 32.86 (6.54) | 34.12 (6.09) | | **0.040** |
| After 6 months | 32.71 (6.63) | 32.85 (6.88) | | 0.846 |
| Difference | -0.15 | -1.27 | 1.20 | 0.087 |
| **PA Practice** | | | | |
| Baseline | 6.59 (2.05) | 6.94 (1.93) | | 0.621 |
| After 6 months | 5.97 (2.17) | 5.94 (2.22) | | 0.891 |
| Difference | -0.62 | -1.0 | 0.38 | 0.085 |
| **Overall Practice (Diet and PA)** | | | | |
| Baseline | 39.45 (6.92) | 41.06 (6.39) | | 0.013 |
| After 6 months | 38.68 (6.96) | 38.79 (7.16) | | 0.760 |
| Difference | -0.77 | -2.27 | 1.50 | **0.048** |
| **Physical activity (hrs/wk)** | | | | |
| Baseline | 2.94 (1.62) | 3.01 (1.43) | | 0.644 |
| After 6 months | 3.00 (1.63) | 2.68 (1.55) | | 0.175 |
| Difference | 0.06 | -0.33 | 0.39 | 0.124 |
| **Screen time (hrs/day)** | | | | |
| Baseline | 2.93 (1.59) | 3.22 (1.55) | | 0.050 |
| After 6 months | 2.42 (1.62) | 2.56 (1.64) | | 0.383 |
| Difference | -0.51 | -0.65 | 0.14 | 0.368 |
| **Sleep (hrs/day)** | | | | |
| Baseline | 7.36 (2.33) | 7.44 (1.97) | | 0.654 |
| After 6 months | 7.28 (2.06) | 7.28 (2.05) | | 0.959 |
| Difference | -0.08 | -0.16 | 0.08 | 0.355 |

*$p$-value <0.05 was calculated with independent sample $t$-test.

**Table-3: Secondary outcomes among intervention and control groups after intervention.**

| Variable | Baseline | After 6 months | Changes after the intervention | Diff in changes | *p*-value* |
|---|---|---|---|---|---|
| **Nutritional status** | | | | | |
| **Normal** | | | | | |
| Intervention | 80.70% | 83.41% | 2.71% | 0.55 | 0.321 |
| Control | 78.10% | 80.26% | 2.16% | | |
| **Overweight/Obese** | | | | | |
| Intervention | 19.28% | 16.59% | -2.69% | 0.51 | 0.822 |
| Control | 21.92% | 19.74% | -2.18% | | |
| **Lipid profile** | | | | | |
| **Total cholesterol levels** | **mean(SD)** | | | | |
| Intervention | 182.27 (29.40) | 179.84 (30.89) | -2.43 (15.70) | 3.84 | ****0.019** |
| Control | 184.01 (30.60) | 185.42 (34.91) | 1.41 (17.61) | | |
| **Triglycerides levels** | **mean(SD)** | | | | |
| Intervention | 81.58 (39.02) | 74.86 (37.29) | -6.72 (40.85) | 4.55 | **0.476 |
| Control | 94.21 (45.83) | 92.04 (41.86) | -2.17 (36.17) | | |
| **LDL-C levels** | **mean(SD)** | | | | |
| Intervention | 108.48 (27.47) | 107.22 (29.74) | -1.26 (14.55) | 2.64 | **0.068 |
| Control | 103.29 (25.74) | 99.39 (24.81) | -3.9 (14.31) | | |
| **HDL-C levels** | **mean(SD)** | | | | |
| Intervention | 59.27 (13.13) | 63.33 (13.06) | 4.06 (8.59) | 2.23 | ****0.028** |
| Control | 60.18 (14.48) | 62.01(15.92) | 1.83 (7.88) | | |

*$p$-value <0.05 was calculated with independent sample $t$ -test. **$p$-value <0.05 was calculated with chi-square test.

## DISCUSSION

The study suggested a possible effectiveness of a 6-month multicomponent life-skills intervention for reducing overweight and increasing physical activity and diet-related behaviour in young adolescents. The findings showed some changes of practices on dietary habits and physical activity, lowered total cholesterol levels, and higher HDL-C levels in the intervention group.

It was reported significantly differences in overall mean practice in diet and PA between intervention and control groups. This might be due to the significant increase in overall knowledge scores in the intervention group. Although, the knowledge at baseline in the two groups were significantly different, there was a significant higher knowledge scores in the intervention (+4.11 mean score) group as compared to the control (+3.23 mean score) which should be due to the intervention program.

