The Impact of Lunch Program on Obesity among School-Age Children: A Scoping Review

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ABSTRACT

Context: Obesity is one of the most significant issues among school ages children from both developed and developing countries. Poor eating behavior and lack of physical activity are among the main causes of obesity in school ages children. It is known that the school period is the pivotal time for adopting interventions such as healthy eating and more physical activities for a long time.

Aim: This review was conducted to evaluate the impact of the school-lunch program on obesity among school-aged children.

Methods: Five databases, such as Google Scholar, PubMed, ScienceDirect, CINAHL, and MEDLINE, were employed to search the research studies conducted on the interventions that had school lunch programs to decrease the obesity issue among children. Ten relevant studies were extracted and included in this review. The inclusion criteria for the research study in this review were the research papers published after 2010. The exclusion criterion was the research studies that did not provide relevant information about the study's objectives.

Results: The findings of the studies indicated several interventions to improve the eating behavior of the children as well as physical fitness. The practical-based interventions include the food items in the school lunches, such as more intake of fruits and vegetables and avoiding the intake of packed items that were found useful in the intake of nutrients. Besides, the interventions related to increasing physical activities, such as sports, were provided with positive results in preventing obesity among children. In addition, the education programs for the parents and children were also useful in reducing obesity issues as they increased the children's and the parent's knowledge about healthy eating.

***Conclusion*:** Most reviewed studies targeting obesity prevention focused on dietary and exercise behaviors affecting anthropometric measures. Most school-based intervention programs positively affect the school children's healthy lifestyle and anthropometric measurements. Future studies are needed to include behavioral therapy interventions for children and education for the parents, as they are the main agents for improving the children's nutrition habits.

Keywords: Lunch program, school-age children, obesity

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1. Introduction

Obesity among children is a common problem nowadays all over the world. It is also observed that overweight children are likelier to be obese than adults *(Bhurosy & Jeewon, 2014).* If the children are overweight according to their age and height, they are considered obese. The accumulation of fats in the large amount within the body is referred to as obesity. The problems of obesity cause significant health risks for people *(Nuttall, 2015).* The constant measurement of height and weight is necessary for children due to physiological changes. Weight and height will be changed according to the growth levels of the children. Children mostly encounter obesity problems when the body absorbs more calories than it burns *(Martin-Pelaez et al., 2013).*

There are several causes of obesity among children. These include eating junk food or packed items that include variability in the oil and nutrient contents. Lack of physical activity and genetic and psychological disorders such as anxiety, depression, and cultural factors can cause obesity among children. The cultural factors include the family's eating patterns that increase obesity issues. In general, obesity is caused due to overeating, particularly food items containing more oil contents *(Bender, 2014).* Behavioral factors are also among the factors that lead to obesity in children. These factors include consuming food high in calories and drinking food with high sweeteners. Among the behavioral factors, less physical activity in children can cause to increase in their weight of the children *(Gurnani et al., 2015).*

Furthermore, children spend most of their time watching or playing video games which can cause to increase in weight of the children. It was noticed in the study conducted by *Geiker et al. (2018)* that children aged between 8 to 18 years usually spent 7 hours on average per day playing games. Several environmental factors can contribute to increasing obesity problems among children. These factors include the environment of the school, home, and other places in which the children spend their time. In these areas, children eat and develop eating habits with time that will contribute towards gaining weight and cholesterol.

The physical symptoms can be large fat accumulation within the human body. Several complications related to

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health include breathing disorders, sleep disorders, pulmonary diseases, hypogonadism, and depression. Also, it can be the risk of several chronic diseases such as cancers, hypertension, and stroke due to high cholesterol, joint diseases, and others. Further complications include psychosocial, pulmonary, neurological, gastrointestinal, cardiac, and endocrine. The psychological complications include poor self-esteem, depression, anxiety, and other eating disorders *(Arnold et al., 2017).*

Healthy food habits and more physical activity will cause to increase the likelihood that children will become healthy. Studies showed that children's eating habits and physical activity also depend on the communities in which they live and spend most of their time. These include the schools' communities, health care settings, family environment, and media. Besides, several foods and beverage industries will cause to increase the obesity problems among children. Treating the obesity issue among children should include modifications in the eating plan and adopting more physical activity *(Raj & Kumar, 2010).*

2. Significance of the study

Childhood obesity is a significant problem in developed and developing countries *(Chan & Woo, 2010).* Several health risks can occur due to obesity issues, such as hypertension, diabetes, cardiovascular disorders or stroke, and others. Therefore, this is important to address the issue as being obese can be a problem for children in performing school activities and daily life work *(Bhurosy & Jeewon, 2014).* It has been noticed that the school lunch menus can be a contributory factor to increased calorie intake among children. Besides, the packed food items are also contributory factors as often the contents of the packed food items are not known. The daily intake of food items can cause health issues for the children as this also affects their mental health, consequently low performance in the studies. It was observed that the utilization of convenience food is also one of the contributory factors that cause to increase the weight *(LaCaille et al., 2011).* These convenience food items comprise fats, high glycemic, high energy, and more food. Besides, this was noticed that convenience food mostly constitutes fewer fiber contents and fewer nutrients that can deteriorate the health of the children. The study of the school lunch program will help assess the association between the lunch served to the school children and obesity issues.

3. Aim of the study

This review evaluated the impact of the school-lunch program on obesity among school-aged children.

3.1. Review questions

The following are the research questions of the study.

- What is the target population of the research study?
- What can be the possible interventions to address the issue?
- Does improvement in the school lunch programs contribute to decreasing the obesity issue among children?

3.2. PICO Framework

The PICO (people, intervention, comparison, and outcomes) model will be used in the study to address the issue. This framework is usually applied to solve the nursing-based issue and address it by comparing it with the control cases to identify the main reason for the evidence-based issue. Besides, the intervention is proposed for the health issue to solve the problem.

Table (1): PICOT Question.

