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Methods to encourage healthy eating in children: Review of current findings

Authors' Contribution:

A – Study Design
B – Data Collection
C – Statistical Analysis
D – Data Interpretation
E – Manuscript Preparation
F – Literature Search
G – Funds Collection

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Key words: children, adolescents, eating behavior, methods, health promotion, schools, dietary habits.

Abstract

Background: *Healthy eating, especially fruit and vegetable consumption, is a major contributor to the prevention of chronic non-communicable diseases. The multiple benefits of healthy food and nutrition in childhood and adolescence reinforce the need for studies encouraging young people to healthy nutrition. The present review increases understanding of what methods (interventions) should be performed to encourage healthy eating in children and adolescents.*

Material/Methods: *A scientific literature review of Medline (Pubmed) database was performed, a total of 615 publications were found. Of these, only 15 papers were selected for the analysis.*

Results: *The multi-component interventions (encouraging of fruit and vegetable consumption was usually combined with physical activity promotion and overweight/obesity control, n=8) could be considered as effective in encouraging healthy nutrition. Findings showed that programs and empowering policies at schools based on scientific evidence can increase consumption of fruit and vegetables among children and adolescents and promote healthier lifestyle as significant changes in healthy eating after intervention were identified in two thirds of projects. Barriers and limitations such as possible difficulties of implementation, duration and density of intervention, however, must be considered and prevented prior to interventions when it is possible because multi-component strategies may not lead to positive eating behaviour changes as intended. Moreover, single strategies such as fruit and vegetable campaigns also appeared to have positive effects on healthy foods consumption by children.*

Conclusions: *The multi-component interventions (combinations of methods to encourage fruit and vegetable consumption, physical activity and overweight or obesity control) can be considered as effective in healthy eating promotion of children and adolescents. However, barriers and limitations (difficulties in implementation, duration and density of an intervention) should be prevented prior the interventions.*

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Introduction

The importance of developing healthy food habits during childhood and adolescence is obvious for several reasons [1, 2]. Proper nutrition promotes the optimal growth and development of children [3]. Healthful eating (HE) during childhood and adolescence reduces the risk of immediate nutrition-related health problems such as obesity [4, 5], dental caries [6, 7, 8], iron deficiency, and osteoporosis [9, 10]. In addition, young people who developed healthy eating habits early in life are more likely to maintain them and thus be at reduced risk of chronic diseases such as cardiovascular diseases, cancer, type II diabetes and osteoporosis in adulthood [5, 11, 12]. There is enough evidence that HE improves children's learning ability, leading to better academic performance [13, 14]. Good nutrition also fosters mental, social and physical well-being, contributing to increased self-esteem and positive body image [15, 16, 17]. In contrast, a strong desire to be thin and dieting has been identified as a powerful predictor of a new eating disorders and can lead to anorexia nervosa or bulimia nervosa [18].

However, despite the evidence, the recognition of the benefits of HE has been largely lost as a result of globalization and the development of international food markets. The nutritional status of diets across the world has suffered as a result of trade actions that have increased reliance on food imports and cheap food of poor nutritional quality [19].

The fundamental issues behind public health concerns for young people are the significant changes in their food habits as a result of the globalization of food and social factor influence [20]. Over the past few decades significant changes have taken place in eating habits and home environments. Western youngsters live in the obesogenic environment [21] and are particularly at risk because of their erratic eating behaviour, including snacking on energy dense products, such as sweets, sugar-sweetened beverages, and fast food, low fruit and vegetable (FV) consumption, skipping breakfast [22, 23, 24]. Many children and adolescents grow up without learning the basic skills of how to promote for a healthy diet [25]. Moreover, eating habits, food choice and meal patterns of young people reflect the weakening influence of the family and increasing peer pressure [25]. These causes have numerous negative impacts on children's health and wellness [26]. For that reasons children and adolescents' nutrition related health problems are considered as public health priority and should be solved as early as possible at this age [27]. So, now the crucial question is how to encourage children to eat healthier.

Scientists say that interventions can change eating habits, especially in children and adolescents [28]. Children and adolescents are more sensitive to outside influences, so their eating behaviour is affected by a variety of factors: food choice, personality, family modelling, school environment, influence of friends, socio-demographic and cultural impacts, price, marketing and promotion techniques, availability, accessibility, and etc. [4, 21, 23, 29, 30, 31]. For that reason, interventions at this age are considered to have larger effects than in older people [31] and must be public health priority in achieving better nutrition related health in young people [32, 34]. Now, the main question is how to develop and implement effective methods that will improve nutrition and lifestyle of children and adolescents.

Literature suggests that multi-component interventions (involvement of schools, parents, child care centres, community, government, policies, etc.) of a long duration and intensity are more effective than single-component strategies [34, 35, 36]. In multi-component strategies, involvement of schools (school policies and strategies, classroom curriculum, FV availability, etc.) and parents (parental intake, promotion of home availability and accessibility) considered to be the main components affecting young people's eating behaviour: schools seems to be an ideal setting for disseminating interventions to promote life-long HE and physical activity (PA) [4, 31, 35, 38, 39, 40], parents are identified to be a model of eating practice and habits [30, 39]. Both factors affect food preferences in children and adolescents.

Some studies show that a single strategy (but not educational [42]) can also be effective especially in increasing adolescents' FV intake [34, 38]. There is now strong evidence that interventions promoting FV consumption (regular and adequate FV consumption is identified as a determinant of HE [43]) can prevent a number of chronic non-communicable including

cardiovascular disease and some cancers [22, 44] and could be the key strategy in children health promotion [32].