The study reported a greater reduction in the prevalence of overweight/obesity in the intervention group (-2.71%, $p$=0.55) as compared to control group (-2.16%). Although the reduction is not significant, these results were consistent with other similar studies.[17,18] The non-significance reduction in overweight in this study might be due to too short intervention period. A recent Italian study[16] which also had a similar multicomponent school-based intervention on education, diet, PA, and school environment conducting in young adolescents, reported a significant reduction in overweight (-0.18 BMI z-score, $p$=0.01) children with an intervention period of 2 years. Other studies with an intervention period of at least 1 academic year reported significant reduction in the prevalence of overweight in the intervention group.[19–22]

Furthermore, the statistically different overall practice mean score of 1.5 observed in both groups scored was lower after the 6-month intervention period (intervention group -0.77, control group-2.27). This could be explained by the accessibility and availability to healthy food. In other words, knowing healthy food choices without environmental support, it could not be successful. It is assumable that with longer intervention period, more accessibility to healthy food, more recreational space, and better awareness among the school and parents will lead to higher positive changes among the intervention groups. Studies have shown that environment was undoubtedly one of the most important settings in relation to shaping children's eating and physical activity behaviours.[23-25] In addition, using a self-administered questionnaire in dietary intake and PA might have some recall-bias particularly in young students.

The study showed no significant change in children nutritionals status. This corresponded with another study using school-based education interventions and reported that there was an increase in PA and improvement in dietary habits, but there were still conflicting results on the changes in BMI.[26] It was reported that changes towards the nutritional status might take a longer period of time.[27,28]

The increase in children's PA (+0.06 hr/day) and reduced sedentary behaviour (-0.51hr/ day) in the intervention group in our study were supported by the decrease in total cholesterol (-2.43±15.70) and the increase in HDL-C levels (4.06±8.59). Our findings were similar to another study[29] that have reported significant increase in children's PA and reduction in total cholesterol and LDL-C levels, while one study reported significant reduction in both BMI and blood lipid[30]. Moreover, lipid abnormalities among children were related to higher risk of insulin resistance and development of heart disease later in life.[31,32] Therefore, lipid profile should be used as an important indicator of the secondary outcomes than those eating and physical activities behaviours which are more subjective and less reliable.

Our findings addressed an importance of a multicomponent/combined intervention programs for the treatment of childhood obesity and its health consequences. However, questions remained on which aspect of the multicomponent attributed to the change. This may have to be further explored. Additional research with a multiple arm intervention study is required to understand which component of the intervention has significance on the outcome variables.

We believed that a major factor to the success of the intervention was the involvement of schools and parents through the participatory approach. Based on evidence of the effectiveness of community-based participatory approach,[33,34] this study included school staffs, teachers, and parents. A key point of the intervention was that it was focused on changes in the school environment as well as individual behaviour changes through several reinforcement tools.

A major strength of this study was the use of lipid blood profile as a biological marker with high number of participants. Strength of the study is the high responsive rate of over 90% participants providing the study with a rather large sample. Final strength of the study was the development of the intervention program which was based on an extensive literature review and identification of reported successful components of behavioural changes in dietary habits, PA, and nutritional changes including the adaptation for all the above components to meet the Thai context.

The major limitation of the study was the absence of randomization of selected participants. Randomization was necessary to overcome possible selection bias. The use of a self-administered questionnaire might have some bias and limitations. Due to the limited resources, children's PA was relied on a self-administered questionnaire. Long-term study to see the sustainability of the effectiveness of this program on children nutritional status and lipid profiles is suggested.

## CONCLUSION

Results from this study indicated that multicomponent school-based intervention including school environment is likely to be the effective way to reduce rates of child overweight/obesity and improve physical activity and eating behaviours in young adolescents. Future school-based intervention programs should have a longer intervention period, use a multi-arm randomization intervention design, and should seek to incorporate individual behaviour change strategies with policy and environmental changes in order to make a substantial and sustainable impact on children's health.

**Conflict of interest:** The authors declare that there is no conflict of interest

## ACKNOWLEDGEMENTS

This study was supported by a grant from The Bright and Healthy Thai Kid project through Thai Health Promotion Foundation and "The 90th Anniversary of Chulalongkorn University Fund". The authors would like to thank all the four schools, teachers, parents, and students for their participation and cooperation; Dr. Robert Sedgwick Chapman and Assoc. Prof. Chaweewan Boonsuya for statistical review; Miss Teeraporn Seripong for data collection; Assoc. Prof. Ratana Somrongthong, Prof. Sathirakorn Pongpanich, and Dr. Nanta Auamkul for a critical review of the study.

## AUTHORS' CONTRIBUTION

NC was the principal investigator. NC, CS and AP contributed to the study design and the interpretation of the results. NC was involved in development of the program intervention, data collection, program intervention, data analysis and drafting of the results and manuscript. CS was responsible for the budget preparation, supervision, preparing the research site, coordination and planning for program implementation, program evaluation and interpretation of the results. AP had full access to all of the data in the study and provided statistical and methodological advice. ST gave valuable statistical input. RK and ST critically revised the manuscript. CS revised the content and approved the final manuscript.

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| *Received: 9 July, 2017* | *Revised: --* | *Accepted: 17 September, 2016* |
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