

# Sahtak bi sahnak. Your health on your plate

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**SAHTAK BI SAHNAK**

**YOUR HEALTH ON YOUR PLATE**

THE DEVELOPMENT, IMPLEMENTATION, AND EVALUATION OF  
A NUTRITION PROGRAMME FOR LEBANESE ADOLESCENTS



Liliane Said

The research presented in this dissertation was conducted at the School for Nutrition and Translational Research in Metabolism: NUTRIM, Department of Health Promotion, of the Maastricht University.



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**THE DEVELOPMENT, IMPLEMENTATION, AND EVALUATION  
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ADOLESCENTS**

Dissertation

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# Chapter 1

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## General Introduction

## Chapter 1

Obesity is defined as an excessive accumulation of fat mass (1). The term is derived from Latin *obesus* meaning fat or stout (2), and it appeared in the English language in the seventeenth century (2). Although the negative health complications related to obesity were already described by several ancient physicians such as the Greek physician Hippocrates, the Roman physician Galen, and the well-known philosopher and physician Ibn Sina (i.e., Avicenna) (3), it was considered as a symbol of wealth, health, and beauty (4). This is reflected in the pre-historic figurine known as the Venus of Willendorf, dating to 25000 BC, as well as in the numerous renaissance paintings such as *Venus at the Mirror* (by Pieter Paul Rubens) and *Portrait of the Tuscan General Alessandro del Borro* (attributed to Charles Mellin; 4, 5). Interestingly, what was once regarded as a beauty standard, today has become a global epidemic.

To battle this health issue, two options may be considered: (i) obesity treatment, for instance by following the appropriate dietary treatment (i.e., medical nutrition therapy, exercise, behavioural interventions, and possible pharmacotherapy and bariatric surgery; 6, 7); (ii) obesity prevention: According to Lobstein, Baur (8), “prevention is the only realistic solution”, as our current options to treat obesity do not cure it, but merely bring it under control. In addition, the multidisciplinary and intensive approach needed to treat obesity is expensive and may be unaffordable for numerous countries (8).

As yet, the obesity pandemic cannot be resolved with a vaccine or a pill, as its causes have been rooted into the individuals’ lifestyle, environment, and system. Obesity can be impeded with healthy eating and regular physical activity (9). This emphasises the importance of obesity prevention interventions especially among the youth which represents the future generations.

This dissertation presents the development, implementation, and evaluation of *Sahtak bi Sahnak* <sup>1</sup>صحتك بصحتك, a school-based nutrition programme aimed at improving the dietary knowledge and adherence among 15-18-year-old adolescents in Lebanon. This general introduction starts with a description of the rationale of the programme. Next, it provides a description of the nutritional status of Lebanese adolescents and the Lebanese educational system. The second part of this chapter presents the design of *Sahtak bi Sahnak* and its aims. This introduction ends with an outline of the studies presented in this thesis.

## Rationale

According to the World Health Organization (10), paediatric obesity is one of the most serious global health problems of the current century. In the last 40 years, the number of obese children and adolescents increased by more than 11 times, reaching a total of 124 million in 2016 (11). The Arab countries are no exception. In 2016 (representing the currently

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<sup>1</sup> We use the original Arabic title of the programme throughout this dissertation. *Sahtak bi Sahnak* means “your health on your plate” in English which reflects the importance of nutrition for the overall health.

most recent data), the prevalence of obesity among 5-19- year-old children and adolescents reached 22.9% in Kuwait, 17.6% in Egypt, 12.9% in Jordan, and 8.5% in Tunisia (12). In Lebanon, the prevalence of obese children and adolescents increased from 9.4% in 2000 to 13.9% in 2016 (12). No serious efforts were undertaken in the region, including Lebanon, to manage this issue, despite the alarming rates.

The body mass index (BMI) is considered an appropriate predictor of adiposity in children and adolescents older than nine years of age (13). BMI measurements are inexpensive, non-invasive, and relatively easy and quick to obtain in schools and communities (14, 15). They may be also used in surveillance studies and in intervention evaluations (15).

Paediatric obesity is of concern because it is associated with numerous immediate and later onset health issues. First, obese youth are more likely to have cardiovascular complications, hypertension, dyslipidaemia, sleep apnoea, non-alcoholic fatty liver disease, type 2 diabetes (8), and orthopaedic problems (16). Second, obese children are at a higher risk of having psychosocial distress such as stigmatisation, low self-esteem, body dissatisfaction, and depression (8), as well as impairments in academic achievement (8, 17-19). Furthermore, paediatric obesity may last until adulthood leading to even more health complications (1) such as diabetes type II, coronary heart diseases, and some types of cancer (20, 21). From an economic point of view, obesity increases the burden on the healthcare system, as well as on the national budget, both directly (i.e., increased costs of health care) and indirectly (i.e., lost productivity) (22, 23). In addition, reversing the obesity balance may positively impact both health and financial sectors in the country. For instance, a reduction of obesity by 1% would reduce the diabetes incidence by over 1000 cases per 100 000 of the population by 2030 in Lebanon, Kuwait, and Saudi Arabia (24). Similarly, a micro-simulation showed that a 1% reduction in the BMI of overweight and obese Mexicans might save 43 million USD in 2030 (25). Therefore, obesity prevention should be considered an international priority.

### *Determinants of paediatric obesity*

Weight gain, mostly in the form of fat storage, occurs when energy intake outweighs the energy expenditure (26). Although maintaining an energy balance looks like a fairly simple equation, in reality it is a far more challenging process considering the multitude of genetic, biological, psychological, sociocultural, and environmental factors (9). As the genetic and biological factors are currently beyond our reach (i.e., gene modification), we will focus on the energy balance-related behaviours (EBRBs). Several unhealthy eating behaviours were correlated with obesity such as the consumption of soda and all sugar-sweetened beverages (27), higher fat intake (28), lower intake of dairy products (29), a decreased intake of vegetables (30), fruits, and milk (31), skipping meals and breakfast (32, 33), and an increased number of snacking (34). In addition to the dietary habits, the physical

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activity (PA) level has also an impact. Toschke et al. (2005) reported that a decreased PA level at school was associated with higher odds of obesity (32). In line with this, a large study conducted in the UK found that active commuting was significantly and independently associated with a decreased BMI and percentage of body fat for men and women (35). Additionally, an increased screen viewing time was positively associated with obesity (36).

According to the EnRG framework (37), energy balance-related behaviours are affected by cognitive factors, environmental factors, and moderators. Several theories address the cognitive determinants related to eating behaviours and levels of PA. According to the Theory of Planned Behavior (TPB) (38), behaviour is predicted by intention, which is guided by three main factors: attitude, subjective norm, and perceived behavioural control. The Integrated Behavior Model (IBM) suggests that in addition to the previously mentioned determinants, knowledge, skills, habit, and environmental constraints also influence the behaviour (39). Similarly, the DONE framework, an interdisciplinary framework of the factors that shape nutrition and eating, mentioned similar determinants (40). Interestingly, the latter framework allows us to focus on age-specific categories such as school-aged children and to rate the determinants according to their relevance and modifiability. This is of great importance as it allows narrowing the target behaviours when planning an age-tailored intervention (41). Several studies have shown that higher levels of nutrition knowledge are significantly and positively correlated with healthier eating habits (e.g., 42-44). In addition, self-efficacy was found to be strongly associated with fruit and vegetable consumption (45) and with nutrition knowledge (46). In Lebanon specifically, very few studies have evaluated the determinants related to eating habits and PA of children and adolescents. Nutrition knowledge was found to be a protective factor against overweight/obesity among university students in Tripoli, Lebanon, but its influence on the dietary intake was not examined (47).

Furthermore, the environment shapes the EBRBs (37). The ANGELO framework (48) describes this influence in detail at the macro- and microlevel. It is important to note that environmental determinants may be among the hardest to influence as it often means targeting decision makers, rather than the target population (41). For instance, a lack of fruits and vegetables in the neighbourhood supermarkets may lead the children to not eating them (49). In such case, what individuals could do is to learn how to use the available resources to their own good. In line with this, Bartholomew-Eldredge (41) suggested that, in some situations, it might be difficult to modify an environmental condition (e.g., limited financial resources, inability to replace competitive food with healthy options at school shops, etc.). As a solution, the programme planners can prepare the at-risk population to deal with the environmental conditions instead of modifying the environment (e.g., teaching the adolescents to prepare their own snacks and bring them to school). Such an approach was previously used in the Kaledo intervention (50). Therefore, the current

dissertation will focus solely on the individual determinants and factors related to paediatric obesity and overweight.

The EnRG framework also indicated that moderators might influence the impact of environmental and cognitive determinants on EBRBs. These moderators include demographic factors (37). According to Naja, Hwalla (51), adolescent girls are more adherent with the traditional Lebanese diet compared to boys, which was associated with lower odds of overweight. Another study also found that the male gender is associated with higher odds of obesity among Lebanese 12-19-year adolescents (52). Furthermore, a study found that adolescents aged 17-19 years with a higher socioeconomic status (SES) consume less carbohydrates, more proteins, and more fat compared to those of lower SES (53). In addition, engagement in clustered behaviour (i.e., co-occurrence of behaviours) is another important factor influencing EBRBs (37). Unhealthy EBRBs often cluster with other unhealthy ones (e.g., eating unhealthy snacks and watching TV), whereas healthy behaviours also often co-occur with other healthy behaviours. For instance, a study from New-Zealand found that adolescents who adhere to screen viewing time guidelines had healthier dietary patterns as they consumed less soft drinks and fast food (54). Another review reported that the pattern of a meal (e.g., having or skipping breakfast) is an important determinant of diet quality, and thus may influence the overall health (55).

### *The role of parents*

Parents also shape the eating patterns of their children by influencing several aspects such as the food availability at home, food purchases, meal preparation, and consumption (i.e., restriction or pressure to eat more) (56-61). In addition, parental dietary knowledge may also affect the diet of the children (40). In younger children, some studies have reported significant and positive correlations between parental nutrition knowledge and their child's diet quality (62). On the other hand, Chari, Warsh (63) found no significant association between adolescent's obesity and the food literacy of the parents. It is also important to note that some studies found no significant correlation between the eating behaviours of the parents and their children's weight status (64). In Lebanon, very few studies investigated the parental influence on their children's eating patterns (65), and none studied the correlation between both the parental and their children's dietary adherence and knowledge levels. Such research could help us understand the determinants surrounding the EBRBs of Lebanese adolescents and consequently plan health promotion interventions accordingly.

### *Lebanese adolescents' eating patterns*

During the last decades, the changes in demographic, socioeconomic, and health status in most Arab countries, including Lebanon, were accompanied with a nutrition transition, resulting in a shift from traditional Mediterranean dietary patterns towards unhealthier eating habits (66, 67). In terms of macronutrients, the fat intake of Lebanese adolescents aged 12-19 years exceeded the acceptable macronutrient distribution ranges

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(AMDRs), whereas the carbohydrate and protein intake were normal (52). This may be partially due to a high fast food intake representing 17% of the daily intake (52). As for the micronutrients consumption, very few studies are available. Salamoun, Kizirian (68) reported that 88% and 84% of Lebanese adolescents did not meet the adequate intake recommendations of calcium and vitamin D, respectively. No data is available regarding the prevalence of iron deficiency in school-aged children (69).

The EBRBs of the Lebanese children and adolescents changed over time as well. As they grow older, they tend to eat breakfast less frequently, eat more outside of the home, and are less physically active and more sedentary (52). Several dietary and lifestyle factors were found to be significantly associated with overweight and obesity among Lebanese adolescents. For instance, higher intakes of sugar sweetened beverages and a prolonged sedentary time were positively correlated with obesity, while higher intakes of milk, dairy products, fruits, and vegetables were inversely correlated with overweight and some adiposity indicators, respectively (52). These findings emphasize the importance of implementing preventive measures focusing on EBRBs to improve the eating habits and PA level of this age category.

### *Strategies to prevent obesity and the role of schools*

In response to the alarming increase of obesity rates and the unhealthy shift in dietary patterns, numerous regional and international strategies and recommendations have been established to resolve this global issue. Schools should be considered as a national focal point for obesity prevention (15), especially that they are one of the most practical and favourable settings (8, 70) that may play a significant role in preventing childhood obesity (71). In addition, integrating nutrition education as part of the school's curriculum and improving nutrition literacy is in line with the schools' pedagogical mission (71). Several studies showed that school-based nutrition interventions resulted in improved dietary knowledge (72, 73), eating patterns (72, 74) and reduced overweight and obesity (74, 75). In Lebanon, more than half of the adolescents (64.9%) are enrolled in secondary schools (76). Therefore, schools are a favourable access point due to their high potential reach.

Additionally, a systematic approach should be used to develop, implement, and monitor healthy eating and PA policies (77). The health education should provide children and adolescents with the knowledge, attitude, skills, and experiences needed for healthy eating and PA (77). This may be done by implementing a planned and sequential curriculum that is culturally appropriate and that addresses a clear set of behavioural outcomes promoting healthy eating and PA (77). The curricula should be consistent with scientific evidence of effectiveness in helping children and adolescents improve healthy eating and PA (77). It would be also beneficial to use classroom instructional methods and strategies that are interactive and relevant to the daily lives and experiences of participants (77). In addition, the current school's curricula should be periodically reviewed and evaluated to update the nutrition information and make it suitable with the local and Arab situation (78).

So far, Arab interventions to prevent paediatric obesity are very scarce despite the increases in obesity rates (73, 79-87). This emphasizes the importance of designing and implementing theory-based nutrition intervention programmes to prevent obesity among children and adolescents representing the future generation of the region. In Lebanon, there are only two interventions, targeting children aged 9-11 years in primary schools (73, 88, 89). As yet, no interventions have addressed secondary schools or older adolescents.

### *Overview of the Lebanese educational system*

In Lebanon, school education is divided to three main parts: (i) kindergarten (age 3 to 5 years); (ii) primary and intermediate (age 6 to 14 years); and (iii) secondary (15-18 years). Arabic is the main language of instruction, but English and French are taught starting early in elementary school.

There are two types of secondary schools in Lebanon: public and private. One of the main differences between them is the tuition fees, which are higher in private schools. As a result, families with middle- to high-incomes tend to enrol their children in private schools. In 2017-2018, the total number of students enrolled in secondary schools in Lebanon was 129,428, of which 53.4% were registered in private schools (90).

The topic of nutrition is included in the school curriculum as part of the science course in younger classes and biology course in older classes (decree number 10227, May 1997, and general pre-university education curricula). However, most of the information included in the curriculum is not up to date (e.g., the latest food guides are not mentioned), and it is not taught to all grades.

### *Intervention development*

The current dissertation focuses on the development and evaluation of *Sahtak bi Sahnak*, meaning your health on your plate, which is the first nutrition school-based intervention targeting Lebanese adolescents enrolled in secondary schools. This programme was systematically developed based on the Intervention Mapping (IM) framework and its main purpose was to prevent paediatric overweight and obesity by improving the eating habits of Lebanese adolescents enrolled in public and private secondary schools and located in urban and rural regions.

Intervention Mapping is a systematic framework ensuring evidence-based and theory-driven development, implementation, and evaluation of health promotion programmes and interventions, guided by six steps (41). It presents several advantages related to planning interventions in health promotion: (i) it allows developing a programme that is tailored to the particular needs and characteristics of the target population. As the existing literature offers countless research data that may be used in programme planning, IM allows filtering them to apply the relevant information to the target population (41); (ii) it is a theory-driven framework. It is well-known that theory-based interventions are the

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“only” acceptable way to promote healthy lifestyles (91). Theories are used to explain behaviours (i.e., determinants), as well as to design effective interventions; (ii) it considers all the aspects related to adoption, implementation, and maintenance of the programme. This includes specifying the tasks of each person who may play a significant role in applying the intervention (e.g., school principal, teacher, and health promoter in the case of schools); and (iii) it evaluates the intervention to assess its effectiveness and efficiency.

Intervention Mapping is widely used to design various interventions related to disease prevention and health promotion (92). Studies showed that IM is useful in planning programmes to improve body composition among children and adolescents (93). It is also an effective tool for both the initial development as well as further adaptations of the initial programme (94). Yet, no obesity prevention interventions based on IM were adopted in the Arab world.

In addition to all the strengths, there are several factors to take into consideration when implementing IM, as it is a time-consuming framework and it requires highly skilled health promotion experts (95). Yet, when it comes to schools, time is not always an ally (e.g., complying with the schools’ academic calendar, having the schools on board as soon as the classes start, and not being able to contact the schools in summer). A lack of local findings can be an additional challenge. Very few studies were previously conducted among Lebanese children and adolescents (52), therefore resulting in a need to rely on findings from other countries. However, theories, determinants, and applications should be conscientiously selected as some of the foreign findings may not be applicable to the Lebanese or Arab context. Another consideration is the lack of detailed study protocols: most of the available study protocols based on IM do not elaborate in detail all the six steps. This may affect the implementation and evaluation processes as researchers will not be able to take into consideration past experiences and build upon them.

### *Dietary knowledge and adherence assessment*

Data collection methods are one of the major determinants of data quality. The collected data and methods used for this should be relevant to the research objectives, standardised across the studies, efficient for recording and processing, and appropriate for statistical analysis (96). In nutrition-related research, it is crucial for the measurement tools to be both valid and reliable (97). Multiple journals and books have provided guidelines for questionnaire development in the areas of nutrition and health promotion (98-101). Yet, to our knowledge, none of the previously published papers described the development and validation process of Lebanese questionnaires measuring dietary knowledge and adherence.

In the current thesis, two questionnaires were developed: the dietary knowledge questionnaire (DKQ) and the dietary adherence questionnaire (DAQ). Their main purposes are to evaluate the baseline levels of dietary knowledge and adherence of Lebanese adolescents and to evaluate the outcomes of the intervention. The DKQ was based on the

previously validated and reliable Nutrition Knowledge Questionnaire developed by Parmenter and Wardle (100) and it included five parts: (1) knowledge of dietary recommendations; (2) knowledge of nutrient sources; (3) knowledge of common misconceptions in nutrition; (4) using knowledge in nutrition to make dietary choices; and (5) knowledge of associations between nutrition and diseases. The DAQ was designed based on the Schools Physical Activity and Nutrition Survey (SPANS) year 8 and 10 student questionnaire (102), and it included four parts: (1) food choices; (2) eating habits; (3) physical activity and screen-viewing time; and (4) smoking. To assess reliability, the inter-item reliability was measured reflecting the extent to which the indicators of a questionnaire are correlated (97). The test-retest method was not approached because it is time-consuming and it is related to a specific time period that cannot be repeated (making it unsuitable for some questionnaires such as the 24h recall (97). The validity of both DKQ and DAQ was assessed by referring to face validity (which indicates whether a variable appears to be a sensible indicator of what it is measuring), and content validity (which focuses on whether the variables cover all aspects of the concept it is measuring; 97). The DAQ was further validated by using the relative validity (which is determined by comparing a test method with a reference method of demonstrated validity; 97, 103).

### *Objectives of this thesis*

The primary objectives of this thesis are: (1) developing a culturally fit nutrition programme that can be easily integrated in the schools' curriculum; and (2) assessing the effect of Sahtak bi Sahnak on the levels of dietary knowledge, adherence, and intake of Lebanese adolescents. The secondary objectives are the following: (1) developing valid and reliable dietary and adherence questionnaire; (2) assessing the current level of dietary knowledge and adherence levels as well as anthropometrics of Lebanese adolescents; (3) comparing the levels of dietary knowledge and adherence of Lebanese adolescents living in urban regions (Beirut) vs. rural regions (Baalbeck and Rayak); (4) comparing the levels of dietary knowledge and adherence of Lebanese adolescents attending public vs. private secondary schools; (5) evaluating the relationship between the dietary knowledge and adherence levels of the parents and their children; and (6) evaluating the relationship between the dietary knowledge and adherence of the adolescents and their parents, and their children's BMI.

### *Outline of the thesis*

**Chapter two** reports the development and validation of the dietary and adherence questionnaires. This feasibility study was conducted during the academic year 2016-2017 and it included 220 adolescents and 108 parents. **Chapter three** includes the cross-sectional study conducted on 1535 adolescents and 317 parents that aimed at assessing the levels of dietary knowledge, dietary adherence (in relation to recommendations), and the body mass index (BMI) of Lebanese adolescents in association with demographic variables, their

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parents' dietary knowledge and adherence levels, and with other lifestyle behaviours. **Chapter four** presents the application of IM in developing *Sahtak bi Sahnak* by describing the methodology of the study, the development of the intervention, and the implementation process. **Chapter five** reports the results of the effect evaluation of *Sahtak bi Sahnak* that was conducted in 2017-2018. **Chapter six** presents the General Discussion of the results and methodological considerations, as well as some recommendations for further implementation and dissemination of the programme.





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# Chapter 2

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## **Development of Dietary Knowledge and Adherence Questionnaires for Lebanese Adolescents and their Parents**

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## Chapter 2

### **Abstract:**

The availability of practical tools to assess dietary knowledge and adherence is essential to evaluate the effectiveness of dietary interventions. The aims of this paper were to develop reliable dietary knowledge and adherence questionnaires, suitable for Lebanese adolescents and their parents, and to estimate the feasibility of conducting studies involving such participants in the school-based setting. Eight Lebanese high schools participated in this study (involving 220 adolescents aged 15-18 years). Self-administered dietary knowledge and adherence questionnaires (DKQ and DAQ, respectively) were completed by the high school students and their parents. A 24h recall was additionally administered for the adolescents by a dietitian and a trained interviewer at school, to validate the adolescents' answers in the DAQ. The cognitive interview method was used to qualitatively evaluate the questionnaires. The resulting Cronbach's alpha ranged from 0.61 to 0.78 for the adolescent questionnaires and from 0.46 to 0.89 for the parental ones. In addition, 23 items (out of 25) of the adolescent DAQ matched with the administered 24h recall. A significant negative correlation was found between the knowledge score (DKQ) and the unhealthy items of the adolescent DAQ. There was a significant positive correlation between the DKQ of the parents and the knowledge score of their children. This is the first study of dietary questionnaires involving Lebanese high school students from different regions, while also including their parents.

## 1. Introduction

Pediatric obesity is the most common childhood nutritional disorder in the world (104). This global epidemic is the cause of many chronic diseases such as diabetes mellitus, metabolic syndrome, dyslipidemia, cardiovascular diseases, obstructive sleep apnea and hypertension, as well as psychosocial complications such as low self-esteem, higher rates of anxiety disorders, decreased health-related quality of life (QOL) and decreased educational and financial attainment (105, 106). These health consequences constitute a serious economic burden. The incremental lifetime direct costs from the perspective of a 10-year-old obese child relative to a normal weight child reaches an average of \$16,000 (22). Obesity is preventable, however (1). According to the World Health Organization (1), over 340 million children and adolescents aged 5-19 years were overweight or obese in 2016 worldwide. Lebanon, a Mediterranean country in the Middle East, is no exception, as 30.8% of adolescents aged 12-19 years are overweight and 10.3% are obese (52).

Since childhood obesity carries over into adulthood (1), it is important to direct all of our efforts to preventing this problem early on. However, there are no specific programs to prevent obesity in Arab countries (107). There are some activities promoting specific healthy behaviors in some of these countries, but they have limited effects (107).