PICOT	CONTENT	PICOT QUESTION
P	School children with ages ranging from 6 to 12 years	what is the effect of school lunch programs on obesity among school-age children?
I	Healthy eating programs in the school lunches	
C	Children eat packed food items and unhealthy lunches.	
O	Children eating healthy food in school lunches will be less obese.	
T	2010 upward	

4. Methodology

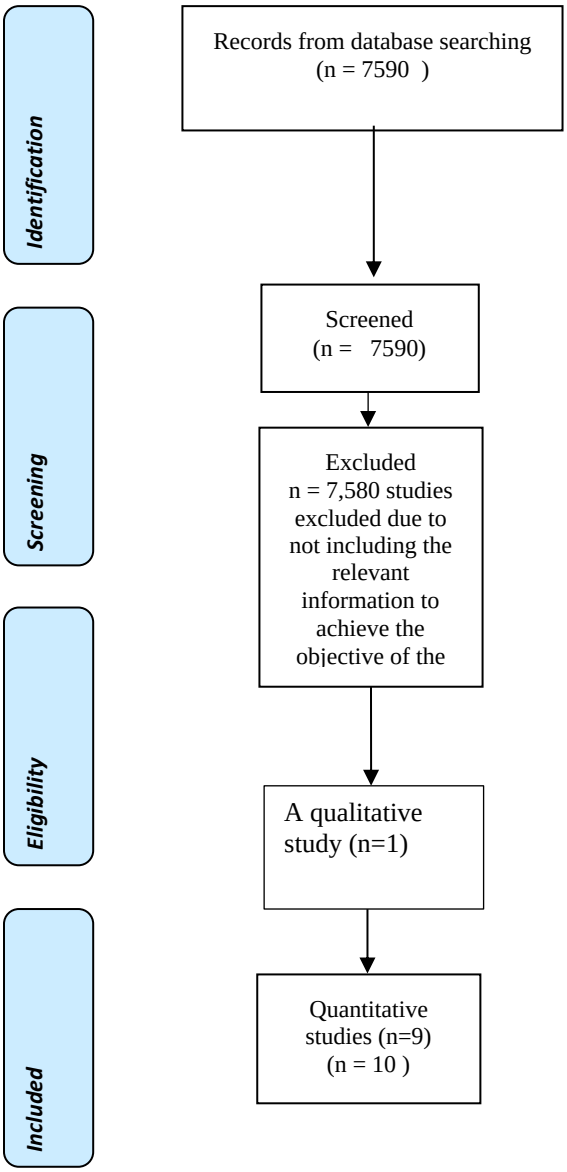
In the present review study, the collected information was based on qualitative and quantitative methods to answer the study's research questions *(Choy, 2014).*

4.1. Search strategy

The search strategy for this scoping review was based on data collection and information published in previous years. The databases for finding these research articles include PubMed, Google Scholar, Science Direct, CINAHL, and MEDLINE. The keywords used to search the published research studies include "school lunches, obesity, children, interventions, causes of obesity, treatment methods, and healthy measures." A Prisma diagram was used to explain the search strategy employed in this systematic review. This Prisma flow diagram is the systematic approach used to explain the detailed information about the search strategies in the present review articles *(Stovold et al., 2014).*

Figure 1 shows information about the Prisma flow diagram, which explains the detailed search strategies used for this scoping review. On PubMed, there were 810 research articles found by using these keywords. Besides, there were 5400 research articles and reports found after searching on the database of Google Scholar. The database of Science Direct provided the research results of 550 studies. CINAHL provided the records of 450 research studies published related to this topic. Besides, there were 380 research studies found after searching the keywords on MEDLINE. Therefore, 7,590 research studies were found after searching the abovementioned keywords on these databases. Ten research

articles were used that provided relevant information related to the topic. These research articles helped provide the information to achieve the research objectives. Based on the above information, the study's objectives were formulated.



4.2. Research Approach

The employed research approaches in the present review were based on qualitative and quantitative research studies. Therefore, mixed approaches were used. The published studies used to collect the information provided relevant information related to the objectives of the present study. The information was collected from past published research articles, books, reports, and others in secondary data collection methods. Both qualitative and quantitative-based studies were used to collect information. Therefore, the obtained results were in the form of both numeric and non-numeric data form. Furthermore, the collected data was based on the articles used as the primary methods for their research study.

4.3. Inclusion criteria of the study

The inclusion criteria for this scoping review were to include the information from the research studies carried out and published after 2010. Therefore, up-to-date information was the first criterion for shortlisting the required information. The selected research articles included in this review were written in English. The research studies on assessing school lunches' impacts on obesity among school-aged children were shortlisted and included in the present systematic review.

4.4. Exclusion criteria of the study

The exclusion criteria of the present study are those research articles published before 2010. The other criteria for exclusion are the research articles that did not show the original work. The research articles and books did not provide relevant information and were excluded from the study. The studies or the books and reports for which the full-text articles were not available were also excluded from this study.

4.5 Quality appraisal

There was the inclusion of only that information available on authentic websites and databases. The data from the unpublished sources were not included in the present review. In most cases, it was observed that published data was reliable, and there was no need to re-examine the data. Furthermore, the confidentiality of the studied subjects used in the previous research was preserved. The reliability of the secondary data used for this study was checked by following the processes such as checking the researcher who used to collect the data relevant to this study. The aims and objectives of the published studies were examined. The data from the publication and the research year were double-checked. The method used for the data collection was examined and evaluated carefully, as this was important to produce the study results. Therefore, that information was included in the present review if the appropriate method was used. The data types were also evaluated. The consistency of the obtained data in the studies was checked compared to the other studies. This perspective was important in selecting the relevant information from the particular study.

4.6 Characteristics of included research studies.

Table 2 shows the results of the evidence from the ten published research studies carried out in 2010 and so forth. All the studies used primary data collection methods from school ages children. Different interventions were proposed to the children at the school to improve the nutritional behavior of the children so that there will be improved BMI for a long time. *Hollar et al. (2010a,b)* conducted two primary-based studies on school children. The first study included 3769 children, and the second included 4588 children. The first study aimed to evaluate the effectiveness of the program used to improve the nutrition contents in

children's diets to improve health conditions. The second study aimed to identify the impacts of intervention programs on decreasing obesity and children's overall academic performance.

Greening et al. (2011) did a primary-based study on 450 students ranging from 6 to 10 years old. The research study aimed at a healthy lifestyle school-based obesity intervention in a rural community where the obesity rates were high by doing interventions in dietary habits and physical activities. Also, *Gittelsohn et al. (2014)* conducted a study on 75 children aged 10 to 14. This study was conducted to find better prevention programs to reduce obesity among children with low-income backgrounds. Another research carried out was the primary-based study by *Lloyd et al. (2018)* on 1324 children ranging from 9 to 10 years old. The study aimed to assess the effectiveness of the intervention program in reducing obesity issues among school children. *Zask et al. (2012)* and *De Bock et al. (2011)* researched 560 and 348 children aged 3 to 6 years old to determine the impacts of nutritional-based interventions on maintaining children's weight.

