

Article

Effectiveness of school-based nutrition interventions promoted in the League of Arab States: a systematic review

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Abstract

Arab countries are doubly burdened with undernutrition as well as overweight and obesity. To provide guidance to those looking to address concerns of obesity and overweight among children in this region, the current review bridges an existing knowledge gap and systematically characterizes and evaluates the available scientific evidence pertaining to school-based nutrition interventions completed to date across the Arab world. Using Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines and relevant keywords, terms and phrases, a search of the literature across 14 databases for school-based nutrition interventions implemented in this region was conducted. Out of 1568 articles from 14 databases, 38 full-text articles meeting the inclusion criteria were retrieved. Further assessment for eligibility excluded 23 articles and included one article from hand-searching references, leaving 16 articles in the final analysis. Most articles ($n = 7$) with the implementation of 5 months or longer found strong positive and significant impacts on limiting sweets consumption, increased dietary knowledge, self-efficacy, breakfast and fruit and vegetable consumption, among others. We also found evidence ($n = 5$) that teachers trained by experts such as dietitians and pediatricians can effectively implement nutrition interventions that achieve the intended outcomes. Training teachers to implement theory-based nutrition and health promotion curricula serves as a potential solution to improving nutrition knowledge, health behaviors and dietary practices among children living in Arab countries. Appropriately designed and implemented nutrition interventions can positively impact nutrition knowledge, health and diet-related behaviors in children and adolescents in this region.

Keywords: children, adolescents, Middle East, North Africa, obesity

INTRODUCTION

Psychological and physiological health and wellness status during adulthood is greatly predicated on childhood and adolescent experience (Hoyt *et al.*,

2012; Wennberg *et al.*, 2015; Mäestu *et al.*, 2020). Studies indicate health behaviors in childhood may predict obesity and associated comorbidities, such as hypertension, Type II diabetes, cardiovascular disease

Contribution to Health Promotion

- The current work fills knowledge gaps by systematically analyzing school health nutrition literature in Arabic-speaking countries.
- A synopsis of scientific underpinnings from the studied interventions assists expansion and improvement of future nutrition interventions in this area.
- Involving and training teachers emerge as a key cost-effective strategy in implementing successful school nutrition interventions in Arab states.
- Future research should explore sustainable nutrition education models, considering intervention efficacy and duration, with evidence suggesting that interventions lasting longer than 5 months are most effective.

and increased risk of some cancers, in adulthood (Mamun *et al.*, 2009; Wennberg *et al.*, 2015; Mäestu *et al.*, 2020). Set up in 2015 by the United Nations General Assembly, the Sustainable Development Goals or Global Goals are a collection of 17 inter-linked global goals designed to be a ‘shared blueprint for peace and prosperity for people and the planet, now and into the future’ and are intended to be achieved by 2030 (United Nations, 2015). Goals two, ‘no hunger’ and three ‘good health and well-being’ are inextricably linked. Nutrition status is critical for good health, particularly in children; good health is related to proper nutrition including adequate access to a diverse variety of healthful foods and food security (Qi and Niu, 2015; Gillies *et al.*, 2020). However, good health also relates to the prevention and management of overweight and obesity which can be related to chronic health issues, particularly later in life (United Nations, 2022). Developing countries that formerly faced a high rate of undernutrition are now doubly burdened with undernutrition as well as overweight and obesity, both posing potential risks for malnutrition among their populous (Caleyachetty *et al.*, 2018; Dickerson *et al.*, 2022; Hernández-Ruiz *et al.*, 2022).

The Middle East and North Africa (MENA) region reported the highest percentage of overweight children under 5 (12%) in the year 2020 (UNICEF, 2021). A number of MENA countries have experienced industrialization, nutritional transition and a modernized lifestyle including reduced physical activity and increased consumption of convenience foods which have contributed to the increased

obesity rates (Aboul-Enein *et al.*, 2017). Particularly in oil-producing countries of the Arab Gulf (Kuwait, Qatar and Saudi Arabia), obesity among adult men hovers around 30% with higher rates (40%) among adult women (World Obesity Global Obesity Observatory, n.d). Published reviews estimated the 2013 prevalence of overweight and obesity in the MENA region in boys and girls <20 years old to be 22.2% and 27.9%, respectively (Ng *et al.*, 2014; Farrag *et al.*, 2017).