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 (108). During the last five decades, most Arab countries encountered important challenges related to demographic and socioeconomic factors, and health status (107). They are also facing a nutrition transition characterized by replacing traditional diets with high fat and processed foods (107). In Lebanon specifically, high consumption of fast food and sugar sweetened beverages have been found to be associated with higher odds of overweight (52). Higher intakes of milk, dairy products, fruits and vegetables, daily breakfast consumption and decreased sedentary time were associated with lower odds of overweight and obesity (52). Identification of these determinants of overweight helps guiding the development of tools to detect these behaviors.

Both body mass index (BMI) and eating habits are strongly influenced by urbanization (40, 109). From 1985 to 2017, the proportion of the world's population living in urban regions increased by 14%, and over the same period of time the mean BMI increased by 2.1 kg/m<sup>2</sup> in women and by 2.2 kg/m<sup>2</sup> in men (109). In low to middle income countries, rural areas were previously characterized with a lower BMI compared to the cities, but the urbanization of rural life (due to the mechanization of agriculture, transport development and the availability of processed food) contributes to the increasing BMI of the rural population (109). In Lebanon, living in the capital Beirut seems to be associated with higher odds of overweight (compared to adolescents residing in other governorates; 52), for reasons that have not been empirically studied to date. It is important to examine potential

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differences in eating patterns, to be able to initiate the targeted measures to avoid adverse health outcomes (110). However, to our knowledge, no previous studies have compared the difference in dietary patterns between Lebanese adolescents living in urban versus rural regions.

Identifying the percentage of the population who follows the dietary guidelines (111) for specific food groups will guide prevention strategies to improve dietary quality and reduce the prevalence of obesity (112). Nutritional recommendations cover a broad range of intake behaviors (e.g., water intake, fiber intake, fruit and vegetable consumption). Therefore, gaining insight on knowledge regarding specific topics allows us to elucidate the areas which require attention (113), resulting in nutrition interventions that are more specific and more efficient. Dietary knowledge is one of the few modifiable determinants influencing nutritional behavior (114). People with higher dietary knowledge levels are almost 25 times more likely to consume sufficient amounts of fruits, vegetables, and fat, compared to those with a lower level of dietary knowledge (44). Hence, increasing knowledge will eventually improve the diet of target populations (100). However, knowledge is not the only factor to take into consideration. It is also well known that the family exerts a major influence on adolescents' eating behaviors (115). Parents play a key role in the food environment of their children (116). Parental nutritional knowledge has previously been found to be positively associated with adequate intakes of dairy products, fruits, vegetables and meat, among their children (117). However, the association between the parents' dietary adherence and knowledge and those of their children has not yet been studied in Lebanon. Knowing the extent of influence of Lebanese parents on their children's eating behavior will guide future interventions to promote healthy eating and to prevent obesity.

Before planning any program aimed at improving the dietary habits of adolescents, it is crucial to identify the necessary tools to monitor and assess intervention effects. Information related to dietary patterns can be obtained from tools measuring nutrient intake (e.g., food records, 24 h recall, etc.), but they are mostly complicated, time consuming and expensive (118). In addition, such tools often present a high subject burden and methodological concerns when used for school-aged children (119), whereas self-administered questionnaires present no interviewer-related bias, are time-saving, and permit more careful responding (since respondents are not hurried; 120). Questionnaires can be a feasible, reliable and valid method to evaluate nutrition knowledge and the correlation between dietary awareness and eating behavior (121).

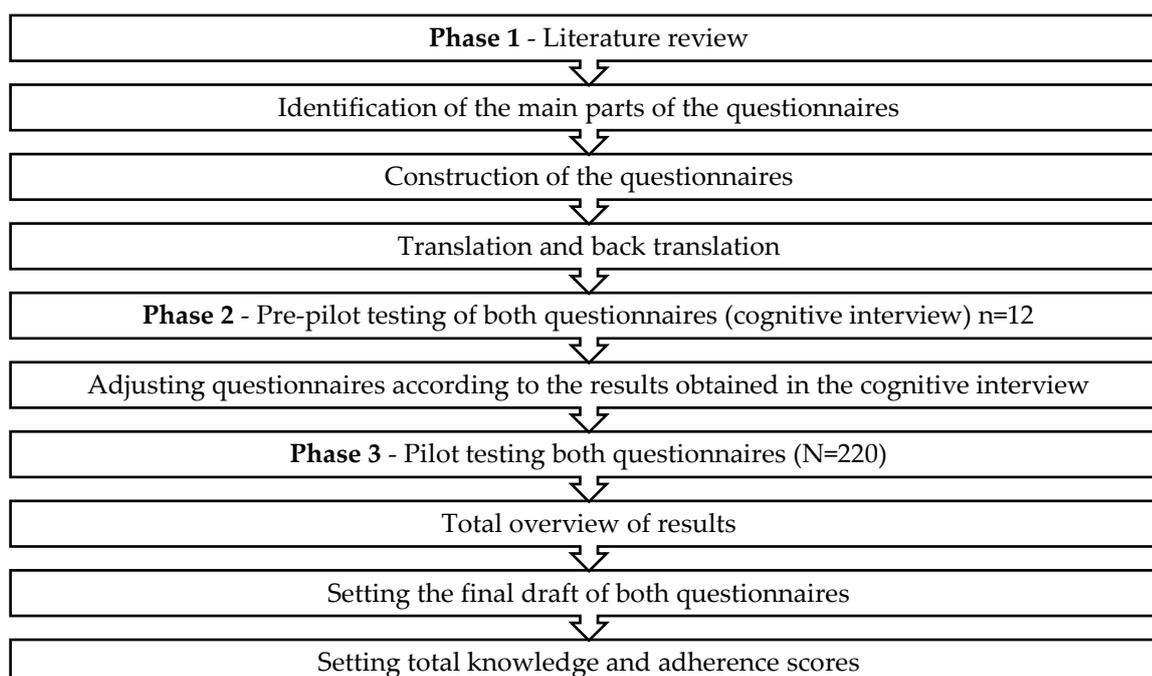
There is a paucity of validated dietary knowledge and adherence questionnaires for Lebanese adolescents. Previous dietary knowledge questionnaires were often designed specifically for a particular study and lacked psychometric validation (44). In addition, the few available studies involving Lebanese children did not describe the details of the process for developing such questionnaires. In addition, despite the difference between urban and

rural regions as described above, previous studies often did not include participants living in rural regions (73). This highlights the need to develop reliable and valid, user-friendly and inexpensive tools to assess levels of dietary knowledge and adherence among Lebanese adolescents living in urban and rural areas.

The current study assessed the psychometric properties of new instruments to measure the dietary knowledge and adherence to nutritional guidelines of Lebanese adolescents. The aims of this paper are to describe the step-by-step process of developing these questionnaires for Lebanese adolescents and their parents, to analyze their feasibility and internal validity in the target population, and to examine the correlation between parental and adolescent scores.

## 2. Materials and Methods

We developed two questionnaires: the Dietary Knowledge Questionnaire (DKQ), to assess the level of dietary knowledge of Lebanese adolescents and their parents, and the Dietary Adherence Questionnaire (DAQ), to assess the level of adherence to nutritional guidelines (111). Both questionnaires were developed following the same steps (see Figure 1).



**Figure 1.** Development phases of dietary knowledge and adherence questionnaires

### 2.1. Phase 1- Literature review

First, a thorough literature review of dietary knowledge, general dietary recommendations for adolescents, and dietary behaviors linked to overweight and obesity, was done to identify the main parts of the questionnaires. Second, the format of both questionnaires was

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determined (e.g., type of questions, method of administration, duration, language, etc.). Both questionnaires are self-administered structured ones with closed questions. All questions were designed to suit both target groups (adolescents and adults) and participants with different socioeconomic backgrounds.

Particular attention was paid to the first few questions, as they influence the respondent's attitude and cooperation (122). The first page of both questionnaires included statements summarizing the purpose of the study and confirming the consent to participate once the questionnaire is completed and submitted.

Both questionnaires were administered during classes and in Arabic. They were designed to be convenient for Lebanese adolescents and their parents. It should be possible for 20 to 35 students to fill out the questionnaires during a class session lasting 40-50 minutes. This explains the reason behind choosing a self-administered format, closed questions and a relatively small number of answer options. To make sure that the selected items suited the Lebanese population and culture, some were taken from existing questionnaires (see below), while others were added or adapted to the Lebanese eating culture.

The third step involves translation and back translation. Both questionnaires were originally developed in English by a dietitian with practical experience in nutrition in Lebanon, then translated into Arabic, and back translated to English. The initial translation and back-translation were done by two different individuals. To avoid bias, the back-translator was not aware of the concepts the questionnaires intend to measure (123).

### 2.1.1. Dietary Knowledge Questionnaire

The Dietary Knowledge Questionnaire (DKQ) aims to assess the level of dietary knowledge of Lebanese adolescents (see Supplementary Materials S1 and S2) and their parents (see Supplementary Material S3 and S4). It was based on the Nutrition Knowledge Questionnaire (NKQ) developed by Parmenter and Wardle (100), which meets the criterion for construct validity, and has a total Cronbach's alpha of 0.97, reflecting a high internal reliability. It was adapted to suit the Lebanese culture: for instance, Lebanese food items, such as Akawi cheese and labneh, replaced foods less common in Lebanon, like edam cheese. The selected items were meant to be representative of a broad range of dietary knowledge (100). The questions ask about very basic and general nutrition information to assess whether the participants have a minimum level of knowledge, allowing them to make decisions regarding their food intake.

The DKQ consists of five parts and a total of 56 items (including questions and subquestions) and takes 15-20 minutes to fill out. Some questions are divided into additional sub-questions, making 40 sub-questions in total. Each question has three to five answer options and only one correct answer per question/sub-question. A "do not know" option was added to all questions.

The five parts are: (1) Knowledge of dietary recommendations, to determine if participants are familiar with the current ones; (2) knowledge of nutrient sources, to determine whether participants know if the indicated food items are good or bad sources of the nutrient in question; (3) knowledge of common misconceptions in nutrition, to determine whether participants are aware of some of those related to nutrition; (4) using knowledge of nutrition to make dietary choices, to determine whether participants are able to choose the healthiest option when given different food choices; (5) knowledge of associations between nutrition and diseases, to determine if the participants are aware of the correlation between eating habits and health. The original NKQ questionnaire included the same parts (100), but the “understanding of terms” part was renamed “knowledge of common misconceptions in nutrition”, although the questions remained the same. As more than 92.7% of young adults relies on online resources to obtain nutrition information and only 4.7% refers to healthcare professionals, it is important to verify if the received information is correct (124).

Answers were coded as follows: zero for the wrong answer or if the participant did not know the answer, and one point for the correct answer.

The weighting of the various items is indicated in Appendix A. The total knowledge score was calculated by summing up the points on all items. Thus, the maximum possible score is 56 and the minimum is zero. The same DKQ was administered to both the parents and their children.

### 2.1.2. Dietary Adherence Questionnaire

The Dietary Adherence Questionnaire (DAQ) (see Supplementary Materials S5 and S6) was based on the Schools Physical Activity and Nutrition Survey (SPANS) year 8 and 10 student questionnaire (102). The questions and answer options were modified to lower the burden for participants by making them shorter, to avoid response fatigue and inaccurate results (98). It is a self-administered questionnaire with close-ended questions, and takes about 20 min to complete. It consists of 30 questions and is divided into four parts: (1) food choices, related to the consumption of specific food groups like lean meats, sweets, etc.; (2) eating habits, related to meal pattern consumption such as the number of meals, snacks and breakfast consumption; (3) physical activity (PA) and screen-viewing time; (4) smoking. The number of options per question ranges from two to six.

Even though the DAQ included one question regarding smoking and four related to engaging in PA and screen time, it was still called the Dietary Adherence Questionnaire because those questions were added to examine the correlation of diet with smoking and PA to identify potentially clustered behaviors. Based on a cross-sectional study of Brazilian adolescents, a significant positive correlation was found between smoking and high intake of sweets, low fruit intake, and high intake of soft drinks (125). The questions regarding PA and screen-viewing time were added because studies have shown that active individuals

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tend to have healthier diets (37). The questions and scoring system were identical for both the parents and their children, except for the question about PA in school, which was omitted as irrelevant from the parents' DAQ (see Supplementary Materials S7 and S8).

This questionnaire was designed to assess each question separately by checking, for instance, whether the participant eats high fat meat or lean meat, or eats breakfast or not. However, to facilitate the evaluation of the overall dietary behavior, instead of looking at each question separately, the total adherence index was created. Therefore, it presents a useful, user-friendly, and rapid tool for health promoters to detect unhealthy eating behavior, potentially leading to overweight or obesity and correcting it. It also allows us to compare the answers before and after an intervention.

Scoring was zero for "No, I did not eat any of the foods listed above yesterday", one point for "Yes, I ate it once", two points for "Yes, I ate it twice", and three points for "Yes, I ate it three times or more". In the question related to breakfast consumption, the option "yes" was equal to two points while "no" was equal to zero, as breakfast cannot be consumed more than once a day, as well as to emphasize the importance of this meal. In questions 26 and 27, related to PA practice, "yes" was equal to one point and "no" to zero. The weekly duration of PA practiced was coded as follows: zero for "0 h", one point for "1 h", two points for "2-4 h" and three points for "more than 5 h". As for smoking, "yes" was equal to two points, and "no/stopped smoking" was equal to one point. The question related to screen-viewing time (duration spent watching television, using phones or tablets, or playing video games) was removed to improve reliability (increased Cronbach's alpha).

Next, to simplify the use of this questionnaire in interventional studies, and to be able to assess the overall adherence to dietary guidelines instead of looking at each question separately, a total adherence index was developed by dividing the score of healthy items by the score of unhealthy items:

$$\text{Total adherence index} = \frac{\text{Healthy items score}}{\text{Unhealthy items score}}$$

If the score is above 1, then the healthy food choices and habits outweigh the unhealthy ones, and if the score is below 1, there are more unhealthy choices compared to healthy choices (see Table 1 and appendix B). All individuals started with one point on the unhealthy score to avoid zero as a denominator. The maximum possible index score is 37 (reflecting a total adherence to dietary guidelines) and the minimum score is zero. The items related to number of snacks and juices consumed were removed from the calculation of the index score, as it is hard to distinguish whether the snack itself is healthy or unhealthy. For instance, an apple is not the same as soft drinks. The same goes for natural juices: to avoid controversy about whether to consider the item healthy or unhealthy, it was not included in the index. Thus, a maximum of 37 points for the healthy items and a maximum of 38 points for unhealthy items is obtained.

**Table 1.** Total adherence score components for adolescents

Items	Questions	Maximum points
Healthy items	1-Yesterday, did you eat meat (like chopped meat in stews), chicken breast (grilled/boiled/not fried), or fish (grilled/boiled/not fried)?	37
	4- Yesterday, did you eat any of these foods? Labneh, shanklish, kareesha	
	5- Yesterday, did you eat any of these cheeses: Mozzarella, feta, akawi, baladiye, khadra?	
	7- Yesterday, did you drink milk or laban?	
	8- Yesterday, did you drink skimmed milk (reduced or 0% fat) or skimmed laban?	
	10- Yesterday, did you eat whole bread, oat bread, brown bread, tortillas?	
	12- Yesterday, did you eat beans like lentils, white beans, fava beans (do not count green beans)?	
	13- Yesterday, did you eat any vegetables (do not count potatoes)?	
	14- Yesterday, did you eat fresh fruits? Do not count fruit juice and dried fruits.	
	22- Yesterday, did you have breakfast?	
	23- Yesterday, how many meals did you eat (meals include breakfast, lunch, and dinner)?	
	26- Do you participate in physical education sessions at school?	
	27- Do you participate in any sports activity (other than physical education session at schools)?	
28- How many hours per week do you exercise?		
Unhealthy items	2- Yesterday, did you eat fried chicken, chicken nuggets, fried fish, fried meat, hot dogs, sausage, mortadella, or ham?	38
	3- Yesterday, did you eat chocolate cream or potato chips?	
	6- Yesterday, did you eat any of these foods: Cheddar cheese, gruyere, edam, goat cheese, gouda, parmesan, Roquefort, kashkawan, cream cheese, kishk?	
	9- Yesterday, did you eat white Arabic bread, kaak, franjeh bread?	
	11- Yesterday, did you eat French fries (fried potatoes)?	
	16- Yesterday, did you drink commercial fruit juice?	
	17- Yesterday, did you drink soft drinks (Pepsi, 7up, Miranda, Sprite, Coca Cola, Fanta...)?	
	18- Yesterday, did you drink diet soft drinks (Pepsi diet, 7up diet, Coca Cola diet, ...)?	
	19- Yesterday, did you drink energy drinks (Red Bull, AMP, ...)?	
	20- Yesterday, did you eat any sweets such as sweet rolls, cookies, cakes, pies, brownies, cheesecake, doughnuts?	
	21- Yesterday, did you eat any Arabic sweets (namoura, knefeh, halewet el jibn, znood el sitt...)?	
	25- Yesterday, how many times did you eat food from outside of your house? (restaurants, fast food restaurants, pizza places, and cafeterias)	
	30- Do you smoke? (cigarettes and narjileh are included)	

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It is important to note that the DAQ does not investigate the reasons behind the participants' actions and attitudes.

### 2.2. Phase 2- Cognitive interview

The cognitive interview method (126) was selected to test the clarity and interpretation of the Arabic version of the questionnaires. According to Miller (127), large sample sizes are not necessary at this stage because problems in questionnaires are supposed to be revealed immediately. Therefore, 12–25 cases are sufficient to pre-test questionnaires, although sample sizes are often influenced by the survey schedule, leading to a typical sample of 5–15 participants (127).

A group of 12 students was asked to fill out both questionnaires (DKQ and DAQ) and to add a (+) or a (-) next to the questions they liked or did not like for different reasons. For instance, they could add a (-) next to the questions they did not understand or if something was not clear, and a (+) sign next to the comprehensible questions. After filling out the questionnaires, each student handed them and discussed their comments with the interviewer (see Table 2). Adjustments were made to the final draft of the questionnaires according to the results obtained during the cognitive interviews, before testing both questionnaires on a larger sample size.

**Table 2.** List of comments reported by the adolescents and the corresponding adjustments to the questionnaires, based on the cognitive interview results

Feedback categories	Comments	Adjustments
1. Language problems	DAQ: A participant asked to clarify the part "fish (not fried)".	The question was modified to include the following words "grilled/boiled/not fried".
	DKQ: Many adolescents did not know what fibers and saturated fatty acids are.	No modifications made because this is related to the level of knowledge and is an essential part of the DKQ.
2. Logical problems	DKQ: One of the participants asked if smoking includes water pipes.	The words "cigarettes and waterpipes" were added to make it clear that both ways of smoking are included.
	DAQ/DKQ: One of the respondents asked if the word "vegetables" in question 10 (DKQ) and question 13 (DAQ) included pickles too, or just fresh vegetables like cucumbers.	In the DKQ, participants are asked if vegetables are high or low in sodium, and the word "fresh" was added to make it clearer. In the DAQ, it was left as is because both pickles and fresh vegetables are included. The purpose of this question is not related to sodium consumption, but rather to fiber intake.

### 2.3. Phase 3- Pilot Testing the Questionnaires

#### 2.3.1. Inclusion Criteria and Sampling Method

Lebanese public and private high schools located in Beirut, Baalbeck, and Rayak were included, thus covering both urban and rural regions. The urban region refers to Beirut, the capital and largest city of Lebanon, and the rural region refers to Baalbeck and Rayak located in the Bekaa region, which is considered Lebanon's most important farming region (see Figure 2).



**Figure 2.** Map of Lebanon

Even though Baalbeck is a small city, it is considered part of the rural area along with Rayak, as schools in Baalbeck include many children coming from the villages nearby. In addition, no international fast-food chains, shopping malls or buses (connecting different locations in the same town) are located in Baalbeck. There are only some local restaurants and coffee shops.

As few studies involved Lebanese adolescents, assessing the feasibility of conducting research in Lebanese school-settings is one of the first key learnings of the current study. This includes experiences with school and participant recruitment, questionnaire administration in classes, data collection scheduling during class time, and facing challenges and opportunities in the implementation of the study protocol.

Several inclusion criteria for the participating adolescents were used: (1) being Lebanese and enrolled in Lebanese public or private high schools located in Beirut, Baalbeck and Rayak; (2) aged 15-18 years; (3) being fully capable (cognitive, psychiatric, and physical ability) of communicating (as reported by parents or by school administration); (4) not having any chronic or genetic disease (such as chronic kidney diseases or other diseases, as reported by parents or by school administration). Lebanese high schools are either public or

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private. Public high schools are managed by the Lebanese Ministry of Education and Higher Education, while private schools are managed by individuals or organizations. Due to the higher tuition fees in private schools, Lebanese families with higher incomes tend to enroll their children in private schools, while children from lower socioeconomic groups more often attend public schools. In this study, both types of schools were taken in consideration to include adolescents from different socioeconomic backgrounds.

The sampling method was non-selective, meaning that all participants meeting the inclusion criteria and present at the moment of data collection were selected. All subjects gave their informed consent for inclusion before they participated in the study. The questionnaire stated clearly that once it was filled in and handed in, this meant that the adolescent accepted and assented to participate in the study. Consent was also orally confirmed by the PI before administering the questionnaire. A similar assent statement was also included in the parents' version of the questionnaires. The study was conducted in accordance with the Declaration of Helsinki, and the protocol was approved by the Lebanese Ministry of Education and Higher Education (3/15465; date: 24/10/2016).

The total number of adolescents enrolled in high schools located in Beirut (urban area) is 12,983 (128). The number of public schools located in Beirut is 18 (obtained from the Lebanese Ministry of Education and Higher Education). However, the total number of private high schools in this region is not reported. The number of adolescents enrolled in high schools located in Bekaa (Baalbeck, Rayak and other towns and villages) is 15,843 (128). The number of public high schools located in Baalbeck and Rayak is four, the number of private schools is not reported. For the current study, a total of seven schools were recruited: four public (one from Beirut, two from Baalbeck and one from Rayak) and three private (one from each city/town) schools.

According to Hulley, Cummings (129) and taking into consideration that this observational study involves correlations as the principal form of analysis, the total sample size is calculated as follows:

Total sample size =  $N = [(Z\alpha + Z\beta/C)^2 + 3]$ ; taking into consideration:

- $\alpha = 0.05$ ;  $Z\alpha = 1.96$ ;  $\beta = 0.2$ ;  $Z\beta = 0.842$
- $r = 0.3$  (according to Asaad, Sadegian (130), the obtained correlation between fruits and vegetable servings, high sugar foods and high fiber foods obtained from the perceived dietary adherence questionnaire and the 24 h recalls were 0.30, 0.40 and 0.46, respectively. Other correlations were not considered, as they were irrelevant in our case, e.g., low glycemic index foods)
- $C = 0.5 \times \ln [(1+r)/(1-r)]$

This results in a minimally required sample of  $N = 85$  participants. The actual obtained sample size in the current study was 220.

