

Effects of school-based interventions on children's healthful nutritional outcomes (2009-2013): implications for future research

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Introduction

1. Vegetable consumption in children counteracts childhood illnesses, like respiratory difficulties and childhood overweight. However, vegetable consumption in young children does not meet the national recommendations worldwide.
2. Discovery of strategies that improve children's vegetable consumption is essential.
3. What children eat is especially based on their liking for food tastes. Most children show a natural rejection in response to bitterness. Indeed, the main reason, why children don't consume enough amounts of vegetables has been attributed to the bitter taste of vegetables.
4. Early experiences with edibles, including vegetables, induce establishment of stable and long-lasting food preferences and nutritional habits. Promoting an increase of vegetable intake via effective strategies in young children is essential, therefore, for inducing an everlasting healthy child eating behavior.
5. Many children receive at least one meal at school. This is a world wide phenomenon. Therefore, the school is an environment that provides many children with edibles and thus it may shape childhood food preferences and eating habits.

Results

A total of seventeen studies that met the inclusion criteria were included. A systematic analysis and descriptive review of these studies, rather than a meta-analysis, was conducted because of the marked heterogeneity in the types of school-based interventions carried out. Furthermore, the studies used a wide range of methods and outcomes to assess effects on children's nutritional outcomes.

Main objective of the present review

To answer three questions: 1. Which school-based interventions during the compulsory education period may be effective in increasing healthful nutritional outcomes in children? 2. What limitations are found in these studies? 3. How can these limitations be overcome in future research efforts to develop viable strategies for promoting healthy nutritional outcomes in children? In an attempt to answer these questions, pertinent research on school based interventions published from 2009 – 2013 is reviewed.

Methods

1. Criteria for considering studies. Studies were included if they dealt with the following particular healthy nutritional outcomes:

- Fruits and vegetables (FV) -related nutritional knowledge. - Psychosocial variables associated with eating FV. - Preferences for FV. - FV selection. - FV consumption. - Liking for FV. - Attitudes toward FV. - Beliefs toward FV. - Availability of FV at home. - Parent/teacher influence on children's FV attitudes. - Children's ability to identify FV. - Children's willingness to try FV.

2. Search strategy: The search strategy involved Pubmed and Scencedirect as the databases to identify published studies. Only studies that met all of the following criteria were included: *population* (six-eleven year-old and thus school-aged children); *interventions* (school-based interventions, school-based nutrition programs, or school-based nutritional interventions); *school food environment* (school lunches, school meals, canteen, cafeteria, or food services); *targeted edibles* (FV); *nutritional outcomes*.

Discussion and implications for future research

Based on the review of the included studies, the answers to the three questions formulated in the introductory section are presented below, along with several implications for future research.

1. School-based interventions executed during the compulsory education period that may be effective in increasing healthful nutritional outcomes in children

School-based interventions focused, at least partially, on providing children with nutritional education programs are effective in increasing healthful nutritional outcomes, such as choosing and eating a variety of vegetables (i.e. carrots, broccoli, cabbage and zucchini), as well as their preference for these items. Their nutritional knowledge also improves if they are exposed to this combination of strategies, but to the same extent as when children only receive nutritional education. Furthermore, this type of intervention does not impact children's selection, consumption or preferences for fruits, when only one fruit (i.e. blueberry) is offered. Therefore, these authors recommend that future research should examine the same intervention, but using a variety of fruits. Providing children with nutritional knowledge, such as the physiology of digestion and the need for consuming healthy foods, using a language adapted to their age, together with modification of the social environment by, for instance, encouraging children to participate in school assemblies where the message to consume FV is delivered, also result in an increase in healthy nutritional knowledge. Other effective school-based interventions are those focused on repeated exposure to FV as the only strategy applied. Repeated exposure increases liking for vegetables and FV in children who did not like the targeted items before this repeated taste-related experience. This result was constant across time (four and ten months later) and subject to gender and grade variables. In the case of fruits, fewer exposures –two- are required for observing an increase in liking for these items, in comparison to the number of exposures required to increase liking for vegetables –three-. The authors attribute this effect to children's innate liking and rejection for the sweet and bitter tastes of fruits and vegetables, respectively. In contrast, repeated exposure does not change liking for vegetables and FV in children who already liked vegetables before the repeated tastings. Therefore, it is suggested that future research should examine whether adding to the targeted vegetables some sweetener or even a sweet fruit, that is, using the so-called evaluative conditioning experimental paradigm. In addition to the strategies that have been discussed so far in this section, there are four more that deserve readers' attention. 1. Manipulation of the food environment at schools. For example, offering sliced fruits in the cafeteria has been shown to encourage children's fruit selection and consumption of oranges, especially among younger children, but does not impact consumption of apples. 2. Others' influence. Provision of a FV snack stand in classrooms by peers increased children's fruits consumption. Furthermore, peer modeling has been observed to increase children's FV intake. 3. Influence of chefs. School programs in which chefs teach children to prepare and taste healthy food has been demonstrated to increase children's V intake as well as their skills and confidence to prepare and ask for the ingredients to be purchased for use at home. 4. promotion of FV consumption by means of loudspeaker announcements, instructional material (DVD), contingent rewards, and take-home activity books has been found to increase children's FV consumption, although this effect declines across time (three months later)⁴³. This kind of intervention has also demonstrated increases in children's FV knowledge, but does not change their preferences for FV, however⁴³. These authors attribute this result to the fact that they did not make the FV more palatable. Therefore, the effectiveness of increased palatability of the FV served in enhancing children's preferences for those food items should be tested in the future. As can be seen, the effectiveness of a school-based intervention in increasing healthful nutritional outcomes in child population relies on the specific strategy or strategies used. Across the included studies, fourteen strategies have been used.

2. Limitations of these studies and ways to overcome them in future research

a. Limitations derived from the experimental designs used. Future research should therefore examine the effectiveness of these interventions in the long-term by adding at least one follow-up assessment at any post-intervention month or even year, as well as control groups and randomized experimental designs. b. Limitations derived from the experimental procedures used. Future studies should combine both home and school food environments as well as provide children with enough opportunities to learn to like the flavor of FV. Assessment of children's motivation (liking or preference) for the targeted stimuli and attentional focus during and after their intervention is also desirable. c. Limitations affecting participant samples. The effectiveness of interventions should be examined in different ethnic and socioeconomic groups in the future. Larger participant sample sizes are also desirable. Finally, previous experience of some schools with these interventions may have resulted in advantages over other schools in implementing the intervention. Hence, this variable should be controlled in future school-based interventions. d. Limitations concerning data collection. They should be avoided in the future.

Concluding remarks

The present review aimed to identify school-based interventions executed during the compulsory education period that may be effective in increasing healthful nutritional outcomes in children, along with their associated limitations and implications for future research. Seventeen different school-based interventions that are effective in increasing children's nutritional outcomes during this period were identified. Taken as a whole, these school-based interventions vary according to the specific strategy used to promote healthy nutritional outcomes in children and evidence four types of limitations. Finally, the principal contribution of this review is to enhance awareness within the scientific community of the need to conduct further research on strategies that promote children's healthy nutritional outcomes. **Acknowledgements.** This work was developed through the efforts from Dr. Richard H Porter in making interesting suggestions and refining the English language of the text.