Several theories suggest that health behavior is impacted by socio-environmental factors, as well as knowledge of perceived harm or benefits (Conner, 2010). School and family settings (Al Yazeedi *et al.*, 2021) pose as fundamental social environments for school-aged children, and as such, are critical settings to teach and model health behaviors. Given that schools provide a convenient setting for educational sessions, social (peer-influence) and direct environmental (distribution of healthy marketing and meals) interventions, school-based programs may be key to significant improvement of children/adolescents’ health if tailored correctly (Hoelscher *et al.*, 2013; Murimi *et al.*, 2017; Jacob *et al.*, 2021).

Prior international meta-analyses and systematic reviews of school-based nutrition interventions have communicated both some promising and mixed results (Kamath *et al.*, 2008; Brown and Summerbell, 2009; Van Cauwenberghe *et al.*, 2010; Verstraeten *et al.*, 2012; Bleich *et al.*, 2018). Yet in an effort to provide guidance to researchers, practitioners and interventionists looking to address concerns of obesity and overweight among children in the MENA region, we find a gap in the literature that communicates on the overall effectiveness of school-based programs addressing pediatric dietary behavior across the Arabic-speaking region. Although many international reviews (Dabravolskaj *et al.*, 2020; Xu *et al.*, 2020; Jacob *et al.*, 2021) exist on school-based dietary intervention programs, it is crucial to systematically evaluate school-based efforts in the MENA region that are tailored to the cultural, and ethnic diversity the region offers. A recent review of nutritional guidelines for children in nurseries and schools in MENA lack comprehensive guidelines for educational setting, particularly for preschools (Garemo *et al.*, 2019). Furthermore, a region-specific review that communicates differences in obesity rates, and considers leveraging region-specific school system nuances is warranted. Accordingly, the current review bridges an existing knowledge gap in the literature and systematically characterizes and evaluates the available scientific evidence pertaining to school-based and health-promotion nutrition interventions completed to date across the Arab world.

METHODS

Selection criteria

The Population, Intervention, Comparison, Outcomes and Study (PICOS) design guidelines (Higgins *et al.*, 2019) were incorporated to develop the research question: ‘Do children and adolescents in the “Arab world” (P) that are offered school-based nutrition interventions (I) have improved health and wellness parameters (O) compared with those that do not participate in school-based nutrition interventions(C)?’ and subsequent inclusion and exclusion criteria (see Table 1). Peer-reviewed articles published in English, French or Arabic languages were included. Interventions reported outside traditional peer-reviewed articles were excluded in this review. The search was conducted in the Spring of 2023 and the results communicate literature published through April 2023. For the purpose of this review, the ‘Arab World’ was defined as the 22-member countries of the League of Arab States (Blair *et al.*, 2014).

Search procedures

For this systematic review, we followed Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Page *et al.*, 2021) and began with a comprehensive search within biomedical bibliographic databases using a combination strategies of medical subject heading keywords, terms, phrases and Boolean operators (see Supplementary Material). The following 14 databases were searched: EBSCOHost, BIOSIS, CINAHL, ScienceDirect, ArticleFirst, Biomed Central, BioOne, ProQuest, SAGE Reference Online, Scopus, SpringerLink, PubMed, Taylor & Francis and Wiley Online. Search strategies were adapted according to the indexing systems of each respective database.

Risk of bias and quality assessment

Two of the authors [B.A.E. and E.D.] conducted the searches for relevant articles and one author utilized Rayyan QCRI software (Ouzzani *et al.*, 2016) to assist in the screening process. All retrieved articles were screened for relevance to the topic. In addition, reference lists from retrieved articles were also hand reviewed to identify any additional relevant publications. Titles and abstracts were screened for relevancy, and potentially relevant journal abstracts were reviewed by three of the authors [K.H.N.A.S., M.A.I.E.F. and N.B.]. Potential articles for inclusion in this review were evaluated independently for relevance, merit and inclusion/exclusion criteria. Articles accepted for inclusion were individually reviewed by each author. Additionally, each study was assessed by an independent reviewer and the reference list of each

included article was screened for potentially eligible articles. Any disagreement was resolved by consensus or by a second reviewer. Quality assessment of the articles was conducted using the Academy of Nutrition and Dietetics Evidence Analysis Manual (AND EAL) quality criteria checklist for primary research (Academy of Nutrition and Dietetics, 2016).