### 2.3.2. Questionnaire Administration and Data Collection

Data collection took place between January and May 2017. A total of seven high schools were included. School administrations assigned one session per class during the normal schedule (40-50 min). The interviewers visited each class, explained the purpose of the study in detail, gave the necessary instructions to fill out the DKQ and DAQ questionnaires, and distributed and collected them. In addition, a 24h dietary recall was administered to each student by the interviewers during the same session. The 24 h recalls were unstructured, although a stepwise protocol was used. A blank sheet was filled by the interviewer based on what the participants answered to the question concerning what they ate in the previous 24 h. In the next step, the interviewers asked about the missing information, such as the portion sizes, brand names of food items and cooking methods (grilled, boiled, fried, etc.). At the end, the interviewers went over the answers one more time, to make sure that the adolescents did not forget anything. The recall was used to compare the DAQ filled in by the students with the DAQ filled in by an expert based on the 24h recall, to check the validity of the DAQ answers related to food and meal consumption. In addition, the parents' DKQ and DAQ were handed to the children, for their parents to complete at home. After one to two weeks, the completed parental questionnaires were collected at the schools.

### *2.4. Statistical analyses*

Data were entered and analyzed using the Statistical Package for Social Sciences version 25.0 (SPSS Inc., Chicago, IL, USA). p-values of <0.05 were considered statistically significant. Descriptive statistics were used to analyze the participant characteristics. Cronbach's alpha test was used to assess the internal consistency and reliability of the questionnaires. Coefficients from 0.5 to 0.75 suggest moderate reliability, and values >0.75 reflect good reliability (131).

Independent t-tests were employed to determine significant differences between subgroup means (boys vs. girls, urban vs. rural, and public vs. private). Pearson's correlations were used to explore potential relations between knowledge and adherence scores of adolescents and parents. One-Way ANOVA Post Hoc was used to determine any differences between the three study locations.

## **3. Results**

### *3.1. Cognitive Interview*

A total of 12 adolescents was asked to fill out both questionnaires (DKQ and DAQ) and comment on them in a cognitive interview. These opinions were divided into three categories: (1) language problems (e.g., not knowing the meaning of a word); (2) logical problems (interpreting questions the wrong way); and (3) general feedback (e.g., positive feedback; not shown). The comments and subsequent adjustments to the questionnaires are listed in Table 2.

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### 3.2. Demographic Characteristics

A total of 220 adolescents, recruited from seven high schools, submitted both questionnaires. As for the parents, 108 (49%) returned the DKQ and 89 (40.5%) filled out the DAQ. Their demographic characteristics are shown in Table 3.

**Table 3.** Demographic characteristics of the participants

	Adolescents (N=220)	Parents (N=108)
	Mean (SD) or n (%)	
Age, mean (SD)	16.8 (0.8)	44.3 (6.9)
	Gender, n (%)	
Male	90 (40.9)	11 (19.6)
Female	129 (58.6)	45 (80.4)
	Location, n (%)	
Beirut (U)	53 (24.1)	7 (6.5)
Baalbeck (R)	117 (53.2)	64 (59.3)
Rayak (R)	50 (22.7)	37 (34.3)
	Type of school, n (%)	
Public	187 (85.0)	92 (85.2)
Private	33 (15.0)	16 (14.8)

U: urban; R: rural

### 3.3. Feasibility

All adolescents agreed to participate, and they were positively engaged. They were able to fill out both questionnaires during the assigned time. The presence of a teacher in class was experienced as favorable, as the adolescents were more disciplined and worked faster.

### 3.4. Internal Reliability

The internal reliability reflects how well the individual items of the scores fit together and assess the same construct (119). Values for Cronbach's alpha ranged from 0.46 to 0.89 (see Table 4).

**Table 4.** Values for Cronbach's alpha for the different questionnaire groups.

Scores	Value of Cronbach's Alpha
DKQ – Adolescents	0.78
DKQ – Parents	0.89
DAQ – Adolescents, Healthy Items	0.61
DAQ – Adolescents, Unhealthy Items	0.61
DAQ – Parents, Healthy Items	0.46
DAQ – Parents, Unhealthy Items	0.61

### 3.5. Dietary Knowledge and Adherence Scores

Adolescents scored an average of 30.7 (SD  $\pm$ 6.9) on the DKQ, ranging from 7 to 50, and 34.54% answered more than half of the questions incorrectly. The mean total adherence index score was 2.1 (SD $\pm$ 1.5), ranging from 0.2 to 12, and 10% of adolescents obtained a score below 1. In terms of demographic characteristics such as age, gender and type of school, there was no significant difference either for the knowledge score or for the total adherence

score between groups (see Table 5). There was a significant difference for the knowledge score between urban and rural regions ( $p < 0.01$ ). When comparing the three locations separately, there was a significant difference for the total knowledge and adherence scores between them (see appendix D). Post-hoc analyses revealed that the difference was significant between Beirut and Baalbeck ( $p < 0.05$ ). Parents had a mean of 32.4 ( $SD \pm 10.0$ ) on the DKQ, ranging from 2 to 49, and there were no significant differences between the groups based on demographics. Detailed responses of both questionnaires are shown in Appendices C and E.

**Table 5.** Means and differences in total knowledge and adherence scores among adolescents and their parents [maximum points: 56 for dietary knowledge (DKQ) and 37 for dietary adherence (DAQ)].

	Adolescents				Parents			
	Mean total DKQ knowledge score (SD)	<i>p</i> value	Mean total DAQ adherence index (SD)	<i>p</i> value	Mean total DKQ knowledge score (SD)	<i>p</i> value	Mean total DAQ adherence index (SD)	<i>p</i> value
Gender								
<i>Boys</i>	30.4 (7.2)	0.55	2.3 (1.8)	0.20	31.0 (10.8)	0.31	2.4 (1.7)	0.91
<i>Girls</i>	30.9 (6.8)		2.0 (1.1)		33.0 (9.6)		2.5 (2.4)	
Age/class								
<i>Grade 11</i>	29.8 (7.2)	0.07	2.5 (1.6)	0.06	33.5 (10.6)	0.20	2.0 (1.3)	0.12
<i>Grade 12</i>	31.6 (6.5)		2.0 (1.4)		30.8 (10.2)		2.8 (2.9)	
Type of school								
<i>Public</i>	30.5 (7.1)	0.20	2.1 (1.4)	0.71	32.5 (9.9)	0.77	2.4 (2.2)	0.64
<i>Private</i>	32.0 (6.1)		2.2 (2.0)		31.7 (10.8)		2.7 (2.5)	
Location								
<i>Urban</i>	33.0 (6.9)	<0.01	2.6 (1.9)	0.07	38.3 (12.1)	0.11	3.8 (2.3)	0.13
<i>Rural</i>	29.9 (6.8)		2.0 (1.2)		32.0 (9.8)		2.4 (2.2)	
<i>Beirut (U)</i>	33.0 (6.9)	0.02	2.6 (1.9)	0.06	38.3 (12.1)	0.27	3.8 (2.3)	0.22
<i>Baalbeck (R)</i>	29.9 (6.9)		1.9 (1.0)		31.9 (10.0)		2.2 (2.4)	
<i>Rayak (R)</i>	30.2 (6.6)		2.2 (1.7)		32.3 (9.6)		2.6 (1.9)	

U: Urban; R: Rural

### 3.6. Correlations between Scores

The DAQ of the parents was not included in the correlation analyses, as its Cronbach's alpha was low ( $< 0.50$ ). There was no statistically significant correlation between the knowledge score of adolescents and the corresponding total adherence index (Table 6). However, a significant negative correlation ( $r = 0.158$ ,  $p = 0.02$ ) was found between the DKQ and the unhealthy items score of the DAQ.

**Table 6.** Correlations between the knowledge and adherence scores among participants.

	Total Adherence score - Adolescents	Healthy Items - Adolescents (DAQ)	Unhealthy Items - Adolescents (DAQ)	Total Knowledge score - Parents
Total Knowledge score - Adolescents	0.10	0.01	-0.16*	0.36**
Total Adherence score - Adolescents		0.30**	-0.58**	0.24*
Healthy Items - Adolescents			0.33**	0.05
Unhealthy Items - Adolescents				-0.33**

\* $p < 0.05$ ; \*\* $p < 0.01$

There was a significant positive correlation ( $r = 0.359$ ,  $p < 0.001$ ) between the knowledge score of the parents and the knowledge score of their children. The parental knowledge score further correlated positively with the total adherence score of the children ( $r = 0.242$ ,  $p = 0.02$ ). A significant positive correlation was found between the unhealthy items and the healthy items of DAQ ( $r = 0.33$ ,  $p < 0.001$ ).

When comparing the DAQ items completed by the adolescents and those by the dietitian based on the 24h recall, we found a significant, positive correlation between all the items related to food intake and meal consumption (questions 1-25) in the DAQ and their correspondents based on the 24h recall except for two items (question 8 - skimmed milk and question 18 - diet soft drinks) (see Appendix F).

#### 4. Discussion

Overweight and obesity are multifactorial and largely preventable conditions (132), affecting more than 40% of Lebanese adolescents (52). However, prior to planning any health promotion program targeting this particular age category, it is necessary to have reliable tools to assess the current levels of dietary knowledge and adherence to determine the effectiveness of such interventions later on. To our knowledge, studies assessing the relationship between dietary knowledge and adherence are scarce (73), particularly in the Middle East. Correspondingly, there is a paucity of reliable Arabic questionnaires measuring dietary knowledge and adherence.

Few studies have described the detailed process of developing such questionnaires, and none of them investigated the potential correlation between the dietary knowledge and adherence of the parents and of their children.

Many dietary questionnaires do not include physical activity questions, even though it is an essential part of energy expenditure (133). Nor are all methods of dietary assessment (e.g., 24h recall, diet records, etc.) feasible for administration in school settings due to their high cost and respondent burden (133). The aim of the present paper was to describe the step-by-step process of developing dietary knowledge and adherence questionnaires suitable for Lebanese adolescents and their parents living in urban and rural areas, to examine their feasibility and internal validity in the target population, and to analyze the correlation between parental and adolescent scores.

#### 4.1. Feasibility

As few previous studies involved Lebanese adolescents, it was important to assess the feasibility of conducting research in Lebanese school-settings (i.e., recruiting schools and participants, administering questionnaires to large groups of individuals at once, investigating potential challenges and opportunities). This step is essential, not only to guide future assessment studies, but also to plan future nutrition intervention in Lebanese schools. All adolescents agreed to participate in the study. By contrast, their parents showed low participation rates (49.0% for DKQ and 40.5% for DAQ). This suggests that involving the parents in future nutrition studies might be quite challenging, in line with previous findings (134). There might be several reasons behind the low participation rate of the parents, including a lack of motivation to participate in research studies or events organized in schools. This was confirmed by school principals of the schools participating in the current study, reporting that many parents do not attend parents' meetings or lectures organized by the schools. This was in line with another study conducted in Lebanese schools (134). Some parents might not have received the questionnaires, as some adolescents reported forgetting to hand the questionnaires to their parents, even though many teachers reminded them. In addition, parents might have a lack of interest in activities that do not affect the educational attainments of the children. Besides recruitment of parents, another challenge was recruiting private schools to participate in the study. There was no difficulty in convincing public schools, since we obtained the approval of the Lebanese Ministry of Education and Higher Education, allowing direct access to public schools. The private schools had to be approached individually for participation. Similar challenges were also reported in another study involving Lebanese children aged 9–11 years (134).

As for the feasibility of administering the questionnaires, all students were able to fill in both DKQ and DAQ during the assigned time, and the interviewer was also able to collect a 24 h recall in the same session. For classes with more than 20 students, two interviewers are required to cover all participants. Also, in some cases, it was beneficial to work with the students in the presence of a teacher or teacher assistant, as they were more disciplined and worked faster then.

#### 4.2. Internal Reliability

The internal reliability of the dietary knowledge questionnaires we developed for both adolescents and their parents was more than acceptable (131). The parental version had a somewhat higher Cronbach's alpha value, which can be explained by the fact that the current DKQ was based on a knowledge questionnaire that was originally developed for adults (100). The internal validity of the current questionnaire is higher compared to previously developed knowledge questionnaires for younger Lebanese children (aged 9-11 years; alpha: 0.66) (73), and for older adolescents (aged 17-18 years; alpha ranged from 0.5 to 0.75) (135).

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As for the dietary adherence questionnaire, Cronbach's alpha was moderate for both components of the total adherence score for adolescents (healthy and unhealthy items), as well as for the unhealthy items for parents. A lower Cronbach's alpha was found for the healthy items adherence questionnaire of the parents, which can potentially be attributed to the small number of participants who filled in the DAQ (N=89). Therefore, we suggest retesting it on a larger sample size in future studies. It is difficult to compare the current DAQ to similar questionnaires in other studies, because the scoring system and the target sample are often different, and Cronbach's alpha values were not always calculated (119).

Nonetheless, a nutrition questionnaire developed for Australian children aged 10–12 years and the New Zealand Diet Quality Index for Adolescents aged 14–18 years had both a lower Cronbach's alpha (0.5) for healthy behavior score and for measuring diet quality, respectively (119, 136).

### *4.3. Dietary Knowledge and Adherence Scores*

Adolescents scored a mean of  $30.7 \pm 6.95$  for their dietary knowledge score, while their parents scored  $32.4 \pm 10.03$ , both groups scoring positive on more than half of the items on average. Even though only around 30% of adolescents answered incorrectly on more than half of the DKQ, this does not exclude the fact that some adolescents might have scored correctly by chance. The findings underline the necessity of studying the dietary adherence of adolescents within the contextual influence of dietary knowledge and of developing interventions to improve their dietary knowledge level. Another study involving adolescents aged 17–19 years showed that 27.4% had inadequate nutrition knowledge (113), which is similar to the current findings. A higher weighting was used for the nutrient sources partly because we believe that it will be easier to understand the difference between healthy and unhealthy foods after explaining the nutrients present in different foods; the same weighting was used in the original knowledge questionnaire (100).

It is important to note that the absence of a significant difference between the dietary knowledge level of Lebanese adolescents enrolled in public vs. private schools suggests that using the same educational material and strategy when planning nutrition education is appropriate.

As for the total adherence index score, adolescents scored a mean of  $2.1 \pm 1.48$ , indicating that the healthy items outweighed the unhealthy ones. However, although only 10% had an adherence score of less than 1, this does not mean that the remaining 90% had adopted healthy lifestyles. The DAQ focuses on the frequency of consumption of a certain item and not on the portion size, as it uses a non-quantified food frequency approach (133). Its main purpose was to compare the effectiveness of dietary interventions and to track eating patterns over time. It included short questions about the previous day, and the number of questions was limited to address the specific behaviors related to weight gain and ease the respondent burden (133).

#### 4.4. Correlations between Scores

In addition to the reliability analyses, a validity testing of the adolescent DAQ was done by comparing results from the food choice and eating habits sections and 24h recall. This showed significant correlations for the vast majority of the items (23 out of 25), indicating that the DAQ is a valid tool in reflecting the food choices and eating habits of Lebanese adolescents (118). These findings differ from those in other studies. Hoelscher, Day (133) reported that the percentage agreement between the School-Based Nutrition Monitoring questionnaire and the 24h recall ranged from 38 to 89%, and Asaad, Sadegian (130) reported that six out of nine items (67%) of the Perceived Dietary Adherence Questionnaire designed for diabetic patients were significantly correlated with the 24 h recall. However, the current study showed no significant correlation between the DAQ and the dietary recall for the items regarding skimmed milk and soft drinks. Perhaps the adolescents missed the word “skimmed” (for milk) and “diet” (for soft drinks), since both questions related to similar food items in the previous question (i.e., regular milk; regular soft drinks) with only one word difference, unlike all the other questions.

The correlation between the total knowledge and total adherence index scores of adolescents was not significant. This was similar to the finding in a previous study of adolescent athletes, which also showed no correlation between nutritional knowledge and dietary intake (114). However, the knowledge score of adolescents was strongly correlated with the unhealthy items of the total adherence score rather than with the healthy items. This suggests that when adolescents know more about nutrition, they seem to eat less unhealthily. In other words, dietary knowledge may act as an inhibitor of unhealthy behavior, but to a lesser extent as a stimulant for healthy food choices. Future studies should consider interpreting the total adherence index versus examining the healthy and unhealthy components of the DAQ separately.

Very few studies have previously investigated the correlation between dietary adherence and dietary knowledge, making it difficult to compare these results. Our findings are somewhat similar to another study reporting that a higher nutrition knowledge score was associated with a significantly higher consumption of some healthy food items and significantly lower consumption of some unhealthy food items (137). In addition, Kresic, Kendel Jovanovic (43) reported an association between the nutrition knowledge of university students and their dietary intake, but this relationship was significantly influenced by other factors, such as gender and university status.

The positive correlation between both adherence score components (healthy and unhealthy items) can be regarded as surprising. It might be explained by the fact that when an individual is eating excessive amounts of foods, he/she is eating unhealthy and healthy food items at the same time, especially as the traditional Lebanese diet includes both healthy

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(e.g., labneh, salads, etc.) and unhealthy food (e.g., Arabic sweets, high fat cheese, etc.). More studies are needed to examine these findings further.

From the present study, it seems that their parents' knowledge affects adolescents' food choices and practices more than their own knowledge does. Similarly, parental knowledge regarding the daily recommended servings of many food groups, has previously been found to be positively associated with adequate average child intakes of dairy products, fruit, vegetables, grains and cereals, and meat (117). This might not be surprising because parents play a pivotal role in the development of their child's energy intake habits (food preference, availability of energy-dense food, etc.; 138). There was also a positive correlation between the knowledge score of the parents and that of their children.

### *4.5. Strengths and Limitations*

The current study has various strengths. A systematic mixed methods approach, combining both qualitative and quantitative analyses, was used to develop and test both questionnaires. They were designed by a dietitian with practical experience in nutrition in Lebanon. Adolescents from three different areas in Lebanon with differing socio-economic status were included in the sample (both urban and rural areas). The study also had an appropriate sample size (N=220). According to Oldewage-Theron, Egal (139), a minimum sample size of 94 adolescents is required to study nutrition knowledge and dietary intake patterns.

As for the limitations, while most of the DAQ questions were compared against the 24h recall, this was not the case for the DKQ and the rest of the DAQ questions related to physical activity, screen-viewing time, and smoking. Further validation of the DKQ and the rest of the DAQ is desirable. In addition, more girls than boys participated. This can be attributed to the higher number of girls enrolled in Lebanese schools (128). Some Lebanese public high schools are for girls only, but there are no schools for boys only. Another limitation is the unequal number of adolescents in the urban and rural regions. Rural regions have fewer schools, but the number of students per class is higher compared to urban high schools. The unequal number between public and private school students is due to the higher number of students per school in the recruited public schools compared to private high schools.

### *4.6. Implications for Research*

The current pilot study is the first one including Lebanese adolescents from both rural and urban areas, and their parents. The development of a measure of dietary knowledge and adherence designed specifically for use among Lebanese adolescents is likely to be a useful addition to existing methods of dietary assessment. Both questionnaires are inexpensive, time-saving, and present a low burden. The questionnaires can be used in epidemiological studies to assess the general knowledge level, gaps in certain areas in nutrition, food choices, eating patterns. As nutrition knowledge is a broad topic, specifying the areas to focus on

can guide future nutrition interventions and education strategies in nutrition and elucidate the hidden problems.

#### *4.7. Implications for Practice*

The DKQ and DAQ can be used by public health promoters and researchers when planning and assessing nutrition interventions for adolescents, and by policy makers to develop effective strategies to promote healthy eating and prevent obesity. The DAQ is helpful to track progress by looking at the total adherence index reflecting the overall dietary adherence, and then looking closer at separate items separately to identify specific targets (e.g., low fruit and vegetable intake, frequent soft drink consumption, meal skipping). In addition, both questionnaires can be used by nutrition professionals and dietitians in face-to-face counseling to evaluate levels of dietary knowledge and adherence of adolescents, and therefore specify the areas and topics to focus on when educating individuals and planning diets.

### **5. Conclusions**

The Dietary Knowledge (DKQ) and Dietary adherence questionnaires (DAQ) are brief and relatively inexpensive assessment questionnaires of dietary knowledge and adherence to nutritional recommendations that can be used in Lebanon. Future testing should investigate whether these questionnaires can be used in other Arabic countries. This study paved the way for subsequent nutrition education campaigns by assessing the feasibility of conducting such interventions and providing them with useful tools to evaluate their success.

## Appendices - Chapter 2

### Appendix A

**Table A1.** Dietary Knowledge Questionnaire (DKQ) structure

<b>Parts</b>	<b>Subject</b>	<b>Purpose</b>	<b>Number of Items/ maximum points<sup>a</sup></b>
1	Knowledge of dietary recommendations	To determine whether participants are familiar with the current dietary recommendations	6
2	Knowledge of nutrient sources	To determine whether participants know if the indicated food items are good or bad sources of the nutrient in question	37
3	Knowledge of common misconceptions in nutrition	To determine whether participants are aware of some misconceptions related to nutrition	4
4	Using knowledge in nutrition to make dietary choices	To determine whether participants are able to choose the healthiest option when given different food choices	4
5	Knowledge of associations between nutrition and diseases	To determine whether participants are aware about the correlation between eating habits/smoking and health	5
Total			56

<sup>a</sup> Each correct item corresponds to 1 point on the DKQ.

## Appendix B

**Table A2.** Structure of the dietary adherence questionnaire

Parts	Subject	Number of items
1	Food choices	21
2	Eating habits	4
3	PA and screen-viewing time	4
4	Smoking	1

PA: physical activity

**Table A3.** Scoring system for total adherence score calculation.

Questions	Options	Points
1 to 21	No, I did not eat any of the foods listed above	0
	Yes, I ate it once	1
	Yes, I ate it twice	2
	Yes, I ate it three times or more	3
22	Yes	2
	No	0
23 and 25	No, I did not have any meal	0
	Yes, I had one meal	1
	Yes, I had two meals	2
	Yes, I had 3 meals	3
26 and 27	Yes	1
	No	0
28	0 hour	0
	1 hour	1
	2-4 hours	2
	≥ 5 hours	3
30	Yes	2
	No/ stopped smoking	1

**Table A4.** Total adherence score components for the parents

Items	Questions	Maximum points
Healthy items	1- Yesterday, did you eat meat (like chopped meat in stews), chicken breast (grilled/boiled/not fried), or fish (grilled/boiled/not fried)?	33
	4- Yesterday, did you eat any of these foods? Labneh, shanklish, kareesha	
	5- Yesterday, did you eat any of these cheeses: Mozzarella, feta, akawi, baladiye, khadra?	
	8- Yesterday, did you drink skimmed milk (reduced or 0% fat) or skimmed laban?	
	10- Yesterday, did you eat whole bread, oat bread, brown bread, tortillas?	
	12- Yesterday, did you eat beans like lentils, white beans, fava beans (do not count green beans)?	
	13- Yesterday, did you eat any vegetables (do not count potatoes)?	
	14- Yesterday, did you eat fresh fruits? Do not count fruit juice and dried fruits.	
	22- Yesterday, did you have breakfast?	
	23- Yesterday, how many meals did you eat (meals include breakfast, lunch, and dinner)?	
26- Do you practice physical activity regularly?	32	
27- How many hours per week do you exercise?		
Unhealthy items		2- Yesterday, did you eat fried chicken, chicken nuggets, fried fish, fried meat, hot dogs, sausage, mortadella, or ham?
		3- Yesterday, did you eat chocolate cream or potato chips?
		6- Yesterday, did you eat any of these foods: Cheddar cheese, gruyere, edam, goat cheese, gouda, parmesan, Roquefort, kashkawan, cream cheese, kishk?
		7- Yesterday, did you drink whole milk or whole laban?
		11- Yesterday, did you eat French fries (fried potatoes)?
		17- Yesterday, did you drink soft drinks (Pepsi, 7up, Miranda, Sprite, Coca Cola, Fanta...)?
		19- Yesterday, did you drink energy drinks (Red Bull, AMP, ...)?
		20- Yesterday, did you eat any sweets such as sweet rolls, cookies, cakes, pies, brownies, cheesecake, doughnuts?
	21- Yesterday, did you eat any Arabic sweets (namoura, knefeh, halewet el jibn, znood el sitt...)?	
	25- Yesterday, how many times did you eat food from outside of your house? (restaurants, fast food restaurants, pizza places, and cafeterias)	
30- Do you smoke? (cigarettes and narjileh are included)		

Remarks:

Some items were not included in the total adherence score for the following reasons:

- To improve reliability, by removing the question related to refined bread and commercial juices, our Cronbach's alpha value increases.
- Some items are acceptable to eat by children, but are then less recommended to consume as adults, and vice versa. This explains the reason behind considering whole milk/labani as part of the unhealthy items for adults.
- To avoid controversy, diet soft drinks were removed from both scores for adults, as it depends on the overall health of each individual separately.