Unfortunately, interventions are not always implemented as intended; effectiveness of interventions is often low or unclear [35, 45] and the knowledge about the long term effect is also lacking [46, 47, 48]. Still remains unclear what methods should be used and how they need be implemented in achieving more healthy eating in children and adolescents.

Given that a complex relationship exists between methods (interventions) and HE in children and adolescents, this research was undertaken to review the methods used to encourage healthy eating in this population. The aim of the present paper was to systematically synthesize worldwide evidence from published literature on methods (interventions) used to encourage healthy eating in children and adolescents and their effectiveness.

Material and methods

Data sources. Medline (Pubmed) database was searched electronically. Bibliographic database was chosen purposefully as being one of the most sensitive, precise databases which identifies more than 62% of all citations and used worldwide [49, 50].

Study selection. A search was performed of the following key words: “encouraging of eating, promotion of eating” to find publications that assessed encouraging of children’s eating; “methods, intervention” was used to search for methods used in eating promotion; “children, childhood, adolescents, adolescence” – to identify the age group. Search was supplemented by manual cross checking of relevant publications references. Duplicates were removed. Assessment of titles and abstracts of the identified studies were performed. The following were adopted as criteria of inclusion: date of publication from 2008 to December 2012; only free full text articles published in English (as accessible for most health system specialists, school administrators and others who are responsible for children and adolescents’ nutrition promotion process [31, 39, 51]); intervention/methods used to encourage nutrition of children (6-12 years old) and adolescents (13-18 years old); no specific requirements for the study type; changes of nutrition at follow-ups were analysed. Articles were excluded when the titles were read, based on inclusion and exclusion criteria. Abstracts were screened by one reviewer and rejected if it was clear that the article did not meet inclusion criteria. For the publications that met the inclusion criteria, the full articles were analysed and evaluated by both authors.

Data extraction. Key articles were retrieved via online database and manual searching of reference lists were used for the further searches. Key words were used to narrow the results from reference lists. Critical appraisal and quality of studies in review was performed using a standardized tool [52]. Questions used to perform this analysis included: “Was the research question clearly stated? Were study groups comparable? Were interventions described in detail? Were the intervening factors described? Were outcomes clearly defined? Were conclusions supported by results with bias and limitations taken into consideration? Is bias due to study’s funding/sponsorship/associations unlikely?” [52]. The quality of studies was assessed by two authors and stated as “positive” as most of the answers were designated with “+” symbol.

Finally, the effectiveness of the intervention was evaluated. The primary criterion to evaluate the effect of intervention was based on a positive significant change in healthy eating (e.g. an increase in the proportion of children who eat fruit and vegetable on a daily basis). In addition, changes in knowledge and attitudes to healthy eating were taken in consideration as secondary parameters. Changes in PA and overweight/obesity were taken in regard, too.

Results

A total of 615 publications were found. Of these, 591 articles were excluded when the titles were read, based on inclusion and exclusion criteria. 24 abstracts and texts were read and only 15 papers (Figure 1) were selected for the analysis (8 of these were excluded due to lack of analysis or results; 1 of them – due to not meeting inclusion criteria fully). The general study characteristics are summarized in Table 1.

