

# Application of the Intervention Mapping Protocol to Develop *Sahtak bi Sahnak*, a School-Based Intervention to Prevent Pediatric Obesity among Lebanese Adolescents



DESIGN PAPER

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## ABSTRACT

**Background:** Pediatric obesity is a major public health concern worldwide. Improving dietary and physical activity habits at a young age could prevent many health complications during adulthood and later years.

**Objective:** This paper describes the application of the Intervention Mapping protocol for the systematic development of the Lebanese intervention “*Sahtak bi Sahnak*” (meaning Your health in your plate) that focuses on preventing pediatric obesity and promoting a healthy lifestyle through a systematically designed and culturally appropriate, school-based program.

**Method:** The development of this intervention is based on the six steps of the Intervention Mapping (IM) protocol. This intervention targets Lebanese adolescents aged 15–18 years enrolled in Lebanese public and private high schools, located in urban and rural areas. Its effectiveness will be tested in a Clustered Randomized Controlled Trial in 16 high schools.

**Discussion and conclusion:** The IM protocol allowed us to develop a theory based, low resource intervention which can be integrated as part of the educational curriculum of public and private high schools in Lebanon. This study provides a detailed example of the application of the IM approach in the Lebanese high school context. Even though it is a time-consuming process, IM serves as a valuable tool in the health promotion field and provides a high level of transparency to improve and replicate the process in the future.

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## 1. INTRODUCTION

Pediatric obesity is a major public health concern worldwide (WHO, 2018). This problem is associated with various medical, psychological, social, and economic complications that can persist into adulthood (Finkelstein, Graham, & Malhotra, 2014; WHO, 2018). The underlying reason for obesity is a positive imbalance between energy consumption and energy expenditure, resulting in an excess weight gain (Hruby & Hu, 2015). In Lebanon, 30.8% of Lebanese adolescents are overweight, and 10.3% are obese (Nasreddine et al., 2014). This highlights the urgent need to develop, implement, and evaluate weight management interventions designed to improve the health of children and adolescents.

Schools are considered an important setting to improve children's physical activity level and eating behaviors (WHO, 2017). School health interventions can be standardized and have been found effective in preventing pediatric obesity (Styne et al., 2017). Knowing that 81.1% of Lebanese adolescents attend secondary schools or high schools (CAS & UNICEF., 2009), a school-based intervention can potentially reach a large part of the target population. To our knowledge, and based on a comprehensive search in relevant databases, only one pilot intervention to promote healthy eating and physical activity among 9- to 11-year-old Lebanese children (Habib-Mourad et al., 2014) was published from the Asian Arab region. However, only a limited number of participants ( $n = 374$ ) was involved in this study, and it did not take into consideration rural areas, focusing solely on urban areas.

It is well known that participants and communities are more likely to benefit from health promotion programs that are developed and guided by theories of health behavior and health behavior change (Kok, Schaalma, Ruiters, van Empelen, & Brug, 2004). An example of such a systematic approach is Intervention Mapping (IM), which describes a process for the planned and systematic development of theory-based health education programs (Bartholomew-Eldredge, 2016). It suggests specific steps to guide the problem-driven development, application, and integration of behavior change theories (Bartholomew-Eldredge, 2016). However, the available related articles do not fully elaborate all six steps. In addition, most of the studies did not provide details regarding the epidemiological processes (e.g., methods of data collection and study analysis, study design, etc.) (Garba & Gadanya, 2017). To our knowledge, no interventions based on IM were conducted in the Arab world, even though there is crucial need to create global awareness and training regarding the use of IM in disease prevention (Garba & Gadanya, 2017). The current paper describes the application of the IM protocol for the systematic development of the Lebanese intervention "Sahtak bi Sahnak" ("Your health on your plate") while following all the steps of IM in detail, including planning

the adoption, implementation, and evaluation process. This intervention focuses on preventing pediatric obesity by promoting healthy eating habits and an active lifestyle among Lebanese adolescents, through a systematic and culturally appropriate program.

## 2. MATERIALS AND METHODS

The purpose of Intervention Mapping (IM) is to provide program planners in health education with a foundation for effective decision making at each step of the intervention development process (Bartholomew, Parcel, & Kok, 1998). The IM approach requires collaboration between developers, implementers, and program participants (Bartholomew et al., 1998). It is based on the following principles (Bartholomew-Eldredge, 2016).

(1) Ecological perspective – the interrelationships between the involved individuals and their environment. For instance, an adolescent's eating behavior is not only affected by his/her own preferences, but also by his/her parents, the school environment, his/her friends, the media, and relevant legislation (Stok et al., 2017);

(2) Participatory approach – the development, implementation, and evaluation of a health promotion program should include community members. This will add more knowledge and expertise to the program, as well as more external validity due to the recognition and inclusion of relevant parties;

(3) Theory use – the use of relevant theory is crucial to describe and address the factors causing a health problem and to find the right approach to solve it;

(4) Science-based approach – every step of the IM requires a bibliographical search and a critical evaluation of published data regarding the determinants related to behaviors and the environment on the one hand and the right method to use to modify a given problem on the other.

Intervention Mapping is a six-step process: (1) needs assessment; (2) identification of behavioral outcomes, performance objectives, and change objectives; (3) selection of theory-based methods and strategies; (4) program development; (5) adoption and implementation; (6) program evaluation (Bartholomew-Eldredge, 2016).

In the following sections (2.1–2.6), each step is briefly described by first, listing its corresponding tasks, then explaining the procedures, and finally elaborating the outcomes by applying them in the development of the *Sahtak bi Sahnak* program.

### 2.1. STEP 1 – NEEDS ASSESSMENT

The first step of IM provides the foundation for starting intervention development (Bartholomew et al., 1998). The main tasks in this step are: (1) analyzing the health and quality of life problems and their causes; and (2) defining the program goals (Bartholomew-Eldredge, 2016).

This needs assessment may be formulated based on theory, empirical evidence, and available epidemiological data (Bartholomew et al., 1998). At the end of this step, the program planner defines program goals based on the observed health problem (see *Figure 1*).

**2.1.1. Task 1 – Analyzing health and quality of life problems and their causes**

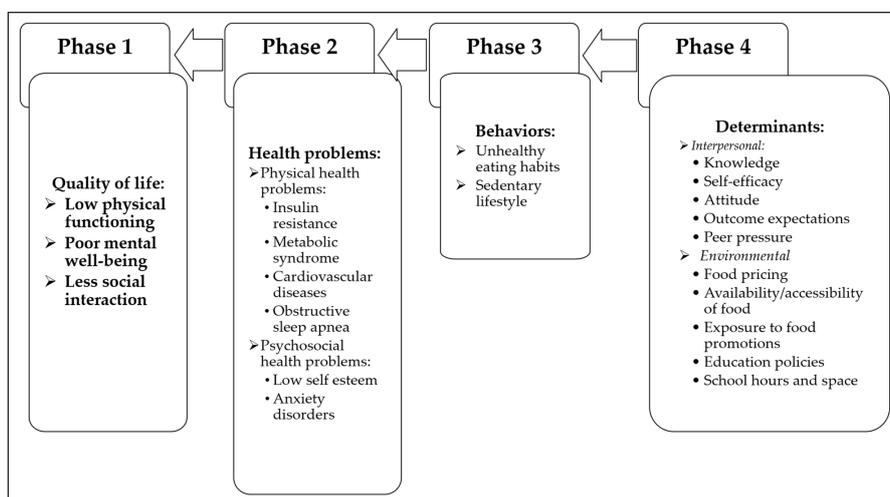
**Task 1 – a) Defining the health problem and its impact on quality of life**

Obesity is, and has been for a long time, a major health problem defined as “the accumulation and storage of excess body fat”, while overweight is “weight in excess of a weight reference standard” (Eknoyan, 2006; Ogden & Flegal, 2010; Yanovski, 2015). Children and adolescents with a BMI z-score between 1.04 and 1.63 are considered overweight, and those with a BMI z-score  $\geq 1.64$  are considered obese (Hoelscher, Kirk, Ritchie, & Cunningham-Sabo, 2013). The prevalence of obesity among children and adolescents varies greatly between regions and countries. In Lebanon, a national cross-sectional study (2009) showed that the prevalence of overweight in 6- to 19-year-old children and adolescents was 34.8%, whereas the prevalence of obesity among the same group was 13.2% (Nasreddine et al., 2012). Physical complications of pediatric obesity include insulin resistance, metabolic syndrome, dyslipidemia, and obstructive sleep apnea (Gungor, 2014; Yanovski, 2015). Psychosocial complications include low self-esteem, higher rates of anxiety disorders, decreased health-related quality of life (QOL), and decreased educational and financial attainment (Gungor, 2014; Yanovski, 2015). These health consequences constitute a serious economic burden. The incremental lifetime direct cost from the perspective of a 10-year-old obese child relative to a normal-weight child amounts to more than \$13,000 (Finkelstein et al., 2014). Yet, pediatric obesity is considered preventable (WHO, 2018).

