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RESEARCH ARTICLE

Impact of a School-Based Nutrition Intervention in Preventing Overweight and Obesity in Children in Thailand

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ABSTRACT

BACKGROUND: This study evaluated the impact of a school-based nutrition program on preventing overweight and obesity in children in Thailand from 2014 to 2019.

METHODS: We used difference-in-differences with matched comparison group to evaluate program impact. Treatment schools were categorized into those that participated in phase 1 only, and those that participated in phase 1 and 2. We matched 311 treatment schools in phase 1 only with 1504 comparison schools, and 75 treatment schools in both phases with 216 comparison schools. Administrative data from Thailand Office of Basic Education Commission were used from 2014 (baseline), 2016 (first follow-up), and 2019 (second follow-up).

RESULTS: Program resulted in a 0.6-1.1 percentage point reduction in the students' probability of overweight by the end of phase 1, and 1.7 percentage points by the end of phase 2. Impact on obesity was found only for schools participating in both phases (0.4 and 0.9 percentage points by the end of phase 1 and 2, respectively).

IMPLICATIONS FOR SCHOOL HEALTH POLICY, PRACTICE, AND EQUITY: Program continuity and intensity are key to achieve a reduction in overweight and obesity in schoolchildren.

CONCLUSIONS: The program was successful in reducing overweight and/or obesity given appropriate level of continuity and intensity.

Keywords: nutrition; environmental health; school health program evaluation; weight management.

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Childhood overweight and obesity are increasingly becoming a major global health concern. An abundance of studies shows a link between childhood obesity and poor health outcomes as adults. Children with obesity are more likely to grow up with obesity, with increased risks for chronic diseases, type 2 diabetes, heart disease, stroke, asthma, and poor mental health.[1-5] Furthermore, people with obesity are estimated to incur approximately 30% higher medical costs than people with normal weight.[6]

Given the health and economic consequences of childhood overweight and obesity, addressing the issue is an international priority. The prevalence of childhood overweight and obesity is still on the rise in many parts of the world. In developed countries, the prevalence of childhood overweight and obesity has risen from 16.9% in boys and 16.2% of girls in 1980 to 23.8% in boys and 22.6% in girls in 2013.[7] In the United States, the prevalence of obesity among 6- to 11-year old children seemed to be leveling off in 2013-2014 at 17.4%, but started to increase again to 20.3% and 20.7% in 2017-2020.[8,9]

Developing countries also faced a rapid rise of the prevalence, with boys increasing from 8.1% to 12.9% and girls from 8.4% to 13.4% from 1980 to 2013.[7] Thailand, like many other developing

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countries, has been experiencing a continuous rise in childhood overweight and obesity in the past decades. The overweight and obesity prevalence rate among Thai school children (6-14 years) was 5.8% in 1995, increasing to 6.7%, 9.7%, and 13.9% in 2001, 2009, and 2014 respectively; totaling to a 2.4-fold increase in the prevalence in 2 decades.[10]

Promoting healthy behaviors from a young age, including eating healthy and being physically active, is crucial in controlling the continuous increase of overweight and obesity rates in children and adults. Schools are considered an ideal venue to deliver interventions to children as they have access to most of the target population and are equipped with structures and systems to promote healthy behaviors.[11] Systematic reviews show that school-based interventions have positive results when they consist of both physical activity and diet components, particularly when reinforced by home and community involvement.[12-17] The evidence for diet-only component was moderate for children 6 to 12 years old and adolescents 13 to 18 years old, whereas physical activity interventions alone are shown to have more impact on health outcomes.[16]

Nevertheless, diet remains an important aspect of health promotion, particularly when the goal is to control the rise of overweight and obesity. Changing dietary behavior is complex and depends greatly on the socioeconomic and cultural contexts of each setting. Many diet-only interventions focus only on a few aspects of diet or can only influence a small part of a child's diet. For example, many interventions aim to influence diet through providing nutrition education or altering the school environment such as providing education sessions or making fresh water more easily accessible to encourage children to choose water over sugar-sweetened beverages.[18-20] Few interventions have a more multifaceted component to alter the larger food environment. In developed countries, the main food sources are market-based, but in developing countries there are nonmarket sources, such as own production, that play an important role in the food environments.[21]

In this paper, we examined the impact of a school-based nutrition intervention called Dek Thai Kam Sai that aims to improve students' nutritional status through multifaceted activities. The intervention was evaluated for its effectiveness in preventing overweight and obesity by comparing the likelihood of students with overweight and obesity in intervention and comparison schools.