## Appendix C

**Table A5.** Responses to dietary knowledge questionnaire by adolescents.

	Number of answers	Percent
Recommended number of fruit and vegetable servings per day		
False/ Do not know	198	90.0
Correct answers	22	10.0
Type of fat to cut down		
False/ Do not know	117	53.2
Correct answers	103	46.8
Recommended type of dairy products		
False/ Do not know	160	72.7
Correct answers	60	27.3
Recommended daily water intake		
False/ Do not know	105	47.7
Correct answers	115	52.3
Recommended duration of daily physical activity		
False/ Do not know	93	42.3
Correct answers	127	57.7
Recommended intake of energy drinks per day		
False/ Don't know	102	46.4
Correct answers	118	53.6
Do you think these are high or low in added sugar?		
Apples		
False/ Do not know	53	24.1
Correct answers	167	75.9
Ice cream		
False/ Do not know	47	21.4
Correct answers	173	78.6
Commercial juices		
False/ Do not know	12	5.5
Correct answers	208	94.5
Soft drinks		
False/ Do not know	26	11.8
Correct answers	194	88.2
Grapes		
False/ Do not know	66	30.0
Correct answers	154	70.0
Do you think these foods are high or low in fat?		
Pasta		
False/ Do not know	83	37.7
Correct answers	137	62.3
Beans		
False/ Do not know	60	27.3
Correct answers	160	72.7
Honey		
False/ Do not know	152	69.1
Correct answers	68	30.9

Table A5. (continued)

	Number of answers	Percent
<b>Nuts</b>		
False/ Do not know	88	40.0
Correct answers	132	60.0
<b>Bread</b>		
False/ Do not know	128	58.2
Correct answers	92	41.8
<b>Cheddar cheese</b>		
False/ Do not know	90	40.9
Correct answers	130	59.1
<b>Chips</b>		
False/ Do not know	60	27.3
Correct answers	160	72.7
<b>Kashkawan cheese</b>		
False/ Do not know	63	28.6
Correct answers	157	71.4
<b>Mortadella</b>		
False/ Do not know	85	38.6
Correct answers	135	61.4
<b>Do you think these are high or low in SFA?</b>		
<b>Whole milk</b>		
False/ Do not know	103	46.8
Correct answers	117	53.2
<b>Olive oil</b>		
False/ Do not know	112	50.9
Correct answers	108	49.1
<b>Margarine</b>		
False/ Do not know	38	17.3
Correct answers	182	82.7
<b>Chocolate cream</b>		
False/ Do not know	70	31.8
Correct answers	150	68.2
<b>Do you think these are high or low in salt?</b>		
<b>Sausage</b>		
False/ Do not know	121	55.0
Correct answers	99	45.0
<b>Meat</b>		
False/ Do not know	83	37.7
Correct answers	137	62.3
<b>Vegetables</b>		
False/ Do not know	24	10.9
Correct answers	196	89.1
<b>Potato chips</b>		
False/ Do not know	23	10.5
Correct answers	197	89.5

Table A5. (continued)

	Number of answers	Percent
Fries		
False/ Do not know	46	20.9
Correct answers	174	79.1
Do you think these are high or low in protein?		
Chicken		
False/ Do not know	45	20.5
Correct answers	175	79.5
Cheese		
False/ Do not know	128	58.2
Correct answers	92	41.8
Fruits		
False/ Do not know	150	68.2
Correct answers	70	31.8
Beans		
False/ Do not know	39	17.7
Correct answers	181	82.3
Butter		
False/ Do not know	77	35.0
Correct answers	143	65.0
Eggs		
False/ Do not know	24	10.9
Correct answers	196	89.1
Do you think these are high or low in fibers?		
Eggs		
False/ Do not know	122	55.5
Correct answers	98	44.5
Meat		
False/ Do not know	132	60.0
Correct answers	88	40.0
Broccoli		
False/ Do not know	89	40.5
Correct answers	131	59.5
Nuts		
False/ Do not know	169	76.8
Correct answers	51	23.2
Fish		
False/ Do not know	155	70.5
Correct answers	65	29.5
Beans		
False/ Do not know	117	53.2
Correct answers	103	46.8
Rice		
False/ Do not know	153	69.5
Correct answers	67	30.5

Table A5. (continued)

	Number of answers	Percent
<b>Bulgur</b>		
False/ Do not know	142	64.5
Correct answers	78	35.5
<b>True/False (T/F): Some foods contain a lot of fat but no cholesterol</b>		
False/ Do not know	165	75.0
Correct answers	55	25.0
<b>T/F: Brown sugar is a healthy alternative for white sugar</b>		
False/ Do not know	180	81.8
Correct answers	40	18.2
<b>T/F: There is more protein in a glass of whole milk than in a glass of skimmed milk</b>		
False/ Do not know	173	78.6
Correct answers	47	21.4
<b>A type of oil which contains mostly unsaturated fatty acids is:</b>		
False/ Do not know	160	72.7
Correct answers	60	27.3
<b>Which of these breads contain the most vitamins and minerals?</b>		
False/ Do not know	133	60.5
Correct answers	87	39.5
<b>T/F: There is more Calcium in a glass of whole milk than a glass of skimmed milk</b>		
False/ Do not know	195	88.6
Correct answers	25	11.4
<b>If a person wanted to reduce the amount of fat in their diet, which would be the best choice?</b>		
False/ Do not know	99	45.0
Correct answers	121	55.0
<b>Which cheese would be the best choice as a lower fat option?</b>		
False/ Do not know	173	78.6
Correct answers	47	21.4
<b>What do you think will help prevent heart diseases?</b>		
<b>Increasing fiber intake</b>		
False/ Do not know	96	43.6
Correct answers	124	56.4
<b>Decreasing salt intake</b>		
False/ Do not know	42	19.1
Correct answers	178	80.9
<b>Increasing saturated fatty acid intake</b>		
False/ Do not know	63	28.6
Correct answers	157	71.4
<b>Are you aware that many chronic diseases (such as diabetes, heart diseases and certain types of cancer) are related to a low intake of fruits and vegetables?</b>		
False/ Do not know	119	54.1
Correct answers	101	45.9

**Table A5.** (continued)

	<b>Number of answers</b>	<b>Percent</b>
Are you aware that smoking causes many chronic diseases (such as lung cancer and heart diseases)?		
False/ Do not know	21	9.5
Correct answers	199	90.5

**Table A6.** Responses to dietary adherence questionnaire by adolescents

	<b>Frequency</b>	<b>Percent</b>
Yesterday, did you eat meat (like chopped meat in stews), chicken breast (not fried), or fish (not fried)?*		
None	109	49.5
Once	95	43.2
Twice	11	5.0
≥Three times	3	1.4
Yesterday, did you eat fried chicken, chicken nuggets, fried fish, fried meat, hot dogs, sausage, mortadella, or ham?***		
None	160	72.7
Once	51	23.2
Twice	4	1.8
≥Three times	2	0.9
Yesterday, did you eat chocolate cream or potato chips?***		
None	62	28.2
Once	121	55.0
Twice	21	9.5
≥Three times	14	6.4
Yesterday, did you eat any of these foods? Labneh, shanklish, kareesha?*		
None	109	49.5
Once	94	42.7
Twice	12	5.5
≥Three times	1	0.5
Yesterday, did you eat any of these cheeses? Mozzarella, feta, akawi, baladiye, khadra?*		
None	139	63.2
Once	69	31.4
Twice	7	3.2
≥Three times	2	0.9
Yesterday, did you eat any of these foods? Cheddar cheese, gruyere, edam, goat cheese, gouda, parmesan, Roquefort, kashkawan, cream cheese, kishk***		
None	180	81.8
Once	35	15.9
Twice	1	0.5
≥Three times	2	0.9
Yesterday, did you drink milk or laban?*		
None	144	65.5
Once	71	32.3
Twice	2	0.9
≥Three times	1	0.5

Table A6. (continued)

	Frequency	Percent
Yesterday, did you drink skimmed milk (reduced or 0% fat) or skimmed laban?*		
None	184	83.6
Once	31	14.1
Twice	2	0.9
≥Three times	1	0.5
Yesterday, did you eat white Arabic bread, kaak, franjeh bread?***		
None	49	22.3
Once	119	54.1
Twice	38	17.3
≥Three times	12	5.5
Yesterday, did you eat whole bread, oat bread, brown bread, tortillas?*		
None	142	64.5
Once	59	26.8
Twice	9	4.1
≥Three times	7	3.2
Yesterday, did you eat French fries (fried potatoes)?**		
None	127	57.7
Once	81	36.8
Twice	8	3.6
≥Three times	2	0.9
Yesterday, did you eat beans like lentils, white beans, fava beans (do not count green beans)?*		
None	172	78.2
Once	44	20.0
Twice	1	0.5
≥Three times	1	0.5
Yesterday, did you eat any vegetables (do not count potatoes)?*		
None	60	27.3
Once	131	59.5
Twice	19	8.6
≥Three times	8	3.6
Yesterday, did you eat fresh fruits? Do not count fruit juice and dried fruits*		
None	81	36.8
Once	110	50.0
Twice	18	8.2
≥Three times	9	4.1
Yesterday, did you drink natural fruit juice?		
None	153	69.5
Once	61	27.7
Twice	3	1.4
≥Three times	1	0.5
Yesterday, did you drink commercial fruit juice?***		
None	150	68.2
Once	59	26.8
Twice	4	1.8
≥Three times	3	1.4

Table A6. (continued)

	Frequency	Percent
Yesterday, did you drink soft drinks (Pepsi, 7up, Miranda, Sprite, Coca Cola, Fanta...)?**		
None	98	44.5
Once	85	38.6
Twice	26	11.8
≥Three times	9	4.1
Yesterday, did you drink <u>diet</u> soft drinks (Pepsi diet, 7up diet, Coca Cola diet, ...)?**		
None	207	94.1
Once	8	3.6
Twice	2	0.9
≥Three times	0	0
Yesterday, did you drink energy drinks (Red Bull, AMP, ...)?**		
None	198	90.0
Once	15	6.8
Twice	3	1.4
≥Three times	1	0.5
Yesterday, did you eat any sweets such as sweet rolls, cookies, cakes, pies, brownies, cheesecake, doughnuts?***		
None	156	70.9
Once	50	22.7
Twice	10	4.5
≥ Three times	0	0
Yesterday, did you eat any Arabic sweets (namoura, knefeh, halewet el jibn, znood el sitt...)?**		
None	169	76.8
Once	47	21.4
Twice	2	0.9
≥ Three times	0	0
Yesterday, did you have breakfast?*		
No	49	22.3
Yes	168	76.4
Yesterday, how many meals did you eat (meals include breakfast, lunch, and dinner)?*		
None	1	0.5
One meal	36	16.4
2 meals	100	45.5
3 meals	81	36.8
Yesterday, did you have a snack? A snack is a food or drink (except for water) that you eat or drink between meals.		
None	63	28.6
1 snack	93	42.3
2 snacks	42	19.1
≥3 snacks	17	7.7

Table A6. (continued)

	Frequency	Percent
Yesterday, how many times did you eat food from outside of your house? (restaurants, fast food restaurants, pizza places, and cafeterias)**		
None	169	76.8
One meal	36	16.4
2 meals	10	4.5
≥ 3 meals	3	1.4
Do you participate in physical education sessions at school?*		
No	60	27.3
Yes	158	71.8
Do you participate in any sports activity (other than physical education session at schools)?*		
No	99	45.0
Yes	117	53.2
How many hours per week do you exercise?*		
0 hours	36	16.4
1 hour	68	30.9
2-4 hours	66	30.0
≥ 5 hours	48	21.8
How many hours per day do you usually spend playing video games, watching TV, using tablets, and chatting on the phone?		
0 hours	9	4.1
1 hour	39	17.7
2 hours	36	16.4
3 hours	31	14.1
4 hours	36	16.4
5 hours	20	9.1
≥ 6 hours	48	21.8
Do you smoke? (cigarettes and narjileh are included)**		
No	149	67.7
Yes	65	29.5
Stopped smoking	4	1.8

\*: Questions included in healthy items score; \*\*: Questions included in unhealthy items score

## Appendix D

**Table A7.** Total knowledge score differences between the three locations (Beirut, Baalbeck, and Rayak)

<b>Total Knowledge Score</b>	<b>Mean Difference (SE)</b>
Beirut vs. Baalbeck	3.14* (1.14)
Beirut vs. Rayak	2.82 (1.35)
Baalbeck vs. Rayak	-0.32 (1.16)

\*  $p < 0.05$ **Table A8.** Total adherence score differences between the three locations (Beirut, Baalbeck, and Rayak)

<b>Total Adherence Score</b>	<b>Mean Difference (SE)</b>
Beirut vs. Baalbeck	0.61* (0.25)
Beirut vs. Rayak	0.40 (0.30)
Baalbeck vs. Rayak	-0.20 (0.26)

\*  $p < 0.05$

**Table A9.** Responses to dietary knowledge questionnaire by parents/caregivers

	Number of answers	Percent
Recommended number of fruit and vegetable servings per day		
False/ Do not know	98	90.7
Correct answers	10	9.3
Type of fat to cut down		
False/ Do not know	28	25.9
Correct answers	80	74.1
Recommended type of dairy products		
False/ Do not know	74	68.5
Correct answers	34	31.5
Recommended daily water intake		
False/ Do not know	58	53.7
Correct answers	50	46.3
Recommended duration of daily physical activity		
False/ Do not know	41	38.0
Correct answers	67	62.0
Recommended intake of energy drinks per day		
False/ Do not know	35	32.4
Correct answers	73	67.6
Do you think these are high or low in added sugar?		
Apples		
False/ Do not know	33	30.6
Correct answers	75	69.4
Ice cream		
False/ Do not know	22	20.4
Correct answers	86	79.6
Commercial juices		
False/ Do not know	16	14.8
Correct answers	92	85.2
Soft drinks		
False/ Do not know	15	13.9
Correct answers	93	86.1
Grapes		
False/ Do not know	40	37.0
Correct answers	68	63.0
Do you think these foods are high or low in fat?		
Pasta		
False/ Do not know	39	36.1
Correct answers	69	63.9
Beans		
False/ Do not know	26	24.1
Correct answers	82	75.9
Honey		
False/ Do not know	53	49.1
Correct answers	55	50.9

Table A9. (continued).

	Number of answers	Percent
<b>Nuts</b>		
False/ Do not know	31	28.7
Correct answers	77	71.3
<b>Bread</b>		
False/ Do not know	65	60.2
Correct answers	43	39.8
<b>Cheddar cheese</b>		
False/ Do not know	24	22.2
Correct answers	84	77.8
<b>Chips</b>		
False/ Do not know	32	29.6
Correct answers	76	70.4
<b>Kashkawan cheese</b>		
False/ Do not know	22	20.4
Correct answers	86	79.6
<b>Mortadella</b>		
False/ Do not know	36	33.3
Correct answers	72	66.7
<b>Do you think these are high or low in saturated fatty acids?</b>		
<b>Whole milk</b>		
False/ Do not know	37	34.9
Correct answers	69	65.1
<b>Olive oil</b>		
False/ Do not know	43	40.6
Correct answers	63	59.4
<b>Margarine</b>		
False/ Do not know	13	12.3
Correct answers	93	87.7
<b>Chocolate cream</b>		
False/ Do not know	27	25.5
Correct answers	79	74.5
<b>Do you think these are high or low in salt?</b>		
<b>Sausage</b>		
False/ Do not know	39	36.8
Correct answers	67	63.2
<b>Meat</b>		
False/ Do not know	49	46.2
Correct answers	57	53.8
<b>Vegetables</b>		
False/ Do not know	15	14.2
Correct answers	91	85.8
<b>Potato chips</b>		
False/ Do not know	9	8.6
Correct answers	96	91.4

Table A9. (continued).

	Number of answers	Percent
Fries		
False/ Do not know	25	23.8
Correct answers	80	76.2
Do you think these are high or low in protein?		
Chicken		
False/ Do not know	25	23.8
Correct answers	80	76.2
Cheese		
False/ Do not know	59	56.2
Correct answers	46	43.8
Fruits		
False/ Do not know	56	53.8
Correct answers	48	46.2
Beans		
False/ Do not know	32	30.8
Correct answers	72	69.2
Butter		
False/ Do not know	51	49.0
Correct answers	53	51.0
Eggs		
False/ Do not know	12	11.5
Correct answers	92	88.5
Do you think these are high or low in fiber?		
Eggs		
False/ Do not know	44	42.3
Correct answers	60	57.7
Meat		
False/ Do not know	57	54.8
Correct answers	47	45.2
Broccoli		
False/ Do not know	31	30.1
Correct answers	72	69.9
Nuts		
False/ Do not know	87	83.7
Correct answers	17	16.3
Fish		
False/ Do not know	60	57.7
Correct answers	44	42.3
Beans		
False/ Do not know	46	44.2
Correct answers	58	55.8
Rice		
False/ Do not know	52	50.0
Correct answers	52	50.0

**Table A9.** (continued).

	<b>Number of answers</b>	<b>Percent</b>
<b>Bulgur</b>		
False/ Do not know	61	58.7
Correct answers	43	41.3
<b>T/F: Some foods contain a lot of fat but no cholesterol</b>		
False/ Do not know	71	68.3
Correct answers	33	31.7
<b>T/F: Brown sugar is a healthy alternative for white sugar</b>		
False/ Do not know	88	84.6
Correct answers	16	15.4
<b>T/F: There is more protein in a glass of whole milk than in a glass of skimmed milk</b>		
False/ Do not know	79	76.0
Correct answers	25	24.0
<b>A type of oil which contains mostly unsaturated fatty acids is:</b>		
False/ Do not know	62	59.6
Correct	42	40.4
<b>Which of the indicated breads contain the most vitamins and minerals</b>		
False/ Do not know	46	44.2
Correct answers	58	55.8
<b>T/F: There is more Calcium in a glass of whole milk than a glass of skimmed milk</b>		
False/ Do not know	72	69.2
Correct answers	32	30.8
<b>If a person wanted to reduce the amount of fat in their diet, which type of meat would be the best choice?</b>		
False/ Do not know	35	33.7
Correct answers	69	66.3
<b>Which cheese would be the best choice as a lower fat option?</b>		
False/ Do not know	86	82.7
Correct answers	18	17.3
<b>What do you think will help prevent heart diseases?</b>		
<b>Increasing fiber intake</b>		
False/ Do not know	37	35.6
Correct answers	67	64.4
<b>Decreasing salt intake</b>		
False/ Do not know	25	24.0
Correct answers	79	76.0
<b>Increasing saturated fatty acid intake</b>		
False/ Do not know	33	31.7
Correct answers	71	68.3
<b>Are you aware that many chronic diseases (such as diabetes, heart diseases and certain types of cancer) are related to a low intake of fruits and vegetables?</b>		
False/ Do not know	54	51.9
Correct answers	50	48.1

**Table A9.** (continued).

	<b>Number of answers</b>	<b>Percent</b>
Are you aware that smoking causes many chronic diseases (such as lung cancer and heart diseases)?		
False/ Do not know	13	12.5
Correct answers	91	87.5

**Table A10.** Answers to dietary adherence questionnaire per question by parents

	<b>Number of answers</b>	<b>Percent</b>
Yesterday, did you eat meat (like chopped meat in stews), chicken breast (not fried), or fish (not fried)?*		
None	44	44.0
Once	53	53.0
Twice	3	3.0
≥Three times	0	0
Yesterday, did you eat fried chicken, chicken nuggets, fried fish, fried meat, hot dogs, sausage, mortadella, or ham?***		
None	74	74.0
Once	24	24.0
Twice	2	2.0
≥Three times	0	0
Yesterday, did you eat chocolate cream or potato chips?***		
None	40	40.0
Once	51	51.0
Twice	8	8.0
≥Three times	1	1.0
Yesterday, did you eat any of these foods? Labneh, shanklish, kareesha?*		
None	42	42.0
Once	55	55.0
Twice	2	2.0
≥Three times	1	1.0
Yesterday, did you eat any of these cheeses? Mozzarella, feta, akawi, baladiye, khadra?*		
None	72	72.0
Once	26	26.0
Twice	2	2.0
≥Three times	0	0
Yesterday, did you eat any of these foods? Cheddar cheese, gruyere, edam, goat cheese, gouda, parmesan, Roquefort, kashkawan, cream cheese, kishk**		
None	77	77.0
Once	21	21.0
Twice	1	1.0
≥Three times	1	1.0
Yesterday, did you drink milk or laban?***		
None	44	44.0
Once	51	51.0
Twice	3	3.0
≥Three times	2	2.0

Table A10. (continued).

	Number of answers	Percent
Yesterday, did you drink skimmed milk (reduced or 0% fat) or skimmed laban?*		
None	80	80.0
Once	16	16.0
Twice	3	3.0
≥Three times	1	1.0
Yesterday, did you eat white Arabic bread, kaak, franjeh bread?		
None	17	17.2
Once	53	53.5
Twice	23	23.2
≥Three times	6	6.1
Yesterday, did you eat whole bread, oat bread, brown bread, tortillas?*		
None	66	66.7
Once	23	23.2
Twice	7	7.1
≥Three times	3	3.0
Yesterday, did you eat French fries (fried potatoes)?**		
None	46	46.0
Once	47	47.0
Twice	3	3.0
≥Three times	4	4.0
Yesterday, did you eat beans (do not count green beans) like lentils, white beans, fava beans?*		
None	72	72.0
Once	22	22.0
Twice	6	6.0
≥Three times	0	0
Yesterday, did you eat any vegetables (do not count potatoes)?*		
None	19	19.0
Once	67	67.0
Twice	12	12.0
≥Three times	2	2.0
Yesterday, did you eat fresh fruits? Do not count fruit juice and dried fruits?*		
None	26	25.7
Once	52	51.5
Twice	20	19.8
≥Three times	3	3.0
Yesterday, did you drink natural fruit juice?		
None	68	67.3
Once	29	28.7
Twice	4	4.0
≥Three times	0	0

Table A10. (continued).