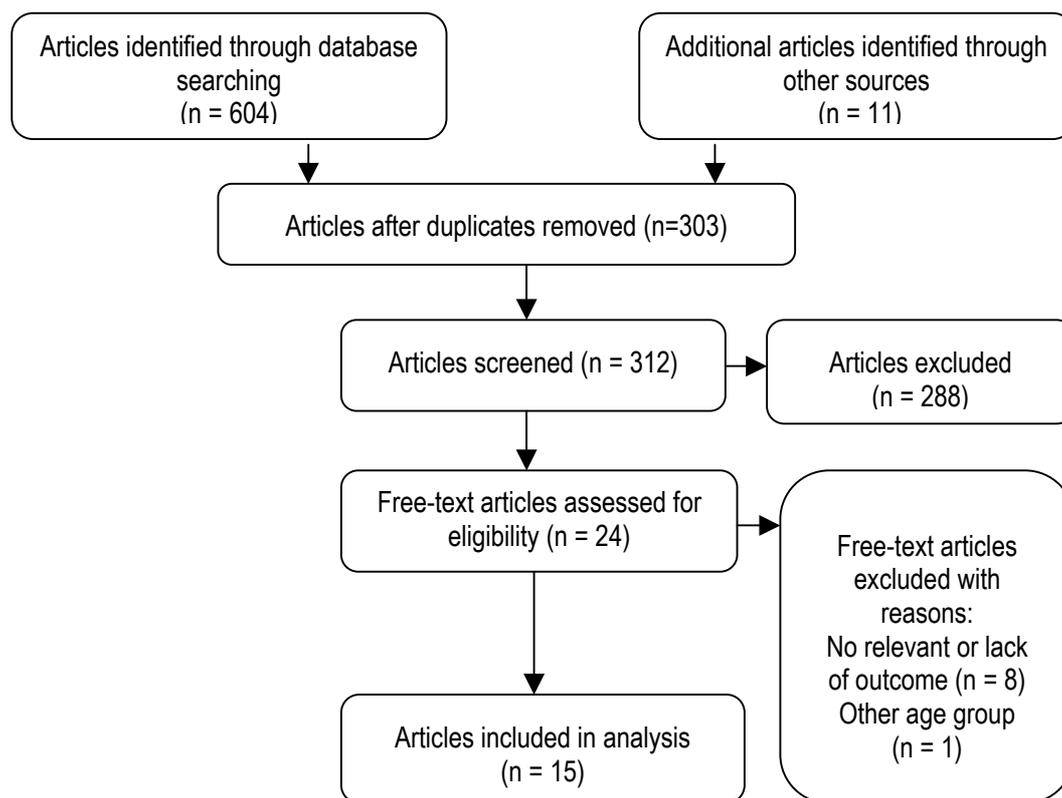


Fig. 1. Diagram of articles included in the review

Tab. 1. General characteristics of publications

No.	Author	Year	Location	Participants	Age/ grade
1.	Rosario et al. [32]	2012	Portugal	464 (233 – intervention; 231 – control)	6-12
2.	Fotu et al. [53]	2011	Tonga	2868 (7 – intervention ; 6 – control schools)	11-19
3.	Fung et al. [11]	2012	Canada	500 (350 – APPLE intervention and 150 – Alberta control schools)	5 grade
4.	Jamelske et al. [34]	2008	USA	1127 (784 - 10 intervention schools and 343 – 10 control schools)	4, 7 and 9 grades
5.	Tomlin et al. [54]	2012	Br. Columbia	148 (intervention group)	12.5 ± 2.2 y
6.	Rogers et al. [37]	2009	USA	3570 (7 primary and 2 middle schools)	N/A
7.	Lakshman et al. [44]	2010	UK	2519 (12 intervention and 13 control sch.)	9-11
8.	Mozaffarian et al. [55]	2010	USA	445 (intervention group)	5-14
9.	Neumark-Sztainer et al. [15]	2010	USA	356 girls (6 intervention and 6 control sch.)	15.8 ± 1.2 y
10.	Toral et al. [42]	2012	Brasil	860 (487 - intervention and 373 - control group)	11-19
11.	Iversen et al. [48]	2011	USA	119 (intervention group of overweight and obese children)	4-6 grade
12.	Duncan et al. [33]	2011	New Zealand	97 children (57 - intervention, 40 – control)	9-11
13.	Coleman et al. [38]	2012	USA	1273 (827 from 2-3 grade and 446 from 6 grade; 4 intervention and 4 control schools; low-income schools)	2, 3 and 6 grade
14.	Fahlman et al. [31]	2008	USA	576 (407 – intervention, 169 –control)	11-12
15.	Foster et al. [39]	2008	USA	921 (510-intervention, 411- control)	11-12

Publication dates of articles – from 2008 to December 2012. Most of surveys were performed in the USA (n = 8). The number of participants varied from 97 (New Zealand) to 3570 (USA). The children’s age – from 6 to 18 (the age of participants wasn’t defined in Rogers et al. intervention [37], but the article was approved because the intervention was performed in primary and middle schools). Exclusively girls in Neumark-Sztainer et al. project [15] and ‘at risk’ (overweight and obese) children participated - in Iversen et al. Fun 5 program [48] and ≥ 50% of children eligible for federally subsidized, free or reduced-price meals – in Foster et al. initiative [39] participated in these interventions.

The main methods (interventions) encouraging healthy eating in children and adolescents as well as the main findings of surveys are presented in Table 2.

Tab. 2. Summary of main methods used to encourage healthy eating in children and adolescents

Author	Aims	Interventions	Follow-ups	Data collection	Main findings
Rosario et al. [32]	Nutrition educational program delivered by teachers to prevent overweight and obesity in children	Involvement of children and teachers. 12 sessions of healthy nutrition and lifestyle for teachers; classroom activities for intervention children after each session	6 months	24-h dietary recall; anthropometry; PA questionnaire	BMI z-score in the intervention group was significantly lower [0.176 units, p = .009], lower proportion of children became overweight than in the control group (5.6% vs. 18.4%; p = .037). Energy intake increased from 2091 to 2388 kcal/day. Sedentary physical activity reduced from 14 % to 5.9 %; low activity reduced from 50 % to 47.1%. Conclusion: Teachers may play a role in successful implementation of healthier lifestyles
Fotu et al. [53]	Ma'alahi Youth Project [MYP] to promote HE, regular PA and reduce overweight and obesity in adolescents	Involvement of adolescents, parents, schools, community. Social marketing [media reports and promotion, developed and sourced materials etc.]; HE and PA activities [policies, activities, programs, infrastructure]	36 months	Dietary and physical behaviour, school food audit questionnaire, interviews, anthropometry, body fatness and quality of life measurements, community readiness assessment	Multiple positive outcomes including increases in the availability and consumption of vegetables, employment and household income reported. The intervention reach, frequency and dose showed no consistent patterns. The dose and the frequency of activities were insufficient and not sustained. Conclusion: The project resulted in increased community awareness of healthy behaviours.
Fung et al. [11]	Alberta Project Promoting active Living and healthy (APPPLE) Schools to improve HE and PA and prevent obesity in children	Involvement of children, school staff, teachers, parents. Professional development days for teachers and school staff, parent information nights, cooking clubs, after school PA programs, weekend events and celebrations, newsletters, walk to school days etc.	24 months	Harvard Youth/Adolescent FFQ, Diet Quality Index (DQI), PAQ-C; anthropometry	Effect over time: FV s consumption increased by 0.55 (-0.02, 1.13), dietary energy intake (kcal) per day decreased by 212.1(-315.07,-109.16). DQI increased by 1.14 (-0.55, 2.83). PAQ-C score increased by 0.10 (0.01, 0.20). Decline in obesity OR by 16 % (adjusted 0.84; 95 %CI, 0.52, 136). Conclusion: Positive results in the improvement of dietary habits and physical activity were identified