The Dek Thai Kam Sai Program

The Dek Thai Kam Sai (DTKS) Program was initiated in 2014 to address the malnutrition issue in Thai children. The program consisted of 8 main components based on Her Royal Highness Princess Maha Chakri Sirindhorn initiative to improve childhood nutrition and health. The 8 components included school farming, student cooperatives, food provision and management, monitoring of nutritional status, developing hygiene, promoting a healthy environment, providing health services, and providing health education. Details of the DTKS 8 components are provided in Supporting Information.

The DTKS program was implemented in phases. This study aimed to evaluate the effectiveness of the program's first 2 phases. In phase 1 (2014-2016), schools submitted a proposal and were selected for participation based on a set of predetermined criteria such as size, region, and location. In this first phase, 544 schools across Thailand were selected to participate. The main activities in this phase consisted of training workshops for schoolteachers and other school staff and distributing educational materials to provide the basic guidelines on implementing DTKS. Schools received funding of 60,000 Thai baht (approximately 2000 USD) and were free to carry out any of the 8 activities as they see appropriate.

From the 544 schools in phase 1, a total of 100 schools were selected to continue in phase 2. In this phase (2016-2019), the main difference was a closer supervision by the program. Program staff routinely visited all the school sites to monitor the activities and provide consultation. School's body measurement tools were calibrated or replaced when necessary. Schools were also required to implement all 8 activities and receive an additional budget of 80,000-120,000 Thai baht (approximately 2600-4000 USD) depending on the school size.

METHODS

Outcomes of Interest

The main outcomes of interest were overweight and obesity status of children aged 6 to 12 years. The body mass index (weight in kilograms divided by the height in meters squared) was calculated and compared to the International Obesity Task Force (IOTF) guideline for children to determine overweight/obesity status. The IOTF guideline for overweight and obesity in children was developed based on data from 6 countries: Singapore, the Netherlands, Brazil, Hong Kong, the UK, and the USA.[22] The guideline was based on gender- and age-specific body mass indices to classify the nutritional statuses of children. It has been found that the World Health Organization (WHO) guidelines tend to overestimate overweight and/or obesity in children,[23] and therefore the IOTF criteria were used in this study.

Data Analysis

The data used in this study are drawn from Thailand Office of Basic Education Commission (OBEC). This

administrative database routinely collects data from over 30,000 schools across Thailand twice a year, once in the first semester and again in the second semester, covering over 6 million students under OBEC supervision. The data included individual-level information on students' weight and height, as well as other demographic and socioeconomic characteristics. For this study, we used data from the second semester for the years 2014 (baseline data), 2016, and 2019.

Another set of data used in this study was school-level data from OBEC, which included school characteristics such as the total number of students, boy-to-girl ratio, student to teacher ratio, number of students per class, and school location. The school-level dataset was merged with the individual-level dataset for analysis.

The aim of this study was to determine the impact of school's participation in DTKS on the likelihood of students to have overweight or obesity. The main method used in this study was difference-in-differences using matched comparison group from propensity score matching.

To evaluate any program, it is crucial to have a credible estimate of the counterfactual. In our case, there was certainly an issue of selection bias in terms of program participation as school assignment to the program was not random. Propensity score matching (PSM) is a widely used statistical approach to find a comparison group that has the most similar characteristics as the treatment group as possible to reduce potential bias.[24] The propensity score was computed for all schools in the database at the baseline (before the start of DTKS) to determine each school's probability of participating in the program.

To calculate the propensity score of schools, a set of characteristics including number of students, student-to-teacher ratio, location (urban or rural), region (north, northeast, central, south), percentage of religious beliefs, percentage of underprivileged students, and percentage of different modes of commute (walk, bike, private vehicle, public transport) were used. Treatment schools were categorized into 2 groups: schools that participated in only phase 1 and schools that participated in phase 1 and phase 2. Nearest neighbor matching with replacement provided the best balancing results in terms of bias reduction compared to radius and kernel. The balancing results were best achieved when 5 nearest neighbors were used to find a comparison group for schools that participated only in the first phase, and 3 nearest neighbors for schools that participated in both phases. Results for PSM was done using the command psmatch2 in Stata 15.