	Number of answers	Percent
Yesterday, did you drink commercial fruit juice?		
None	72	71.3
Once	24	23.8
Twice	1	1.0
≥Three times	4	4.0
Yesterday, did you drink soft drinks (Pepsi, 7up, Miranda, Sprite, Coca Cola, Fanta...)?**		
None	55	54.5
Once	37	36.6
Twice	8	7.9
≥Three times	1	1.0
Yesterday, did you drink <u>diet</u> soft drinks (Pepsi diet, 7up diet, Coca Cola diet, ...)?		
None	90	90.0
Once	7	7.0
Twice	2	2.0
≥Three times	1	1.0
Yesterday, did you drink energy drinks (Red Bull, AMP, ...)?**		
None	95	93.1
Once	4	3.9
Twice	2	2.0
≥Three times	1	1.0
Yesterday, did you eat any sweets such as sweet rolls, cookies, cakes, pies, brownies, cheesecake, doughnuts?*		
None	72	70.6
Once	24	23.5
Twice	4	3.9
≥Three times	2	2.0
Yesterday, did you eat any Arabic sweets (namoura, knefeh, halewet el jibn, znood el sitt...)?**		
None	75	72.8
Once	26	25.2
Twice	1	1.0
≥Three times	1	1.0
Yesterday, did you have breakfast?*		
No	14	13.9
Yes	87	86.1
Yesterday, how many meals did you eat (meals include breakfast, lunch, and dinner)?*		
None	3	3.0
One meal	10	9.9
2 meals	28	27.7
3 meals	60	59.4

Table A10. (continued).

	Number of answers	Percent
Yesterday, did you have a snack? A snack is a food or drink (except for water) that you eat or drink between meals.		
None	37	36.6
1 snack	44	43.6
2 snacks	15	14.9
≥3 snacks	5	5.0
Yesterday, how many times did you eat food from outside of your house? (restaurants, fast food restaurants, pizza places, and cafeterias)**		
None	87	87.9
One meal	11	11.1
2 meals	1	1.0
≥ 3 meals	0	0
Do you practice physical activity on a regular basis? And for how many hours per week?*		
No	51	50.0
Yes	51	50.0
0 h	26	26.0
1 h	30	30.0
2-4 h	24	24.0
≥ 5 h	20	20.0
How many hours per day do you usually spend playing video games, watching TV, using tablets, and chatting on the phone?		
0 h	3	3.0
1 h	22	21.8
2 h	25	24.8
3 h	21	20.8
4 h	14	13.9
5 h	6	5.9
≥ 6 h	10	9.9
Do you smoke? (cigarettes and narjileh are included)**		
No	60	60.0
Yes	35	35.0
Stopped smoking	5	5.0

\*: Questions included in healthy items score; \*\*: Questions included in unhealthy items score

**Table A11.** Pearson's correlations between the DAQ items and the corresponding items based on the 24h recall

Items	Pearson correlation
Lean meat	0.29***
High fat meat	0.30***
Unhealthy snacks (potato chips and chocolate cream)	0.48***
Low fat dairy	0.54***
Medium fat dairy	0.30***
High fat dairy	0.32***
Whole milk	0.42***
Skimmed milk	0.14 <sup>†</sup>
Refined bread	0.27***
Whole bread	0.15*
French fries	0.53***
Beans	0.45***
Vegetables	0.38***
Fruits	0.49***
Natural juices	0.52***
Commercial fruit juices	0.45***
Soft drinks	0.56***
Diet soft drinks	0.13 <sup>†</sup>
Energy drinks	0.51***
Sweets	0.30***
Arabic sweets	0.33***
Breakfast	0.66***
Number of meals	0.61***
Number of snacks	0.20**
Meals eaten outside	0.40***

\*\*\* $p < 0.001$ ; \*\* $p < 0.01$ ; \* $p < 0.05$ ; <sup>†</sup> $p < 0.10$

Note: The full supplementary material is available at: <https://www.mdpi.com/602998>





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# Chapter 3

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## **Dietary Knowledge, Dietary Adherence and BMI of Lebanese Adolescents and their Parents**

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### **Abstract**

Paediatric obesity is a severe public health problem accompanied by several physical and mental complications, mainly due to an imbalance between energy input and output. Dietary behaviours are influenced by many demographic factors and determinants such as the place of residence and the level of dietary knowledge of the children and their parents. The aim of the current paper is to assess the levels of dietary knowledge, dietary adherence (in relation to recommendations), and the body mass index (BMI) of Lebanese adolescents in association with demographic variables, their parents' dietary knowledge and adherence levels, and with other lifestyle behaviours. This cross-sectional study included 1535 Lebanese adolescents aged 15 to 18 years, from 16 public and private high schools located in urban and rural regions, and 317 of their parents. Our results showed that 30.2% of the adolescents were overweight or obese. Participants enrolled in private schools and those living in urban regions had a significantly higher BMI z-score compared to those enrolled in public schools and living in rural regions, respectively. In addition, Lebanese adolescents generally had low levels of dietary knowledge and 32.4% had low levels of dietary adherence. Their dietary adherence was significantly associated with their parents' dietary adherence. The findings underline the significant role of the parents in shaping their children's eating behaviours, in addition to the other determinants and factors affecting the diet of Lebanese adolescents. As the prevalence of paediatric overweight and obesity reached alarming rates among Lebanese youth, the results of the current study have important implications for both Lebanese nutrition policies and obesity prevention interventions in the Middle East and worldwide.

## 1. Introduction

Adolescence is a critical period during growth and development (140). Among the various health problems faced by this age category is paediatric obesity (141). According to the World Health Organisation (WHO), the prevalence of obesity among children and adolescents aged 5-19 years in Lebanon was 13.9% in 2016 (12). Overweight and obesity can lead to numerous physical and mental complications (106). Overweight and obesity are caused by an energy imbalance between the energy input (i.e., food intake) and the energy output (i.e., resting metabolic rate and physical activity), and are highly influenced by the obesogenic environment (142). Among Lebanese adolescents specifically, the intake of sugar-sweetened beverages was found to be positively correlated with overweight, and higher intakes of milk and dairy products were negatively associated with overweight (52).

Many demographic factors affect eating behaviours, including the age, gender, degree of urbanisation, place of residence, and socio-economic status (40). Studies have shown that older children had a significantly higher intake of energy-dense snacks compared to younger participants (143). Furthermore, adolescent girls are more adherent to red meat intake guidelines compared to boys, but the intake of fruits and vegetables is low for both genders (112). In Lebanon, obesity is more prevalent among women living in urban areas and having a higher socio-economic status (107). In addition, dietary knowledge plays an important role (40): individuals with higher dietary knowledge levels are almost 25 times more likely to consume adequate amounts of fruits, vegetables and fat, compared to those with a lower level of dietary knowledge (44). In addition, the clustering or co-occurrence of behaviours is another important factor influencing eating habits (37). For instance, eating unhealthy snacks and watching television are two separate behaviours that are often performed simultaneously (37). It seems that unhealthy behaviours often cluster with other unhealthy ones, and that healthy behaviours also often co-occur with other healthy behaviours. Other determinants of adolescents' dietary intake include parental nutrition knowledge and food habits (40). Romanos-Nanclares, Zazpe (117) reported that parental dietary knowledge of the recommended daily servings of food groups was positively correlated with the adequate consumption of dairy products, fruits, vegetables, and other food groups by their children. Similarly, healthier parental eating attitudes were associated with greater consumption of fruits and vegetables, and lower consumption of butter and meat by their children (117).

In Lebanon, studies have investigated neither the correlation between the dietary knowledge and dietary adherence of adolescents and children, nor the influence of the parents on their children's dietary knowledge and adherence. In addition, very few studies have analysed the correlation between dietary habits and anthropometric outcomes of Lebanese adolescents. Moreover, there are no studies examining potential determinants related to eating habits of Lebanese adolescents. Therefore, the aim of the current paper is

to assess the levels of dietary knowledge, dietary adherence, and the BMI of Lebanese adolescents, as well as their association with demographic variables, parental dietary knowledge and adherence levels, and with clustered behaviours. This cross-sectional study included participants living in both urban and rural areas in Lebanon, from different socio-economic backgrounds.

## 2. Materials and Methods

### 2.1. Study Design and Participants

The current cross-sectional study was conducted between October and December 2017, among 15- to 18-year-old adolescents attending public and private high schools in Beirut, Baalbeck, and Rayak in Lebanon, as well as their parents. Beirut, the capital of Lebanon, is an urban region, whereas Baalbeck and Rayak are rural regions. A total of 16 high schools were randomly selected from a list of high schools from the Ministry of Education, located in the selected locations: eight high schools from Beirut (six public and two private), six high schools from Baalbeck (three public and three private), and two high schools from Rayak (one public and one private). Participation was voluntary. Inclusion criteria for the participating adolescents included: (1) being Lebanese and enrolled in a Lebanese public or private high school located in one of the selected regions; (2) aged 15–18 years; (3) being fully capable (cognitive, psychiatric and physical ability) of communicating (as reported by parents or by school administration); (4) not having any chronic or genetic diseases (as reported by parents or by school administration).

The required sample size ( $n$ ) is directly proportional to the prevalence of overweight and obesity among Lebanese adolescents. As the adolescents participating in the previous pilot study (144) were highly cooperative, we did not oversample our required sample size to anticipate attrition (145). This resulted in a minimally required sample size of 331 and 165, based on overweight and obesity prevalence, respectively.

The sampling method was nonselective, meaning that all participants meeting the inclusion criteria and present at the moment of data collection were approached. After receiving the consent of the school principal, all subjects gave their informed consent for inclusion before participating in the study. The questionnaire stated clearly that once it was filled in and handed in, this meant that the adolescent accepted and assented to participate in the study. A similar assent statement was also included in the parents' version of the questionnaires. In addition, students' consent was also orally confirmed by the principal investigator (PI) before administering the questionnaire. The study was conducted in accordance with the Declaration of Helsinki, and the protocol was approved by the Lebanese Ministry of Education and Higher Education (15465/3/2016; date: 06/10/2017) and the Institutional Review Board of the Lebanese International University (LIUIRB-171,212-LS1). The final sample included 1535 adolescents and 317 parents (participation rate 19.4%). None of the approached adolescents refused to participate.

## *2.2. Data collection*

Data collection at schools was performed by a dietitian (PI) and a trained research assistant. Quality control measures such as training, pre-testing of the study questionnaires, and data collection and data entry monitoring (e.g., data curation, double entry, range checks for data values, etc.) were applied. Data was collected using Arabic questionnaires (native language of the participants). We describe the collected data in more detail below.

### *2.2.1. Socio-Demographic Data*

The sociodemographic information included the following: (1) age of the participants and their date of birth; (2) their gender; (3) the school class; (4) the type of school (public or private) and (5) the address (urban or rural).

### *2.2.2. Dietary Knowledge*

A Dietary Knowledge Questionnaire (DKQ) was administrated to adolescents and their parents. This questionnaire aims to assess the level of dietary knowledge of Lebanese adolescents and their parents. It was specifically designed for the current population and it was previously validated on a smaller similar sample of Lebanese adolescents ( $N=220$ ) and parents ( $N=108$ ) (144). The DKQ consists of five parts, covering different nutrition-related themes (144). After filling in the questionnaire, a total knowledge score is calculated by adding the points obtained on each item. The maximum possible score is 56, reflecting an extremely high level of dietary knowledge, and the minimum score is zero. The questionnaire showed an acceptable internal reliability, as Cronbach's alpha was 0.82 for adolescents and 0.83 for the parents (144).

### *2.2.3. Dietary Adherence*

A Dietary Adherence Questionnaire (DAQ) was administrated to adolescents and their parents, aiming to assess their level of adherence to the dietary recommendations listed in the consensus statement from the American Heart Association (111) and the Dietary Reference Intakes (146). This DAQ was designed specifically to suit the Lebanese population and it was previously pre-tested (144). It consists of four parts. The total dietary adherence index is obtained by dividing the score for healthy items by the score for unhealthy items. If the resulting index is higher than 1, this means that the healthy food choices and habits outweigh the unhealthy ones. The opposite is true if the index is lower than 1. The maximum possible score is 37, reflecting a total adherence to dietary recommendations, and the minimum score is zero. The internal reliability was acceptable, as the Cronbach's alpha was 0.64 for adolescents' healthy items and 0.61 for adolescents' unhealthy items (144). As for the parents, Cronbach's alpha was 0.56 for both healthy and unhealthy items.

### *2.2.4. Anthropometric Measurements*

Weight and height were measured using standardised protocols and procedures (147) and calibrated equipment. Adolescents were weighed to the nearest 0.1 kg in light indoor clothing and without shoes (147). Height was measured without shoes and recorded to the nearest 0.1 cm. Adolescents were standing with their heels together, arms by their sides,

legs straight, shoulders relaxed, and head in the Frankfort horizontal plane (147). Body Mass Index (BMI) was calculated by dividing weight (kg) by height squared (m<sup>2</sup>) (147).

BMI is recognised as the most appropriate measure to detect paediatric obesity (148) and it is a strong predictor for total fat mass in children and adolescents older than nine years (13). BMI measurement presents many advantages: it is inexpensive, relatively easy to obtain, non-invasive, and quick (14). The WHO recommends using z-scores for consistency and comparability, compared to percentiles (149). BMI z-scores, also known as BMI standard deviation (SD) scores, are measures of relative weight adjusted for age and gender (150). In the current study, the gender- and age-specific BMI z-scores were calculated using the WHO AnthroPlus software (151). As a frame of reference, BMI z-scores were classified as follows:  $\leq -3$  indicating severe malnutrition; -2 to -2.9 indicating moderate malnutrition; -1 to -1.99 indicating mild malnutrition (152); -0.99 to 1.03 indicating normal weight; 1.04 to 1.63 indicating overweight; 1.64 to 2.32 indicating obesity; and  $\geq 2.33$  indicating severe obesity (15).

Anthropometric measurements were obtained for 1418 out of 1535 (92.4%) adolescents. The rest of the participants were either absent during the measurement collection, refused to take their weight and/or height (e.g., because they were shy), or refused to follow the required procedure (e.g., refused to take their shoes off).

### *2.3. Statistical Analyses*

Data were entered and analysed using the Statistical Package for Social Sciences version 25.0 (SPSS Inc., Chicago, IL, USA). We used descriptive statistics to analyse the participant characteristics, the average scores, the BMI z-score average, and the participants' answers to the questionnaires. Independent *t*-tests were employed to determine significant differences between subgroup means (boys vs. girls, urban vs. rural, and public vs. private). Pearson's correlations were used to explore potential relations between knowledge, the adherence scores of adolescents and parents, and BMI z-scores. Effect sizes were categorised to three groups: small ( $r=0.10$ ), medium ( $r=0.30$ ), and large ( $r=0.50$ ) (153). One-Way analysis of variance (ANOVA) with a post hoc Tukey's test was used to determine any differences between the three study locations (Beirut, Baalbeck, and Rayak). *p* values of less than 0.05 were considered statistically significant. The obtained scores are expressed as mean and standard deviation (SD).

## **3. Results**

### *3.1. Demographic Characteristics*

The demographic characteristics of the participating adolescents and parents are shown in Table 1. The sample included more females than males (66.1% of the adolescents and 76.4% of their parents), more participants living in rural regions (67.3% of the adolescents and 50.2% of their parents), and more participants enrolled in public high schools (71.3% of adolescents and 90.5% of their parents).

**Table 1.** Demographic characteristics of the participants

	Adolescents (N = 1535)	Parents (N = 317)
Age, mean (SD)	15.8 (0.8)	43.3 (8.2)
Gender, n (%)		
Male	520 (33.9)	72 (23.6)
Female	1015 (66.1)	233 (76.4)
Location, n (%)		
Beirut (U)	501 (32.6)	158 (49.8)
Baalbeck (R)	834 (54.3)	122 (38.5)
Rayak (R)	200 (13.0)	37 (11.7)
Type of school, n (%)		
Public	1094 (71.3)	287 (90.5)
Private	441 (28.7)	30 (9.5)
Grade, n (%)		
Grade 10	870 (57.0)	181 (57.3)
Grade 11	655 (43.0)	135 (42.7)

U: Urban; R: Rural; SD: Standard deviation

### 3.2. Dietary Knowledge Score

Adolescents scored an average of 26.91 (SD=7.46) out of 56 on the DKQ, and 59.2% answered more than half of the questions incorrectly. In terms of demographic characteristics, there was no significant difference for the knowledge score between groups, except for the location: adolescents from rural schools scored higher than those from urban ones ( $p<0.001$ ; see Table 2).

**Table 2.** Means (SD) and differences in total knowledge and adherence scores among adolescents and their parents

	Adolescents				Parents			
	Total Knowledge Score	<i>p</i> Value	Total Dietary Adherence Index	<i>p</i> Value	Total Knowledge Score	<i>p</i> Value	Total Dietary Adherence Index	<i>p</i> Value
<i>Overall</i>	26.91 (7.46)	-	1.80 (1.57)	-	35.29 (7.65)	-	2.69 (1.82)	-
Gender								
<i>Male</i>	26.45 (8.37)	0.10	1.68 (1.39)	0.02	34.21 (6.56)	0.11	2.86 (2.08)	0.40
<i>Female</i>	27.15 (6.94)		1.87 (1.65)		35.86 (7.84)		2.64 (1.73)	
Class								
<i>Grade 10</i>	26.60 (7.27)	0.10	1.80 (1.52)	0.86	34.62 (7.77)	0.07	2.81 (1.90)	0.16
<i>Grade 11</i>	27.24 (7.70)		1.82 (1.65)		36.20 (7.46)		2.50 (1.69)	
Type of school								
<i>Public</i>	26.70 (6.85)	0.11	1.83 (1.46)	0.40	34.87 (7.64)	<0.01	2.68 (1.71)	0.79
<i>Private</i>	27.44 (8.76)		1.75 (1.83)		39.37 (6.59)		2.78 (2.76)	
Location								
<i>Urban</i>	25.36 (7.80)	<0.01	1.61 (1.28)	<0.01	35.84 (7.33)	0.21	2.78 (1.63)	0.41
<i>Rural</i>	27.66 (7.17)		1.91 (1.70)		34.75 (7.94)		2.60 (1.99)	
<i>Beirut (U)</i>	25.36 (7.80)	<0.01	1.61 (1.28)	<0.01	35.84 (7.33)	0.27	2.78 (1.63)	0.33
<i>Baalbeck (R)</i>	27.59 (6.99)		1.87 (1.50)		34.42 (7.89)		2.70 (2.19)	
<i>Rayak (R)</i>	27.99 (7.86)		2.04 (2.30)		35.86 (8.14)		2.25 (0.99)	

Notes: Maximum points are 56 for dietary knowledge (DKQ) and >1 for dietary adherence (DAQ) reflecting better adherence to healthy rather than unhealthy behaviours. Differences were examined using independent *t*-test for binary variables and ANOVA Post Hoc for differences between Beirut, Baalbeck, and Rayak. Abbreviations: DKQ: Dietary Knowledge Questionnaire; DAQ: Dietary Adherence Questionnaire; U: Urban; R: Rural

Parents scored an average total knowledge score of 35.29 (SD=7.65) out of 56 on the DKQ, and there were no significant differences between the groups based on demographics, except for the type of school, with parents of students from private schools scoring significantly higher (see Table 2). Detailed responses on the DKQ for both adolescents and parents are shown in Supplementary Files – Table S1.

### 3.3. Dietary Adherence Index

The mean total dietary adherence index score was 1.80 (SD=1.57), and 32.4% of adolescents obtained a score below 1 (i.e., healthy items score was lower than unhealthy items score). Girls scored significantly higher than boys ( $p = 0.02$ ), and adolescents living in rural regions scored higher than adolescents living in urban regions ( $p < 0.001$ ).

The mean healthy items score among adolescents was 8.83 (SD=3.64) out of 37. There were significant differences between groups regarding gender, grade, and location. The

mean unhealthy items score was 6.37 (SD=3.19) out of 38, and there were significant differences between groups related to gender, type of school, and location (see Supplementary Files - Table S3).

In terms of physical activity, younger adolescents from grade 10 and from public schools tended to practice physical activity (PA) at school more than adolescents from grade 11 and from private schools ( $p < 0.001$  for both). Similarly, adolescents living in urban regions tended to participate more in physical activity classes compared to adolescents from rural regions ( $p < 0.001$ ). As for the screen-viewing time of adolescents, girls and adolescents living in urban regions tended to spend more time watching television, and looking at smartphones, tablets, and other screens, compared to boys and adolescents living in rural regions ( $p < 0.001$  and  $p = 0.011$ , respectively, see Supplementary Files – Table S4).

Parents had a mean total dietary adherence index of 2.69 (SD=1.82), and there were no significant differences between the groups based on demographics (see Table 2).

The mean healthy items score among parents was 10.21 (3.31), and there were no significant differences between groups in terms of demographics except for the gender. The mean unhealthy items score among parents was 4.87 (SD = 2.59), and there were no significant differences between groups, except for the location (see Supplementary Files – Table S3). Detailed responses on the DAQ for both adolescents and their parents are shown in Supplementary Files – Table S2.

#### 3.4. BMI z-Score

The mean BMI z-score of the adolescents was 0.44 (SD  $\pm$  1.20), ranging from -3.78 to 4.11 (see Table 3). Overall, more than half of the adolescents (59%) had a normal BMI z-score (-0.99 to 1.03). A total of 13.9% were overweight, 16.3% were obese, and 10.7% were underweight.

**Table 3.** Means of BMI z-scores among Lebanese adolescents

Mean BMI z-score (SD)	
<i>Overall</i>	0.44 (1.20)
Gender**	
<i>Boys</i>	0.58 (1.33)
<i>Girls</i>	0.38 (1.12)
Grade	
<i>Grade 10</i>	0.43 (1.22)
<i>Grade 11</i>	0.45 (1.17)
Type of school**	
<i>Public</i>	0.38 (1.16)
<i>Private</i>	0.60 (1.28)
Location**	
<i>Urban</i>	0.57 (1.27)
<i>Rural</i>	0.38 (1.16)

Notes: \*\* Within each group, mean BMI z-scores are significantly different at  $p < 0.01$ . Differences were examined using independent *t*-test. Abbreviations: BMI: Body mass index; SD: Standard deviation.

### 3.5. Correlations

#### **3.5.1. Knowledge and Adherence Scores**

Table 4 shows the correlations between knowledge and adherence scores. There was a significant medium positive correlation between the total knowledge score of the adolescents and the total knowledge score of the parents ( $p < 0.001$ ). There were significant small positive correlations between the total knowledge score of the adolescents and their healthy items ( $p < 0.001$ ), and their total dietary adherence index ( $p < 0.001$ ). In addition, a significant small negative correlation was found between the total knowledge score of adolescents and their unhealthy items score ( $p < 0.001$ ).