Evans et al. (2010a,b) conducted two research studies on 1291 children between 8 and 9 years old to improve the nutrient contents in their lunch boxes. Another study included in the present review was the research carried out by *Myers et al. (2014)* on 1140 children aged 7 to 10 years old to evaluate the intervention's effectiveness in improving the children's physical fitness and weight. *Evans* conducted a cross-sectional study in *2020* to analyze the foods and nutrients in packed lunches in 2016 to highlight the difference in diet and nutrient quality since 2006 in the United Kingdom.

4.7. Limitation of the study

The study suggested limitations in some areas, as observed. The study is a prefecture analysis restricted to schools with an age group of 6-12 years. Also, women in their pubertal age are affected by irregular eating habits, mood swings, and eating junk regularly. The review did not indicate gender differences.

Also, this review did not elaborate on the average ratio of consumed and leftover lunch to maintain good statistics. Besides, the study discussed childhood obesity and its relationship with school lunches. However, it was restricted to elaborate on a child's eating habits from a very early stage as set by the parents. The calorie consumption per day was not made part of this review as it is essential while suggesting an intervention and its relationship with a healthy diet. The targeted child population was also limited as there was no specific region. The consequences of commodities were initially discussed, but no ratios were articulated regarding the prevalence of the most associated disease that immediately hits the child at a very early stage. Also, the survival from these commodities was not evaluated if it happens in an early pubertal stage of a child. This review did not deal with the consequence of diseases that might affect children in childhood due to obesity. These diseases may include cardiovascular problems, angina pectoris, hypertension, diabetes mellitus, atherosclerosis, myocardial infarctions, and other orthopedic diseases. If not overlooked at the preliminary stage, the child may facade many issues in adulthood.

5. Results

The screening results, using both electronic and manual searching methods, accepted ten articles for inclusion, emphasizing the impact of the school-lunch program on obesity among school-aged children. The included studies were retrieved and categorized into two themes, including the interventions for obesity prevention/management among school children and the effects of interventions on obesity prevention/management among children.

5.1. Interventions for obesity prevention/management among school children

Different interventions are used in the studied research to prevent obesity issues among children. *Zask et al. (2012)* and *De Bock et al. (2011)* introduce the interventions in which the children were given more fruits and vegetables in their lunch boxes compared to the control group. Besides the nutrition content was also assessed in the children's school lunch boxes to examine the nutrient contents. *Zask et al. (2012)* added more activities of sports for the children as well as increased the nutrient-based contents in the children's lunch boxes. *Myers et al. (2014)* included interventions such as dietary intake patterns and children's physical activity behaviors. The knowledge and attitude of the children and their parents were also evaluated to determine the effectiveness of the diet in maintaining health and improving health by controlling the weight of the children, *Evan et al. (2010b)* introduced the SMART lunch box in which fruits, sandwiches, vegetables, and dairy foods were included. These interventions were proposed in the children's lunch boxes to maintain their health and improve their dietary habits.

Gittelsohn et al. (2014) also proposed an intervention program to improve children's weight and reduce obesity. This program includes the multi-level, multi-component interventions of the food and social environments to increase access to, demand for and consumption of healthier foods. *Greening et al. (2011)* designed school-based interventions that include monthly physical activity and nutritional events during a 9-months academic year in a rural community. *Hollar et al. (2010a)* designed a school-based obesity prevention program, including modified dietary offerings, nutrition/lifestyle educational curricula, physical activity components, and wellness projects over two years (2004-2006). *Hollar et al. (2010a)* implemented a school-based intervention that included dietary, curricula, and physical activity components. *Lloyd et al. (2018)* implemented Healthy Lifestyles Program (HeLP) includes creating a receptive environment, drama activities, goal setting, and reinforcement activities.

5.2. Effects of interventions on obesity prevention/management among children

Greening et al. (2011) indicated an improvement in the children's dietary habits, body fat, physical activity, and performance on fitness tests compared to the control children. *Hollar et al. (2010a)* found a statistically significant positive impact of the obesity prevention program on controlling children's BMI. In addition, there were also significant positive effects on the academic performance of the children. Children's other physical health conditions, such as blood pressure, were also controlled due to improved dietary habits.

Also, *Hollar et al. (2010b)* found that children who participated in the intervention program lost their BMI and control weight compared to the control group. This finding indicated the positive impacts of the changing dietary habits of children on their health conditions. Besides, the intervention group children got statistically significantly higher math grade scores in both intervention years. *Myers et al. (2014)* indicate an improvement in the nutritional behavior of the intervention group compared to the control group regarding observed vegetable intake at lunchtime based on digital images of lunch trays, number of times reported drinking milk per day, percentage of students reported watching >2 hours of programs or movies per day. This regimen is proposed to positively impact children in the long term.

Gittelsohn et al. (2014) documented that using the BHCK model was a helpful intervention model for obesity reduction among children. *Evans et al. (2010a)* found that nutrient intake was improved by intervention in the children's lunch boxes, which helped to control and maintain the children's weight. The packed lunches were analyzed with the nutritional contents, and observed that they were less in nutrients as compared to the lunch boxes provided to the children. The study of *Evans et al. (2010b)* concluded a positive impact of SMART lunch box intervention on improving children's health, which may have long-term impacts on weight maintenance and preventing obesity among children.

Zask et al. (2012) reported significant improvement in children's movement skills and more fruit and vegetable served. Besides, they were less likely to have unhealthy food items in their lunch boxes after the intervention. There was also a significant difference in waist circumference and a reduction in BMI. Also, *De Bock et al. (2011)* reported a significant increase in fruit and vegetable intake with no significant changes in water consumption, sugar drinks, or anthropometric measurements.

Evans et al. (2020) found that some food types' frequency of provision and portion size changed substantially. The frequency of provision of confectionery, sweetened drinks, cakes, and biscuits not containing chocolate in lunch is reduced. The study also found that vegetable provision in lunches remained low, and there was a substantial change in the percentage of lunches meeting some nutrient standards of non-milk extrinsic sugars, vitamins A, C, and Zinc.

Lloyd et al. (2018) found no significant impacts on the BMI of the intervention group compared to the control group. This finding can be due to the study's limitations in which school-based interventions might not be sufficiently intense to affect both the school and the family environment, and hence the weight status of children, and for the fewer determinants included.