Using PSM, we were able to control for some mean and median bias, but not for unobserved characteristics such as school quality, policy, and level of commitment that might also have an impact on the outcomes. To reduce the risk of bias in the impact estimation, the matching procedure was combined with difference-in-differences (DD) to compare the changes in the outcomes overtime between participating and nonparticipating schools.

We used data from 3 years: baseline (2014), first follow-up (2016), and second follow-up (2019) for the evaluation. For estimating the impact of the program on the nutritional status of students, we used the following model:

$$\begin{aligned} Y_{ijt} = {} & \beta_1 + \beta_2 \text{Program}_j + \beta_3 T1_t + \beta_4 T2_t \\ & + \beta_5 \text{Program}_j * T1_t + \beta_6 \text{Program}_j * T2_t \\ & + \gamma X_{ijt} + \delta Z_j + \mu_{ij} + \mu_j + \theta_{ijt} \end{aligned}$$

where Y_{ijt} refers to overweight or obesity status of student i in school j at time t. Program_j is the program participation status of school j, with $\text{Program}_j = 1$ if in program and $\text{Program}_j = 0$ if not in program. $T1_t$ indicates if the observation is from the first follow-up survey, where $T1_t = 1$ if the observation year is 2016, and $T1_t = 0$ otherwise. Similarly, $T2_t$ indicates if the observation is from the second follow-up survey, where $T2_t = 1$ if the observation is from 2019, and $T2_t = 0$ otherwise. The interaction terms between program participation and follow-up survey dummy variables were added with β_5 and β_6 as their respective coefficients. X_{ijt} refers to individual-level characteristics of student i at time t, and Z_j refers to school-level characteristics. μ_{ij}, μ_j and θ_{ijt} are the 3 error terms reflecting unobserved characteristics.

RESULTS

From a total of 544 treatment schools, 386 were under OBEC supervision. Of those 386 schools, 311 schools participated in phase 1 only; and 75 participated in both phase 1 and 2. For the comparison group, 1504 schools were good matches for schools that participated in phase 1 only (using 5 nearest neighbors as it achieved the best balance). For schools that participated in both phases, 216 schools were good matches (using 3 nearest neighbors as it achieved the best balance). At the baseline year, the treatment and comparison schools had similar characteristics (Table 1).

To assess the goodness of the PS matching, Table 2 compares the unmatched and matched samples for schools in phase 1 only, and schools in phase 1 and 2. We were able to reduce the overall mean and median bias in both tables. The absolute standardized differences of the means of the linear index of the propensity score in the treated and nontreated group, or Rubins' B, were reduced to be less than 25 in both cases; and the ratios of treated to nontreated variances

Table 1. **School Level Characteristics at Baseline Year**

	Phase 1 Only					Phase 1 and 2				
	Treatment Schools		Comparison Schools			Treatment Schools		Comparison Schools		
	Mean	SD	Mean	SD	p-Value	Mean	SD	Mean	SD	p-Value
Percent overweight students	0.152	0.077	0.146	0.078	0.000	0.166	0.080	0.147	0.076	0.000
Percent obese students	0.042	0.031	0.042	0.032	0.001	0.050	0.034	0.043	0.031	0.000
Sex					0.173					0.742
Male	51.63		51.94			51.49		51.36		
Female	48.37		48.06			48.51		48.64		
Age	9.742	2.568	9.838	2.625	0.000	9.754	2.568	9.934	2.699	0.000
Nationality					0.000					0.000
Thai	97.52		98.02			98.51		97.54		
Non-Thai	2.48		1.98			1.49		2.46		
Parents' marital status										
Married	85.24		84.61		0.000	82.88		84.39		0.000
Divorced	14.76		15.39			17.12		15.61		
Percent mode of transportation to school					0.000					0.000
By foot	31.13		30.26			27.19		27.19		
Public transport	35.65		35.52			23.86		35.61		
Private transport	33.21		34.20			26.31		37.19		
Number of students	421.65	416.26	441.01	522.74	0.000	816.42	855.04	559.13	457.41	0.000
Student to teacher ratio	15.76	4.98	15.60	4.84	0.000	16.16	5.89	16.55	5.00	0.000
Student per room	23.25	8.57	23.28	8.95	0.410	25.99	9.21	27.91	10.36	0.000
Extended*										0.000
Yes	45.54		53.25		0.000	41.56		50.57		
No	54.46		46.75			58.44		49.43		
Percent underprivileged students	0.718	0.450	0.658	0.474	0.000	0.565	0.496	0.572	0.495	0.085
Area					0.000					0.000
Urban	47.18		42.13			44.37		53.99		
Rural	52.82		57.87			55.63		46.01		
Region					0.000					0.000
North	19.31		12.69			12.25		18.05		
Central	22.61		26.51			33.50		22.83		
South	19.56		20.32			25.70		12.38		
Northeast	40.14		40.48			28.55		46.74		
Number of schools	311		1504			75		216		