RESULTS

Characteristics of the studies

The search elicited 1568 papers and an additional 4 from hand searching ($N = 1572$). After the removal of duplicates and screening titles and abstracts for eligibility, the researchers retrieved 38 full-text papers—16 of which met the inclusion criteria (see Figure 1). A total of 16 articles were included in this systematic review, with 4 articles on children, 9 articles on adolescents and 3 articles including both children and adolescents. The intervention characteristics are tabulated in Table 2. Region-wise, most articles were conducted in the Arab states of the African continent (Tunisia, Egypt and Morocco), followed by Levant countries (Lebanon, Palestine, Jordan, Iraq and Syria) and gulf cooperation council (GCC) countries (the UAE and Kuwait). The study population ranged from 110 to 2148 participants in articles on children, 14 to 4275 participants in articles on adolescents and 180 to 1362 participants in studies inclusive of both children and adolescents. A little over half ($N = 5$) of the adolescent articles ($N = 9$) included a follow-up assessment, with three articles examining the medium-term intervention effects (3 months—1 year), (Harrabi *et al.*, 2010; Ghayeb *et al.*, 2013; Stanley *et al.*, 2017; Elseifi *et al.*, 2020) and two articles assessing the short-term effects (<3 months) (Elseifi *et al.*, 2020; Megally and Ghoneim, 2020). None of the articles among children and two articles (Dawood and Aziz, 2019; Jamaluddine *et al.*, 2020) inclusive of both children and adolescent populations included a follow-up assessment, with one examining short-term effects and both examining medium-term effects (Dawood and Aziz, 2019; Jamaluddine *et al.*, 2020). Most articles were conducted with both biological sexes (gender distinctions were not observed), but one study targeted only female adolescents and provided education in relation to nutrition, menstruation and anemia (Husseini and Donchin, 2020; Abu-Baker *et al.*, 2021), and one study targeted only male adolescents (Al-Haifi *et al.*, 2012).

Intervention characteristics

Most interventions included ($N = 13$) were designed based on a specific theoretical framework or health promotion model, with four using a health promotion

Table 1: PICOS criteria for inclusion and exclusion of studies

Parameter	Inclusion criteria	Exclusion criteria
Population	<ul style="list-style-type: none"> School-aged students (i.e. around 6 years old and above) who were examined in any country of the Arab League 	<ul style="list-style-type: none"> Students who are not of school age Arab Students who are not studying in an Arab League country Students undergoing medical nutrition therapy-based diets
Intervention type	<p>Any kind of school-based intervention that addresses nutrition-related aspects, including:</p> <ul style="list-style-type: none"> Educational interventions Environmental interventions Multi-componential interventions 	<ul style="list-style-type: none"> Interventions that are not based on school facilities Interventions that do not address nutrition-related outcomes
Comparators	<p>Pre-intervention, baseline nutrition-related variables (i.e. anthropometric measures, biochemical parameters, nutrition-related knowledge, dietary habits, perceived hunger) of student groups who were:</p> <ul style="list-style-type: none"> Control: received no intervention. Received partial intervention, for example, educational intervention only vs. multi-componential intervention 	<ul style="list-style-type: none"> N/A
Outcomes of interest	<ul style="list-style-type: none"> Positive changes in anthropometric outcomes, for example: BMI for age, height for age Positive changes in biochemical outcomes Increase in nutrition-related knowledge Increase in meeting the dietary macronutrient and/or micronutrient recommendations Increase in adherence to healthy dietary habits and avoidance of unhealthy ones Decrease in risks of nutrition-related diseases, for example: obesity or iron-deficiency anemia Decrease in short-term hunger 	<ul style="list-style-type: none"> Non-nutrition-related outcomes
Study type	Experimental intervention studies with quantitative outcomes	Non-numeric/categorical assessments or qualitative studies
Language	English, Arabic, French	All other languages
Study type	Peer-reviewed original research articles Original research conference publications	Non-Peer-Reviewed articles Commentaries Narratives Communications Non-intervention based studies White papers Similar article types Grey literature

Abbreviations: BMI, body mass index; N/A, not applicable.

model (Kebaili *et al.*, 2014; Dawood and Aziz, 2019; Elseifi *et al.*, 2020; Ben Cheikh *et al.*, 2021), three using lifestyle intervention models (Al-Haifi *et al.*, 2012; Maatoug *et al.*, 2015; Ghammam *et al.*, 2017), two were based on the Social Cognitive Theory (SCT) (El Harake *et al.*, 2018; Habib-Mourad *et al.*, 2020), one employing the Health Belief Model (Abi Haidar *et al.*, 2011), one using Theory of Change (Jamaluddine *et*

al., 2020) and one intervention curricula emphasized competency-based active learning (Amahmid *et al.*, 2020). The interventions utilized educational sessions, distribution of educational materials and/or a change in the educational curriculum in their approach to education. Many articles combined both educational and environmental components (Al-Haifi *et al.*, 2012; Kebaili *et al.*, 2014; Maatoug *et al.*, 2015; Ghammam