6. Discussion

Obesity is the most common issue among school ages children in both developed and developing countries *(Yildirim et al., 2014).* There is a need for interventions to be proposed to the students and included in the children's school activities, as students spend most of their time in school. Therefore, the necessary interventions must be implemented in the school policies. This scoping review included the outcomes and descriptions of the previous research studies aiming to evaluate the impact of the school-lunch program on obesity among school-aged children. This review included ten research studies based on introducing interventions in the school lunch programs. These interventions were proposed to reduce and maintain the BMI of school ages children.

The previous research studies proposed that several interventions can be possible to improve the weight of the children in the school *(Cluss et al., 2014; Myers et al., 2014).* These interventions aimed at the improvement of dietary habits of school-age children as well as the increase of their physical activity at school. However, most studies proposed that management interventions will reduce obesity among school children *(Taber et al., 2013).* Studies showed that the interventions in the school-based programs were successful because some children ages 3 to 6 years were enrolled in childcare centers. Therefore, these interventions are easy to implement for the school administration. Besides, the schoolteachers, school administration, and parents are important in implementing intervention programs for children as it is cost-effective *(Hunsberger et al., 2014).*

Moreover, by providing guidelines, schools can provide a suitable environment for children to improve their dietary habits and physical activities. It was also noticed in one of the studies that providing sufficient knowledge to the parents and schoolteachers about health promotion was helpful in the enhancement of the healthy behavior of the children. This finding revealed the requirement to include interventions to increase knowledge about the schoolteachers' healthy behaviors because most parents and teachers did not know enough about improving healthy behavior among children *(Flattum et al., 2015).* The review results indicated that the BMI of the children is reduced by following the interventions that are practically based. Besides, the children's academic performance increased with increased physical fitness and healthy eating.

The study showed that the students must have behavioral training regarding healthy eating in daily life to improve the children's and their parents' knowledge about including healthy eating in their diet *(Pittman et al., 2012). Laws et al. (2014)* identified that parental engagement could

have a more significant impact on preventing obesity among school-aged children. There must be short-term, and long-term goals for the students as this will cause improvement in the children's weight, consequently affecting their overall fitness.

Also, obesity can be prevented among school children by avoiding packed items. A study found that the packed items have low nutritional content compared to the lunch boxes provided to the intervention group *(Pittman et al., 2012).* The continuous intake of packed items in school lunches will cause an increase in obesity issues among children. Avoiding the intake of packed items may be one of the interventions in reducing or preventing obesity among school children *(Singh et al., 2021).*

The role of parents is important in controlling the dietary habits and practices of the children. The interventions must include education programs for the parents to increase their knowledge about healthy lunches for the children as it reduces the chances of diseases among the children in the long term *(Langford et al., 2015).* Besides, there must be an education program for school ages children about the importance of adopting healthy eating such as the intake of more fruits and vegetables in the diet. Obesity can be prevented if school policies include more sports programs for children. Physical activities will likely prevent fat deposition in the body, maintain the cholesterol level, and reduce the chance of stroke or cardiovascular disorders. A study showed that school-aged children showed more importance to healthy eating in maintaining weight than physical activity *(Ohri-Vachaspati et al, 2012).*

This finding indicated the need for an intervention program of physical activity among the children so that they will have proper knowledge of the impacts of physical activities on their health. Therefore, teaching school children about healthy eating behaviors and the importance of physical activities in daily life is recommended to have more cognition of good health. The proposed interventions for future studies can involve the parents and teachers in the intervention program. This finding will help increase their knowledge and provide the children with an environment to adopt healthy lifestyles *(Evans et al., 2010a).* Besides, the role of the community is also important, which helps the children to adopt positive behavior. In future studies, this is proposed to include other aspects that can help in the positive behavior of the children so this will be easy to determine the impact of each behavior on reducing obesity among the children.

The current study has used different databases to acquire significant research outcomes. Following the findings from the current review, interventions used to prevent obesity could impact children differently. For instance, the current study has reviewed the research proposed by *Greening et al. (2011)* and observed that interventions could positively impact the prevention of obesity among children. This study collected data from four-hundred and fifty school-going children aged between 6 and 10 years. The targeted children's nutritional knowledge, dietary habits, physical activities, body fat percentage, fitness level, waist circumference, and BMI percentile were considered. The findings of this study, however, depicted statistically significant improvement in the children's variables used to be measured after the implementation of interventions. Thus, this study significantly claimed that intervention programs to change the sedentary behavior of school-aged children could positively impact obesity among the targeted population. On the contrary, *Rosiek et al. (2015)* argued that changes in sedentary behavior cannot significantly control obesity in children; rather, excessive physical activities could have a more positive impact on the prevention of childhood obesity.

Notwithstanding, the current review has considered the findings of *Hollar et al. (2010a)* to understand the impact of interventions used to prevent obesity among children. This study aimed to assess the impacts of school-based intervention programs to prevent obesity among children. This study selected a quasi-experimental research design and conducted research for about two years to observe the targeted population's academic and physical performance. The findings of this study, however, indicated that after the implementation of school-based intervention programs, children in the intervention group were observed to have a normal BMI percentile compared to those in the control group. Other than this, the findings of this study showed statistically significantly substantial academic scores for the school-going children included in the intervention group, for about two years, compared to the control group. Thus, this study claimed that school-based intervention programs positively impact the academic, physical, and mental productivity of school-aged low- and middle-income children.

On the other hand, *Laws et al. (2014)* identified that the children's body mass index within the intervention and control group varied between -0.29kg/m^2 to -0.54 kg/m^2 after excessive children engaged with their parents. On the contrary, *Gortmaker et al. (2015)* argued that interventions are often observed to have a negligible impact on preventing obesity among children because of their financial issues.

Besides this, the current review found that the prevention of childhood obesity is significantly associated with improved physical activity and sedentary behavior. The outcomes of research conducted by *Myers et al. (2014),* who assess the impact of Energy Balance for Kids with Play (EB4K with play) interventions on preventing obesity among children. Nevertheless, *Myers and colleagues* determined the effects of an intervention on the targeted population's physical activity and nutrition behaviors. This study conducted a cluster-randomized trial to collect relevant data and employed third- and fifth-grade children. As a result, this study found an increased eligibility ratio for low-priced or free food, along with increased rates of obesity among school-aged children. However, this study depicted a significant impact of a healthy diet on the prevention of childhood obesity among low-income school-going students, in comparison to those who preferred to eat low-priced or free lunch in school.