*Schools under OBEC typically cover primary 1-6 levels. Opportunity expansion schools extend to secondary levels to target underprivileged children.

Table 2. **Comparison Between Unmatched and Matched Samples**

Sample	Ps R2	LR chi^2	p > chi^2	Mean Bias	Median Bias	*B*	*R*	%Var
Schools in phase 1 only								
Unmatched	0.014	47.55	0	12.5	7.6	39.8*	1.07	25
Matched	0.003	2.2	1	2.9	2.3	11.9	1.05	8
Schools in phase 1 and 2								
Unmatched	0.034	33.98	0.002	22.2	20.7	66.4*	1.34	42
Matched	0.01	2.07	1	4.4	4.5	23.4	0.63	17

of the propensity score index, or Rubins' R, were both between 0.5 and 2, which indicate that the samples were sufficiently balanced.

Analyses to determine the impact of the program on students' nutritional status, ie, overweight and obesity, were done at the individual level using DD with matched comparison group from PSM. Two separate analyses were done for schools that participated in phase 1 only, and schools that participated in both phase 1 and 2.

A DD estimation with matched comparison group using logistic regression was conducted. The coefficients of the interaction terms between being in a program and year of observation are negative and statistically significant for overweight for schools in phase 1, implying that being in the program reduces the probability of students being overweight. For schools that continued to phase 2, the magnitude of the coefficient is larger for Program*T2 than Program*T1, suggesting an increasing impact over time as schools remained

Table 3. **Predictive Margins of Program Impact on Overweight and Obesity**

	Overweight					Obesity				
	2014	2016	2019	Difference (2016-2014)	Difference (2019-2014)	2014	2016	2019	Difference (2016-2014)	Difference (2019-2014)
Schools in phase 1 only										
Treatment schools	0.114	0.120	0.141	0.006‡	0.026‡	0.042	0.043	0.063	0.001	0.021‡
Comparison schools	0.108	0.120	0.138	0.012‡	0.030‡	0.042	0.043	0.061	0.001†	0.019‡
Difference in differences				−0.006‡	−0.003				−0.000	0.003*
Schools in phase 1 and 2										
Treatment schools	0.118	0.127	0.138	0.009†	0.020‡	0.047	0.048	0.061	0.001	0.014‡
Comparison schools	0.111	0.131	0.148	0.020‡	0.037‡	0.015	0.050	0.067	0.005‡	0.022‡
Difference in differences				−0.011‡	−0.017‡				−0.004*	−0.009‡

*Significant at 90% confidence level.
†Significant at 95% confidence level.
‡Significant at 99% confidence level.

in the program. However, schools that participated only in phase 1 saw the opposite effect. The impact of the program declined once the school dropped out of the program. As for obesity, the coefficients from the logistic regression were not statistically significant for schools that participated in phase 1 only, but there was a small impact for schools that participated in both phases. The impact also increased in magnitude the longer the schools participated in the program (logistic regression results in Supporting Information).

To determine the impact of the program, we calculate the predictive margins for treatment and comparison schools for the years 2014, 2016 and 2019 from the DD estimation using matched samples. Table 3 shows predictive margins for treatment and comparison schools for each time period. The difference of the predictive margins between time periods for the treatment schools is the first difference, and the difference between time periods for comparison schools is the second difference. The difference between the differences is the impact of the program.