The total knowledge score of the parents was significantly positively correlated with their total dietary adherence index ( $p = 0.007$ ), and negatively correlated with their unhealthy items score ( $p = 0.01$ ). The healthy items score of the parents was significantly positively correlated with the healthy items score of their children ( $p < 0.001$ ), and the same medium positive correlation was found between the unhealthy items score of the parents and their children. In addition, both total dietary adherence indexes of the parents and adolescents were significantly positively correlated ( $p = 0.007$ ). Detailed correlations between the DAQ items of the parents and adolescents are shown in Supplementary Files – Table S6.

#### **3.5.2. BMI z-Score and Total Knowledge and Adherence Scores**

The BMI z-score of the adolescents was significantly positively correlated with their total knowledge score ( $p = 0.001$ ) and the total knowledge score of the parents ( $p = 0.029$ ). By contrast, the BMI z-score was significantly negatively correlated with the healthy items and

unhealthy items score of adolescents ( $p < 0.01$ ), and the healthy items score of the parents ( $p = 0.005$ ; see Table 5). Detailed correlations between the BMI z-score and the DAQ items of adolescents are shown in Supplementary Files – Table S6.

### 3.5.3. Clustered Behaviours

There was a significant negative correlation between the breakfast intake among adolescents and the intake of high-fat meats ( $r = -0.09$ ;  $p = 0.001$ ), the intake of commercial fruit juices ( $r = -0.08$ ;  $p = 0.002$ ), the number of snacks ( $r = -0.20$ ;  $p < 0.001$ ), and the screen-viewing time ( $r = -0.08$ ;  $p = 0.004$ ).

Physical activity of adolescents at schools was significantly and positively correlated with the following: the intake of vegetables ( $r = 0.06$ ;  $p = 0.03$ ), physical activity practice outside school ( $r = 0.25$ ;  $p < 0.001$ ), and the weekly number of hours spent on physical activity ( $r = 0.53$ ;  $p < 0.001$ ). There was a significant negative correlation with the intake of high-fat dairy products ( $r = -0.05$ ;  $p = 0.049$ ), the intake of commercial juices ( $r = -0.06$ ;  $p = 0.03$ ), the number of snacks ( $r = -0.07$ ;  $p = 0.009$ ), and the screen-viewing time ( $r = 0.07$ ;  $p = 0.012$ ; see Supplementary Files -Table S5).

**Table 4.** Correlations between knowledge and adherence scores of the adolescents and their parents

	Adolescents				Parents		
	Healthy Items score	Unhealthy Items score	Total Dietary Adherence index	Total Knowledge score	Healthy Items score	Unhealthy Items score	Total Dietary Adherence index
<b>Adolescents</b>							
Total Knowledge score	0.12***	-0.13***	0.14***	0.26***	0.09	-0.04	0.10
Healthy Items score		0.15***	0.45***	-0.02	0.28***	0.09	0.10
Unhealthy Items score			-0.54***	-0.05	0.04	0.29***	-0.15*
Total Dietary Adherence index				0.08	0.15*	-0.14*	0.16**
<b>Parents</b>							
Total Knowledge score					0.11	-0.15*	0.16**
Healthy Items score						0.27***	0.30***
Unhealthy Items score							-0.62***

\*  $p < 0.05$ ; \*\*  $p < 0.01$ ; \*\*\*  $p < 0.001$  (Using Pearson's correlation).

**Table 5.** Correlations between knowledge and adherence scores and BMI z-scores of adolescents

	Total Knowledge Score of Adolescents	Total Dietary Adherence Index of Adolescents	Healthy Items Score of Adolescents	Unhealthy Items Score of Adolescents	Total Knowledge Score of Parents	Total Dietary Adherence Index of Parents	Healthy Items Score of Parents	Unhealthy Items Score of Parents
BMI z-Score of Adolescents	0.09**	0.02	-0.11***	-0.09**	0.13*	-0.01	-0.17**	-0.08

\*  $p < 0.05$ ; \*\*  $p < 0.01$ ; \*\*\*  $p < 0.001$  (Using Pearson's correlation).

## 4. Discussion

To the best of our knowledge, the current study is the first to examine dietary knowledge and dietary adherence levels of Lebanese adolescents from urban and rural regions and their parents, as well as the correlation between them, and their association with the BMI z-score of adolescents.

Adolescents scored relatively low on the knowledge score. A previous study on 9- to 11-year-old Lebanese children showed higher knowledge scores (average 63% compared to 48% in the current study). The interviewers of the current study insisted that if participants did not know the answer to a question, they should indicate “do not know” rather than provide random answers. As this eliminates filling in the correct answer by chance, this might have influenced the lower knowledge score. However, another cross-sectional study reported that 86% of the participating United Arab Emirati adolescents had a low level of dietary knowledge (154). With regard to the parents, their average dietary knowledge score was 63%, thus scoring higher than their children. This is in line with another study reporting similar knowledge scores among parents (155).

The average total dietary adherence index among adolescents was above 1, meaning that, overall, the healthy items outweighed unhealthy ones, in line with a previous study (144). These findings are in line with previous studies in various countries. In a study using the Healthy Eating Index, Brazilian adolescents scored an average of 51.8 (out of 100) (156). In European countries, poor compliance with the dietary recommendations was observed in 37.6% of children (157), in line with the 32.4% in the current study. Additionally, the current study showed relatively low healthy items scores, compared to another study among adolescents aged 15-18 years from New Zealand using the Healthy Dietary Habits for adolescents index (158).

With regard to the parents, the total dietary adherence index was well above 1, and the healthy items score was also higher than their children’s scores. It therefore seems that parents’ diets are healthier than those of their adolescent children. To our knowledge, there are no studies assessing the level of dietary adherence of parents specifically, but a study in Qatar among adults in general, reported similar dietary adherence scores (159). Another study including Saudi adults showed a lower level of dietary adherence (average score of 47.4%) (160).

Overall, the present study showed high rates of overweight and obesity among Lebanese adolescents (13.9% and 16.3%, respectively). Especially the percentage of obesity appeared high. This could be due to the nutrition transition affecting Lebanese children and adolescents who are adopting the Western lifestyle, characterised by long hours of screen-viewing time and excessive consumption of fast food (52). In a previous study among Lebanese youth, the prevalence of overweight (30.8%) was higher (52), and the prevalence

of obesity was lower (10.3%). Another cross-sectional study including Jordanian adolescents also reported higher rates of overweight (15.7%) and lower rates of obesity (8.7%) (161), although different cut-off points were used in both studies to interpret the BMI z-scores. Furthermore, the BMI z-score was significantly higher among boys compared to girls in the current study, in line with other studies reporting that boys are at a higher risk for obesity (52). As for the type of school, the average BMI z-score was significantly higher in private high schools compared to public ones. Thus, adolescents with a higher socio-economic status (more often attending private schools with higher tuition fees (73)), tend to be overweight or obese more often. Similar to many developing countries, in Lebanon, obesity is more prevalent among individuals with a higher socio-economic status (107). Furthermore, the average BMI z-score was also higher among urban participants compared to rural individuals, which is also reported in other studies conducted in Lebanon and Jordan (52, 161).

However, underweight is another nutritional problem this age category faces, with 10.7% of the current adolescents being undernourished. In a study in Tunisia, the prevalence of underweight among a similar sample of adolescents was lower (4.8%) (162). Underweight among adolescents was reported in many Arab countries, ranging from 5 to 25% (107). These numbers indicate the presence of both types of malnutrition (under- and overnutrition) in one country and among a critical age category, requiring further attention. This is assumed to be mainly due to unhealthy eating habits and a lack of dietary knowledge (107). The double burden of high prevalence of both overweight and underweight in many developing countries has devastating public health and economic consequences, especially in low-income countries (163).

Despite mostly small effect sizes, the significant positive correlation between the dietary knowledge of adolescents and the total dietary adherence index shows that knowledge is one of the factors influencing dietary habits of Lebanese adolescents. In other words, the more adolescents know about nutrition, the better they follow the dietary guidelines. These findings are in line with other studies reporting that university students with a higher nutrition knowledge score were more likely to be following the dietary guidelines (43). The current results also showed that the level of the parents' dietary knowledge influences their children's eating behaviours only indirectly, by influencing their children's dietary knowledge; a direct correlation between parents' knowledge and children's eating was not evident. Zarnowiecki, Sinn (155) also reported that dietary knowledge levels of children and their parents were positively correlated. Studies among younger children (8-11 years) do report a direct correlation between parents' knowledge and their children's healthy food intake (164), which might reflect the gatekeeping role parents have for younger children's eating behaviour (165). In adolescents, parents have less control over what their children eat (115). Nonetheless, adolescents' eating behaviours were similar to their parents' dietary habits. Parents frame family diets, shape the development

of culturally appropriate eating patterns in children, and are role models for eating behaviour (165).

As for the parents, we noticed a positive correlation between their total knowledge score and the adherence index, reflecting once again that knowledge is an important determinant of dietary habits (40). There was also a negative correlation between the unhealthy items score and the knowledge score, but there was no significant correlation between the healthy items and the knowledge level. This means that, among parents, the dietary knowledge may act as an inhibitor of unhealthy eating habits rather than as a stimulator of healthy eating habits. These individuals may thus be aware of what should be avoided, but not necessarily of the available healthy alternatives. A similar correlation between the knowledge and the healthy and unhealthy items was found in a previous study among Lebanese adolescents (144).

A positive correlation between the BMI z-score of adolescents and their dietary knowledge score was found, which might indicate that overweight and obese children tend to be more interested in nutrition compared to other children. Similarly, parents of children with higher BMI z-scores tended to be more knowledgeable about nutrition as well. In line with this, Milosavljević, Mandić (113) reported that the minimum knowledge score of adolescents was higher among those with a higher BMI. However, a study conducted in Jordan found that mothers with a high to moderate level of knowledge were more likely to have a child with a decreased waist circumference, but their knowledge was unrelated to their children's BMI (166). Other available studies did not measure the BMI z-score, but rather only the BMI, failing to adjust for gender and age differences in BMI among adolescents (14). The BMI z-score of the current adolescents was further significantly negatively correlated with the intake of both the healthy items and the unhealthy items. Previous research has also shown that adolescents with higher BMIs tend to adopt less healthy behaviours (30). However, their lower consumption of unhealthy items indicates that overweight and obese adolescents tend to eat less food overall (both healthy and unhealthy), perhaps to decrease their weight. Alternatively, there might be a higher social desirability bias among overweight and obese adolescents. In addition, the negative correlation between the BMI z-score and the healthy items score of the parents indicates that healthy eating habits and PA practices of the parents influence the weight of their children. This is because parents following healthy habits may influence their children to adopt similar healthier choices (see correlation of healthy items score of adolescents and their parents), thereby leading to a decreased BMI z-score. To our knowledge, studies have not evaluated the association between the child's BMI z-score and the healthy and unhealthy behaviours of the parents, separately.

The main strength of the present study is its large and diverse sample covering both urban and rural regions and different types of high schools. Data collection was performed

according to standardised and quality-controlled procedures. This is the first study in the region to investigate the correlation between dietary knowledge and dietary adherence of adolescents and their parents. It is also the first study to examine the correlation between the BMI z-score of Lebanese adolescents and the levels of dietary knowledge and dietary adherence of adolescents and their parents. The current study allows us to understand the dietary behaviour of Lebanese adolescents and the factors influencing it. In addition, all the questionnaires used were pre-tested and designed specifically to suit the Lebanese population (144). Furthermore, the study focused on both healthy and unhealthy food and health-related behaviours.

Some limitations should be also considered. First, the sample did not include participants from all the Lebanese regions, and it is therefore unclear whether results can be generalised to the larger population. Second, the sample was not equally distributed over the different subgroups (e.g., based on gender, region). These differences in the sample subgroups were expected based on previous studies conducted on a similar sample, with more girls than boys, as the percentage of girls enrolled in Lebanese high schools is higher compared to boys (144). Similarly, the number of participants from rural regions was higher than those from urban regions, despite having included fewer rural schools, because the number of students per class in rural schools is higher compared to urban high schools (144). In line with this, an unequal number of participants between public and private school students could be expected (144). This was also observed in other studies outside Lebanon (161, 167). Third, the dietary knowledge and adherence variables were based on self-reports rather than on objective assessment, potentially causing bias. However, direct measurements (e.g. observation) are not feasible in studies with a large population (157).

### *Implication for Research, Practice, and Policy*

Our findings are of interest to researchers, health promoters, educators, dietitians, and policy makers involved in improving the nutritional status and diet quality of adolescents worldwide. This study is the first step preceding the implementation of a dietary intervention to ameliorate the eating habits of Lebanese adolescents. Such interventions should be planned carefully to suit individuals with different BMI z-scores, to prevent further weight loss among adolescents with undernutrition (10.7%). Health promoters should target the factors with the highest effect sizes with regard to BMI z-score and dietary adherence to make the intervention more effective and more efficient, especially knowing that schools have limited time when it comes to extra-curricular activities. In addition, interventions should focus on individuals with the lowest dietary knowledge and adherence scores, e.g., adolescents from urban regions. Additionally, as some healthy behaviours co-occur with other healthy eating habits, future interventions must emphasise the importance of these specific behaviours (e.g., breakfast consumption and decreased screen-viewing time) to enhance their effectiveness.

## 5. Conclusions

This study indicates that the prevalence of overweight and obesity has reached alarming rates among Lebanese adolescents and it emphasises the importance of implementing interventions to prevent paediatric obesity among the youth. Such interventions should target behaviours that are associated with a lower BMI z-score such as breakfast consumption, and focus on nutrition topics for which adolescents show the lowest knowledge and dietary adherence. National studies to investigate the change of obesity rates, as well modifications in the dietary knowledge and adherence levels in Lebanon, are recommended.

## Appendix- Chapter 3:

Table S1 – Responses to the Dietary Knowledge Questionnaire by the adolescents and their parents.

	Adolescents n (%)		Parents n (%)	
	False/ Do not know	Correct answers	False/ Do not know	Correct answers
<i>Recommended number of fruit and vegetable servings per day</i>	1402 (91.3)	133 (8.7)	271 (85.5)	46 (14.5)
<i>Type of fat to cut down on</i>	1005 (65.5)	530 (34.5)	79 (24.9)	238 (75.1)
<i>Recommended type of dairy products</i>	1105 (72.0)	430 (28.0)	173 (54.6)	144 (45.4)
<i>Recommended daily water intake</i>	679 (44.2)	856 (55.8)	91 (28.7)	226 (71.3)
<i>Recommended duration of daily physical activity</i>	743 (48.4)	792 (51.6)	132 (41.6)	185 (58.4)
<i>Recommended intake of energy drinks per day</i>	681 (44.4)	854 (55.6)	77 (24.3)	240 (75.7)
<i>Do you think these are high or low in added sugar?</i>				
<i>Apples</i>	461 (30.0)	1074 (70.0)	80 (25.2)	237 (74.8)
<i>Ice cream</i>	380 (24.8)	1155 (75.2)	65 (20.5)	252 (79.5)
<i>Commercial juices</i>	173 (11.3)	1362 (88.7)	22 (6.9)	295 (93.1)
<i>Soft drinks</i>	238 (15.5)	1297 (84.5)	33 (10.4)	284 (89.6)
<i>Grapes</i>	626 (40.8)	909 (59.2)	130 (41.0)	187 (59.0)
<i>Do you think these foods are high or low in fat?</i>				
<i>Pasta</i>	689 (44.9)	846 (55.1)	105 (33.1)	212 (66.9)
<i>Beans</i>	420 (27.4)	1115 (72.6)	54 (17.0)	263 (83.0)
<i>Honey</i>	1102 (71.8)	433 (28.2)	147 (46.4)	170 (53.6)
<i>Nuts</i>	728 (47.4)	807 (52.6)	100 (31.5)	217 (68.5)
<i>Bread</i>	976 (63.6)	559 (36.4)	171 (53.9)	146 (46.1)
<i>Cheddar cheese</i>	548 (35.7)	987 (64.3)	67 (21.1)	250 (78.9)
<i>Chips</i>	384 (25.0)	1151 (75.0)	52 (16.4)	265 (83.6)
<i>Kashkawan cheese</i>	513 (33.4)	1022 (66.6)	32 (10.1)	285 (89.9)
<i>Mortadella</i>	583 (38.0)	952 (62.0)	78 (24.6)	239 (75.4)
<i>Do you think these are high or low in SFA?</i>				
<i>Whole milk</i>	1073 (69.9)	462 (30.1)	109 (34.4)	208 (65.6)
<i>Olive oil</i>	1192 (77.7)	343 (22.3)	111 (35.0)	206 (65.0)
<i>Margarine</i>	892 (58.1)	643 (41.9)	22 (6.9)	295 (93.1)
<i>Chocolate cream</i>	988 (64.4)	547 (35.6)	35 (11.0)	282 (89.0)

Table S1. (continued).

	Adolescents n (%)		Parents n (%)	
	False/ Do not know	Correct answers	False/ Do not know	Correct answers
<i>Do you think these are high or low in salt?</i>				
<i>Sausage</i>	849 (55.3)	686 (44.7)	93 (29.3)	224 (70.7)
<i>Meat</i>	598 (39.0)	937 (61.0)	139 (43.8)	178 (56.2)
<i>Vegetables</i>	205 (13.4)	1330 (86.6)	33 (10.4)	284 (89.6)
<i>Potato chips</i>	170 (11.1)	1365 (88.9)	21 (6.6)	296 (93.4)
<i>Fries</i>	308 (20.1)	1227 (79.9)	61 (19.2)	256 (80.8)
<i>Do you think these are high or low in protein?</i>				
<i>Chicken</i>	309 (20.1)	1226 (79.9)	64 (20.2)	253 (79.8)
<i>Cheese</i>	821 (53.5)	714 (46.5)	162 (51.1)	155 (48.9)
<i>Fruits</i>	1035 (67.4)	500 (32.6)	162 (51.1)	155 (48.9)
<i>Beans</i>	479 (31.2)	1056 (68.8)	88 (27.8)	229 (72.2)
<i>Butter</i>	645 (42.0)	890 (58.0)	157 (49.5)	160 (50.5)
<i>Eggs</i>	205 (13.4)	1330 (86.6)	36 (11.4)	281 (88.6)
<i>Do you think these are high or low in fibres?</i>				
<i>Eggs</i>	1170 (76.2)	365 (23.8)	147 (46.4)	170 (53.6)
<i>Meat</i>	1247 (81.2)	288 (18.8)	190 (59.9)	127 (40.1)
<i>Broccoli</i>	1122 (73.1)	413 (26.9)	102 (32.2)	215 (67.8)
<i>Nuts</i>	1367 (89.1)	168 (10.9)	230 (72.6)	87 (27.4)
<i>Fish</i>	1321 (86.1)	214 (13.9)	213 (67.2)	104 (32.8)
<i>Beans</i>	1194 (77.8)	341 (22.2)	133 (42.0)	184 (58.0)
<i>Rice</i>	1307 (85.1)	228 (14.9)	197 (62.1)	120 (37.9)
<i>Bulgur</i>	1251 (81.5)	284 (18.5)	168 (53.0)	149 (47.0)
<i>True/False (T/F): Some foods contain a lot of fat, but no cholesterol</i>	1188 (77.4)	347 (22.6)	212 (66.9)	105 (33.1)
<i>T/F: Brown sugar is a healthy alternative to white sugar</i>	1158 (75.4)	377 (24.6)	245 (77.3)	72 (22.7)
<i>T/F: There is more protein in a glass of whole milk than in a glass of skimmed milk</i>	1206 (78.6)	329 (21.4)	225 (71.0)	92 (29.0)
<i>A type of oil which contains mostly unsaturated fatty acids is:</i>	1213 (79.0)	322 (21.0)	180 (56.8)	137 (43.2)
<i>Which of these breads contain the most vitamins and minerals?</i>	865 (56.4)	670 (43.6)	143 (45.1)	174 (54.9)
<i>T/F: There is more Calcium in a glass of whole milk than a glass of skimmed milk</i>	1192 (77.7)	343 (22.3)	219 (69.1)	98 (30.9)
<i>If a person wanted to reduce the amount of fat in their diet, which would be the best meat choice?</i>	815 (53.1)	720 (46.9)	95 (30.0)	222 (70.0)
<i>Which cheese would be the best choice as a lower fat option?</i>	1242 (80.9)	293 (19.1)	185 (58.4)	132 (41.6)

**Table S1.** (continued).

	<b>Adolescents n (%)</b>		<b>Parents n (%)</b>	
	False/ Do not know	Correct answers	False/ Do not know	Correct answers
<i>What do you think will help prevent heart diseases?</i>				
<i>Increasing fibre intake</i>	715 (46.6)	820 (53.4)	107 (33.8)	210 (66.2)
<i>Decreasing salt intake</i>	362 (23.6)	1173 (76.4)	60 (18.9)	257 (81.1)
<i>Increasing saturated fatty acid intake</i>	441 (28.7)	1094 (71.3)	88 (27.8)	229 (72.2)
<i>Are you aware that many chronic diseases (such as diabetes, heart diseases and certain types of cancer) are related to a low intake of fruits and vegetables?</i>	895 (58.3)	640 (41.7)	154 (48.6)	163 (51.4)
<i>Are you aware that smoking causes many chronic diseases (such as lung cancer and heart diseases)?</i>	173 (11.3)	1362 (88.7)	19 (6.0)	298 (94.0)

T/F: True or false; Percentages are calculated according to the number of participants with non-missing values for each item

**Table S2.** Responses to the Dietary Adherence Questionnaire of the adolescents and their parents

	Adolescents n (%)				Parents n (%)			
	None	Once	Twice	≥3 times	None	Once	Twice	≥3 times
<i>Yesterday, did you eat meat (like chopped meat in stews), chicken breast (not fried), or fish (not fried)?</i>	827 (55.5)	591 (39.7)	61 (4.1)	10 (0.7)	99 (33.2)	176 (59.1)	18 (6.0)	5 (1.7)
<i>Yesterday, did you eat fried chicken, chicken nuggets, fried fish, fried meat, hot dogs, sausage, mortadella, or ham?</i>	896 (60.0)	506 (33.9)	76 (5.1)	16 (1.1)	224 (75.4)	68 (22.9)	5 (1.7)	0
<i>Yesterday, did you eat chocolate cream or potato chips?</i>	702 (46.9)	616 (41.2)	130 (8.7)	48 (3.2)	168 (56.6)	112 (37.7)	13 (4.4)	4 (1.3)
<i>Yesterday, did you eat any of these foods? Labneh, shanklish, kareesha?</i>	939 (62.9)	481 (32.2)	65 (4.4)	8 (0.5)	100 (33.8)	172 (58.1)	21 (7.1)	3 (1.0)
<i>Yesterday, did you eat any of these cheeses? Mozzarella, feta, akawi, baladiye, khadra?</i>	1249 (83.5)	219 (14.6)	21 (1.4)	6 (0.4)	189 (63.6)	96 (32.3)	10 (3.4)	2 (0.7)
<i>Yesterday, did you eat any of these foods? Cheddar cheese, gruyere, edam, goat cheese, gouda, parmesan, Roquefort, kashkawan, cream cheese, kishk</i>	977 (65.4)	434 (29.0)	71 (4.7)	13 (0.9)	217 (73.1)	75 (25.3)	3 (1.0)	2 (0.7)
<i>Yesterday, did you drink milk or laban?</i>	1177 (78.7)	276 (18.5)	38 (2.5)	4 (0.3)	128 (43.0)	155 (52.0)	13 (4.4)	2 (0.7)
<i>Yesterday, did you drink skimmed milk (reduced or 0% fat) or skimmed laban?</i>	1461 (97.9)	19 (1.3)	8 (0.5)	5 (0.3)	263 (88.3)	31 (10.4)	2 (0.7)	2 (0.7)
<i>Yesterday, did you eat white Arabic bread, kaak, franjeh bread?</i>	294 (19.7)	674 (45.2)	385 (25.8)	138 (9.3)	51 (17.1)	180 (60.2)	47 (15.7)	21 (7.0)
<i>Yesterday, did you eat whole bread, oat bread, brown bread, tortillas?</i>	1357 (90.9)	101 (6.8)	24 (1.6)	11 (0.7)	222 (74.2)	53 (17.7)	17 (5.7)	7 (2.3)
<i>Yesterday, did you eat French fries (fried potatoes)?</i>	917 (61.4)	528 (35.3)	39 (2.6)	10 (0.7)	175 (58.5)	114 (38.1)	7 (2.3)	3 (1.0)

Table S2. (continued).