There are many behavioral factors related to pediatric overweight and obesity. It is well known that overeating and a sedentary lifestyle are the main contributors (Kremers, Visscher, Seidell, van Mechelen, & Brug, 2005). However, the underlying behaviors for obesity in Lebanese children and adolescents specifically are still largely unknown (Chacar & Salameh, 2011). Nevertheless, long periods of screen viewing, physical inactivity, high intake of fast food, and an increase of food intake outside the home are associated with this issue among children and adolescents in the countries of this region (Musaiger, Hassan, & Obeid, 2011). Frequent snacking, the replacement of traditional foods with energy-dense fast foods and water with soft drinks, along with a low intake of fruits and vegetables contributed to the rising rates of obesity in the United Emirates (Wen Ng et al., 2011). A cross-sectional study conducted on Lebanese adolescents (aged 13–19 years) showed that the Western dietary pattern was positively associated with overweight, compared to the Lebanese traditional dietary pattern (Naja et al., 2015).

**Task 1 – b) Defining the target population**

For the current intervention, high school students (15–18 years old) were selected as the target population for the following reasons: (1) today’s adolescents are tomorrow’s adults, and overweight in adolescence increases the risk of morbidity for several chronic diseases in adulthood (Must, Jacques, Dallal, Bajema, & Dietz, 1992); (2) adolescents who benefit from nutrition promotion can act as change agents by spreading messages to a large segment of the population (Wang & Stewart, 2013); (3) many adolescents prepare their own snacks and meals because of their parents’ work schedule (Gidding et al., 2005); (4) during adolescence, peer pressure begins to outweigh parental authority and unhealthy diets may be initiated (Gidding et al., 2005). The program did not include parents, also because expected participation rates of parents were low, based on a pilot study (Said, Gubbels, & Kremers, 2019).



**Figure 1** Representation of the logic model in IM-Step 1.

### **Task 1 – c) Determinants behind eating and exercise behaviors**

The third part of the first task in the needs assessment is to search for the determinants behind the behavior of the group at risk (Bartholomew-Eldredge, 2016). Determinants can potentially be changed by interventions that influence the target group's thinking regarding a certain issue or their ability to change a behavior (Bartholomew-Eldredge, 2016). Those related to eating and exercise behaviors were classified as: (1) individual and interpersonal; (2) environmental and policy (Stok et al., 2018; Stok et al., 2017).

#### *Individual and interpersonal determinants*

One of the main individual determinants of eating is dietary knowledge (Stok et al., 2018). A study including Lebanese children aged 9–11 years revealed low dietary knowledge (Habib-Mourad et al., 2014). Even though dietary knowledge does have a large effect on eating habits, knowledge alone is not always sufficient to change the way adolescents eat (Story, Neumark-Sztainer, & French, 2002). Skills and self-efficacy related to healthy eating and cooking are also important determinants (Stok et al., 2017). Perceived self-efficacy for healthy eating was found to predict eating behaviors in studies involving adolescents. Lebanese children showed a relatively high average self-efficacy score (Habib-Mourad et al., 2014). In line with this, a review studying the association between physical activity (PA) and different determinants among 13- to 18-year-old adolescents showed that PA was positively correlated with knowledge, self-efficacy, attitude, and outcome expectations (Sallis, Prochaska, & Taylor, 2000).

Interpersonal determinants include peer pressure, food habits of the family, family meal frequency, parental control, and parenting styles (Stok et al., 2017). Children's food related preferences and consumption are related to their parents' beliefs and attitudes toward food (Patrick & Nicklas, 2005). However, parents are not the only ones influencing children. Peers also have a strong impact on overall adolescent behavior (Story et al., 2002). As for the family meal frequency, the increase in dining out is correlated with a decline in dietary quality from childhood to adolescence (Story et al., 2002). According to Nasreddine et al. (2014), 58.4% of Lebanese teenagers eat outside of their homes more than once per week.

#### *Environmental and policy determinants*

Examples of environmental determinants include food pricing, product convenience, availability and accessibility of food, and exposure to food promotions (Stok et al., 2018; Stok et al., 2017). Whenever a food is available, it is more likely to be consumed (Patrick & Nicklas, 2005). Parents are a major gatekeeper, but not the only influencers on food availability and accessibility. Schools and neighborhoods also play a major role in controlling

this environment (Kremers et al., 2006). When it comes to PA, this includes city planning, health education, education policies, school hours and space, social media, access to transport, and social expectations (Condello et al., 2016). Relevant policies include health awareness campaigns and governmental regulation (e.g., food advertisements). In many Lebanese schools, the school food-shops are operated by third parties and are therefore mainly concerned about the revenues, when it comes to food selection (Habib-Mourad & Ghandour, 2015). To our knowledge, Lebanese school shops are not allowed to sell soft drinks, but there is no official ban on the other high-sugar/high-fat snacks.

### **2.1.2. Task 2 – Program goals**

In the IM framework, program goals are defined as the changes to be made regarding the health, quality-of-life, behavioral, or environmental factors identified in the needs assessment (Bartholomew-Eldredge, 2016). Based on our needs assessment, we decided that our intervention should mainly address dietary patterns during adolescence because diet quality influences risk regardless of energy balance (Mozaffarian, 2016). The overall program goals are as follows: (1) improving dietary adherence to nutritional guidelines; (2) increasing the level of dietary knowledge; and (3) preventing the development of obesity during adolescence. Any materials developed should be culturally appropriate, easy to use by Lebanese dietitians, and easy to understand by Lebanese students, and capable of being incorporated later in the school curriculum.

It is worth noting that the program focuses on adolescents and does not include parents for two reasons: (1) adolescents are capable of preparing their own food and applying the advice mentioned in this program, in contrast to younger children; (2) based on a pilot study (Said et al., 2019), the participation rates of parents filling in questionnaires were low, and therefore it was not promising to include parents in an intervention.

As a first step, only individual determinants were taken into consideration because a previous study (Said et al., 2019), conducted on a smaller similar sample, indicated that it would be wise to focus first on high schools, to prevent making the intervention too disruptive for other settings at the same time. According to (Bartholomew-Eldredge, 2016), it might be difficult to modify an environmental condition in some situations. In that case, the program planners can prepare the at-risk population to deal with the environmental condition instead of planning an intervention for an environmental outcome. For instance, due to limited financial resources and space at schools, school shops are not able to offer healthy snacks to the students. In this case, it is possible to teach the students how to prepare their own snacks at home and bring them to school. The current intervention did not directly involve the parents, the schools, nor other

environmental factors. Such an approach was previously used in Kaledo intervention (Viggiano et al., 2015).