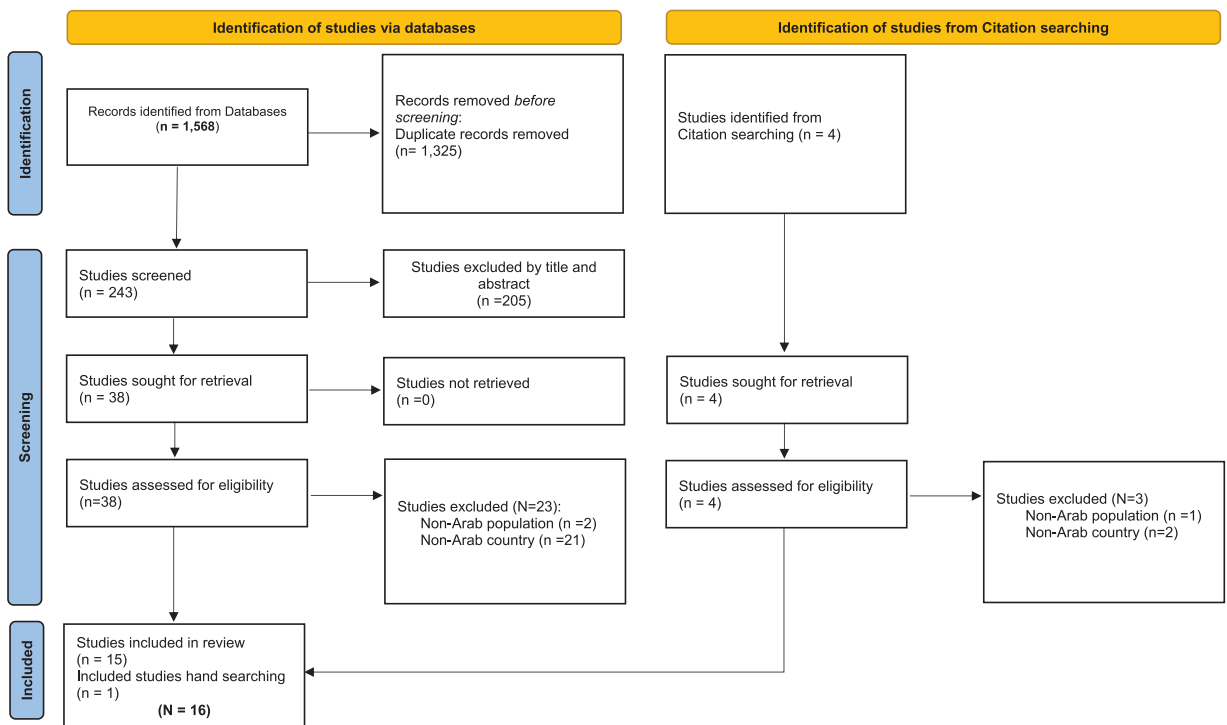


Fig. 1: Search flow diagram following PRISMA 2020 guidelines.

et al., 2017; El Harake *et al.*, 2018; Habib-Mourad *et al.*, 2020; Jamaluddine *et al.*, 2020; Ben Cheikh *et al.*, 2021). Because of the multi-component nature of these interventions, these articles focus on both educational as well as environmental aspects of behavior change such as school-wide initiatives and school policy changes (e.g. type of food sold in cafeterias or sessions incorporated in the schools' curriculum). The intervention duration differed greatly between the articles targeting children and adolescents, with the former ranging from 2 weeks to a maximum of 1 year (Abi Haidar *et al.*, 2011; Habib-Mourad *et al.*, 2020) while the latter ranged from a minimum of two workshop sessions to as long as 3 years (Maatoug *et al.*, 2015; Abu-Baker *et al.*, 2021). Seven of the articles note utilizing research incentives such as free subscription for distributed meals, or student recognition at dedicated events (Al-Haifi *et al.*, 2012; Kebaili *et al.*, 2014; Maatoug *et al.*, 2015; Ghammam *et al.*, 2017; Jamaluddine *et al.*, 2020; Megally and Ghoneim, 2020; Ben Cheikh *et al.*, 2021). Many ($N = 9$) of the articles addressed behavior and/or knowledge of multiple dietary issues, while other articles addressed specific knowledge gaps or dietary concerns, such as breakfast consumption (Elseifi *et al.*, 2020; Jamaluddine *et al.*, 2020), water and soft drink intake (Abi Haidar *et al.*, 2011), iron-deficiency anemia (Abu-Baker *et al.*, 2021)