Author	Aims	Interventions	Follow- ups	Data collection	Main findings
Lakshman et al. [44]	Novel education intervention: "Top Grub card game to increase nutrition knowledge among primary school children	Involvement of children, teachers. Summer term classroom activities to teach HE curriculum using "Top Grub" card game in intervention schools. HE curriculum: HE week, fruit testing day etc. for control schools	2.1 month (9 weeks)	Modified questionnaire ('healthy eating quiz') pre and post intervention	The total nutrition knowledge score at follow-up was higher in the intervention than in the control schools [mean difference = 1.1; 95% CI: 0.05 to 2.16; p = .042. Mean Healthy/Balanced diet domain score at follow-up was higher in the intervention than in the control schools (mean difference = 0.6; 95% CI: 0.1 to 1.1; p = .018). At follow-up, more children in the intervention schools said they "currently eat a healthy diet" [39.6%] or "would try to eat a healthy diet" (35.7%) than in control schools (34.4% and 31.7%, respectively). Conclusion: A modest increase in nutrition knowledge scores was found. A change in knowledge alone is unlikely to result in behaviour change
Rogers et al. [37]	5-2-1-0 goes to school: a pilot project to promote HE habits and PA by delivering the message	Involvement of children, schools, parents, community. 5-2-1-0 message in classrooms and schools: encouraging ≥ 5 servings of FV daily, limiting screen time to \leq or 2 hours per day, promoting ≥ 1 hour of PA daily, avoiding sugar-sweetened beverages; FV provision at schools; handouts for parents, community	2 academic years	Questionnaires for school administrators, parents; focus group discussions with students about awareness and attitude and health promotion	All administrators reported the project being worthwhile. 73% of the teachers reported changes in students; 56.6% of the teachers did not use the 5-2-1-0 resource kit. 91.2% of parents reported handouts being useful; 33.1% made changes because of the message. Students found this project as "a big change," "a good way to get kids healthy," etc. Conclusion: School-wellness programs may be an effective way to deliver health-promotion messages to children, school staff and parents
Tomlin et al. [54]	Action Schools! BC – school physical activity and healthy eating intervention to change health outcomes (obesity related body composition, PA levels, aerobic fitness, CV risk, HE)	Involvement of children, schools, families, community. Classroom-based HE education at least once a month; FV campaign; PA activities and after-school strategies, regular PA education classes	7 months	24- hour dietary recall, anthropometry; 20 m shuttle run [aerobic fitness]; PA questionnaire, accelerometer	The variety of consumed vegetables increased from 1.10 \pm 1.18 to 1.45 \pm 1.24; aerobic fitness increased by 22 % (25.4 \pm 15.8 to 30.9 \pm 20.0 laps); No BMI, PA, CV or other dietary [fruit consumption, caloric intake, sugar sweetened beverages] changed Conclusion: No change in SSB and only a small improvement in FV intake was identified
Jamelske et al. [34]	Fresh FV Program (FFTP) of US Department of Agriculture [USDA] to improve nutrition and reduce the prevalence of childhood overweight and obesity	Involvement of children and school: FV campaign: A free fresh FV snack provided daily to each child in intervention schools	3 months	Questionnaire about lifestyle: fast food consumption, PA, limits on video games/TV time, eating family dinners; willingness to try new FV at home and school, frequency of consumption and knowledge; 24 hour dietary recall	Intervention students reported an increased willingness to try new fruits (24.8% versus 12.8%, p<.01) and vegetables (25.1% versus 18.4%, p<.01) at school, but not at home. Conclusion: Short-term positive effects in attitudes and behaviour among children were found

Author	Aims	Interventions	Follow- ups	Data collection	Main findings
Toral et al. [42]	Six-month stage-based intervention to improve FV intake in adolescents	Educational printed materials: intervention group received monthly magazines and newsletters aimed at promotion of healthy eating	6 months	Questionnaire to assess FV consumption; anthropometry pre and post intervention	Intervention did not produce any significant changes to fruit and vegetable intake ($p = 626$) or to the stages of change ($p = 905$). Conclusion: Nutritional intervention exclusively based on printed educational materials was not enough to change the dietary habits of adolescents
Neumark-Sztainer et al. [15]	New Moves, a school-based program to prevent weight-related problems in adolescent girls	Involvements of girls schools, parents. 1 st semester Nutrition: Be Fueled [promotion of FV consumption, choosing healthy snacks etc.]. PA promotion: Be Fit. Social support: Be Fab. (girl pages, workbook, chapters regarding nutrition). Parent outreach by cards. 2 nd semester	3 school years (2007-2008-2009)	24-hour dietary recall; 3-Day PA recall; dual-energy x-ray absorptiometry for calculation of body fat; anthropometry	Sedentary behaviours by approximately one 30-minute block a day ($p=0.050$) decreased in intervention girls; portion control behaviours increased ($p=0.14$); the percentage of girls using unhealthy weight control behaviours decreased by 13.7% ($p=0.021$). FV consumption increased ($p=0.002$), regular breakfast eating improved ($p=0.028$) as compared to control girls. Improvements were seen in body image ($p=0.045$) and self-esteem ($p=0.031$). Conclusion: Program did not lead to significant changes in the girls' percentage of body fat or BMI, but improvements in sedentary activity, eating patterns, unhealthy weight control behaviours, and body/self-image were identified
Mozaffarian et al. [55]	YMCA after school program to improve snack and beverage quality in children and promote HE, PA	HE campaign. Component of YMCA program - YLC: 1) Offering fresh FV options daily; 2) Not serving foods with trans fats; 3) Offering water as the primary beverage; 4) Not serving SSB; 5) Serving more whole grains instead of processed grains; Advising to offer 100% juice and low-fat or skimmed milk 2 or 3 times per week	3 school years (2005-2006-2007)	Spreadsheets to record snack and beverage menus for each day	Increase in servings of fresh FV (from 1.3 to 3.9 servings per week; $p = .02$), and servings of snacks containing trans fat decreased significantly (from 2.6 to 0.7 servings per week; $p= .01$). The total number of FV increased substantially (from 1.9 to 5.2 servings per week; $p=.009$); significant individual increases in both servings of fruit (from 1.2 to 3.2 servings per week; $p = 0.02$) and vegetables (0.7 to 1.9 servings per week; $p = .048$). Low nutrient density foods declined for desserts (from 1.3 to 0.5 servings per week; $p = 0.049$) and foods with added sugars (from 3.9 to 2.4 servings per week; $p = .03$). Conclusion: Participation in learning collaboration may lead to overall improvements in snack and beverage quality in after-school food environments.