## 2.2. STEP2 – IDENTIFICATION OF BEHAVIOURAL OUTCOMES, PERFORMANCE OBJECTIVES AND CHANGE OBJECTIVES

In the second step of IM, behavioral, performance, and change objectives are formulated (Bartholomew-Eldredge, 2016). Four tasks need to be accomplished within this step (Bartholomew-Eldredge, 2016): (1) stating expected program outcomes for health behaviors and environmental conditions to improve health and quality of life (QOL); (2) subdividing behavioral and environmental outcomes into performance objectives; (3) selecting important and changeable determinants of the behavioral and environmental health outcomes; (4) creating a matrix of change objectives for each ecological level to be included in the intervention (e.g., individual, intrapersonal, organizational, community, and societal). The outcomes and objectives in this step were selected by following the steps of Core Processes (Bartholomew-Eldredge, 2016). This method minimizes the possibility of incomplete understanding or the selection of ineffective solutions because it relies on evidence before conducting new research (Ruiter & Crutzen, 2020).

### 2.2.1. Task 1 – Behavioral outcomes

Behavioral outcomes are behaviors to be accomplished as a result of the health promotion program (Bartholomew-Eldredge, 2016). They can additionally be considered the final or distal objectives (Fassier et al., 2016). In this study, behavioral outcomes were divided into two categories: (a) health-promoting behaviors representing actions taken to protect or enhance health; (b) risk-reduction behaviors defined as actions that have been demonstrated to directly decrease the risk of disease or disability (Bartholomew-Eldredge, 2016).

All outcomes (see **Box 1**) target Lebanese adolescents participating in the intervention group and are expected to be achieved by the end of the intervention. They are based on the recommendations listed in the consensus statement from the American Heart Association (Gidding et al., 2005) and the Dietary Reference Intakes (Institute of Medicine, 2005), and they are obtained as a result of the needs assessment (Step 1). Although this intervention focused on dietary behaviors, the educational material included one chapter related to PA for the following reasons: (1) the influence of PA levels on food intake; (2) clustered behaviors or the co-occurrence of healthy behaviors with other healthy ones (e.g., exercising and following a healthy diet), and vice versa (Kremers et al., 2006). It is important to note that while two behavioral outcomes regarding physical activity and screen time were included in addition to the nutrition-related behavioral outcomes (**Box 1**), we will further address the recommendations and focus as “dietary” for the purpose of clarity of the paper.

1. Be physically active for at least one hour per day\*
2. Limit screen viewing time to no more than two hours per day\*\*
3. Eat breakfast every day\*
4. Consume three meals every day\*
5. Increase vegetable intake to no less than twice per day\*
6. Increase fruit intake to no less than twice per day\*
7. Consume whole grain products at least once per day\*
8. Drink milk or laban at least once per day\*
9. Avoid consuming unhealthy drinks (soft drinks, artificial juices, and energy drinks)\*\*
10. Decrease intake of unhealthy snacks\*\*
11. Replace high-fat meat with lean meat\*\*
12. Replace high-fat dairy products with medium-to low-fat dairy\*\*
13. Drink 8/11 cups of fluids per day, for girls and boys, respectively\*

#### **Box 1** Behavioral outcomes of *Sahtak bi Sahnak*

\* Health-promoting behaviors; \*\* Risk-reduction behaviors.

As achieving some dietary recommendations may not be a realistic goal for many individuals, it was decided that the objective of the intervention would be to “increase” or “decrease” the intake of certain food products with a view to achieving the recommended levels.

### 2.2.2. Task 2 – Performance objectives

The second task of the second step is to specify performance objectives (POs) for each behavioral outcome. POs represent a step-by-step checklist of what needs to be done in order to reach the outcome (Bartholomew-Eldredge, 2016). To select the POs, we conducted an extensive literature review and a pilot study on a similar sample to make sure that the listed POs are feasible, possible to reach within the current school settings and resources, culturally appropriate, and accepted by the adolescents (Said et al., 2019). They can be found in Table S1-A (Supplementary file 1).

### 2.2.3. Task 3 – Determinants

The third task of the second step is to select determinants of the stated POs for the health-promoting and risk-reducing behaviors (Bartholomew et al., 1998). First, following the Core Processes methodology, a brainstorming session was conducted to identify determinants correlated with the eating behavior of children and adolescents. Next, we reviewed the empirical evidence linking the factors to the behavior and the evidence that once the determinants change, the behavior condition will also change (Bartholomew-Eldredge, 2016). Each determinant was assigned a score (Stok et al., 2018; Stok et al., 2017). The ranking procedure was adapted from Bartholomew-

Eldredge (2016) as + meaning not very important/not very easy to change; ++ meaning important/changeable; +++ meaning very important. Finally, the determinants with the highest modifiability and relevance scores were selected (knowledge, self-efficacy, attitude/positive emotions, and self-regulatory skills). The importance and modifiability scores of each of the determinants can be found in supplementary file 1 (Table S1-B).

After identifying the determinants of each behavioral outcome, we linked them to relevant POs using the literature review gathered from the needs assessment.

#### 2.2.4. Task 4 – Change objectives

After writing the POs for each behavioral outcome and specifying the corresponding determinants, the final task in Step 2 is to assess each cell of the matrix and judge whether the determinant is likely to influence accomplishment of the PO (Bartholomew-Eldredge, 2016). A selection of determinants was made to maintain a feasible length for the total program. Next, the planner writes change objectives (COs) for the personal determinants (Bartholomew-Eldredge, 2016). COs describe what needs to change, related to the determinants, for the person to execute the POs (Bartholomew-Eldredge, 2016). **Table 1** presents an example of a behavioral outcome, POs, COs, and their corresponding determinants (the complete matrix is listed in Table S1-A – Supplementary file 1).

### 2.3. STEP 3 – SELECTION OF THEORY-BASED METHODS AND STRATEGIES

In step 3, planners begin to conceptualize and design the intervention (Bartholomew-Eldredge, 2016). At this stage, three tasks need to be accomplished, which are detailed below.

#### 2.3.1. Task 1 – Generating ideas for program themes, components, scope, and sequence with the planning group

First, the planning group (a dietitian and health promotion experts) evaluated both the potential program participants (represented by Lebanese adolescents in our

case) and implementers to achieve a good overall balance between the applications, the program itself, change methods, and the program context (Bartholomew-Eldredge, 2016) based on the needs assessment obtained in Step 1. According to IM principles, the intervention plan must also account for the scope and sequence of the program, a description of each population group and program interface, and a list of program materials and staff required for the interface (Bartholomew-Eldredge, 2016). At this stage, the implementation is small scaled with only one dietitian implementing the intervention. This approach will be evaluated and used as an input for implementation on a larger scale.

In our intervention, the program participants are Lebanese adolescents aged 15–18 years who are registered in public and private high schools. The implementer of the program is a dietitian who delivers the intervention directly to the students in classroom settings at the participating schools. Each school principal designates one or two sessions per week based on the available courses, exam schedule, and holidays. The length of the intervention is expected to be around 7–10 sessions, until all topics are covered (scope). Each session lasts 20–40 minutes. The interventional material should include different chapters or lessons. Each chapter is supposed to tackle a different topic about nutrition and PA (sequence).

The program theme is encouraging healthy eating habits and regular PA practice. The program is entitled *Sahtak bi Sahnak* (in Arabic *صحتك بصحنك*), which can be translated as ‘your health on your plate’. The title is short, easy to remember, and reflects the purpose of the intervention which is to improve the quality of life and overall health by adopting healthy eating habits.