Participating in phase 1 of the program resulted in a 0.6 percentage point reduction in students' probability of being overweight from 2014 to 2016. However, the impact dissipated in 2019 for schools that participated in phase 1 only. By 2019, we did not find any statistically significant impact on overweight from being in the program. Schools that participated in both phases of the program showed more impactful results on students' nutritional outcomes. From 2014 to 2016, the probability of overweight reduced by 1.1 percentage points. Note that schools that participated in both phases had a higher impact in reducing the probability of overweight than schools that participated in only phase 1, likely due to self-selection. As schools continued in the program to 2019, the level of impact increased to a probability reduction of 1.7 percentage points.

As for obesity, being in the program in phase 1 only did not significantly impact students' probability of being obese in the first 2 years, and the probability increased by 0.3 percentage points for schools in 2019.

Participating in both phases of the program showed to be more impactful on students' probability of obesity. The students' probability of obesity reduced by 0.4 percentage points the first 2 years and reduced further to 0.9 percentage points in 2019.

DISCUSSION

This study showed that participating in phase 1 of the program can reduce the probability of overweight in students by 0.6 percentage points in 2 years of participation but the impact in reducing the likelihood of students being with obesity was not statistically significant in the same time frame. After 5 years of participation, the impact on the probability of overweight was no longer statistically significant.

Participating in both phases of the DTKS program was more impactful on students' nutritional health. Schools that participated in both phases on average were able to reduce the probability of students with overweight by 1.1 percentage points from 2014 to 2016. The impact of the program increased as the schools continued in the second phase, showing a reduction in the students' probability of overweight by 1.7 percentage points by 2019.

Schools that participated in both phases also saw an impact on obesity. From 2014 to 2016, the probability of students with obesity reduced by 0.4 percentage points. The impact on obesity also increased in magnitude as the schools continued in the second phase of the program, with a probability reduction of 0.9 percentage points by 2019.

Note that at the end of the first phase in 2016 there were different levels of impact between schools that participated in Phase 1 only and schools that participated in both phases, which was likely due to selection bias. Schools that had a good performance from the first phase were more likely to be selected

Figure 1. **Predictive Margins of Overweight and Obesity of Students in Schools Participating in Phase 1 Only and Comparison Schools**