Similarly, *Kobes et al. (2018)* showed a significant difference ($P < 0.0001$) between students who preferred to eat vegetables and those who intended to eat unhealthy lunches in school. It has also been identified by *Sharma et al. (2019)*

that the intake of more vegetables and fruits in the diet of school-aged children can have a more profound and positive impact on their physical performance thus, prevent them from getting overweight or obese.

Similar to this study, the author of the current research has reviewed the methodology and outcomes of a study conducted by *Evans et al. (2010b),* in which an in-depth analysis of the influence of SMART lunchboxes on the physical health of school-aged children in the context of prevention of childhood obesity. The authors, however, carried out a cluster-randomized controlled trial in eighty-nine primary schools in the United Kingdom. Around one-thousand, two-hundred and ninety-one students aged between 10 and 14 were targeted. The proportion of students who received different items in packed lunch and the weights of each food item was measured. Following the outcomes of this study, the impact of SMART lunch boxes was observed to be negligibly positive, or it could be said that negligible improvements in the prevention of obesity among children were observed after the use of packed lunches; thus, certain other essential intervention programs have to be taken into consideration to influence the prevention of childhood obesity. For instance, *Cuadrado-Soto et al. (2020)* argued that the proportion of essential nutrients in the food provided to children must be accurate to avoid the excessive intake of any one nutrient, which could adversely impact the physical health of students.

In addition, the current study has reviewed the research results presented by *Lloyd et al. (2018)* to further evaluate the significant impact of some vital interventions on preventing obesity among school-aged children. This study aimed to determine the association, as well as the efficacy of healthy lifestyle programs in preventing obesity among children primary-school-aged children. This research conducted a cluster-randomized controlled trial and included thirty-two schools in England. The participants were randomly divided into intervention and control groups. The outcomes of this study showed a non-significant mean difference between the BMI score of children in the intervention and control group have been observed. Notwithstanding, an insignificant impact of the intervention on the prevention of obesity has been observed in this study, despite the implementation of extensively and theoretically informed piloted interventions, including follow-up, the fidelity of delivery, and increased levels of engagement. As per *Mehdizadeh et al. (2020),* school-based interventions could not be efficient or intense to influence both the environment of the family and school, thus, the status of children's weight.

7. Conclusion

This review focuses on the influence of school lunches on enhancing the rate of obesity in children. The review here is engrossed in collecting the relevant data from different studies and literature regarding the school-lunch programs to control childhood obesity. It was revealed that certain interventions had been tried to decrease the obesity of school-age children that, include dietary intake, physical exercise, and education for children, parents, and school teachers. Most of the studies that target the school lunch program evidenced the improvement in the children's outcomes through their anthropometric measures, physical activities indicating improvement in their obesity status and their knowledge, and parent and school teacher knowledge.

8. Recommendations

It was proposed that the healthcare associations implement strict rules for these programs so that the parents and the education system would be equally responsible for maintaining the child's health.

The cafeteria and canteens in the schools should be restricted to serving only healthy food. Junk and other unhealthy conventional foods like fast foods should be limited within the school boundaries.

The research studies in the future should include the criteria for evaluating the targeted educational systems with the level of school lunch programs, school health services, and guidelines and policies regarding the students' health. The policies should align to analyze the children's monthly BMI, adiposity index, and weights. The studies should be made to design a proper framework and policies for the schools to deliver quality health services and to edge the foundation of their setups in a healthy way.

The school administration should promote physical exercises and healthy lifestyle awareness sessions to the children from the very initial stage of learning, including the considerate subject areas involving the nutritional needs and effects of food on a child's health in the course line of the education system.

The teachers should stay responsible in addressing a better perspective of health and correlated diseases to the children in their commands. Similarly, apart from schooling, parenting is equally responsible for positively maintaining their children's health, assuring that they do not get addicted or attracted to junk and unhealthy conventional foods.

9. References

Arnold, A. P., Cassis, L. A., Eghbali, M., Reue, K., & Sandberg, K (2017). Sex hormones and sex chromosomes cause sex differences in the development of cardiovascular diseases. *Arteriosclerosis, Thrombosis, and Vascular Biology*, *37*(5), 746-756. https://doi.org/10.1161/ATVBAHA.116.307301.

Bender, D. A. (2014). *Introduction to nutrition and metabolism*. 5th ed. CRC Press. Boca Raton. https://doi.org/10.1201/b16594

Bhurosy, T., & Jeewon, R. (2014). Overweight and obesity epidemic in developing countries: A problem with diet, physical activity, or socioeconomic status? *The Scientific World Journal*, *2014*. 964236. https://doi.org/10.1155/2014/964236.

Chan, R. S., & Woo, J. (2010). Prevention of overweight and obesity: How effective is the current public health approach? *International Journal of Environmental Research and Public Health*, *7*(3), 765–783.

Choy, L.T. (2014). The strengths and weaknesses of research methodology: Comparison and complimentary between qualitative and quantitative approaches. *IOSR Journal of Humanities and Social Science*, *19*(4), 99–104.

Cluss, P. A., Fee, L., Culyba, R. J., Bhat, K. B., & Owen, K. (2014). Effect of food service nutrition improvements on elementary school cafeteria lunch purchase patterns. *Journal of School Health*, *84*(6), 355–362. https://doi.org/10.1111/josh.12157.

Cuadrado-Soto, E., López-Sobaler, A. M., Jiménez-Ortega, A. I., Aparicio, A., Bermejo, L. M., Hernández-Ruiz, Á., Lara Villoslada, F., Leis, R., Martínez de Victoria, E., Moreno, J. M, & Ruiz-López, M. D. (2020). Usual dietary intake, nutritional adequacy, and food sources of Calcium, Phosphorus, Magnesium, and Vitamin D of Spanish children aged one to <10 years. Findings from the EsNuPI study. *Nutrients*, *12*(6), 1787. https://doi.org/10.3390/nu12061787.

De Bock, F., Breitenstein, L., & Fischer, J. E. (2011). Positive impact of a pre-school-based nutritional intervention on children's fruit and vegetable intake: Results of a cluster-randomized trial. *Public Health Nutrition*, *15*(3), 466-475. https://doi.org/10.1017/S136898001100200X.

Evans, C. E. L., Greenwood, D. C., Thomas, J. D., & Cade, J. E. (2010a). A cross-sectional survey of children's packed lunches in the UK: Food-and nutrient-based results. *Journal of Epidemiology & Community Health*, *64*(11), 977–983. https://doi.org/10.1136/jech.2008.085977.