	Adolescents n (%)				Parents n (%)			
	None	Once	Twice	≥3 times	None	Once	Twice	≥3 times
<i>Yesterday, did you eat beans like lentils, white beans, fava beans (do not count green beans)?</i>	1281 (85.7)	191 (12.8)	20 (1.3)	3 (0.2)	184 (61.7)	106 (35.6)	7 (2.3)	1 (0.3)
<i>Yesterday, did you eat any vegetables (do not count potatoes)?</i>	563 (37.7)	774 (51.8)	116 (7.8)	42 (2.8)	52 (17.4)	196 (65.6)	43 (14.4)	8 (2.7)
<i>Yesterday, did you eat fresh fruits? Do not count fruit juice and dried fruits</i>	804 (53.1)	574 (37.9)	103 (6.8)	34 (2.2)	44 (14.5)	190 (62.7)	50 (16.5)	19 (6.3)
<i>Yesterday, did you drink natural fruit juice?</i>	1366 (90.3)	122 (8.1)	18 (1.2)	6 (0.4)	208 (68.6)	84 (27.7)	9 (3.0)	2 (0.7)
<i>Yesterday, did you drink commercial fruit juice?</i>	1021 (67.5)	436 (28.8)	44 (2.9)	11 (0.7)	227 (74.9)	67 (22.1)	4 (1.3)	5 (1.7)
<i>Yesterday, did you drink soft drinks (Pepsi, 7up, Miranda, Sprite, Coca Cola, Fanta ...)?</i>	759 (50.1)	578 (38.2)	128 (8.5)	49 (3.2)	191 (63.0)	95 (31.4)	12 (4.0)	5 (1.7)
<i>Yesterday, did you drink <u>diet</u> soft drinks (Pepsi diet, 7up diet, Coca Cola diet, ...)?</i>	1467 (97.2)	31 (2.1)	7 (0.5)	5 (0.3)	278 (92.1)	19 (6.3)	2 (0.7)	3 (1.0)
<i>Yesterday, did you drink energy drinks (Red Bull, AMP, ...)?</i>	1397 (92.3)	98 (6.5)	9 (0.6)	9 (0.6)	282 (93.4)	19 (6.3)	0	1 (0.3)
<i>Yesterday, did you eat any sweets such as sweet rolls, cookies, cakes, pies, brownies, cheesecake, doughnuts?</i>	864 (57.1)	534 (35.3)	101 (6.7)	14 (0.9)	210 (69.5)	84 (27.8)	6 (2.0)	2 (0.7)
<i>Yesterday, did you eat any Arabic sweets (namoura, knefeh, halewet el jibn, znood el sitt ...)?</i>	1382 (91.4)	116 (7.7)	11 (0.7)	3 (0.2)	226 (76.9)	61 (20.7)	6 (2.0)	1 (0.3)

**Table S2. (continued).**

	Adolescents n (%)				Parents n (%)			
	No	Yes	No	Yes	No	Yes	No	Yes
<i>Yesterday, did you have breakfast?</i>	630 (41.7)		880 (58.3)		52 (17.6)		244 (82.4)	
<i>Yesterday, how many meals did you eat (meals include breakfast, lunch, and dinner)?</i>	None	One meal	2 meals	3 meals	None	One meal	2 meals	3 meals
	8 (0.5)	325 (21.5)	695 (46.0)	483 (32.0)	2 (0.7)	27 (9.2)	125 (42.5)	140 (47.6)
<i>Yesterday, did you have a snack? A snack is a food or drink (except for water) that you eat or drink between meals.</i>	None	1 snack	2 snacks	≥3 snacks	None	1 snack	2 snacks	≥3 snacks
	292 (19.5)	650 (43.3)	448 (29.9)	110 (7.3)	113 (38.6)	103 (35.2)	57 (19.5)	20 (6.8)
<i>Yesterday, how many times did you eat food from outside of your house? (restaurants, fast food restaurants, pizza places and cafeterias)</i>	None	One meal	2 meals	≥3 meals	None	One meal	2 meals	≥3 meals
	1199 (79.5)	270 (17.9)	29 (1.9)	10 (0.7)	254 (85.8)	30 (10.1)	9 (3.0)	3 (1.0)
<i>Do you participate in physical education sessions at school/regularly?</i>	290 (19.5)		1199 (80.5)		208 (70.3)		88 (29.7)	
	887 (59.6)		602 (40.4)					
<i>Do you participate in any sports activity (other than physical education session at schools)?</i>								

Table S2. (continued).

	Adolescents n (%)							Parents (%)						
	0 h		1 h		2–4 h		≥5 h	0 h		1 h		2–4 h		≥5 h
<i>How many hours per week do you exercise?</i>	257 (17.3)		599 (40.4)		412 (27.8)		214 (14.4)	142 (48.0)		75 (25.3)		59 (19.9)		20 (6.8)
<i>How many hours per day do you usually spend playing video games, watching TV, using tablets and chatting on the phone?</i>	0 h	1 h	2 h	3 h	4 h	5 h	≥6 h	0 h	1 h	2 h	3 h	4 h	5 h	≥6 h
	57 (4.1)	179 (12.7)	244 (17.4)	219 (15.6)	178 (12.7)	155 (11.0)	374 (26.6)	18 (6.1)	62 (21.0)	87 (29.5)	53 (18.0)	33 (11.2)	18 (6.1)	24 (8.1)
<i>Do you smoke? (cigarettes and narjileh are included)</i>	No		Yes		Stopped smoking			No		Yes		Stopped smoking		
	1156 (78.0)		289 (19.5)		37 (2.5)			162 (55.3)		121 (41.3)		10 (3.4)		

**Table S3.** Between group comparisons of the healthy items and unhealthy items scores of the adolescents and their parents.

	Adolescents				Parents			
	Mean Total Healthy Items Score (SD)	<i>p</i> Value	Mean Total Unhealthy Items Score (SD)	<i>p</i> Value	Mean Total Healthy Items Score (SD)	<i>p</i> Value	Mean Total Unhealthy Items Score (SD)	<i>p</i> Value
<i>Mean</i>	8.83 (3.64)	-	6.37 (3.19)	-	10.21 (3.31)	-	4.87 (2.59)	-
Gender								
<i>Male</i>	9.65 (3.74)	<0.01	7.29 (3.38)	<0.01	11.04 (3.20)	0.01	5.30 (2.77)	0.11
<i>Female</i>	8.42 (3.51)		5.92 (2.99)		9.93 (3.27)		4.71 (2.54)	
Age/class								
<i>Grade 10</i>	9.05 (3.58)	0.02	6.41 (3.20)	0.57	10.29 (3.25)	0.61	4.73 (2.28)	0.28
<i>Grade 11</i>	8.57 (3.70)		6.31 (3.19)		10.08 (3.42)		5.07 (2.96)	
Type of school								
<i>Public</i>	8.88 (3.56)	0.35	6.24 (3.12)	0.01	10.16 (3.21)	0.42	4.81 (2.42)	0.47
<i>Private</i>	8.68 (3.83)		6.72 (3.34)		10.72 (4.26)		5.38 (3.88)	
Location								
<i>Urban</i>	7.53 (3.12)	<0.01	6.03 (2.86)	<0.01	10.01 (3.26)	0.31	4.50 (2.48)	0.02
<i>Rural</i>	9.51 (3.71)		6.55 (3.34)		10.41 (3.36)		5.22 (2.65)	
<i>Beirut (U)</i>	7.53 (3.12)		6.03 (2.86)		10.01 (3.26)		4.50 (2.48)	
<i>Baalbeck (R)</i>	9.26 (3.53)	<0.01	6.40 (3.15)	<0.01	10.18 (3.11)	0.2	5.06 (2.40)	0.02
<i>Rayak (R)</i>	10.46 (4.20)		7.14 (3.95)		11.15 (4.06)		5.76 (3.35)	

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**Table S4.** Between group comparison of separate Dietary Adherence Questionnaire (DAQ) items according to demographic characteristics.

Adolescents					Parents			
DAQ items	Gender	Grade	Type of school	Location	Gender	Grade	Type of school	Location
<i>Lean meat</i>	Boys ***		Public *	Rural ***				
<i>High fat meat</i>			Private ***	Urban ***				
<i>Unhealthy snacks</i>			Public ***	Rural ***				Rural ***
<i>Low fat dairy</i>	Boys **			Rural ***				
<i>Medium fat dairy</i>							Public *	
<i>High fat dairy</i>	Boys **		Private ***					Rural **
<i>Whole milk</i>				Rural ***				Rural *
<i>Skimmed milk</i>			Private **	Rural ***				
<i>Refined bread</i>	Boys ***			Rural ***				
<i>Whole bread</i>				Rural *				
<i>French fries</i>	Boys ***			Rural *				
<i>Beans</i>				Rural **				
<i>Vegetables</i>			Public *	Rural ***				
<i>Fruits</i>				Rural ***				Rural **
<i>Natural juices</i>	Boys *			Rural ***				
<i>Commercial juices</i>	Boys *		Private ***					
<i>Soft drinks</i>	Boys ***			Rural **	Men *			
<i>Diet soft drinks</i>				Rural *				
<i>Energy drinks</i>	Boys *	Grade 10 *		Rural ***				
<i>Sweets</i>			Private ***					
<i>Arabic sweets</i>			Public ***	Rural ***				
<i>Breakfast</i>			Public **	Rural ***		Grade 10 *		Rural *
<i>Number of meals</i>	Boys ***			Rural ***				
<i>Numbers of snacks</i>	Boys **		Private ***	Urban ***			Private *	
<i>Number of meals outside the house</i>	Boys ***							
<i>PA practiced at school/ regularly</i>		Grade 10 ***	Public ***	Urban ***	Men **			Urban *
<i>PA practiced outside of the school</i>	Boys ***		Private **					
<i>Number of PA hours practiced per week</i>	Boys ***	Grade 10 *			Men *			
<i>Screen viewing time</i>	Girls ***			Urban *			Private *	
<i>Smoking</i>	Boys **							

Note: Only significant differences are reported in the table above. Abbreviations: PA: Physical activity; \*: p<0.05; \*\*: p<0.01; \*\*\*: p<0.001 (Using independent t-test)

Note: All supplementary files may be found at: <https://www.mdpi.com/794410>





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# Chapter 4

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

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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.

## 1. Introduction

Pediatric obesity is a major public health concern worldwide (1). This problem is associated with various medical, psychological, social, and economic complications that can persist into adulthood (1, 22). The underlying reason for obesity is a positive imbalance between energy consumption and energy expenditure, resulting in an excess weight gain (168). In Lebanon, 30.8% of Lebanese adolescents are overweight, and 10.3% are obese (52). 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 (169). School health interventions can be standardized and have been found effective in preventing pediatric obesity (170). Knowing that 81.1% of Lebanese adolescents attend secondary schools or high schools (171), 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 (73) 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 (172). 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 (41). It suggests specific steps to guide the problem-driven development, application, and integration of behavior change theories (41). 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.) (92). 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 (92). 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 (173). The IM approach requires collaboration between developers, implementers, and program participants (173). It is based on the following principles (41).

(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 (40);

(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.

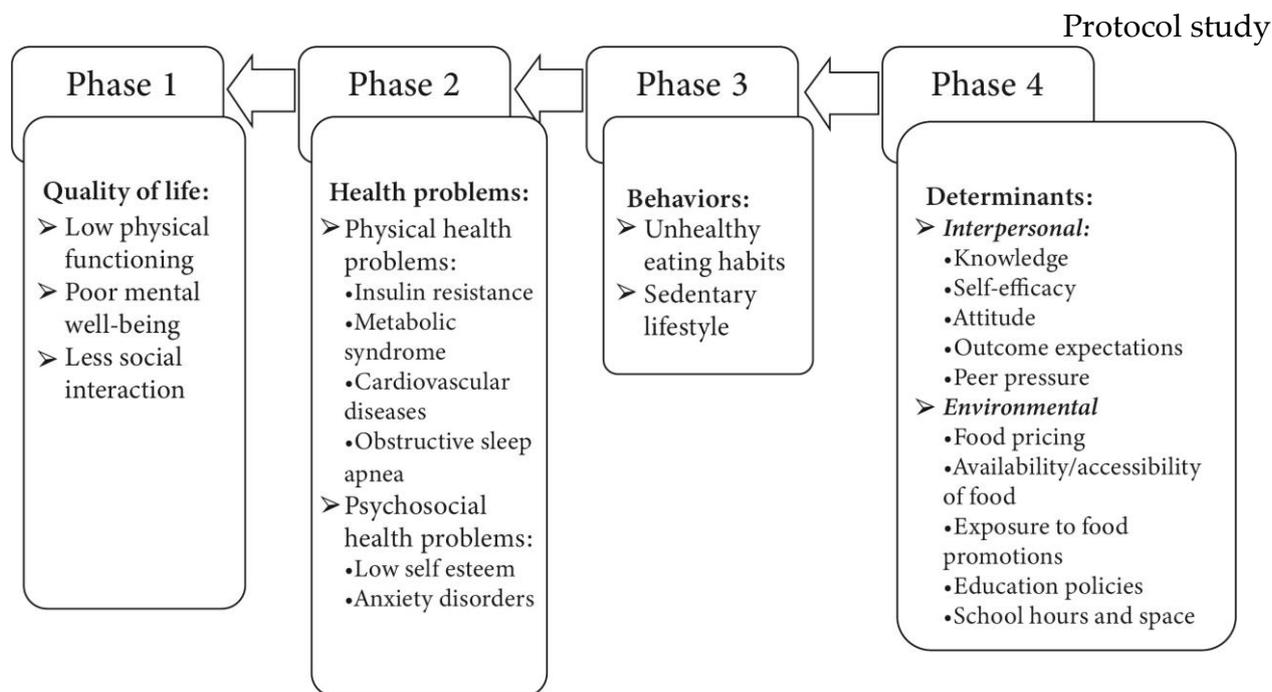
Intervention Mapping is a six-step process: (1) needs assessment; (2) identification of behavioral outcomes, performance objectives, and change objectives; (3) selection of theory-based methods and strategies; (4) program development; (5) adoption and implementation; (6) program evaluation (41).

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 (173). 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 (41).

This needs assessment may be formulated based on theory, empirical evidence, and available epidemiological data (173). At the end of this step, the program planner defines program goals based on the observed health problem (see Figure 1).



**Figure 1.** Representation of the logic model in IM-Step 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” (4, 106, 174). 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 (15). 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% (175). Physical complications of pediatric obesity include insulin resistance, metabolic syndrome, dyslipidemia, and obstructive sleep apnea (105, 106). Psychosocial complications include low self-esteem, higher rates of anxiety disorders, decreased health-related quality of life (QOL), and decreased educational and financial attainment (105, 106). 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 (22). Yet, pediatric obesity is considered preventable (1).

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 (108). However, the underlying behaviors for obesity in Lebanese children and adolescents specifically are still largely unknown (176). Nevertheless, long periods of screen viewing,

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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 (107). 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 (177). 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 (51).

### ***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 (178); (2) adolescents who benefit from nutrition promotion can act as change agents by spreading messages to a large segment of the population (179); (3) many adolescents prepare their own snacks and meals because of their parents' work schedule (111); (4) during adolescence, peer pressure begins to outweigh parental authority and unhealthy diets may be initiated (111). The program did not include parents, also because expected participation rates of parents were low, based on a pilot study (144).

### ***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 (41). 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 (41). Those related to eating and exercise behaviors were classified as: (1) individual and interpersonal; (2) environmental and policy (40, 180).

#### *Individual and interpersonal determinants:*

One of the main individual determinants of eating is dietary knowledge (180). A study including Lebanese children aged 9-11 years revealed low dietary knowledge (73). Even though dietary knowledge does have a large effect on eating habits, knowledge alone is not always sufficient to change the way adolescents eat (115). Skills and self-efficacy related to healthy eating and cooking are also important determinants (40). 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 (73). 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 (181).

Interpersonal determinants include peer pressure, food habits of the family, family meal frequency, parental control, and parenting styles (40). Children's food related

preferences and consumption are related to their parents' beliefs and attitudes toward food (60). However, parents are not the only ones influencing children. Peers also have a strong impact on overall adolescent behavior (115). As for the family meal frequency, the increase in dining out is correlated with a decline in dietary quality from childhood to adolescence (115). According to Nasreddine, Naja (52), 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 (40, 180). Whenever a food is available, it is more likely to be consumed (60). 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 (37). 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 (182). 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 (134). 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 (41). 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 (183). 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 (144), the participation rates of parents filling in questionnaires were low, and therefore it was not promising to include parents in an intervention.

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As a first step, only individual determinants were taken into consideration because a previous study (144), 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 (41), 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 (50).

### *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 (41). Four tasks need to be accomplished within this step (41): (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 based by following the steps of Core Processes (41). This method minimizes the possibility of incomplete understanding or the selection of ineffective solutions because it relies on evidence before conducting new research (184).

#### 2.2.1. Task 1 - Behavioral outcomes

Behavioral outcomes are behaviors to be accomplished as a result of the health promotion program (41). They can additionally be considered the final or distal objectives (95). 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 (41).

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 (111) and the Dietary Reference Intakes (146), 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 (37). 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.

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.

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

- 
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 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\*
- 

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

### 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 (41). 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 (144). 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 (173). First, following the Core Processes methodology, a brainstorming session was conducted to identify determinants correlated

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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 (41). Each determinant was assigned a score (40, 180). The ranking procedure was adapted from Bartholomew-Eldredge (41) 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 (41). 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 (41). COs describe what needs to change, related to the determinants, for the person to execute the POs (41). 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).

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

<b>Behavioral outcome 3: Eat breakfast every day</b>			
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

### *2.3. Step 3 - Selection of theory-based methods and strategies*

In step 3, planners begin to conceptualize and design the intervention (41). 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 (41) 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 (41). 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* intervention has many advantages. First, an expert in nutrition represents a powerful source of influence and persuasion (41). 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 (41). Advantages related to using a booklet include: good audience segmentation, high audience receptivity,

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strong possibility for tailoring, control of distribution, and multiple messages with ongoing reach (41). 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 (41). However, they have a limited influence on learning and change objectives (41), 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 (41). 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 (41).

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 (185). Verbal persuasion helps to mobilize more efforts to achieve certain behaviors and sustaining them (186). In addition, guided practice is used to initiate a behavior and improve consistency (187). Feedback helps in maintaining self-efficacy by solving identified problems and adjusting unhealthy behaviors (188). As for self-reevaluation, it helps in progressing towards the initiation of a behavior and its' assessment and/or alteration (189). Counterconditioning and stimulus control help in substituting old behaviors with new ones (190, 191). 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 (192, 193), the Transtheoretical Model or Stages of Change (191, 194), 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).

**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).

<b>Change objectives for behavioral outcomes 3 and 4:</b>	
<ul style="list-style-type: none"> <li>• <b>Eat breakfast every day</b></li> <li>• <b>Consume three meals per day</b></li> </ul>	
<p>K1: State at least three benefits of eating breakfast every day</p> <p>K2: List at least three barriers and three solutions to not having breakfast regularly</p> <p>A1: Express positive feelings regarding having breakfast every day</p> <p>S2: Demonstrate the ability to monitor and assess the frequency of breakfast consumption for one week</p> <p>SE1: Express confidence when having breakfast every day</p> <p>K1: State at least three benefits of eating three meals daily</p> <p>K2: List at least three barriers and three solutions to not having three meals regularly</p> <p>A1: Express positive feelings regarding having three meals every day</p> <p>S1-a: Demonstrate ability to participate in planning their own meals</p> <p>S1-b: Demonstrate ability to prepare their own meal</p> <p>S2: Monitor and assess the frequency of meal consumption on a weekly basis</p> <p>SE1: Express confidence when having three meals</p>	<p><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.</p> <p><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.</p> <p><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.</p> <p><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.</p> <p><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.</p> <p><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.</p> <p><b>Feedback</b> (A1 and SE1 of both outcomes 3 and 4): The educator provides feedback after looking at the meal tracker.</p> <p><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.</p> <p><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.</p>

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### 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* focus 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 used familiar examples from daily life and practice to explain complex information (e.g., on 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 (41).

#### 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 (41). Additionally, it is important to indicate where the potential participants are going to interact with the program, and how to ensure that they will be in contact with what was planned (41).

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 (72, 80). Additionally, school-based nutrition education and promotion can improve the students' academic performance (195). In Lebanon, 129,428 students are enrolled in public and private high schools, and 84.4% of all students are Lebanese (90).

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 (41). 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 (41). 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

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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 (196). As we are including all of the students in the classrooms as participants, this reduces social stigmatization (93) 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 (73). Moreover, 3.9% of Lebanese children under the age of 5 years are underweight (107).

### *2.5. Step 5 - Creation of an adoption and implementation plan*

In the fifth step of IM, the planners have four tasks (41).

#### 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 (41). 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 (73, 197). 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 (41). 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 (93). 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 (41). The implementer is well aware of the duration needed to cover the required educational material and follow the plan, in addition to deliver the amount of information to deliver 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) (41). 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

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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 exams. Another challenge to take into consideration is who 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 (197). 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.