Author	Aims	Interventions	Follow- ups	Data collection	Main findings
Coleman et al. [38]	The Healthy Options for Nutrition Environments in Schools [Healthy ONES] study to change nutrition policy and environments in low income schools	Involvement of children, school staff, teachers, HE campaign. Classroom activities Before/After School, school meals changes. Recess: 1) Eliminate unhealthy foods and beverages on campus; 2) Develop nutrition services; 3) School staff modelling for HE.	2008-2010 school years	Anthropometry, monthly behavioural observation of the nutrition environment	School outside food and beverage items per child per week decreased in intervention schools and control school increased over time. Healthy food items increased during lunch in intervention schools only. Changes in rates of obesity for intervention school (28% baseline, 27% year 1, 30% year 2) were similar to those seen for control school (22% baseline, 22% year 1, 25% year 2) children. Conclusion: Healthy ONES model can be used successfully in a variety of school settings to change nutrition policies and environments
Duncan et al. [33]	Compulsory 'Healthy Homework' programme complemented by an in-class teaching resource to increase PA and HE in children	Involvement of children, teachers, families. In-class activities - practical group tasks. Homework tasks as family participation; messages to parents reinforcing the benefits of family support. Reviews of each child's homework tasks; feedback for children and parents (teachers).	1.5 month (August to December 2006)	4-day food and activity diary for screen time, sports participation, active transport to and from school, and the consumption of FV, unhealthy foods and drinks records. PA measurement by pedometers	Significant intervention effects observed for vegetable consumption (0.83 servings.day ⁻¹ , 95% CI: 0.24, 1.43, p = .007) and unhealthy food consumption (-0.56 servings.day ⁻¹ , 95% CI: -1.05, -0.07, p = .027) at weekends but not on weekdays. Significant intervention effect of 2,830 steps day ⁻¹ (95% CI: 560, 5,300, p = .013) was observed. Conclusion: Health program improved vegetable and unhealthy food consumption and increased PA by 25 % in boys and girls.
Iversen et al. [48]	Fun 5 program on FV intake, PA, and BMI for at risk children in Hawaii's A+ After -School program	Involvement of overweight and obese children, leaders. Nutrition intervention: art projects, interactive nutrition booklets, group leaders to encourage healthy role model, positive reinforcement techniques. PA intervention (SPARK AR component) throwing, catching, dancing, developing positive social skills	2004-2005 school years	FFQ; Godin & Shephard's Leisure-Time Exercise questionnaire; anthropometry	Significant increase in FV intake (p<.01) reporting an average FV intake of 2.97 (±1.16) servings per day at T1 and 5.60 (±3.93) servings per day at T2 was found in at risk children. PA increased (p<.01) in minutes per week reporting an average of 125.26 (±76.03) minutes per week at T1 and 222.18 (±180.90) minutes per week at T2. No significant changes in BMI identified. Conclusion: The Fun 5 program had an impact on improving FV intake and PA on the at risk population

Author	Aims	Interventions	Follow- ups	Data collection	Main findings
Fahlan et al. [31]	Michigan Model (MM) Nutrition Curriculum (a pilot study) to change nutritional knowledge, eating behaviours, efficacy expectations in middle schools	Involvement of children and teachers. Training for teachers. 1-month course of lessons (content and benefits of the food groups, eating based on the food groups, food labels, body image, surviving fast food restaurants and school cafeteria) for children	1 month	Nutrition questionnaire of nutrition, knowledge and efficacy expectations	Improvements in consumption of fruits ($F=3.97$, $p=.047$), vegetable ($F=5.61$, $p=.018$) pre to post was higher in the intervention group than controls at post. Students in the intervention group ($F=72.82$, $p<.001$) demonstrated a significant improvement pre to post nutrition knowledge and were also significantly higher than in efficacy expectations detected in intervention group. Conclusion: MM Nutrition Curriculum delivered by trained professionals resulted in significant positive changes in both nutrition knowledge and behaviours in middle school children
Foster et al. [39]	School Nutrition Policy Initiative [SNPI] to prevent overweight and obesity	Involvement of children, school teams (administrators, teachers, nurses, coaches, parents), 10 hours per year training in nutrition education for staff [curricula and supporting materials, nutrition and PA theme packets, cafeteria promotion, parents outreach], 50 hours of food and nutrition education per student per school year; nutrition policy changed to meet nutrition standards; social marketing; raffle tickets for children who met nutrition standards; family outreach: school association meetings, report card nights, education meetings, weekly nutrition workshops.	2 years	Youth/Adolescents questionnaire of dietary intake, PA and sedentary behaviour	Incidence of overweight reduction by 50% detected after intervention. Students in both intervention and control schools showed significant decreases in self-reported consumption of energy, fat, and fruits and vegetable over 2 years no differences between the 2 groups. Decrease in PA detected in both groups. No differences between the 2 groups. Conclusion: A multicomponent school-based intervention can be effective in preventing the development of overweight among children with a high proportion of children eligible for free and reduced-priced school meals.