Evans, C. E. L., Greenwood, D. C., Thomas, J. D., Cleghorn, C. L., Kitchen, M. S., & Cade, J. E. (2010b). SMART lunch box intervention to improve the food and nutrient content of children's packed lunches: UK wide cluster randomized controlled trial. *Journal of Epidemiology & Community Health*, *64*(11), 970–976. https://doi.org/10.1136/jech.2008.085837.

Evans, C. E. L., Melia, K. E., Rippin, H. L., Hancock, N., & Cade, J. (2020). A repeated cross-sectional survey assessing changes in diet and nutrient quality of English primary school children's packed lunches between 2006 and 2016. *BMJ Open*, *10*(1), e029688. https://doi.org/10.1136/bmjopen-2019-029688.

Flattum, C., Draxten, M., Horning, M., Fulkerson, J. A., Neumark-Sztainer, D., Garwick, A., Kubik, M. Y. & Story, M. (2015). HOME Plus: Program design and implementation of a family-focused, community-based intervention to promote the frequency and healthfulness of family meals, reduce children's sedentary behavior, and prevent obesity. *International Journal of Behavioral Nutrition and Physical Activity*, *12*(1), 53. https://doi.org/10.1186/s12966-015-0211-7.

Geiker, N. R. W., Astrup, A., Hjorth, M. F., Sjödin, A., Pijls, L., & Markus, C. R. (2018). Does stress influence sleep patterns, food intake, weight gain, abdominal obesity, and weight loss interventions and vice versa? *Obesity Reviews*, *19*(1), 81-97. https://doi.org/10.1111/obr.12603.

Gittelsohn, J., Steeves, E. A., Mui, Y., Kharmats, A. Y., Hopkins, L. C., & Dennis, D. (2014). B'More Healthy Communities for Kids: Design of a multi-level intervention for obesity prevention for low-income African American children. *BMC public health*, *14*(1), 942. https://doi.org/10.1186/1471-2458-14-942.

Gortmaker, S. L., Wang, Y. C., Long, M. W., Giles, C. M., Ward, Z.J., Barrett, J. L., Kenney, E. L., Sonneville, K. R., Afzal, A. S., Resch, S. C., & Cradock, A. L. (2015). Three interventions that reduce childhood obesity are projected to save more than they cost to implement. *Health Affairs*, *34*(11), 1932-1939. https://doi.org/10.1377/hlthaff.2015.0631.

Greening, L., Harrell, K. T., Low, A. K., & Fielder, C. E. (2011). Efficacy of a school-based childhood obesity intervention program in a rural southern community: TEAM Mississippi Project. *Obesity*, *19*(6), 1213–1219. https://doi.org/10.1038/oby.2010.329.

Gurnani, M., Birken, C., & Hamilton, J. (2015). Childhood obesity: Causes, consequences, and management. *Pediatric Clinics*, *62*(4), 821-840. https://doi.org/10.1016/j.pcl.2015.04.001.

Hollar, D., Lombardo, M., Lopez-Mitnik, G., Hollar, T. L., Almon, M., Agatston, A. S., & Messiah, S. E. (2010a). Effective multi-level, multi-sector, school-based obesity prevention programming improves the weight, blood pressure, and academic performance, especially among low-income, minority children. *Journal of Health Care for The Poor and Underserved*, *21*(2 Suppl), 93-108. https://doi.org/10.1353/hpu.0.0304.

Hollar, D., Messiah, S. E., Lopez-Mitnik, G., Hollar, T. L. Almon, M., & Agatston, A. S. (2010b). Effect of a two-year obesity prevention intervention on percentile changes in body mass index and academic performance in low-income elementary school children. *American Journal of Public Health*, *100*(4), 646-653. https://doi.org/10.2105/AJPH.2009.165746.

Hunsberger, M., McGinnis, P., Smith, J., Beamer, B. A., & O'Malley, J. (2014). Elementary school children's recess schedule and dietary intake at lunch: A community-based participatory research partnership pilot study. *BMC Public Health*, *14*(1), 156. https://doi.org/10.1186/1471-2458-14-156.

Kobes, A., Kretschmer, T., Timmerman, G., & Schreuder, P. (2018). Interventions aimed at preventing and reducing overweight/obesity among children and adolescents: A meta-synthesis. *Obesity Reviews*, *19*(8), 1065-1079. https://doi.org/10.1111/obr.12688.

LaCaille, L. J., Dauner, K. N., Krambeer, R. J., & Pedersen, J. (2011). Psychosocial and environmental determinants of eating behaviors, physical activity, and weight change among college students: A qualitative analysis. *Journal of American College Health*, *59*(6), 531-538. https://doi.org/10.1080/07448481.2010.523855.

Langford, R., Bonell, C., Jones, H., & Campbell, R. (2015). Obesity prevention and the health-promoting schools'

framework: Essential components and barriers to success. *International Journal of Behavioral Nutrition and Physical Activity*, *12*(1), 15. https://doi.org/10.1186/s12966-015-0167-7.

Laws, R., Campbell, K. J., Van Der Pligt, P., Russell, G., Ball, K., Lynch, J., Crawford, D., Taylor, R., Askew, D., & Denney-Wilson, E. (2014). The impact of interventions to prevent obesity or improve obesity-related behaviors in children (0–5 years) from socioeconomically disadvantaged and/or indigenous families: A systematic review. *BMC Public Health*, *14*(1), 779. https://doi.org/10.1186/1471-2458-14-779.

Lloyd, J., Creanor, S., Logan, S., Green, C., Dean, S. G., Hillsdon, M., Abraham, C., Tomlinson, R., Pearson, V., Taylor, R.S., & Ryan, E. (2018). Effectiveness of the Healthy Lifestyles Programme (HeLP) to prevent obesity in UK primary-school children: A cluster randomized controlled trial. *The Lancet Child & Adolescent Health*, *2*(1), 35–45. https://doi.org/10.1016/S2352-4642(17)30151-7.

Martín-Peláez, S., Covas, M. I., Fitó, M., Kušar, A., & Pravst, I. (2013). Health effects of olive oil polyphenols: Recent advances and possibilities for using health claims. *Molecular Nutrition & Food Research*, *57*(5), 760-771. https://doi.org/10.1002/mnfr.201200421.

Mehdizadeh, A., Nematy, M., Vatanparast, H., Khadem-Rezaiyan, M., & Emadzadeh, M. (2020). Impact of parent engagement in childhood obesity prevention interventions on anthropometric indices among preschool children: A systematic review. *Childhood Obesity*, *16*(1), 3-19. https://doi.org/10.1089/chi.2019.0103.