Three communication channels are included in this intervention: interpersonal, circulating print, and display print. Four vehicles were selected: health care provider (registered dietitian), intervention booklet or manual, brochures distributed to the participants at the schools, and posters displayed at schools. Having a registered dietitian with professional experience in dealing with the pediatric population to deliver the *Sahtak bi Sahnak*

BEHAVIORAL OUTCOME 3: EAT BREAKFAST EVERY DAY			
PERFORMANCE OBJECTIVES	DETERMINANTS		
	KNOWLEDGE	ATTITUDE	SKILLS/SELF-EFFICACY
PO1: Eat breakfast every day	K1: State at least 3 benefits of eating breakfast every day	A1: Express positive feelings regarding having breakfast every day	SE1: Express confidence when having breakfast every day
PO2: Detect and solve challenges facing regular breakfast consumption	K2: List at least three barriers and three solutions to not having breakfast regularly		S2: Demonstrate the ability to monitor and assess the frequency of breakfast consumption for one week

**Table 1** Example of behavioral outcome, performance objectives, change objectives and their corresponding determinants (the complete matrix is listed in Supplementary file 1).

intervention has many advantages. First, an expert in nutrition represents a powerful source of influence and persuasion (Bartholomew-Eldredge, 2016). This also captivates audiences interested in personal health issues, increases the ability to integrate evidence-based messages, and involves individuals with expertise in patient assessment and counselling (Bartholomew-Eldredge, 2016). Advantages related to using a booklet include: good audience segmentation, high audience receptivity, strong possibility for tailoring, control of distribution, and multiple messages with ongoing reach (Bartholomew-Eldredge, 2016). In other words, using booklets not only ensures that the information reaches the target population, it also allows for separating participants into two groups (intervention and control; see step 6) later in the evaluation step, and avoiding some bias such as contamination of information by controlling adolescents who receive the booklet. Posters can be very effective vehicles because they include direct messages and can be tailored to an audience by using novel images and language (Bartholomew-Eldredge, 2016). However, they have a limited influence on learning and change objectives (Bartholomew-Eldredge, 2016), so they were combined with other vehicles. As for brochures, they present many advantages as well. They can affect a variety of learning and change objectives (unlike posters). They are useful as part of multi-strategy messages, complementing other vehicles. They are also used for community-based learning, which is suitable in our case, and they reinforce the messages and the delivery of key messages (Bartholomew-Eldredge, 2016). These vehicles were chosen to suit all schools, which have different resources. For instance, PowerPoint presentations were not used because not all classes were equipped with LCD projectors.

### 2.3.2. Task 2 – Choosing theory and evidence-based change methods to address program objectives

Theory and evidence-based methods are general techniques for influencing modifications in determinants of behaviors of the at-risk group or environmental agents. To match a method with a change objective, the linking concept is the determinant involved (Bartholomew-Eldredge, 2016).

Methods were selected to match the indicated determinants, taking into account the suitability for application in a Lebanese school-setting with limited human and financial resources. For instance, active learning strengthens the two-way communication and improves the meaningful application of knowledge (Gleason et al., 2011). Verbal persuasion helps to mobilize more efforts to achieve certain behaviors and sustaining them (Bandura, 1998). In addition, guided practice is used to initiate a behavior and improve consistency (Jackson, 1997). Feedback helps in maintaining self-efficacy by solving identified problems and adjusting unhealthy

behaviors (Glanz, Rimer, & Viswanath, 2008). As for self-reevaluation, it helps in progressing towards the initiation of a behavior and its' assessment and/or alteration (Glanz & Schwartz, 2008). Counterconditioning and stimulus control help in substituting old behaviors with new ones (Bouton, 2000; J. Prochaska, Redding, & Evers, 2008). Therefore, adolescents associate a signal (e.g., hunger) with a healthy event (e.g., healthy food choices) instead of unhealthy behaviors (e.g., unhealthy food choices).

Several theories were applied to target the previously selected determinants (knowledge, self-efficacy, and skills): the Social Cognitive Theory (Bandura, 1999, 2004), the Transtheoretical Model or Stages of Change (J. Prochaska et al., 2008; J. O. Prochaska, DiClemente, & Norcross, 1992), Theories of Information Processing, Theory of self-regulation, Elaboration Likelihood model, and theories of learning. An example of some change methods selected for certain COs, based on these theories, is presented in **Table 2** (see Table S1-C – Supplementary file 1 for the complete table).

### 2.3.3. Task 3 – Selecting or designing practical applications to operationalize change methods

As part of the third task of step 3, the educational booklet of *Sahtak bi Sahnak* focuses on the outcomes listed in **Box 1**. Each chapter deals with one aspect of the nutritional guidelines such as the importance of fiber, water intake, etc. It also includes practical activities and trackers, enabling application of the knowledge gained and following their progress. Each session starts with a discussion between the dietitian and the adolescents. The participants are asked what they already know about the selected topic. Then the educator explains the lesson and uses familiar examples from daily life and practice to explain complex information (e.g., atherosclerosis and osteoporosis). It is important to note that the participants are not supposed to passively receive the information, but rather to participate in the discussions, give their opinion, and compare their own behavior with the recommendations. At the end of the intervention, the adolescents should be able to plan their own meals, self-evaluate their intake, and recognize the available opportunities and barriers affecting their eating habits.

## 2.4. STEP 4 – PROGRAM PRODUCTION

In the fourth step of IM, we have three tasks (Bartholomew-Eldredge, 2016).

### 2.4.1. Task 1 – Refining the program structure and organization that were generated in the preceding step

In the first task of step 4, the planners prepare what the participants will see, read, do, etc. as part of the intervention (Bartholomew-Eldredge, 2016). Additionally, it is important to indicate where the potential participants are going to interact with the program, and how to ensure

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**CHANGE OBJECTIVES FOR BEHAVIORAL OUTCOMES 3 AND 4**


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- **Eat breakfast every day**
- **Consume three meals per day**

K1: State at least three benefits of eating breakfast every day	<b>Active learning and persuasive communication</b> (K1 of both outcomes 3 and 4): The educator explains all the benefits related to eating breakfast and three meals regularly, in addition to what a meal looks like.
K2: List at least three barriers and three solutions to not having breakfast regularly	
A1: Express positive feelings regarding having breakfast every day	<b>Discussion</b> (K2 of both outcomes 3 and 4): Participants discuss their daily meal routines (number of meals, timings, etc.) and the reasons behind skipping meals (barriers). In addition, they discuss their feelings after having three meals versus skipping meals.
S2: Demonstrate the ability to monitor and assess the frequency of breakfast consumption for one week	
SE1: Express confidence when having breakfast every day	<b>Persuasive communication</b> (K2 of both outcomes 3 and 4): Participants receive guidance on how to avoid skipping meals and find solutions for each case.
K1: State at least three benefits of eating three meals daily	
K2: List at least three barriers and three solutions to not having three meals regularly	<b>Verbal persuasion</b> (SE1 of both outcomes 3 and 4): The educator lists successful experiences of eating all the meals regularly and the positive consequences on the daily life of adolescents. In addition, the educator encourages participants to try eating three meals per day for at least 7–10 days and see the difference.
A1: Express positive feelings regarding having three meals every day	
S1-a: Demonstrate ability to participate in planning their own meals	<b>Guided practice</b> (S1-a, S1-b): The educator provides a sample menu for three weeks and teaches the students how to plan healthy meals. Next, the participants try selecting meals of their own according to the process learned. The educator encourages them to try preparing meals by starting with the easiest ones (e.g., breakfast and dinner sandwiches). Adolescents are also guided to participate in family meal planning using their planned menu.
S1-b: Demonstrate ability to prepare their own meal	
S2: Monitor and assess the frequency of meal consumption on a weekly basis	<b>Self-monitoring</b> (S2 of both outcomes 3 and 4): Participants use the provided meal tracker to monitor the frequency of breakfast and meal consumption. In addition, they detect the reasons behind skipping meals.
SE1: Express confidence when having three meals	
	<b>Feedback</b> (A1 and SE1 of both outcomes 3 and 4): The educator provides feedback after looking at the meal tracker.
	<b>Self-reevaluation</b> (A1 of both outcomes 3 and 4): Adolescents share their feelings and experiences after eating meals regularly vs. skipping meals and reevaluate what can be improved.
	<b>Repeated exposure</b> (A1 of both outcomes 3 and 4): Adolescents are repeatedly shown posters and educational material about the importance of regular meals.