and snack consumption (Maatoug *et al.*, 2015). Nine interventions were delivered by the research team, and five of the remaining interventions were delivered by teachers trained by experts or experts with the assistance of school staff. One intervention was delivered as part of the normal nutrition curriculum offered by the school and taught by a teacher (Amahmid *et al.*, 2020). Finally, only a few articles have incorporated peer leaders (Maatoug *et al.*, 2015; Ghammam *et al.*, 2017; Ben Cheikh *et al.*, 2021) to facilitate the behavioral change process, while others included community-based components for participation (Ghammam *et al.*, 2017; El Harake *et al.*, 2018; Jamaluddine *et al.*, 2020; Ben Cheikh *et al.*, 2021). Additionally, seven of the articles reviewed involved participants' families as a part of the intervention process (Al-Haifi *et al.*, 2012; Ghammam *et al.*, 2017; Maatoug *et al.*, 2017; Elseifi *et al.*, 2020; Habib-Mourad *et al.*, 2020; Jamaluddine *et al.*, 2020; Ben Cheikh *et al.*, 2021).

Methodological quality

The quality assessment of articles was conducted via the AND EAL quality criteria checklist with scores (+, 0, -) presented in Table 3. Eight articles had positive ratings (Abi Haidar *et al.*, 2011; Maatoug *et al.*, 2015; Ghammam *et al.*, 2017; El Harake *et al.*, 2018; Habib-Mourad *et al.*, 2020; Jamaluddine *et al.*, 2020;

Table 2 . Study and intervention characteristics of reviewed studies promoting healthy nutrition in children, and both children and adolescent, and adolescents populations

Author (year)	No. of participants (age)	Country	Dietary behaviors/knowledge addressed	Intervention Duration	Follow-up period	Theoretical framework/model	Delivered by	Incentives
Children								
Educational								
Abi Haidar (2011)	110 (Grades 3–4)	Lebanon	Water intake, soft drinks	2 weeks	NA	HBM	RT	
Environmental								
Megally (2020)	405 (2–7 yo)	Egypt	Multiple (but only serum hemoglobin and anthropometric changes)	1 month	NA	NR	T, E	+
Multicomponent								
Ben Cheikh (2021)	558 (6–12 yo)	Tunisia	Decreasing snack consumption	5 months	NA	Health promotion model	RT, SS, E	+
Habib-Mourad (2020)	2148 (9–11 yo)	Lebanon	Multiple	1 year	NA	SCT	E, SS, TTE	
Adolescents and children								
Educational								
Dawood (2019)	180 (11–16 yo)	Iraq	Multiple	NA (12 lectures of 45-min each)	6 weeks and 12 weeks	Health promotion model	RT	
Multicomponent								
Jamaluddine (2020)	1362 (5–13 yo)	Lebanon	Diet diversity, dairy, protein and SSB	8 months	8 months	TOC	RT	+
El-Harake (2018)	203 (6–14 yo)	Lebanon	Multiple	6 months	NA	SCT	TTE	
Adolescents								
Educational								
Elseifi (2020)	224 (12–15 yo)	Egypt	Breakfast consumption and its quality	5 weeks	2 months	Health promotion model	RT	
Ghrayeb (2013)	240 (16–18 yo)	Palestine	Nutrition knowledge	NA (5 lessons)	3 months	NR	RT	
Stanley (2017)	439 (ninth grade)	UAE	Multiple behaviors	NA (2 health workshops)	2–3 weeks	Peer-mediated health education model	RT	
Abu-Baker (2021)	363	Jordan	Iron deficiency anemia	4 weeks	NA	NR	RT, E, T	
Amahmid (2020)	120 (12–15 yo)	Morocco	Multiple behaviors	10 weeks	NA	Competency-based active learning	T	
Multicomponent								
Ghammam (2017)	4275 (11–16 yo)	Tunisia	Multiple	3 years	1 year	Lifestyle intervention	E, TTE, RT	+
Al-Haifi (2012)	14 (15–18 yo)	Kuwait	Multiple	6 months	NA	Lifestyle intervention	E	+

Table 2. Continued

Author (year)	No. of participants (age)	Country	Dietary behaviors/knowledge addressed	Intervention Duration	Follow-up period	Theoretical framework/model	Delivered by	Incentives
Maatoug (2015)	314 (seventh–eighth grade)	Tunisia	Multiple	1 year	4 months	Lifestyle intervention	E, SS, TTE, T	+
Kebaili (2014)	2200 (12–16 yo)	Tunisia	Multiple	3 months	NA	Health promotion model	TTE, E	+

Abbreviations: +, written in the study article; NR, not reported in the study; RT, research team; T, teachers; TTE, teachers trained by experts; E, experts; SS, school staff; NA, not applicable or assessed; HBM, health belief model; TOC, theory of change.