Myers, E.F., Gerstein, D. E., Foster, J., Ross, M., Brown, K., Kennedy, E., Linchey, J., Madsen, K. A., & Crawford, P. B. (2014). Energy balance for kids with play: Design and implementation of a multi-component school-based obesity prevention program. *Childhood Obesity (print)*, *10*(3), 251–259. https://doi.org/10.1089/chi.2013.0075.

Nuttall, F. Q. (2015). Body mass index: Obesity, BMI, and health: A critical review. *Nutrition Today*, *50*(3), 117-128. https://doi.org/10.1097/NT.0000000000000092.

Ohri-Vachaspati, P., Turner, L., & Chaloupka, F. J. (2012). Fresh fruit and vegetable program participation in elementary schools in the United States and availability of fruits and vegetables in school lunch meals. *Journal of the Academy of Nutrition and Dietetics*, *112*(6), 921-926. https://doi.org/10.1016/j.jand.2012.02.025.

Pittman, D. W., Parker, J. S., Getz, B. R., Jackson, C. M., Le, T. A., Riggs, S. B., & Shay, J. M. (2012). Cost-free and sustainable incentive increases healthy eating decisions during elementary school lunch. *International Journal of Obesity*, *36*(1), 76–79. https://doi.org/10.1038/ijo.2011.205.

Raj, M., & Kumar, R. K. (2010). Obesity in children & adolescents. *The Indian Journal of Medical Research*, *132*(5), 598.

Rosiek, A., Maciejewska, N. F., Leksowski, K., Rosiek-Kryszewska, A., & Leksowski, Ł. (2015). Effect of television on obesity and excess of weight and consequences of health. *International Journal of Environmental Research and Public Health*, *12*(8), 9408-9426. https://doi.org/10.3390/ijerph120809408.

Singh, A., Dhanasekaran, D., & Sabarathinam, S. (2021). Junk food-induced obesity- a growing threat to youngsters during the pandemic. *Obesity Medicine*, *26*, 100364. https://doi.org/10.1016/j.obmed.2021.100364.

Sharma, S. V., Vandewater, E., Chuang, R. J., Byrd-Williams, C., Kelder, S., Butte, N., & Hoelscher, D. M. (2019). Impact of the coordinated approach to child health early childhood program for obesity prevention among preschool children: The Texas childhood obesity research demonstration study. *Childhood Obesity*, *15*(1), 1-13. https://doi.org/10.1089/chi.2018.0010.

Stovold, E., Beecher, D., Foxlee, R., & Noel-Storr, A. (2014). Study flow diagrams in Cochrane systematic review updates: An adapted PRISMA flow diagram. *Systematic reviews*, *3*(1), 54. https://doi.org/10.1186/2046-4053-3-54.

Taber, D. R., Chriqui, J. F., Powell, L., & Chaloupka, F. J. (2013). Association between state laws governing school meal nutrition content and student weight status: Implications for new USDA school meal standards. *JAMA Pediatrics*, *167*(6), 513-519. https://doi.org/10.1001/jamapediatrics.2013.399.

Yıldırım, M., Arundell, L., Cerin, E., Carson, V., Brown, H., Crawford, D., Hesketh, K. D., Ridgers, N. D., Te Velde, S. J., Chinapaw, M. J., & Salmon, J. (2014). What helps children to move more at school recess and lunchtime? Mid-intervention results from Transform-Us! A cluster-randomized controlled trial. *British Journal of Sports Medicine*, *48*(3), 271–277. https://doi.org/10.1136/bjsports-2013-092466.

Zask, A., Adams, J. K., Brooks, L. O., & Hughes, D. F. (2012). Tooty Fruity Vegie: An obesity prevention intervention evaluation in Australian preschools. *Health Promotion Journal of Australia*, *23*(1), 10–15. https://doi.org/10.1071/he12010.

Table (2): the reviewed studies matrix.

No.	Author/years	Aim	Method	Intervention used	Sample /sitting	Tool	Findings
1	Greening et al. (2011) USA	To evaluate a healthy lifestyle school-based obesity intervention in a rural southern community.	An experimental (study/control group design) (Study schools and control schools).	Monthly physical activity and nutritional events during a 9-month academic year.	Participants included 450 children ranging from 6 to 10 years of age in schools in a rural southern community in Mississippi.	The children's nutritional knowledge (Know Your Body Questionnaire), number of different physical activities (21-item checklist of age-appropriate physical activities), fitness level (three fitness tests from the President's Challenge Physical Activity and Fitness Awards Program), dietary habits (The children's primary caregivers completed the 17-item Child Dietary Fat Questionnaire about the child's dietary habits), waist circumference, BMI percentile, and percentage body fat were measured pre-and postintervention.	The intervention schools showed statistically significant improvement in percentage body fat, physical activity, performance on fitness tests, and dietary habits compared to the control schools.
2	Hollar et al. (2010a) USA	To reduce childhood obesity rates and improve health status and academic achievement using multi-level strategies to change knowledge about and associated behaviors regarding good nutrition and healthy living.	A quasi-experimental controlled pilot study (study/control design)	Elementary school-based obesity prevention intervention included modified dietary offerings, nutrition/lifestyle educational curricula, physical activity components, and wellness projects over two years (2004-6).	Four intervention schools in Florida, one control school, and a total of 3,769 schoolchildren.	Demographic, anthropometric (body mass index [BMI]), blood pressure, and academic data.	Statistically significant improvements in BMI, blood pressure, and academic scores among low-income Hispanic and White children were seen in the intervention versus controls.
3	Gittelsohn et al. (2014) USA	To design a multi-level intervention for obesity prevention for low-income African American children.	A group randomized study design.	The BHCK intervention involves policies, wholesalers, recreation centers, corner stores/carry-outs, and families/ parents.	Seventy-five children from 10-14 years old are screened. Among those recruited and screened, 24 dyads (comprised of a child and adult pair) were randomly selected in each neighborhood. Thirty low-income geographic zones surrounding re-creation centers have been selected as intervention or comparison areas.	- In-depth interviews (Food Frequency Questionnaire (FFQ) and focus groups with youth and their adult caregivers, ground-truthing of food sources, and environmental scans of food availability. - Child Impact Questionnaire (CIQ)	There was a useful intervention model that could be used to reduce obesity among children. However, stakeholders and policymakers must be included to do the necessary measures.