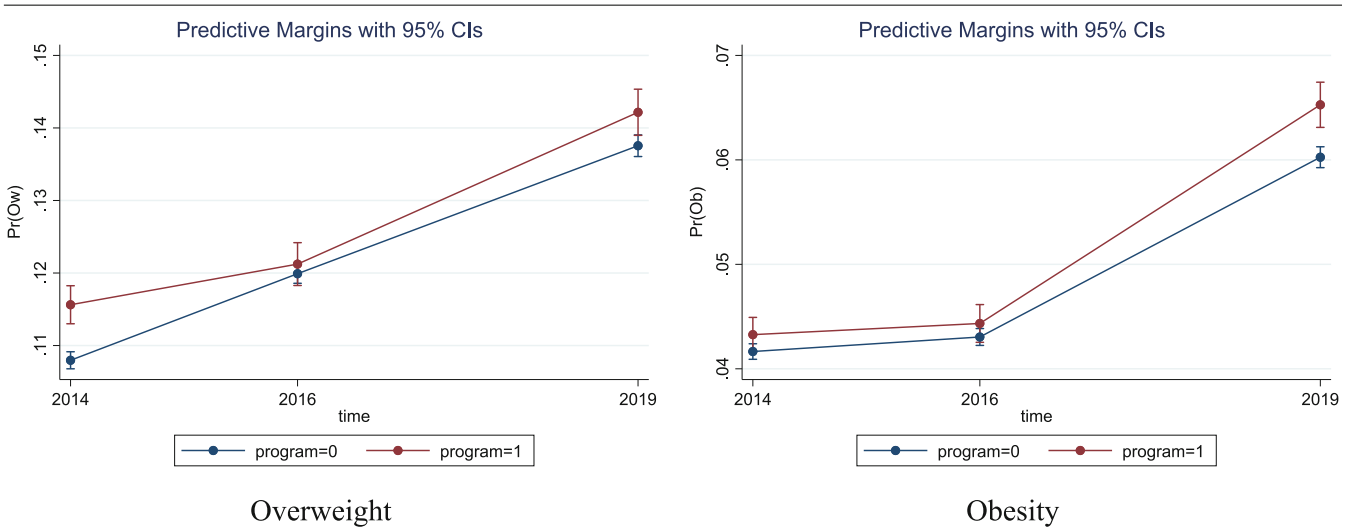
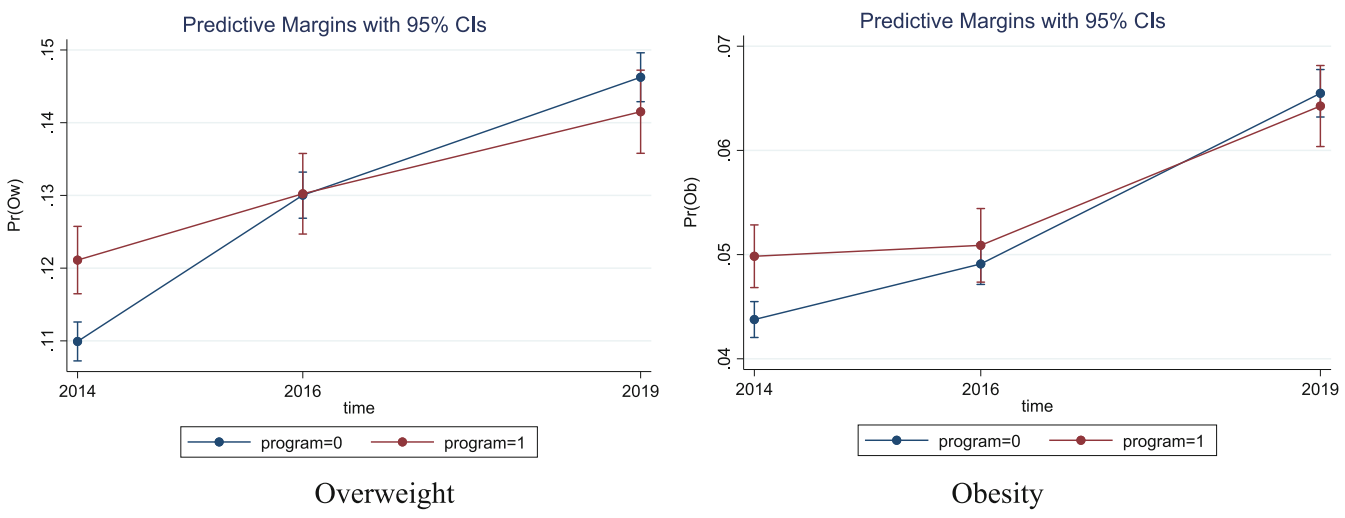


Figure 2. **Predictive Margins of Overweight and Obesity of Students in Schools Participating in Both Phases and Comparison Schools**



to continue in the second phase, therefore the results may overestimate the impact (Figures 1 and 2).

To understand the different impacts of the program on nutritional status, we must examine how each phase of the program was carried out. The activities in the first phase of the program were more focused on raising awareness about nutritional status in children and introducing schools to the concept of improving students' health through the program's 8 activities. Prioritizing raising awareness proved to be effective in reducing the probability of overweight. However, raising awareness alone may be insufficient to tackle obesity.

Phase 2 placed more emphasis on implementation than phase 1. In the second phase, schools were required to implement all 8 activities, received school visits from the program staff, and received additional budget for implementation. School visits were an integral part in this phase as they helped to ensure the success of implementation. For example, the program found that most schools have poor quality height and weight measurement equipment that distorted the correct situation of their students' nutritional status. School visits were central in identifying and resolving potential inaccuracies in implementation.

More importantly, schools that continued in the second phase gained from program continuity. All schools that participated in the program benefited from reduced likelihood of overweight in the first phase, but the impact tapered off once schools left the program. Schools that continued in the second phase not only were able to maintain their success but were able to increase the impact level.

IMPLICATIONS FOR SCHOOL HEALTH POLICY, PRACTICE, AND EQUITY

There are 2 main lessons to be learned from the implementation of DTKS. First, continuity is key. As evidenced in this study, the intervention had a positive impact on the outcomes for all participating schools, but the impact wore off for schools that dropped out of the program, while for schools that continued in the second phase were able to intensify the positive results. Continuity is also critical when tackling with obesity. In this study, minimal impact was detected in the first 2 years of intervention. But as schools continued into the fifth year of the program, we were able to see the program's impact on obesity. Therefore, programs must allow enough time to see the desired changes in the outcomes.