Megally and Ghoneim, 2020; Ben Cheikh *et al.*, 2021), while six received neutral scores (Ghrayeb *et al.*, 2013; Kebaili *et al.*, 2014; Dawood and Aziz, 2019; Amahmid *et al.*, 2020; Elseifi *et al.*, 2020; Abu-Baker *et al.*, 2021). The two articles that were assigned negative scores (Al-Haifi *et al.*, 2012; Stanley *et al.*, 2017) had extremely low sample size with no randomization nor control. These two articles (Al-Haifi *et al.*, 2012; Stanley *et al.*, 2017) were very short in duration (two workshops) and collected negligible information about nutrition or how the intervention may have impacted outcomes.

Evidence of effect

Some of the components that were used to assess the efficacy for the reviewed articles are shown in Table 3, which captures the study design, quality assessment and the intervention effect on measured outcomes. Overall, there was moderate to strong evidence of the effect for improvement in nutrition-related knowledge and/or behavior in interventions targeting both general nutrition knowledge and practice, as well as specific outcomes such as decreasing soft drink consumption and increasing breakfast consumption; this could be attributed in part to the fact that there was an underlying theoretical framework or model employed in the majority of the interventions, which has been shown to increase curricular efficacy (Murimi *et al.*, 2017; Amahmid *et al.*, 2020). There was inconclusive evidence regarding the interventions' effects on anthropometric measures, and fewer articles included anthropometric measures as an intervention outcome. Finally, of the six articles that assessed intervention effect on other health behaviors and outcomes, two had no impact on anemia status (Jamaluddine *et al.*, 2020; Megally and Ghoneim, 2020), two had decreases in physical activity in the intervention groups (Maatoug *et al.*, 2015; Ghammam *et al.*, 2017), one found a reduction in smoking risk (Stanley *et al.*, 2017) and one found improved health responsibility post-intervention (Dawood and Aziz, 2019).

DISCUSSION

Present efforts communicate a systematic characterization and evaluation of the current available literature pertaining to health-promoting school-based nutrition interventions completed across the Arab world. We categorized our results accordingly to reflect, the characteristics of the articles included in this review as well as intervention characteristics, methodological quality and evidence of effect. The interventions included here were implemented to address the findings that most children and adolescents in MENA countries do not meet WHO Eastern Mediterranean (World

Table 3: Study design, overall study quality and overall intervention effectiveness on anthropometrics and dietary behavior of reviewed studies promoting healthy nutrition in children

Author (year)	Study design	Study quality ^a (+,0, -)	Study effect on anthropometrics	Study effect on dietary knowledge and/or behavior	Study effect on other assessed health attitudes, behaviors, outcomes
Children					
Educational					
Abi Haidar (2011)	Pre-post quasi-experimental study	+	NA	Soda consumption decreased ($p < 0.05$), water intake increased ($p < 0.000$) and knowledge increased ($p < 0.000$)	NA
Environmental					
Megally (2020)	RCT	+	No significant effects in stunting level or obesity	NA	No significant effect on hemoglobin or anemia level
Multicomponent					
Ben Cheikh (2021)	Quasi-experimental study	+	NA	Morning snacks and sweets consumption decreased significantly in intervention ($p < 0.009$) compared with control group, with significant decreases in cake, chocolate ($p < 0.000$), chips ($p < 0.003$) and dairy ($p < 0.000$) and increased fruit and vegetable intake ($p < 0.009$)	NA
Habib-Mourad (2020)	Randomized pre-post intervention study	+	NA	Dietary knowledge and self-efficacy increased in both TTE and E groups ($p < 0.05$), breakfast intake increased in TTE group ($p < 0.05$), increased fruit and vegetable intake in the E group ($p < 0.05$) and crisps consumption decreased in both groups ($p < 0.05$).	NA
Adolescents and children					
Educational					
Dawood (2019)	RCT	0	NA	NA	Increased health responsibility post intervention, ($p < 0.000$), and at both follow-up measures ($p < 0.000$)
Multicomponent					
Jamaluddine (2020)	Quasi-experimental intervention with a matched-pair design	+	No effect on BMI overweight or obesity (0) or stunting (0)	Increases in diet diversity ($p = 0.028$), increased consumption of dairy ($p < 0.001$) and protein ($p > 0.001$) and lower sweetened beverages consumption ($p = 0.046$)	No significant effect on anemia