No.	Author/years	Aim	Method	Intervention used	Sample /sitting	Tool	Findings
4	Hollar et al. (2010b) USA	Assessed the effects of a school-based obesity prevention intervention that included dietary, curricula, and physical activity components on body mass index (BMI) percentiles and academic performance among low-income elementary school children.	A quasi-experimental design.	The intervention included dietary, curricula, and physical activity components on body mass index (BMI) percentiles and academic performance among low-income elementary school children over two years.	Four intervention schools and one control school; 4588 schoolchildren.	- Anthropometric data. - The Florida Comprehensive Achievement Test (FCAT).	- Significantly more intervention than control children stayed within normal BMI percentile ranges in both years (P=0.02). - Overall, intervention schoolchildren had significantly higher math scores in both years (P <0.001). - Although not significantly, intervention schoolchildren had higher reading scores in both years.
5	Lloyd et al. (2018) UK	To establish whether a school-based intervention for children aged 9–10 years would prevent excessive weight gain after 24 months.	A pragmatic cluster randomized controlled trial.	Healthy Lifestyles Program HeLP includes creating a receptive environment, drama activities, goal setting, and reinforcement activities.	Thirty-two schools in the southwest of England. One thousand three hundred twenty-four children with an age range from 9-10. Intervention group (628 children), and the control group (616 children).	- BMI - Percentage of body fat. - Physical activity is measured using accelerometry. - Food Intake Questionnaire (FIQ).	- BMI mean was 0.32±1.16 at baseline and 0.35±1.25 at 24 months in the intervention group, and 0.18±1.14 at baseline and 0.22±1.22 at 24 months in the control group. - The mean difference in BMI (SD) score (intervention–control) at 24 months was –0·02 (95% CI –0·09 to 0·05), p=0·57.
6	Zask et al. (2012) Australia	To decrease overweight and obesity prevalence among children by improving fundamental movement skills (FMS), increasing fruit and vegetable intake, and decreasing unhealthy food consumption.	Cluster randomized controlled trial.	The Tooty Fruity Vegie in preschools program included nutrition and physical activity strategies.	The intervention was implemented in 18 preschools for ten months between 2006 and 2007 on 560 children aged from 3-6 years old.	- FMS testing, lunch box audits, and anthropometric measures of children and parents' surveys regarding children's food intake, physical activity, and sedentary behaviors.	In comparison to controls, children in intervention preschools significantly improved movement skills (14.79 units, p<0.001), had more fruit and vegetable serves (0.63 serves, p=0.001), and were less likely to have unhealthy food items (p<0.001) in their lunch boxes following the intervention. There was also a significant difference in waist circumference growth (-0.80 cm, p=0.002) and a reduction in BMI (-0.15, p=0.022).
7	De Bock et al. (2011) Germany	To assess the short-term impact of a nutritional intervention to reduce childhood overweight in German preschool children.	Cluster-randomized study design	Six-month intervention administered once weekly by a nutrition expert consisting of joint meal preparation and activities for children and parents, such as tasting and preparing nutritious, fresh foods.	Three hundred forty-eight healthy children aged 3–6 years were recruited from Eighteen preschools in three south German regions.	- Parent-completed questionnaire assessed fruit and vegetable intakes. - Water and sugared drinks consumption. - BMI, skinfold thickness, and waist-to-height ratio.	Children's fruit and vegetable intakes increased significantly (P=0.001 and P=0.05, respectively); no significant changes in the consumption of water, sugared drinks, or anthropometric measurements were noted.

No.	Author/years	Aim	Method	Intervention used	Sample /sitting	Tool	Findings
8	Evans et al. (2020) UK	To analyze the provision of foods and nutrients in packed lunches in 2016 to highlight differences in diet and nutrient quality since 2006.	Cross-sectional surveys.	Compare between 2006 survey and 2016 survey results.	Data were collected from 1148 children who attended 76 schools across England in 2006 and 323 children attending 18 schools across England in 2016. They were aged 8–9 years (in year 4) for both surveys.	- Standard questionnaire detailing the foods within the lunch boxes. - Food portions were weighed before and after lunch to determine how much each child ate and its nutritional content.	Some food types were frequently provided, and the portion size changed substantially between surveys. The frequency of provision of confectionery in lunches was reduced by 9.9%, sweetened drinks were reduced by 14.4%, and cakes and biscuits not containing chocolate increased by 9.6%. - A vegetable provision in lunches remained low. - Substantial changes were seen in the percentage of lunches meeting some nutrient standards: Non-milk extrinsic sugars (19%, 95% CI 10 to 29%), vitamin A (−8%, 95% CI −12 to −4%), vitamin C (−35%, 95% CI −42 to −28%), and Zinc (−8%, 95% CI −14 to −1%).
9	Evans et al. (2010) UK	To improve the content of children's packed lunches.	A cluster randomized controlled trial in 89 primary schools across the UK.	A "SMART" lunch box intervention program comprised food boxes, bags, and supporting materials.	Involving 1291 children aged 8–9 years at baseline.	- NA - Lunch box content analysis.	- There was a statistically significant moderate-higher weight of fruit, vegetables, dairy, and starchy food, and a lower weight of savory snacks was provided to children in the intervention group. Children in the intervention group had slightly higher vitamin A and folate levels. - 11% more children were provided with vegetables/salad in their packed lunch, and 13% fewer children were provided with savory snacks (crisps). - Children in the intervention group were likelier to receive packed lunches meeting the government school meal standards.
10	Myers et al. (2014) USA	To design and implement a Multi-Component School-Based Obesity Prevention Program.	A cluster-randomized control design.	Energy Balance for Kids with Play (EB4K with Play) is a multi-component school-based intervention designed to address youth's nutrition and physical activity behaviors?	Six elementary schools (K–6) were recruited for the study. 1140 third- to fifth-grade students (751 in the intervention group and 389 in the control group) enrolled from a low-income, urban school district in Northern California. Six schools were recruited to participate.	- Demographic data. - Nutrition knowledge questionnaire. - Students self-reported dietary intake. - Students self-reported 1-mile run test. - Anthropometric data. - Fruit and vegetable attitude questionnaire.	- A significant difference between the intervention and control group in Mean (SD) of observed vegetable intake at lunchtime, based on digital images of lunch trays, mean (SD) no. of times reported drinking milk per day, percentage of students reported watching >2 hours of programs or movies per day. - No statistically significant differences were shown between the two groups regarding the anthropometric data, fitness, and other dietary data.