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**Table 2** Example of methods and applications used for selected change objectives related to outcomes 3 and 4 (see Table S1-C – Supplementary file 1).

that they will be in contact with what was planned (Bartholomew-Eldredge, 2016).

The school setting was selected for several reasons: (1) to reach as many adolescents as possible; and (2) many school-based interventions showed positive outcomes when it comes to improving dietary knowledge, healthy eating habits, PA practice, and adiposity (Ardic & Erdogan, 2017; Maatoug et al., 2015). Additionally, school-based nutrition education and promotion can improve the students' academic performance (Briggs, Fleischhacker, & Mueller, 2010). In Lebanon, 129,428 students are enrolled in public and private high schools, and 84.4% of all students are Lebanese (Center for Educational Research and Development, 2018).

When planning school-based interventions, the planners must determine how much material can be delivered and cognitively processed in one class session, and how many class hours are needed and can be realistically devoted to the program (Bartholomew-

Eldredge, 2016). In the *Sahtak bi Sahnak* program, after receiving the agreement of the school principal, we scheduled 20- to 40-minute sessions once or twice a week to deliver the intervention, depending on the exam dates and holidays.

It is important to note that the feasibility of delivering materials was already taken into consideration during the third step of IM. Therefore, no notable changes in the program structure and organization had to be made at this stage.

#### 2.4.2. Task 2 – Preparing production plans

Production plans or design documents guide production to ensure that the program materials and activities are culturally relevant, meet the intervention's objectives, and follow the parameters for use of their selected COs and practical objectives (Bartholomew-Eldredge, 2016). The lessons were titled as follows: benefits of healthy eating, principles of healthy eating, lipids,

physical activity, healthy weight, challenges of healthy eating and physical activity practice, vitamins and minerals, importance of water, nutritional facts label, diets, and food safety. It is important to note that the last chapter related to food safety was added to increase awareness about another nutrition-related topic leading to healthy eating, as healthy food should also be safe to eat. Table S1-E (see Supplementary file 1) lists all the chapters and activities conducted during the educational sessions.

The dietitian provided the educational sessions to each class in accordance with the schedule proposed by the school until all of the chapters had been covered. The program was age appropriate and written in an understandable language. The material was designed by a Lebanese registered dietitian (PI), taking cultural relevance into account. It was written and delivered in Arabic. The program was carefully designed to suit all Lebanese adolescents. For instance, some food items like alcohol were not part of the material as it is religiously considered a forbidden food by Muslims, who form a large part of the target population. Participants received a booklet of all the educational sessions.

### 2.4.3. Task 3 – Drafting messages and producing preliminary materials and protocols for the health promotion program

In the third task of step 4, all messages were written, translated, and finalized. First, the text of the educational material was originally written and delivered in Arabic (native language of the participants) to avoid language bias. Then, the material was translated into English, and back translated, to ensure that there is an English copy of the material to be consulted by other researchers or health promoters planning health interventions in the future.

Second, all scientific and medical terms were simplified and explained. Clear visuals that were immediately understood were used. No complex figures nor distracting backgrounds were employed. The pictures were more realistic than symbolic. And most importantly, long paragraphs were avoided, and bullet points were used to reduce the text.

Third, the booklets were printed and distributed to participants. They included 11 chapters and many fun activities (see Supplementary file 1 – Table S1-E). We purposefully used physical or hardcopies to make sure that each student would have his/her own material available during the lessons, and to avoid the need of printing the booklet at home and thus additional costs.

Fourth, the material was reviewed by a health expert in health promotion before finalizing it. In addition to the booklet, a poster was displayed on the walls of the classrooms, listing the essential recommendations regarding healthy eating and PA.

The educational material focuses more on healthy eating habits rather than obesity to avoid possible

negative perceptions such as an idealization of thinness leading to an eating disorder (Polivy & Herman, 2002). As we are including all of the students in the classrooms as participants, this reduces social stigmatization (Ten Hoor et al., 2016) and prevents the situation that children who are not overweight or obese would not be interested in participating in the program. This situation was seen with the parents of some students in a previous pilot study (Habib-Mourad et al., 2014). Moreover, 3.9% of Lebanese children under the age of 5 years are underweight (Musaiger et al., 2011).

## 2.5. STEP 5 – CREATION OF AN ADOPTION AND IMPLEMENTATION PLAN

In the fifth step of IM, the planners have four tasks (Bartholomew-Eldredge, 2016).

### 2.5.1. Task 1 – Identify program adopters, implementers, and maintainers

Before making a decision on the implementation, the planners must be informed about certain characteristics of the organization in which the intervention will be implemented, such as the size, leadership, general capacity, and feasibility of implementation (Bartholomew-Eldredge, 2016). In the present intervention, the program adopters are the school principals, as they decide whether or not to participate in an intervention. It is worth noting that public schools are not allowed to participate in any program without the approval of the Lebanese Ministry of Education. This is not the case for private schools.

The implementer of *Sahtak bi Sahnak* is the PI. Having only one implementer decreases the risk of information delivery disparities. This method of information delivery was previously mentioned in other reviews and studies (Habib-Mourad et al., 2014; Van Cauwenberghe et al., 2010). The program did not rely on teachers to deliver the intervention for several reasons: (1) this would require teachers spending additional time to be trained (e.g., staying after school), which is quite challenging; (2) they would need to teach supplementary lessons, requiring additional effort that not all of them were willing to make, and more work without additional pay; (3) the material is not part of the official curriculum, therefore, they will not be motivated to teach it as the students might not take it seriously.

As for the future maintenance of the program, we recommend including the present intervention as part of the school curriculum (e.g., life sciences course), after training the teachers on how to deliver it as part of their continuing education plan. This will reduce the costs of hiring external staff. Teachers will be trained by the PI to deliver the information following the specified methods in table S1-C. Teachers may also use the dietary knowledge and adherence questionnaires to assess the dietary knowledge and adherence levels before and after the intervention. The training will include: (1) an

explanation of the methods that should be applied; (2) the time that should be dedicated for each lesson; and (3) an explanation of the educational material. Teachers may follow the same POs as in **Table 4**.

**2.5.2. Task 2 – Stating outcomes and performance objectives for program adoption and implementation**

During the second task of the fifth step, we need to determine who has to do what in order for the program to be adopted, implemented, and maintained with acceptable completeness and fidelity (Bartholomew-Eldredge, 2016). The main adoption outcome was that at least 10 high school principals would adopt the *Sahtak bi Sahnak* program in the 2017–2018 academic year in their schools located in Beirut, Baalbeck, and Rayak (to reach a sample size of at least 800 participants). In this case, the POs are that the school principals: (1) evaluate the need to implement the program; (2) review all the information regarding the program; (3) sign the consent letter after deciding to participate in the program (see **Table 3**). The school management is an essential stakeholder for this intervention (Ten Hoor et al., 2016). Their commitment and involvement are important for the communication with the students and their parents. After the agreement, the school principals schedule the intervention sessions during class-time and visit all classes to introduce the program adopter (PI) and the program to the students.

As for the implementation, the main outcome is that the *Sahtak bi Sahnak* program is implemented the 2017–2018 academic year in the schools located in Beirut, Baalbeck, and Rayak. POs are the following:

PO1- The PI prepares the educational material for the *Sahtak bi Sahnak* program;

PO2- The PI implements all the lessons;  
 PO3- The PI provides the educational material to all participants (see **Table 4**).

In addition, the PI should provide program updates to the research team. At this stage, the planners clearly describe the implementation outcomes when defining POs for program delivery, considering such elements as fidelity, completeness, and dose (Bartholomew-Eldredge, 2016). The implementer is well aware of the duration needed to cover the required educational material and follow the plan, in addition to the amount of information to deliver in each session to avoid overloading participants with new instructions.