Table 3. Continued

Author (year)	Study design	Study quality ^a (+,0,-)	Study effect on anthropometrics	Study effect on dietary knowledge and/or behavior	Study effect on other assessed health attitudes, behaviors, outcomes
El-Harake (2018)	Quasi-experimental study	+	Increase in BMI z-scores ($p = 0.039$) between intervention and control groups	Increased dietary knowledge ($p = 0.002$), total kcal, fiber, protein and sat. fat intake ($p < 0.05$) and vitamin K ($p < 0.001$), zinc ($p = 0.037$), calcium ($p = 0.017$) and magnesium ($p = 0.007$) intake.	NA
Adolescents					
Educational					
Elseifi (2020)	Pre-post-test intervention study	0	No effect on BMI (0)	Intervention group significantly increased breakfast consumption ($p < 0.001$) and each component of the HPM significantly increased ($p = 0.00$)	NA
Ghrayeb (2013)	Pre-post-test intervention study	0	NA	Significant increase in nutrition knowledge in the intervention group ($p < 0.001$)	NA
Stanley (2017)	Pre-post-test intervention study	-	NA	No significant change in perception and attitude towards nutrition	Improved knowledge and perception regarding tobacco use ($p < 0.05$), significant and negative ($p < 0.05$) satisfaction physical activity level
Abu-Baker (2021)	Pre-post quasi-experimental design	0	NA	Intervention group had significantly higher dietary KAP scores ($p = 0.000$) post-intervention	NA
Amahmid (2020)	Observational analysis	0	NA	Significant increases in knowledge of adolescents nutritional needs ($p < 0.05$) and fresh vegetable preference ($p < 0.01$) in the intervention group	NA
Multicomponent					
Ghammam (2017)	Quasi-experimental study	+	Significant increase in % of students with overweight or obesity in the control group ($p = 0.001$) but not the intervention group ($p = 0.236$)	Increased intake of fruit and vegetable in intervention group at post-assessment ($p = 0.026$), but not post-follow-up ($p = 0.410$), and significant increase in intake of fast food in the control group ($p = 0.001$), but not the intervention group ($p = 0.517$)	Decrease in physical activity ($p = 0.010$) in the intervention group at post-assessment
Al-Haifi (2012)	Interventional prospective study	-	BMI was decreased; however, this is offset by participants increased height.	NA	NA

Table 3. Continued

Author (year)	Study design	Study quality ^a (+, 0, -)	Study effect on anthropometrics	Study effect on dietary knowledge and/or behavior	Study effect on other assessed health attitudes, behaviors, outcomes
Maatoug (2015)	Quasi-experimental study	+	BMI Z-score was significantly reduced in both the intervention and control group at post-assessment ($p < 0.001$ each), but in the intervention group only ($p < 0.001$) at post-follow up.	kcal ($p = 0.001$), lipid ($p < 0.001$), carbohydrates ($p = 0.040$) and protein ($p = 0.002$) intake decreased significantly in the intervention group and control group ($p < 0.001$ all) with the exception of protein ($p = 0.376$)	Physical activity decreased, but not significantly, in the intervention group ($p = 0.69$), and increased significantly ($p = 0.001$) in the control group.
Kebaili (2014)	Pre-post quasi-experimental design	0	NA	Significant increases in dietary knowledge about breakfast, dairy intake, snacking in the evening, fast food intake and intention to eat breakfast, fruits and vegetables daily (all $p < 0.001$) were seen in the intervention group. Additionally, intention to drink soft drinks daily decreased ($p = 0.003$)	NA

NA, not applicable or assessed.

^aStudy quality rated using AND EAL Quality Criteria Checklist (+, 0, -).

Health Organization Regional Office for the Eastern Mediterranean, 2012). The interventions also indicated not have met their own culturally sensitive guidelines (Coats *et al.*, 2019) nor for a healthy diet including at least five servings of fruits/vegetables or the recommendations for physical activity (Nasreddine *et al.*, 2010; World Health Organization Regional Office for the Eastern Mediterranean, 2012, 2014; Allafi *et al.*, 2014; Al Ani *et al.*, 2016; Alsubaie, 2018; Baniissa *et al.*, 2020). To combat increasing rates of youth obesity and overweight among these countries' populous, the current systematic review provides a summary of empirical evidence to guide future research and interventions addressing nutritional needs among children and adolescents of MENA countries. Independent of duration, most of the included interventions demonstrated a moderate to strong effect on the intended outcomes. A strength of the current review is that most of the included interventions were based on a theoretical framework or health promotion model. It has been suggested that appropriate tailoring of theory-based curricula for the intended audience can increase the effectiveness of the intervention (Dudley *et al.*, 2015; Murimi *et al.*, 2017).