All the surveys (n = 15) (follow-ups varied from 1.5 to 36 months; 8 of 15 projects lasted up to 1 year) reached to encourage HE in children and adolescents. In addition, 8 of them aimed to reduce overweight and obesity [11, 15, 32, 34, 39, 48, 53, 54], and 7 of the projects promote PA [11, 15, 37, 39, 48, 53, 54]. Interventions to encourage HE included: school staff and teachers involvements (sessions for administrators, workshops for teachers, educational and practical sessions in HE and lifestyle, empowering messages and reinforcement techniques, curriculum activities, games, HE modelling, feedback provided by teachers, etc.) [11, 15, 31, 32, 33, 34, 37,

38, 39, 44, 54, 55]; parents (materials: HE newsletters, cards, booklets; parents' information nights, weekend activities and celebrations, family support) [11, 15, 33, 37, 39, 53, 54] and community (churches, social marketing: media reports, radio songs, newspaper articles, interviews leaflets, printed breakfast menus) participation [37, 39, 53, 54]. In most of the surveys, classroom activities as educational and practical sessions, curriculum activities, games, empowering messages were held at schools [11, 15, 31, 32, 33, 37, 38, 39, 44, 53, 54]. HE campaign (provision of FV or their snacks daily, testing of healthy products, reduction of unhealthy foods) encouraging HE in young people was performed in 7 surveys [15, 34, 37, 39, 44, 54, 55]. Of them, only one survey [34] concentrated on fresh FV campaign at schools exclusively. All other investigators (n = 14) used educational component to encourage HE in children and adolescents; also menu changes implemented in Neumark's et al. [15], Coleman et al. [38] and Foster et al. [39] projects. After-school programs and interventions (offering fresh FV, not serving unhealthy foods, advises to encourage HE, work books, homework tasks, PA activities) were performed in 5 of 15 projects [11, 15, 48, 54, 55]. In addition, policies [38, 39, 53], computer tasks, girl pages [15], monthly magazines and newsletters [42], nutrition services [38] and social marketing [39] as main source for HE were implemented in several projects.

Significant changes in HE after intervention were identified in two thirds of the projects: Alberta Project [11], 'Action Schools!' [54], Novel education intervention 'Top Grub' [44], 'YMCA after school' program [55], 'New moves' – a school based program [15], 'Fun 5' program [48], 'Healthy homework' program [33], 'Healthy ONES study' [38], 'Michigan Model' (MM) - nutrition intervention Nutrition Curriculum [31] and School Nutrition Policy Initiative [39]. Jamelske et al. [34] in FFTP reported increased willingness to try new fruits and vegetables at school, but it was considered to be a short-term effect. Positive changes in children's health behaviour were identified by 73% of the teachers participating in '5-2-1-0 goes to school' project [37].

Significant positive PA changes in intervention groups reached in 6 of 15 projects: Nutrition educational program [32], Alberta project [11], 'Action Schools!' [54], 'New Moves' program [15], 'Fun 5' program [48], and 'Healthy Homework' program [33]. In School Nutrition Policy Initiative [39] after a 2-year intervention PA drop-off in the intervention and the control group was detected. Overweight or obesity reduction in children were identified in 4 of 15 projects [11, 32, 38, 39]. Two programs did not reach changes in HE, PA or obesity reduction in children after intervention [42, 53]. Six-month stage-based intervention was based on a single strategy (educational printed materials) implementation [42], whereas Ma'alahi Youth Project [53] was a multi-component intervention (policies, social marketing, sourced materials, HE and PA activities, infrastructure improvements) designed for adolescents, schools, parents and community.

In most of the studies changes in HE were measured by 24-hour dietary recall [15, 32, 34, 54], Food Frequency Questionnaire [11, 34, 39, 42, 48, 53], interviews [53], Diet Quality Index [11], spreadsheets to record snack and beverage menus [55], 4-day food and activity diary and records [33]. In all the projects BMI was evaluated using anthropometry. Changes in physical activity were identified by PA questionnaires in 6 studies [11, 32, 39, 48, 53, 54], 20 m shuttle run (aerobic fitness) was used in 'Action School!' [54] and pedometers – in 'Healthy Homework' [33] programs.

Discussion

This paper presents analysis of 15 articles published in Medline (Pubmed) database. The review demonstrates methods used to encourage healthy eating in children (6-12 yrs) and adolescents (13-18 yrs). In particular, interventions on children nutrition improvement were examined and changes of eating behaviour were analysed.

Systematic reviews suggest that a combination of nutrition and physical activity interventions can be helpful to prevent overweight and assist in weight reduction in children [46]. Our results confirm these findings – half (n = 8) of the projects besides of HE promotion (n = 15) aimed to reduce overweight and obesity in children and adolescents [11, 15, 32, 34, 39, 48, 53, 54] and 7 of them – to promote PA [11, 15, 37, 48, 53, 54]. Moreover, 'Six-month stage-based intervention' [42] and Michigan Model Nutrition Curriculum [31] had the goal to increase nutrition knowledge among

primary school children and 'The Healthy ONES' study [38] – to change nutrition policy and environments in low income schools.