The last part of this task is related to program maintenance, when the program continues over time and becomes institutionalized (i.e., integrated as part of the organization’s routines) (Bartholomew-Eldredge, 2016). As maintenance is beyond the scope of the current project, we limit this part to mentioning who will maintain the program and the reasons behind doing so. Thus, before thinking about how this program can be maintained, we must consider the threats and facilitators of maintenance.

The main suggestion to maintain this program in the long term is to make it part of the school curriculum, instead of keeping it as a separate intervention, for several reasons: (1) avoiding the need to take other classes’ time: when this intervention was given during class-time, it was scheduled during other school classes such as physical education, second foreign language, or arts classes; (2) forcing all students to study the material: some students do not take extracurricular courses seriously because they are not included in the official

**ADOPTION OUTCOME: AT LEAST 10 HIGH SCHOOL PRINCIPALS ADOPT THE SAHTAK BI SAHNAK PROGRAM IN THE 2017–2018 ACADEMIC YEAR IN THEIR SCHOOLS LOCATED IN BEIRUT, BAALBECK, AND RAYAK**

PERFORMANCE OBJECTIVES	DETERMINANTS	
	KNOWLEDGE	ATTITUDE
PO1: The school principal evaluates the need to implement the program	K1-a: Define common health risks related to overweight, obesity, and sedentary lifestyle among Lebanese adolescents K1-b: Define the consequence of unhealthy eating habits and sedentary lifestyle on school performance K1-c: List at least 2 factors affecting eating behaviors among Lebanese adolescents K1-d: List at least 2 factors affecting PA practice among Lebanese adolescents	
PO2: The school principal reviews all the information regarding the <i>Sahtak bi Sahnak</i> program	K2-a: List at least 2 objectives of the intervention K2-b: Recall at least 2 benefits of the intervention	
PO3: The school principal signs the consent letter after deciding to participate in the program	K3: Stating where to sign the consent letter presented by the PI	A3: Express positive feelings about signing the consent letter to participate in the <i>Sahtak bi Sahnak</i> program

**Table 3** Program use outcomes, performance objectives, and change objectives for adoption.

**IMPLEMENTATION OUTCOME: THE PRINCIPAL INVESTIGATOR IMPLEMENTS THE SAHTAK BI SAHNAK PROGRAM IN THE 2017–2018 ACADEMIC YEAR IN THEIR SCHOOLS LOCATED IN BEIRUT, BAALBECK, AND RAYAK**

PERFORMANCE OBJECTIVES	DETERMINANTS		
	KNOWLEDGE	ATTITUDE	SELF-EFFICACY/SKILLS
PO1: The PI prepares the educational material for the Sahtak bi Sahnak program	K1-a: Recognize nutritional and PA guidelines of adolescents K1-b: Recognize the cultural characteristics of the Lebanese population		S1: Demonstrate ability to prepare a tracking chart of all the explained lessons in each class
PO2: The PI implements all the lessons of Sahtak bi Sahnak	K2-a: Recall the content of each lesson and activity of the program K2-b: List the order of the lessons and activities of the program	A2: Express positive attitude about implementing the lessons according to the Sahtak bi Sahnak program objectives	SE2: Express confidence in implementing the intervention S2-a: Demonstrate the ability to conduct the intervention by explaining each lesson within the assigned time S2-b: Demonstrate good communication skills to effectively implement the lessons S2-c: Complete records of the lessons that were explained in each class to track progress
PO3: The PI provides the educational material to all participants	K3: Recognize the number of required booklets to provide in each class during the first week of the intervention		SE3: Express confidence in distributing the educational material to all participants S3: Demonstrate the ability to distribute the educational material to all participants including resistant students

**Table 4** Program use outcomes, performance objectives, and change objectives for implementation.

exams. Another challenge to take into consideration is who will be taught to explain the lessons. Taking into consideration the limited financial resources in most of the schools, it would be better to train the teachers to deliver the intervention, as was practiced in many school-based interventions (Van Cauwenberghe et al., 2010). The lessons can be easily translated into English or French (an English copy is already available, and the French booklet is available upon request). However, it is important to note that the same outcome and POs will be followed during maintenance by school teachers, except for PO1 related to the preparation of the educational material as it has already been created.

### 2.5.3. Task 3 – Constructing matrices of change objectives for program adoption, implementation, and maintenance

During the third task of the fifth step of IM, we need to develop a matrix to guide the implementation and adoption (Bartholomew-Eldredge, 2016). We start by listing the determinants and COs related to adoption, and then move to implementation. Many factors affect the adoption of nutrition and PA related programs in Lebanese schools:

- (a) approval of the Lebanese Ministry of Education and Higher Education (MEHE): Lebanese public schools are not allowed to participate in any program without the approval of MEHE first. However, this is not the case for the private schools, which is why they are harder to recruit as each private school needs to be recruited separately (Habib-Mourad & Ghandour, 2015);
- (b) resources: Due to the school's limited resources, the program should not create additional costs (Bergström et al., 2015).
- (c) knowledge: Principals agreed that obesity is an issue among school adolescents in general (Nollen et al., 2007). However, many reported that these cases were exceptions rather than the common rule (Nollen et al., 2007). In addition, they also agreed that schools may influence this problem and should be part of the solution (Nollen et al., 2007). However, recognizing the problem is not enough, the school principals should be aware of the health problems and consequences that obesity has on adolescents' lives;
- (d) school priorities: Even though the school principals felt that student health was important, most of them did not consider it a top priority like academic achievement (Nollen et al., 2007). It is important to emphasize the correlation between healthy eating and PA and improved academic performance to increase the chances of adoption;
- (e) attitude: Some school principals showed a positive attitude towards PA (van den Berg et al., 2017). They reported that they found it important for their students as it positively influences the children's ability to learn (van den Berg et al., 2017);
- (f) educational policy: School principals and school staff reported a lack of coverage of nutrition in the national curriculum (Townsend et al., 2017). They also added that the curriculum did not demand it because teachers lack the necessary knowledge and skills on this topic to teach

them appropriately (Townsend et al., 2017). In addition, the educational policy places more importance in the school curriculum on subjects such as science and mathematics rather than agriculture (Townsend et al., 2017). It is another reason to encourage adopters to participate in this intervention as it fills this gap by having a nutrition expert teaching the students these missing chapters in their schoolbooks.

As for the implementation, the main determinants are (Atkins et al., 2017): (a) knowledge: being aware and familiar with the content of the material, objectives, and how to implement it; (b) attitude; (c) skills: being trained, having skills, and having practiced the implementation of the health promotion intervention in school settings for Lebanese adolescents; (d) self-efficacy: having confidence in implementing the program even when the participants are not motivated.

In addition to these determinants, many factors should be taken into consideration when implementing the intervention:

- (a) flexibility and work routines: Due to the high workload of schools, the program needs to be flexible and not to interfere with the school curriculum and exam schedule (Bergström et al., 2015);
- (b) meaningful content: the program should be perceived as meaningful and dealing with important issues (Bergström et al., 2015);
- (c) being part of a research project is considered a facilitator (Bergström et al., 2015). Apparently, people tend to trust such programs more since they are well controlled and supervised;
- (d) professionalism and personal contact with the research team (Bergström et al., 2015);
- (e) work routines: The classroom component was well accepted because it was well adapted to the school setting and easy to integrate into daily routines (Bergström et al., 2015).

Other determinants related to the implementation of the program include (Bessemers, van Assema, de Vries, & Paulussen, 2014): (a) self-efficacy; (b) modelling; (c) outcome expectations; (d) low program complexity and compatibility with the subject that the implementer teaches; (e) perceived need for innovation: how relevant is the proposed innovation to the public's needs? (Durlak & DuPre, 2008).