When considering duration, it has been suggested that interventions lasting longer than 5 months are ideal in facilitating intended nutrition-related outcomes (Murimi *et al.*, 2017). Seven of the reviewed interventions took 5 months or longer (Al-Haifi *et al.*, 2012; Maatoug *et al.*, 2015; Ghammam *et al.*, 2017; El Harake *et al.*, 2018; Habib-Mourad *et al.*, 2020; Jamaluddine *et al.*, 2020; Ben Cheikh *et al.*, 2021); of these, six of the interventions (Maatoug *et al.*, 2015; Ghammam *et al.*, 2017; El Harake *et al.*, 2018; Habib-Mourad *et al.*, 2020; Jamaluddine *et al.*, 2020; Ben Cheikh *et al.*, 2021) had strong positive and significant impacts on morning snack and sweets consumption, dietary knowledge, self-efficacy, breakfast and fruit and vegetable consumption, diet diversity, dairy and protein consumption, with a decrease in sugar-sweetened beverage consumption, dietary knowledge and increased consumption of total kcal, fiber, protein, saturated fat and vitamin K, calcium and magnesium intake and increased fruit and vegetable intake with a decrease in fast food consumption. One intervention (Elseifi *et al.*, 2020) increased breakfast consumption and adherence to intervention health promotion components. The final intervention running longer than 5 months was implemented over 6 months, but had significant limitations that likely impacted effect, including a sample size of only 14, and no randomization or control; this was one of two articles given a negative quality score yet included in this review (Al-Haifi *et al.*, 2012). Relevant to term of duration, for programs

lasting over 5 months and solely specific to nutrition efforts by Ben Cheikh *et al.* (Ben Cheikh *et al.*, 2021) and Jamaluddine *et al.* (Jamaluddine *et al.*, 2020), communicate no statistically significant anthropometric effect. Yet, each convey a significant effect on changes to dietary knowledge and behavior. Still on the realm of duration, shorter duration interventions were found to have an effect, such as a 2-week intervention aimed at increasing water consumption and decreasing soda consumption (Abi Haidar *et al.*, 2011) and a 5 week intervention to increase breakfast consumption (Elseifi *et al.*, 2020). These successes may be attributed to additional components of the intervention, such as focused lessons on avoiding peer pressure (Cruwys *et al.*, 2015; Higgs, 2015) and strong parental engagement (Niemeier *et al.*, 2012; Verjans-Janssen *et al.*, 2018), respectively.

The articles included here provide important information on how school-based nutrition interventions can positively impact the health of school-aged children in the Arab world. Five of the interventions (Kebaili *et al.*, 2014; Maatoug *et al.*, 2015; Ghammam *et al.*, 2017; El Harake *et al.*, 2018; Habib-Mourad *et al.*, 2020) provide evidence that teachers trained by experts such as dietitians and pediatricians can effectively implement nutrition interventions that achieve the intended outcomes. Utilizing the train-the-trainer method can reduce the costs of implementing such interventions, reach children where they are on a daily basis and empower teachers to help bridge known gaps in nutrition knowledge, health behaviors and dietary practice.

CONCLUSION

This systematic review draws similar conclusions as previous work conducted in non-Arab nations that appropriately designed and implemented nutrition interventions can positively impact nutrition knowledge and health and diet-related behaviors in children and adolescents. School-based interventions are an ideal way to reach children in a familiar environment that they regularly engage with. Training teachers to implement theory-based nutrition and health promotion curricula serves as a potential solution to improving nutrition knowledge, health behaviors and practices including dietary practices, and may serve as a mechanism to promote health outcomes in MENA countries as well as the UN's Sustainable Development Goals 2 and 3 in the Arab world.

Present efforts bridge gaps in the literature for practitioners, researchers and interventionists specific to Arabic-speaking countries. The present article provides a summary of the scientific premise that will assist future efforts to expand on and build upon prior

evidence-based interventions reviewed and communicated here. Of great interest, in the reviewed literature we find that training and including teachers on being an active and important member of interventions that aim on improving health and nutrition outcomes is an effective and low-cost approach to positively impact the health and well-being of children and adolescents. As such, future efforts may examine further evidence of what might serve as a sustainable model of nutrition education, a train-the-trainer model for teachers.

CONFLICT OF INTEREST

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

SUPPLEMENTARY MATERIAL

Supplementary material is available at *Health Promotion International* online.

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