Second, program intensity determined the level of the impact. During Phase 1, schools chose to implement any of the 8 suggested activities and were able to achieve positive results. But once schools were required to implement all 8 activities in the second phase, the level of impact increased. Moreover, close supervision from the program may have played an essential role in boosting the positive results. A support system, for example from program staff or local experts, to monitor and assist with implementation and provide consultations can increase the chances of program success.

Limitations

This study had 2 main limitations. The first limitation concerned the unavailability of OBEC data prior to 2014. As a result, we were unable to establish a baseline trend in the students' health outcomes in each school before the program was implemented. Second, we were unable to identify how much weight each school put in implementing each of the 8 activities. Therefore, we were unable to analyze the effectiveness of each activity within the program.

Conclusions

The Dek Thai Kam Sai Program had an impact in reducing the probability of overweight and obesity in students, although the level of impact varied under different circumstances. The less intensive phase was able to reduce the probability of overweight, but not obesity. To reduce the chances of obesity in students, the program required continuity as well as higher level of implementation intensity.

Human Subjects Approval Statement

The Institutional Review Board at the Institute for Population and Social Research, Mahidol University, approved the study (COA. No. 2019/414).

Conflict of Interest

The authors declare no conflicts of interest.

REFERENCES

1. Barlow SE. Expert committee recommendations regarding the prevention, assessment, and treatment of child and adolescent overweight and obesity: summary report. *Pediatrics*. 2007;120(suppl 4):S164-S192. https://doi.org/10.1542/peds.2007-2329c.
2. Ford ES. The epidemiology of obesity and asthma. *J Allergy Clin Immunol*. 2005;115(5):897-909. https://doi.org/10.1016/j.jaci.2004.11.050.
3. Goran MI, Ball GD, Cruz ML. Obesity and risk of type 2 diabetes and cardiovascular disease in children and adolescents. *J Clin Endocrinol Metab*. 2003;88(4):1417-1427. https://doi.org/10.1210/jc.2002-021442.
4. Griffiths LJ, Parsons TJ, Hill AJ. Self-esteem and quality of life in obese children and adolescents: a systematic review. *Int J Pediatr Obes*. 2010;5(4):282-304. https://doi.org/10.3109/17477160903473697.
5. van Geel M, Vedder P, Tanilon J. Are overweight and obese youths more often bullied by their peers? A meta-analysis on the correlation between weight status and bullying. *Int J Obes*. 2014;38(10):1263-1267. https://doi.org/10.1038/ijo.2014.117.
6. Withrow D, Alter DA. The economic burden of obesity worldwide: a systematic review of the direct costs of obesity. *Obes Rev*. 2011;12(2):131-141. https://doi.org/10.1111/j.1467-789x.2009.00712.x.
7. Ng M, Fleming T, Robinson M, et al. Global, regional, and national prevalence of overweight and obesity in children and adults during 1980-2013: a systematic analysis for the global burden of disease study 2013 [published correction appears in lancet. 2014 Aug 30;384(9945):746]. *Lancet*. 2014;384(9945):766-781. https://doi.org/10.1016/s0140-6736(14)60460-8.
8. National Center for Health Statistics (U.S.), 2021. National Health and Nutrition Examination Survey 2017-March 2020 prepandemic data files development of files and prevalence estimates for selected health outcomes. NHSR No. 158. National Health Statistics Reports. Available at: https://stacks.cdc.gov/view/cdc/106273. Accessed July 14, 2022.
9. Fryar CD, Carroll MD, Afful J. Prevalence of Overweight, Obesity, and Severe Obesity among Children and Adolescents Aged 2-19 Years: United States, 1963-1965 through 2017-2018. NCHS Health E-Stats; 2020. Available at: https://www.cdc.gov/nchs/data/hestat/obesity-child-17-18/obesity-child.htm. Accessed July 14, 2022.
10. Akeplakorn W, Pakchareon H, Thaikra K, Satiennoppakaw W. *The Thai National Health Examination Survey V, 2014*. Bangkok: Health System Research Institute; 2016.
11. Khambalia AZ, Dickinson S, Hardy LL, Gill T, Baur LA. A synthesis of existing systematic reviews and meta-analyses of school-based behavioural interventions for controlling and preventing obesity. *Obes Rev*. 2012;13(3):214-233. https://doi.org/10.1111/j.1467-789x.2011.00947.x.