#### 2.5.4. Task 4 – Choosing change methods and practical applications, designing the scope and sequence, and producing materials for an implementation intervention to influence program use

During the fourth task of the fifth step, the planners

use information from the previous steps to select implementation methods and practical applications (Bartholomew-Eldredge, 2016). In this section, we only elaborated PO2 and PO3 because as the implementer is an experienced dietitian, there is no need for any training related to PO1. The related methods were matched to COs based on Bartholomew-Eldredge (2016). Table S1-F (see Supplementary file 1) provides detailed information of the behavior change techniques and practical applications used during this step (Hurley et al., 2016). The current evaluation study was conducted in accordance with the Declaration of Helsinki, and the protocol was approved by the Lebanese Ministry of Education (15465/3/2016; date: 06/10/2017) and the Lebanese International University Institutional Review Board (LIUIRB-171212-LS1) after reviewing all the educational material, questionnaires, and procedures.

### 2.6. STEP 6 – CREATING AN EVALUATION PLAN

The sixth step in IM consists of planning and conducting an evaluation for the designed intervention (Bartholomew-Eldredge, 2016).

#### 2.6.1. Task 1 – Writing process and effectiveness questions coming from a review of the program logic models, goals, objectives, and the IM matrices

*Effect evaluation*

Effect evaluation is the process of measuring a program's effectiveness in changing one or more aspects of the nutritional or health status (Boyle & Holben, 2012). It describes the differences in outcomes with and without the intervention (Bartholomew-Eldredge, 2016).

As was mentioned under steps 1 and 2, the main behaviors related to obesity among adolescents are unhealthy eating habits and physical inactivity. Therefore, the variables related to effect evaluation are increased consumption of healthy food items, decreased consumption of unhealthy food items, and increased hours of PA practice. These three variables are grouped as increased adherence to dietary guidelines. In addition, one of the main determinants influencing these variables is knowledge, which will be also evaluated. Even though weight and height were collected at baseline, they were not used as indicators of the effectiveness of the intervention. This is because the program's duration was too short to affect anthropometric measurements. In addition, health and quality of life outcomes cannot be evaluated in short-term interventions that seek to change behavior to prevent health effects occurring later (Bartholomew-Eldredge, 2016). The other determinants will not be evaluated due to the limited class session number assigned by the schools. At this stage, we evaluated levels of dietary knowledge and adherence pre- and post-intervention (see Table S1-G, Supplementary file 1). The intervention is considered effective once a significant increase is found in the total knowledge score and total adherence index.

### Process evaluation

Process evaluation aims to describe program implementation (Bartholomew-Eldredge, 2016). It included monitoring of the feedback, reach and recruitment, and participation. Techniques that were used to collect this information involved observations and self-administered questionnaires for the participating adolescents (see Table S1-F, Supplementary file 1). To evaluate the content of the material in terms of interest, comprehension, and novelty, a feedback questionnaire was designed for this purpose (see Table S1-J, Supplementary file 1). Additionally, some participants were interviewed and given open questions to answer regarding the determinants of their eating habits to check if there were any hidden determinants previously mentioned in the literature (see Table S1-I, Supplementary file 1).

## 2.6.2. Task 2 – Developing indicators and measures to assess the selected effect and process evaluation questions

### Questionnaires

As part of the second task of step 6, the selection of indicators was based on the needs assessment by measuring either the behaviour of the at-risk population (i.e., eating healthily) or the determinants (i.e., knowledge) (Bartholomew-Eldredge, 2016). Five instruments were selected and/or created for the evaluation of this program: (1) Dietary Adherence Questionnaire (DAQ); (2) Dietary Knowledge Questionnaire (DKQ); (3) 24-hour recall; (4) Feedback questionnaire; and (5) Determinants of eating habits questionnaire. All of the questions were translated into Arabic (native language of participants) and adjusted to suit the Lebanese culture and lifestyle; for instance, Lebanese traditional dishes and food items like Akkawi cheese and labneh replaced unknown or unpopular food items like edam cheese. As the DAQ and DKQ are detailed elsewhere (Said et al., 2019), the other tools are elaborated below.

- 24-hour Recall:

The 24h recall was administered to all participating adolescents to estimate their dietary intake. Subjects were asked by the dietitian (PI) and the trained research assistant to recall the exact food intake during the previous day (Gibson, 1990). This detailed description of all foods and beverages consumed (e.g., brand names, portion sizes, etc.) was recorded by the interviewer (Gibson, 1990). The 24h recall was administered pre- and post-intervention to evaluate the influence of the intervention on the participants' intake, and to assess the correlation between the DAQ, DKQ, and 24h recall results. Even though this method has some limitations such as misreporting intakes accurately by the subjects and memory bias, it presents a small respondent burden

and high compliance (Gibson, 1990), which may appear useful when dealing with adolescents.

- Determinants Questionnaire:

The brief Determinants Questionnaire consisted of seven open-ended questions about the participants' most and least preferred foods or dishes, factors affecting their eating habits, their interpretation of healthy eating, whether they consider their diet healthy, and the barriers and facilitators of healthy eating. It was administered to the adolescents and their parents. The parents were asked the same questions about their children's eating behaviours. First, classes were randomly selected from public and private schools located in urban and rural regions. Each class was interviewed separately. Only classes with a small number of students ( $\leq 20$ ) were selected because focus groups are usually composed of a relatively small number of participants and we were not able to divide the class into two groups and ask one of them to leave. The total number of students was 44 (none of them refused to participate). However, it is worth mentioning that only one private high school chose to invite the parents; the other school principals reported that the parents will not attend since they did not attend previous meetings either. As a result, only four parents out of more than 220 attended the meeting with the interviewer. The interviewer followed the question sequence listed in Table S1-I (see Supplementary file 1) *by reading them out loud and explaining each question separately. Then the participants were given time to answer orally, express their opinions, and write the responses on the distributed sheets. Each session lasted around 20 minutes. This questionnaire did not target PA because similar interviews are planned for the future.*

- Feedback questionnaire:

A feedback questionnaire (see Table S1-J, Supplementary file 1) was administered at the end of the intervention to assess the satisfaction with interest, clarity, and novelty of the program. It included a total of seven questions: four questions related to program rating (from zero to 10, 10 as the highest score), two questions related to choosing the best and worst chapter(s), and one question related to comments and suggestions.

### Reach and participation rate

Reach was assessed as the percentage of adolescents in the participating schools who received the intervention. As the program was delivered in school settings, the program reached all the adolescents present in schools at the moment of the intervention. One of the indicators of success of any program is the rate of participation and dropouts (Boyle & Holben, 2012). Participation rates were calculated by comparing the number of participants to

the total number of eligible participants in every included school. It is important to note that all subjects gave their informed consent for inclusion before they participated in the study.

### 2.6.3. Task 3 – Specifying designs for conducting process and effect evaluations

The program planners used a clustered randomized controlled trial (CRT) to assess the efficacy of the *Sahtak bi Sahtak* program to improve the level of dietary knowledge of Lebanese adolescents, and to increase their adherence to nutrition recommendations to improve their overall health. Both qualitative and quantitative methods were used, therefore we followed the sequential mixed method design (Bartholomew-Eldredge, 2016). In this case, qualitative findings were used to explain the underlying reasons behind the quantitative results (Wisdom & Creswell, 2013).

#### *Study population*

##### A) Schools:

Schools were selected based on the lists available at the Lebanese Ministry of Education and on its website, including Lebanese public and private schools located in Beirut, Baalbeck, and Rayak. These particular regions were chosen because: (1) Beirut is the capital and largest city in Lebanon (urban sample); (2) Baalbeck and Rayak are located in the Bekaa area, which is considered Lebanon's most important farming region (rural sample). In addition, public and private high schools were both selected to include various socioeconomic levels since middle- and high-income families in Lebanon generally tend to enroll their children in private schools as they can afford the high annual tuition fees, and lower-income families tend to send their children to public schools for a nominal fee (Habib-Mourad et al., 2014).