It appeared that several components were implemented to achieve the aims of these projects. School involvement and classroom activities (n = 12) [11, 15, 31, 32, 33, 34, 37, 38, 39, 44, 53, 54], parents (n = 7) [11, 15, 33, 37, 39, 53, 54], community (n = 3) [37, 53, 54], FV campaign (n = 5) [34, 38, 44, 54, 55] and printed materials to improve FV intake [31, 42] were performed to reach the goals of projects.

In addition, our results show that most of the analysed projects had multi-component strategies (n = 12) except of 'Six-month stage-based intervention [42] 'FFTP' program [34] and 'YMCA after school' program [55]. HE significant improvements ($p < 0.05$) in the intervention group compared to the control group were reported in half (n = 8) of multi-component interventions [11, 15, 31, 33, 38, 39, 48, 54]. Improvements in PA were achieved in 6 out of 10 programs [11, 15, 32, 33, 48, 54] and overweight or obesity reduction in 4 multi-component interventions [11, 32, 38, 39]. No significant changes was identified in Ma'alahi Youth Project although various strategies for 36 months were used in adolescents [53].

In our review 3 projects used single strategies to promote HE in young people: significant positive changes were identified in 2 of them where HE campaigns (FV and FV snacks provision at school and after school, not serving unhealthy foods etc.) were used [34, 55]. However, short-term positive effects in attitudes and eating behaviour among children were identified in FFTP [34]. Results in Torel et al. project [42] showed no significant improvement when educational printed materials such as monthly magazines and newsletters used to promote HE. These findings confirm that multi-component interventions are implemented more often than single strategies reasonably and could be a better way to implement HE practice in children because of their effectiveness compared to single-component strategies due to synergistic effects between educational and environmental strategies [35, 38]. Involvement of schools, parents and communities is considered to be very important in healthy eating promotion of children [4, 35, 38]. Scientists agree that schools can be an ideal setting for health promotion interventions since the target population can easily be reached there [25, 31, 39]. Healthy diet programs of a long duration and density delivered by schools may have effects on food intakes, such as fruit and vegetable intake and fat intake of children and adolescents and promote life-long HE and PA [27, 35, 38]. Moreover, teachers can play a role in successful implementation of healthier lifestyle [32]. In addition, school policies are required to provide healthy and limit unhealthy foods provision at schools [40]. Next, researchers agree about parents' influence on children and adolescents' nutrition because parenting eating style and practice can promote healthy or unhealthy eating habits in young people [30, 56]. For that reason, parents should be the target of prevention programs because children model themselves on their parents' eating behaviours, lifestyles, eating-related attitudes, and dissatisfaction regarding the body image [30, 35, 41, 56].

Despite acknowledgment of multi-component strategies, some studies show that even single strategies can be effective, especially in promoting FV consumption at schools [35]. Programs and empowering policies at schools can increase consumption of fruit and vegetables among children and adolescents, especially from socio-economically disadvantaged families [5, 22, 27, 39] and fruit and vegetable eating among children can improve by as much as 70 percent [5, 24]. We can confirm these findings because several studies [34, 55] from our review show similar results.

Considering the effectiveness of interventions, limitations of projects need to be described. Duration of interventions can be one of important factors to achieve positive changes in healthy eating behaviour [35, 39, 57]. However, it didn't seem to have an impact on project effects in our review: even a short intervention of 1 or 1.5 month seemed to have impact on healthy eating in children [31, 33]. Authors from Michigan Model nutrition Curriculum found that one-month intervention delivered by trained professionals resulted in significant nutrition and eating behaviour changes [31]. Also, 'Healthy Homework' programme [33] enhanced vegetable consumption and reduced unhealthy foods eating at weekends [33] while multi-component 'Ma'alahi Youth Project' [53] of duration of 36 months didn't reach any significant changes in HE, PA or BMI except of increased community awareness of healthy behaviour. This means that other factors need to be

considered as barriers to effectiveness. Authors of this article analysed the limitations in great detail, and several barriers to effectiveness were highlighted: limits of budget and staff, organizational and implementation difficulties, inadequate and diluted dose of intervention etc. Moreover, considering the effectiveness of the projects in our review, it remains unclear whether some projects [32, 33, 34, 44, 54] of duration of 1-7 months could change children's eating behaviour for a long time as scientists suggest that all the programs should be performed for at least 12 months [22, 57, 58]. Next, the educational component in nutrition interventions needs to be mentioned. Some surveys show that no educational component as a single strategy should be used in the eating behaviour promotion process because knowledge does not seem to have effect on eating habits [44]. Our findings confirm these results because no significant improvements were identified in 'Six-month stage-based intervention' [42] when printed educational materials were sent to children. However, educational interventions, especially combined with other components could be effective [31] as a key strategy to prevent overweight and obesity [45]. For that reason, only evidence-based strategies should be used in children's nutrition and lifestyle encouraging process. In addition, barriers to effectiveness must be assessed and taken into consideration to increase the success of interventions [57].

Now, we would like to summarize the elements which are considered as important to encourage HE in children (Figure 2).