12. Gonzalez-Suarez C, Worley A, Grimmer-Somers K, Dones V. School-based interventions on childhood obesity: a meta-analysis. *Am J Prev Med*. 2009;37(5):418-427. https://doi.org/10.1016/j.amepre.2009.07.012.
13. Verjans-Janssen SRB, van de Kolk I, Van Kann DHH, Kremers SPJ, Gerards SMPL. Effectiveness of school-based physical activity and nutrition interventions with direct parental involvement on children's BMI and energy balance-related behaviors - a systematic review. *PLoS One*. 2018;13(9):e0204560. https://doi.org/10.1371/journal.pone.0204560.
14. Bleich SN, Vercammen KA, Zatz LY, Frelier JM, Ebbeling CB, Peeters A. Interventions to prevent global childhood overweight and obesity: a systematic review. *Lancet Diabetes Endocrinol*. 2018;6(4):332-346. https://doi.org/10.1016/S2213-8587(17)30358-3.
15. Jones RA, Lubans DR, Morgan PJ, et al. School-based obesity prevention interventions: practicalities and considerations. *Obes Res Clin Pract*. 2014;8(5):e497-e510. https://doi.org/10.1016/j.orcp.2013.10.004.
16. Brown T, Moore TH, Hooper L, et al. Interventions for preventing obesity in children. *Cochrane Database Syst Rev*. 2019;(7):CD001871. https://doi.org/10.1002/14651858.cd001871.pub4.
17. Waters E, de Silva-Sanigorski A, Hall BJ, et al. Interventions for preventing obesity in children. *Cochrane Database Syst Rev*. 2011;(12):CD001871. https://doi.org/10.1002/14651858.cd001871.pub3.
18. Schwartz AE, Leardo M, Aneja S, Elbel B. Effect of a school-based water intervention on child body mass index and obesity. *JAMA Pediatr*. 2016;170(3):220-226. https://doi.org/10.1001/jamapediatrics.2015.3778.
19. Cunha DB, de Souza BS, Pereira RA, Sichieri R. Effectiveness of a randomized school-based intervention involving families and teachers to prevent excessive weight gain among adolescents in Brazil. *PLoS One*. 2013;8(2):e57498. https://doi.org/10.1371/journal.pone.0057498.
20. Rappaport EB, Daskalakis C, Sendecki JA. Using routinely collected growth data to assess a school-based obesity prevention strategy. *Int J Obes*. 2013;37(1):79-85. https://doi.org/10.1038/ijo.2012.126.
21. Turner C, Aggarwal A, Walls H, et al. Concepts and critical perspectives for food environment research: a global framework with implications for action in low-and middle-income countries. *Glob Food Sec*. 2018;18:93-101. https://doi.org/10.1016/j.gfs.2018.08.003.
22. Scott J. Childhood obesity estimates based on WHO and IOTF reference values. *J Obes Weight Loss Ther*. 2015;5(Special Issue):249. https://doi.org/10.4172/2165-7904.1000249.
23. Kêkê LM, Samouda H, Jacobs J, et al. Body mass index and childhood obesity classification systems: a comparison of the French, International Obesity Task Force (IOTF) and World Health Organization (WHO) references. *Rev Epidemiol Sante Publique*. 2015;63(3):173-182. https://doi.org/10.1016/j.respe.2014.11.003.
24. Gertler PJ, Martinez S, Premand P, Rawlings LB, Vermeersch CM. *Impact Evaluation in Practice*. Second ed. Washington, DC: World Bank Publications; 2016. Available at: https://openknowledge.worldbank.org/handle/10986/25030. Accessed March 31, 2022.

SUPPORTING INFORMATION

The following Supporting Information is available for this article:

Table S1. Details of the DTKS program

Table S2. DD estimation of the impact of participating in phase 1 of DTKS on overweight and obesity using matched comparison group

Table S3. DD estimation of the impact of participating in phase 1 and 2 of DTKS on overweight and obesity using matched comparison group

Additional supporting information may be found online in the Supporting Information section at the end of the article.