Inclusion criteria were (1) public and private high schools located in Beirut, Rayak and Baalbeck; (2) schools starting at eight in the morning and having only seven class sessions. First, and after meeting with the school principal, an informative letter along with the consent form was given to them to sign. The school principal had enough time to read it and ask any additional questions. The consent and informative letters were written in lay terminology, and did not contain any medical or scientific terminology nor any abbreviations and acronyms.

A total of 16 high schools chose to participate, and they were divided into two groups: intervention and control. Nutrition education was provided to the intervention group once or twice per week during one session (20–40 minutes). The control group did not receive any intervention during this period.

##### B) Participants:

Participants were recruited from the included Lebanese high schools located in Beirut and the Bekaa area

(see above). Once the school's approval to participate was received, recruitment of the students was started. After getting the consent of the school administration, the PI, accompanied by the school principal, visited classes, introduced herself, and explained clearly the purpose of the research as well as all the necessary details in Arabic. Questionnaires were distributed to all participants and it was clarified that by filling in the questionnaires and submitting them, the students were agreeing to participate in the program. Inclusion criteria for the students were: (1) Lebanese adolescents enrolled in public and private schools; (2) aged 15–18 years; (3) fully capable in cognitive, psychiatric, and physical terms to communicate as reported by the parents or the school administration; (4) not having any chronic or genetic diseases such as chronic kidney disease, diabetes, etc. as reported by the parents or the school administration.

### 2.6.4. Task 4 – Specifying and completing the evaluation plan

The results of the evaluation plan have been developed and published elsewhere.

## 3. DISCUSSION

This paper presents the detailed stepwise process used to develop *Sahtak bi Sahnak*, the first pediatric obesity prevention intervention designed for Lebanese high school students, as well as the protocol for its evaluation. It is the first intervention for this target group that was developed using the full six steps of the IM process, and it includes students from both urban and rural areas and from both public and private schools. This intervention plan was preceded by a pilot study that tested the questionnaires and assessed feasibility (Said et al., 2019). To our knowledge, very few school-based overweight prevention studies have been conducted in the Asian Arab region (Habib-Mourad et al., 2014). With this paper, we therefore aimed at contributing to the knowledge in this field.

This intervention presents several strengths. It was evidence-based and corresponded with the nutrition guidelines. In addition, the design of this intervention used IM, which is regarded as a model for the design, implementation, and evaluation of the program. It not only guides the path of intervention development and evaluation, it also provides a framework for documenting decisions (Kwak et al., 2007). Schools are not required to adopt new responsibilities nor to work extra hours as the intervention does not rely on teachers to implement the lessons, making it easier to convince the schools to participate. Once the principals see the benefits of such programs, we expect them to be more interested in adopting the intervention in the future.

*Sahtak bi Sahnak* takes into consideration the personal factors affecting food and activity decisions and teaches

adolescents how to make the right choices and adapt healthy lifestyles to their circumstances even if they cannot modify their environment. In addition, the materials are culturally adequate and designed specifically to suit Lebanese students. It is written in Arabic and easy to understand. It is a multicomponent intervention focusing on different aspects to prevent obesity. The program was administered in school settings, which leads to a maintained continuous and concentrated contact with adolescents. Interventions can be made cost-effective in schools and can occur within the context of a child's natural environment (Hoelscher, Evans, Parcel, & Kelder, 2002). Schools and parents expect high grades and good academic performance, but they often disregard healthy eating and a physically active lifestyle. School-based nutrition education and promotion can help augment the students' performance at schools (Briggs et al., 2010).

Limitations were identified as well: the parents were not included in the intervention. Based on the pilot study (Said et al., 2019), we expected low commitment and participation from the parents. Inclusion of the parents may be a future goal in further intervention development and refinement. Furthermore, the adolescents' environment was not changed as that requires more complex procedures involving different administrative approaches, budgeting issues, food safety concerns, and parental involvement, which did not fit into the specified time period for this program and might discourage schools from participating. Even though the intervention mainly targeted dietary behavior, the educational material did include one lesson related to PA. In line with this, the dietary adherence and the dietary knowledge questionnaires also included questions related to PA and sedentary behaviors to assess their baseline activity levels and to evaluate any possible changes after the intervention. Nonetheless, separate evaluation of the different behavioral outcomes would have been valuable. Finally, the duration of the program was limited because it had to correspond with school schedules, holidays, and exams.

With regard to further dissemination, future interventions should consider two important factors that may influence the effectiveness and efficiency of the program: (1) Teachers' training: The research team should estimate the training duration taking into account the number of teachers, their availability, and their location. In addition, a teachers' training manual should be created that is suitable to educators with different dietary knowledge levels; (2) Teachers' readiness to participate: The research team should evaluate the teachers' readiness to deliver the nutrition lessons knowing that most of the school principals in private schools refused to participate for numerous reasons (e.g., lack of time, busy schedule, etc.). One of the schools reported that they were not able to finish the regular curriculum. Future interventions should also

target school staff (principals and teachers) to come up with the best way to integrate the intervention into one of the courses (e.g., life sciences).

### 3.1. IMPLICATION FOR PRACTICE, FUTURE RESEARCH, AND POLICY

The current intervention is the first nutrition intervention for high school adolescents in the Arab world, it is also the first intervention based on the IM protocol in the Arab countries, and the first Lebanese nutrition intervention to include participants from both urban and rural areas.

The paper provides insights in the role of IM in designing a school-based nutrition intervention to prevent pediatric obesity. Future studies are needed to evaluate its application in the school curriculum and in other Arab countries. Taking into consideration the socio-economic challenges faced by some developing countries such as Lebanon, this inexpensive and low-burden intervention can be of a particular interest to policymakers searching to encourage healthy eating habits among the Lebanese youth.

## 4. CONCLUSION

The current paper describes the application of the IM protocol for the development of the *Sahtak bi Sahnak* intervention. The IM protocol allowed us to develop a theory-based, low-resource intervention, which can be integrated as part of the educational curriculum of public and private high schools in Lebanon. This study also provides a detailed example of the application of the IM approach in its six steps. Even though the application of IM is a time-consuming process, it serves as a valuable tool in the health education field and provides a high level of transparency to further and replicate the process further.

## ADDITIONAL FILES

The additional files for this article can be found as follows:

- **Supplementary File 1.** (Table S1.A. The complete matrix of change objectives for adolescents; Table S1-B. Relevance and changeability of the selected determinants influencing dietary behaviors of children and adolescents; Table S1-C. Method and strategy matrix used in the Sahtak bi Sahnak intervention; Table S1-D: List of parameters of each method and their application; Table S1-E. Description of the lessons included in the educational material; Table S1-F. Theoretical methods and practical applications related to the adoption and implementation of the program; Table S1-G. Brief evaluation plan for the program; Table S1-H. Process evaluation questions for the Sahtak bi Sahnak

program; Table S1-I. Questions included in the determinants questionnaire; Table S1-J. Feedback questionnaire). DOI: <https://doi.org/10.5334/hpb.27.s1>

- **Supplementary File 2.** (Intervention material in English and Arabic languages). DOI: <https://doi.org/10.5334/hpb.27.s2>

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## COMPETING INTERESTS

The authors declare no conflict of interest. Al Rifai had no role in the design, execution, interpretation, publication or writing of the study.

## AUTHOR CONTRIBUTIONS

All authors have read and agree to the published version of the manuscript. Conceptualization, L.S. and S.P.J.K.; methodology, L.S. and S.P.J.K.; validation, F.S., J.S.G. and S.P.J.K.; formal analysis, L.S.; investigation, L.S.; resources, L.S.; writing—original draft preparation, L.S.; writing—review and editing, L.S., F.S., S.P.J.K. and J.S.G.; supervision, J.S.G. and S.P.J.K.; project administration, L.S.

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