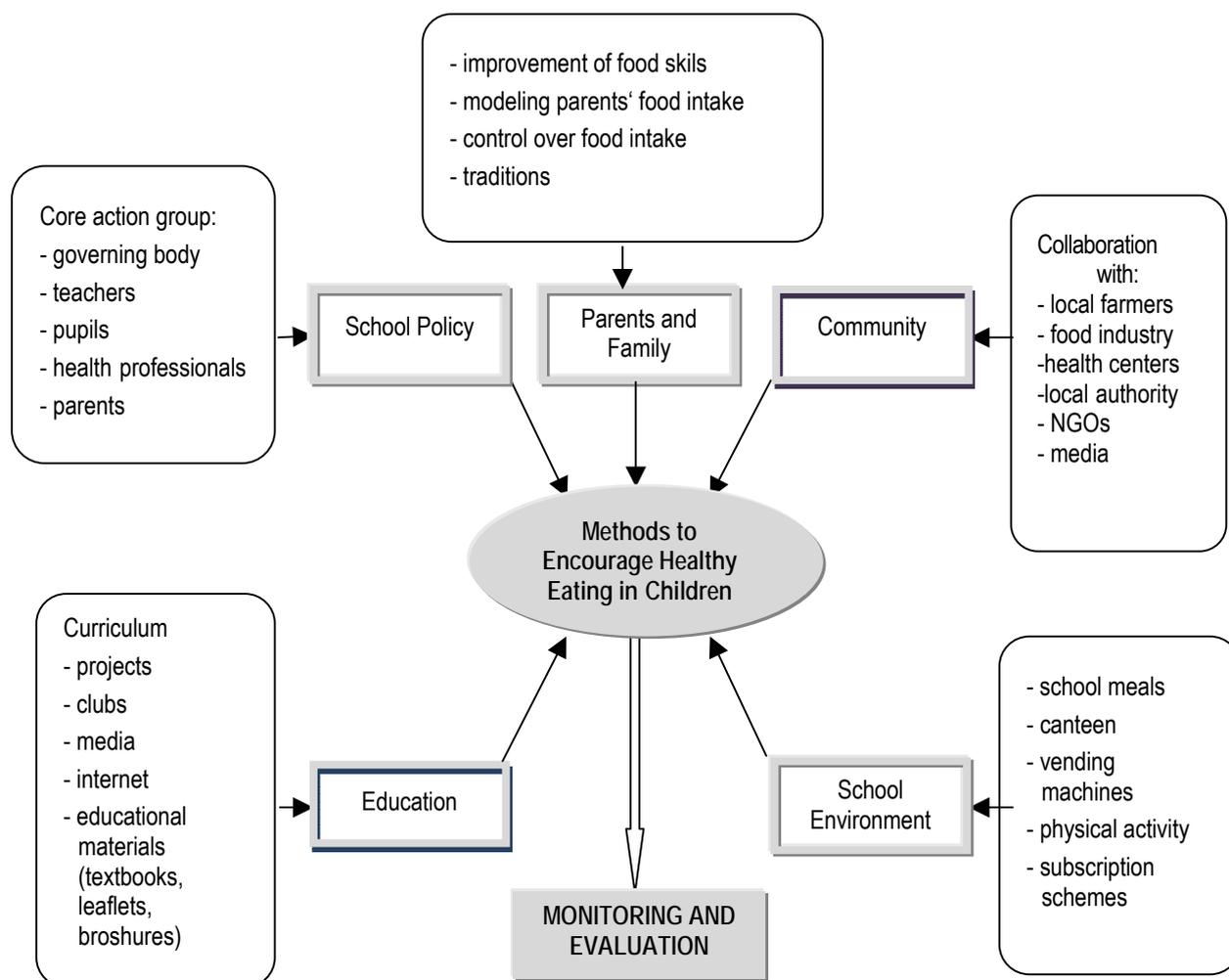


Fig. 2. Elements which are considered as important to encourage healthy eating in children

Firstly, schools as educational institutions are identified as one of the fundamental settings for establishing healthy eating and lifestyle at local, national, regional and global levels by improving health of children, families and all members of community [17, 25, 31, 35, 39, 59]. Secondly, stakeholders and policies should focus on HE as a contributor to prevent non-communicable diseases and their outcomes [35, 40, 45]. Thirdly, education at schools, involving the school curriculum, projects, meals promoting healthy life skills is crucial to develop responsible and sustainable lifestyle habits in young people [5, 31, 39, 44, 45, 46]. Fourthly, families and parents should be the targets of nutrition programs because of life-lasting effect on children's health [30, 41, 45]. Fifthly, community collaboration in HE encouraging process has a vital role because of support for schools on the health concept [45, 60, 61, 62]. Finally, collaboration with local farmers, food industry health centres, local authority, non-governmental organizations and media are required for successful implementation of all five elements [46].

At this stage, however, limitations of our review must be analysed. Systematic review was performed on free full text articles published in English; therefore, some articles may have been missed and the possibility of their bias could not be assessed. Secondly, in three studies [42, 49, 52] children of 5 and adolescents of 19 years old were included into the analysis. A third limitation is that several surveys had relatively short follow-up time and no information on the long-term effect on eating habits promotion was provided. Finally, in the review the cost effectiveness of interventions was not assessed either. Nevertheless, we could say that despite the above mentioned limitations, the present review increases our understanding of what methods [interventions] should be performed to encourage healthy eating in children and adolescents.

Conclusion

The multiple benefits of healthy food and nutrition in childhood and adolescence reinforce the need for studies of methods to encourage young people to healthy nutrition. The present review shows that the multi-component interventions (encouraging fruit and vegetable consumption is usually combined with physical activity promotion and overweight and obesity control) can be identified to be effective in encouraging healthy nutrition. Programs and empowering policies at schools can increase consumption of fruit and vegetables among children and adolescents and promote healthier lifestyle.

Barriers and limitations such as possible difficulties of implementation, duration and density of intervention, however, must be considered prior to interventions when it is possible because multi-component strategies may not lead to positive eating behaviour changes as intended. Moreover, single strategies, such as fruit and vegetable campaigns, also appears to have positive effects on children's healthy foods consumption.

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