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

<b>Adoption outcome: At least 10 high school principals adopt the <i>Sahtak bi Sahnak</i> program in the 2017-2018 academic year in their schools located in Beirut, Baalbeck, and Rayak</b>		
<b>Performance objectives</b>	<b>Determinants</b>	
	<b>Knowledge</b>	<b>Attitude</b>
<i>PO1: The school principal evaluates the need to implement the program</i>	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	
<i>PO2: The school principal reviews all the information regarding the <i>Sahtak bi Sahnak</i> program</i>	K2-a: List at least 2 objectives of the intervention	
	K2-b: Recall at least 2 benefits of the intervention	
<i>PO3: The school principal signs the consent letter after deciding to participate in the program</i>	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

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

**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
<i>PO1: The PI prepares the educational material for the Sahtak bi Sahnak program</i>	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
<i>PO2: The PI implements all the lessons of Sahtak bi Sahnak</i>	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 <i>Sahtak bi Sahnak</i> 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
<i>PO3: The PI provides the educational material to all participants</i>	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

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 (41). 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 (134);
- (b) resources: Due to the school's limited resources, the program should not create additional costs (198);
- (c) knowledge: Principals agreed that obesity is an issue among school adolescents in general (199). However, many reported that these cases were exceptions rather than the common rule (199). In addition, they also agreed that schools may influence this problem and should be part of the solution (199). 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 (199). 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 (200). They reported that they found it important for their students as it positively influences the children's ability to learn (200);
- (f) educational policy: School principals and school staff reported a lack of coverage of nutrition in the national curriculum (201). 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 (201). In addition, the educational policy places more importance in the school curriculum on subjects such as science and mathematics rather than agriculture (201). 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.

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As for the implementation, the main determinants are (202): (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 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 (198);
- (b) meaningful content: the program should be perceived as meaningful and dealing with important issues (198);
- (c) being part of a research project is considered a facilitator (198). Apparently, people tend to trust such programs more since they are well controlled and supervised;
- (d) professionalism and personal contact with the research team (198);
- (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 (198).

Other determinants related to the implementation of the program include (203): (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? (204).

### 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 (41). 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 (41). Table S1-F (see Supplementary file 1) provides detailed information of the behavior change techniques and practical applications used during this step (205). 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 (41).

### 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 (206). It describes the differences in outcomes with and without the intervention (41).

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 (41). 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 (41). 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).

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### 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) (41). 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 (144), 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 (207). This detailed description of all foods and beverages consumed (e.g., brand names, portion sizes, etc.) was recorded by the interviewer (207). 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 (207), 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 (206). 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 (41). In this case, qualitative findings were used to explain the underlying reasons behind the quantitative results (208).

### ***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

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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 (73).

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 (144). To our knowledge, very few school-based overweight prevention studies have been conducted in the Asian Arab region (73). 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 (209). 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 (210). 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 (195).

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

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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).

### *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.

## Supplementary File 1

Table S1.A. The complete matrix of change objectives for adolescents

<b>Behavioral outcome 1: Be physically active for at least one hour per day.</b>			
<i>Performance objectives</i>	Determinants		
	Knowledge	Self-efficacy/ Skills	Attitude
<i>PO1: Select a sport activity related to own's lifestyle and hobbies</i>	K1: List at least one type of sport that is enjoyable and could be practiced regularly		
<i>PO2: Perform selected sport activities for at least two hours per week</i>	K2-a: State the recommended duration of PA practice per day K2-b: List at least three advantages of practicing PA for at least 2 hours per day	SE2: Express confidence in performing the selected sport activity	A2: Express positive feelings in performing the selected sport activities
<i>PO3: Cope with challenges encountered when deciding to practice PA</i>	K3: State at least two barriers (such as bad weather or exams) and two solutions (such as choosing indoor activities) for not practicing PA		A3: Express positive feelings when coping with such challenges
<i>PO4: Monitor progress of PA practiced during the day</i>	K4: List possible ways to monitor progress of practiced PA during the day	S4-a: Rate own number of walked steps or PA duration S4-b: Detecting the reasons behind lower or higher than usual results	
<b>Behavioral outcome 2: Limit screen viewing time to no more than two hours per day</b>			
<i>Performance objective</i>	Determinants		
	Knowledge		Skills
<i>PO1: Decrease the screen viewing time to less than 2 hours per day</i>	K1-a: List at least three consequences of a sedentary lifestyle K1-b: List at least two ways of using the phone/tablet to be more active		S1: Demonstrate the ability to plan one activity to replace screen viewing every day

Table S1.A. (continued).

<b>Behavioral outcome 3: Eat breakfast every day</b>			
<i>Performance objectives</i>	Determinants		
	Knowledge	Attitude	Self-efficacy/ Skills
<i>PO1: Eat breakfast every day</i>	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
<i>PO2: Detect and solve challenges facing regular breakfast consumption</i>	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
<b>Behavioral outcome 4: Consume 3 meals per day</b>			
<i>Performance objectives</i>	Determinants		
	Knowledge	Attitude	Self-efficacy/ Skills
<i>PO1: Eat 3 meals per day</i>	K1: State at least three benefits of eating three meals daily	A1: Express positive feelings regarding having three meals every day	SE1: Express confidence when having three meals S1-a: Demonstrate ability to participate in planning its own meals S1-b: Demonstrate ability to prepare its own meal
<i>PO2: Detect and solve challenges facing regular meal consumption (such as a lack of time)</i>	K2: List at least three barriers and three solutions to not having three meals regularly		S2: Monitor and assess the frequency of meal consumption on a weekly basis
<b>Behavioral outcome 5: Increase vegetable intake to no less than twice per day</b>			
<i>Performance objectives</i>	Determinants		
	Knowledge	Self-efficacy/ Skills	Attitude
<i>PO1: Eat vegetables at least twice per day</i>	K1: List the nutritional recommendation regarding the recommended daily intake of vegetables	S1: Demonstrate ability to monitor the daily intake of vegetables on a weekly basis	
<i>PO2: Overcome barriers influencing the consumption of vegetables</i>	K2: List at least two barriers and two solutions for not eating the recommended amount of vegetables daily	SE2: Express confidence when consuming vegetables on school breaks or at home S2: Demonstrate the ability to incorporate vegetables in different situations (as snacks, as side salads, when watching TV, etc.)	A2: Express positive feelings when consuming vegetables

Table S1.A. (continued).

<b>Behavioral outcome 6: Increase fruit intakes to no less than twice per day</b>			
<i>Performance objectives</i>	Knowledge	Determinants	
		Self-efficacy/ Skills	Attitude
<i>PO1: Consume fruits at least twice per day</i>	K1: List the nutritional recommendation regarding the recommended/advised daily intake of fruits	S1: Demonstrate ability to monitor the daily intake of fruits for one week	
<i>PO2: Overcome the barriers that influence eating fruits every day</i>	K2: List at least two barriers and two solutions for not eating the recommended amount of fruits daily	SE2: Express confidence when consuming fruits on school breaks or at home S2: Demonstrate ability to incorporate eating fruits in different situations	A2: Express positive feelings when consuming fruits
<b>Behavioral outcome 7: Consume whole grain products at least once per day</b>			
<i>Performance objective</i>	Knowledge	Determinants Attitude	Self-efficacy
<i>PO1: Consume whole grain products daily</i>	K1-a: State at least two benefits of consuming whole grain products on a daily basis K1-b: List at least three examples of whole grains available on the Lebanese market	A1: Feel positive when consuming whole grain products	SE1: Express confidence when eating whole grain products
<b>Behavioral outcome 8: Drink milk or laban at least once per day</b>			
<i>Performance objectives</i>	Knowledge	Determinants	
		Self-efficacy/ Skills	
<i>PO1: Drink milk/labani every day</i>	K1: State at least two advantages of drinking milk/labani every day		
<i>PO2: Cope with encountered challenges</i>	K2: List at least two challenges and two solutions for not drinking milk	SE2: Express confidence when consuming milk/labani S2-a: Show ability to include milk/labani in different situations S2-b: Demonstrate ability to monitor daily intake of milk/labani	
<b>Behavioral outcome 9: Avoid consuming unhealthy drinks (soft drinks, artificial juices, and energy drinks)</b>			
<i>Performance objectives</i>	Knowledge	Determinants	
		Self-efficacy	Attitude
<i>PO1: Decrease the consumption of unhealthy drinks</i>	K1-a: List at least two disadvantages when choosing unhealthy drinks K1-b: List at least two healthy alternatives to unhealthy drinks	SE1: Express confidence when saying no to unhealthy drinks in different situations	A1: Feel positive when refusing unhealthy drinks

Table S1.A. (continued).

<b>Behavioral outcome 10: Decrease intake of unhealthy snacks</b>			
<i>Performance objectives</i>	Knowledge	Determinants	
		Self-efficacy	Attitude
<i>PO1: Decrease the consumption of unhealthy snacks</i>	K1: List at least two disadvantages when choosing unhealthy snacks	SE1: Express confidence when saying no to unhealthy snacks in different situations	A1: Feel positive when refusing unhealthy snacks
<i>PO2: Refuse to buy unhealthy snacks</i>	K2: List at least four healthy snack options that could be eaten at school, at home and outside		
<b>Behavioral outcome 11: Replace high fat meat with lean meat</b>			
<i>Performance objectives</i>	Knowledge	Determinants	
			Skills
<i>PO1: Refuse eating high fat meat</i>	K1-a: List at least three examples of each category of meats K1-b: List at least 2 benefits of eating lean meat	S1: Demonstrate ability to replace high fat with lean meat	
<b>Behavioral outcome 12: Replace high fat dairy products with medium- to low-fat dairy</b>			
<i>Performance objectives</i>	Knowledge	Determinants	
			Skills
<i>PO1: Eat medium to low-fat dairy products</i>	K1-a: List at least three examples of each category of dairy products K1-b: List at least 2 benefits of eating low-fat dairy	S1: Demonstrate ability to replace high fat with medium to low-fat dairy	
<b>Behavioral outcome 13: Drink 8/11 cups of fluids per day, for girls and boys, respectively</b>			
<i>Performance objectives</i>	Knowledge	Determinants	
			Skills
<i>PO1: Drink the recommended amount of fluids every day</i>	K1: List at least two benefits of drinking enough fluids		
<i>PO2: Keep a bottle of water in the school bag</i>		S2: Demonstrate ability to replace high sugar beverages with water	
<i>PO3: Monitor own's intake of water</i>		S3: Demonstrate ability to monitor the number of cups of water drank per day	

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**Table S1-B:** Relevance and changeability of the selected determinants influencing dietary behaviors of children and adolescents.

Determinants	Relevance	Changeability	Evidence for importance
<i>Knowledge</i>	++	+++	A positive association was found between nutrition knowledge, food intake, and some dietary and lifestyle behaviors among children and young adolescents. The higher the level of knowledge, the healthier nutritional behavior is (137).
<i>Self-efficacy</i>	+++	+++	Adolescents with higher levels of self-efficacy considered their eating habits healthier (211).
<i>Attitude</i>	++	++	Attitude is one of the factors determining food choice decisions (40). A school-based food garden intervention was able to change the attitude of children regarding fruit and vegetable consumption (212).
<i>Self-regulatory skills</i>	+++	++	Self-regulatory skills are considered to be determinants related to eating and physical activity (40, 182).

Note: The indicated (+/++/+++) were based on the DONE and EU-PAD frameworks (40, 182).

**Table S1-C.** Method and strategy matrix used in the Sahtak bi Sahnak intervention (41, 213, 214):

<b>Methods and Applications</b>	
<p>Methods common to all performance objectives having knowledge as a determinant</p>	<p><b>Active learning:</b> Lessons start with questions regarding the subject to discuss. The implementer asks the students about do they think of a certain topic (like physical activity, eating breakfast, etc.) and by answering the questions and leading the conversation in the right direction, participants find out all the answers.</p> <p><b>Using imagery:</b> Using familiar examples from the adolescents' daily life and practice to explain complex information. For example, obstructed blood vessels can be compared to blocked pipes, and bones can be compared to a sponge, the more wholes it contains, the more fragile it will become.</p> <p><b>Discussion:</b> Adolescents are learning the advantages of healthy eating and PA and discussing their opinions regarding this topic. For instance, after listing the advantages of having breakfast regularly, participants are encouraged to discuss their own personal barriers that keep them away from following the recommendations</p>
<b>Change objectives for behavioral outcome 1</b>	
<p><i>K1: List at least one type of sport that is enjoyable and could be practiced regularly</i></p> <p><i>SE2: Express confidence in performing the selected sport activity</i></p> <p><i>A2: Express positive feelings in performing the selected sport activities</i></p> <p><i>K2-a: State the recommended duration of PA practice per day</i></p> <p><i>K2-b: List at least three advantages of practicing PA for at least 2 hours per day</i></p> <p><i>K3: State at least two barriers (such as bad weather or exams) and two solutions (such as choosing indoor activities) for not practicing PA</i></p> <p><i>K4: List possible ways to monitor progress of practiced PA during the day</i></p> <p><i>A3: Express positive feelings when coping with such challenges</i></p> <p><i>S4-a: Rate own number of walked steps or PA duration</i></p> <p><i>S4-b: Detecting the reasons behind lower or higher than usual results</i></p>	<p><b>Active learning (K1):</b> The educator lists all the type of sport activities that can be practiced indoors and outdoors in different conditions (e.g., good and bad weather).</p> <p><b>Discussion (K1):</b> Next, he/she asks the students to choose their favorite activity and justify their choice.</p> <p><b>Direct experience (A2):</b> Students having matching sports preferences are encouraged to make a team and exercise together in school and outside. Students are better motivated and committed when they are part of a team.</p> <p><b>Active learning (K2-a, K2-b, K3, and K4):</b> The educator explains all the advantages of PA and the recommended duration of PA practice.</p> <p><b>Discussion (K2-a, K2-b, K3, and K4):</b> The students compare their current level of PA to the guidelines.</p> <p><b>Persuasive communication (S4-a and S4-b):</b> Adolescents list the barriers that are keeping them from being active (e.g., bad weather, exams, etc.). Next, the educator guides participants to find a solution for each barrier and to also find ways to adapt to their environment (e.g., living in urban areas with no green spaces around to walk in).</p> <p><b>Guided practice (S4-a and S4-b):</b> The educator lists all the practical ways to track own activity level (e.g., mobile applications, timer, activity tracker, etc.).</p> <p><b>Self-reevaluation (A3):</b> The students set weekly goals related to PA practice (type/duration) and write them on a separate paper. After one week, they report their activity level and justify any changes (higher or lower than usual activities).</p> <p><b>Feedback (A3):</b> The educator asks the students if they achieved their goals, compliments active students, and helps the others to overcome the challenges.</p> <p><b>Repeated exposure (A3):</b> Adolescents are constantly exposed to posters and educational material to remind them of regular PA.</p>

Table S1-C. (continued).

<b>Change objectives for behavioral outcome 2</b>	
<p><i>K1-a: List at least three consequences of a sedentary lifestyle</i></p> <p><i>K1-b: List at least two ways of using the phone/tablet to be more active</i></p> <p><i>S1: Demonstrate the ability to plan one activity to replace screen viewing every day</i></p>	<p><b>Active learning and persuasive communication</b> (K1-a and K1-b): The educator explains all the consequences of a sedentary lifestyle starting from general health issues to specific effects on adolescents' health and performance.</p> <p><b>Discussion</b> (K1-a and K1-b): The educator discusses with participants the main reasons behind long sedentary hours and how to prevent them. Later, the discussion focuses on the use of smartphones and tablets as trackers, not only for PA as was mentioned before, but also for screen time.</p> <p><b>Cue altering</b> (S1): Participants are asked to determine the triggers to use their smartphones and tablets (e.g., boredom, communication with friends, etc.) and to find an alternative to each case</p> <p><b>Self-monitoring</b> (S1): Participants plan one activity for every day to replace long sedentary hours, and track their progress by monitoring their physical activity and screen time trackers</p>
<b>Change objectives for behavioral outcomes 3 and 4</b>	
<p><i>K1: State at least 3 benefits of eating breakfast every day</i></p> <p><i>K2: List at least three barriers and three solutions to not having breakfast regularly</i></p> <p><i>A1: Express positive feelings regarding having breakfast every day</i></p> <p><i>S2: Demonstrate the ability to monitor and assess the frequency of breakfast consumption for one week</i></p> <p><i>SE1: Express confidence when having breakfast every day</i></p> <p><i>K1: State at least three benefits of eating three meals daily</i></p> <p><i>K2: List at least three barriers and three solutions to not having three meals regularly</i></p> <p><i>A1: Express positive feelings regarding having three meals every day</i></p> <p><i>S1-a: Demonstrate ability to participate in planning their own meals</i></p> <p><i>S1-b: Demonstrate ability to prepare their own meal</i></p> <p><i>S2: Monitor and assess the frequency of meal consumption on a weekly basis</i></p> <p><i>SE1: Express confidence when having three meals</i></p>	<p><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.</p> <p><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.</p> <p><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.</p> <p><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.</p> <p><b>Guided practice</b> (S1-a and 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.</p> <p><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.</p> <p><b>Feedback</b> (A1 and SE1 of both outcomes 3 and 4): The educator provides feedback after looking at the meal tracker.</p> <p><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.</p> <p><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.</p>

Table S1-C. (continued).

<b>Change objectives for behavioral outcomes 5 and 6</b>	
<i>K1: List the nutritional recommendation regarding the recommended daily intake of vegetables</i>	<b>Active learning</b> (K1 of both outcomes 5 and 6): The educator explains the recommended daily intake of fruits and vegetables, what a portion of fruits and vegetables looks like, and gives examples of meals (e.g., salads) and snacks that will help adolescents reach the recommended intake.
<i>K2: List at least two barriers and two solutions for not eating the recommended amount of vegetables daily</i>	<b>Discussion</b> (K2 of both outcomes 5 and 6): Participants recognize the barriers interdicting the consumption of fruits and vegetables. Adolescents compare their current intake of fruits and vegetables to the recommended intake.
<i>S1: Demonstrate ability to monitor the daily intake of vegetables on a weekly basis</i>	<b>Persuasive communication</b> (K2 of both outcomes 5 and 6): The educator helps the participants to find solutions for each barrier.
<i>S2: Demonstrate the ability to incorporate vegetables in different situations (as snacks, as side salads, when watching TV, etc.)</i>	<b>Cue altering</b> (S2 of both outcomes 5 and 6): Adolescents replace unhealthy snacks with fruits and vegetables by putting them in the same places at home and bringing them to school.
<i>SE2: Express confidence when consuming vegetables on school breaks or at home</i>	<b>Direct experience</b> (A2 of both outcomes 5 and 6): Adolescents bring fruits and vegetables to school and share them with friends.
<i>A2: Express positive feelings when consuming vegetables</i>	<b>Guided practice</b> (S2 of both outcomes 5 and 6): The educator teaches the participants how to add fruits and vegetables in different food preparations (e.g., sandwiches, side salads, soups, snacks, etc.).
<i>K1: List the nutritional recommendation regarding the recommended/advised daily intake of fruits</i>	<b>Self-monitoring</b> (S1 of both outcomes 5 and 6): Participants use the food tracker in the booklet to monitor their daily intake of fruits and vegetables.
<i>K2: List at least two barriers and two solutions for not eating the recommended amount of fruits daily</i>	<b>Feedback</b> (A2 and SE2 of both outcomes 5 and 6): The educator checks the food tracker and gives positive feedback for good progress. As for the students who are not following the guidelines, the educator tries to find solutions that suit them.
<i>S1: Demonstrate ability to monitor the daily intake of fruits for one week</i>	
<i>S2: Demonstrate ability to incorporate eating fruits in different situations</i>	<b>Repeated exposure</b> (A2 of both outcomes 5 and 6): Adolescents are repeatedly shown posters and educational material about the importance of fruits and vegetables consumption.
<i>SE2: Express confidence when consuming fruits on school breaks or at home</i>	
<i>A2: Express positive feelings when consuming fruits</i>	

Table S1-C. (continued).

<b>Change objectives for behavioral outcomes 7, 8, 9, 10, 11, and 12</b>	
<p><i>K1-a: State at least two benefits of consuming whole grain products on a daily basis</i></p> <p><i>K1-b: List at least three examples of whole grains available on the Lebanese market</i></p> <p><i>A1: Feel positive when consuming whole grain products</i></p> <p><i>SE1: Express confidence when eating whole grain products</i></p> <p><i>K1: State at least two advantages of drinking milk/labani every day</i></p> <p><i>K2: List at least two challenges and two solutions for not drinking milk</i></p> <p><i>S2-a: Show ability to include milk/labani in different situations</i></p> <p><i>S2-b: Demonstrate ability to monitor daily intake of milk/labani</i></p> <p><i>SE2: Express confidence when consuming milk/labani</i></p> <p><i>K1-a: List at least two disadvantages when choosing unhealthy drinks</i></p> <p><i>K1-b: List at least two healthy alternatives to unhealthy drinks</i></p> <p><i>SE1: Express confidence when saying no to unhealthy drinks in different situations</i></p> <p><i>A1: Feel positive when refusing unhealthy drinks</i></p> <p><i>K1: List at least two disadvantages when choosing unhealthy snacks</i></p> <p><i>SE1: Express confidence when saying no to unhealthy snacks in different situations</i></p> <p><i>A1: Feel positive when refusing unhealthy snacks</i></p> <p><i>K2: List at least four healthy snack options that could be eaten at school, at home and outside</i></p> <p><i>K1-a: List at least three examples of each category of meats</i></p> <p><i>K1-b: List at least two benefits of eating lean meat</i></p> <p><i>S1: Demonstrate ability to replace high fat with lean meat</i></p> <p><i>K1-a: List at least three examples of each category of dairy products</i></p> <p><i>K1-b: List at least 2 benefits of eating low-fat dairy</i></p> <p><i>S1: Demonstrate ability to replace high fat with medium to low-fat dairy</i></p>	<p><b>Active learning</b> (K1-a, K1-b, and K1 of outcomes 7, 8, 9, 10, 11, and 12, and K2 of outcome 10): The educator explains the benefits behind making the right choices (eating whole grains, choosing lean meats, etc.). In addition, the educator explains the differences between healthy and unhealthy foods (e.g., lean vs. high fat meat) and clears out any misconceptions related to healthy food options.</p> <p><b>Discussion</b> (K1-b and K2 of outcomes 7, 8, and 10): Participants list all the possible healthy options included in their daily meals (e.g., salads, meal preparations, etc.) and in traditional Lebanese meals (e.g., stews made with milk and vegetables). In addition, students reflect about the barriers to healthy eating (e.g., bad taste, unavailability of healthy food options in school shops, etc.).</p> <p><b>Persuasive communication</b> (K1-a of both outcomes 9 and 10): The educator explains how the disadvantages related to unhealthy food choices affect the daily life of the students (e.g., decreased school performance).</p> <p><b>Using imagery</b> (K1-a and K1 of outcomes 7,8,9, and 10, and K1-b of outcomes 11 and 12): Using familiar examples from the adolescents' daily life and practice to explain complex information. For example, obstructed blood vessels can be compared to blocked water pipes, and bones can be compared to a sponge, the more wholes it contains, the more fragile it will become.</p> <p><b>Guided practice</b> (S2-a of outcome 8, and S1 of outcomes 11 and 12): Adolescents learn how to modify a recipe to make it healthier (e.g., preparing sandwiches with low-medium fat cheeses and vegetables).</p> <p><b>Environmental and self-reevaluation</b> (A1 of outcomes 7, 9, and 10): After detecting the environmental and personal barriers to eating healthy, the adolescents find suitable solutions. The educator asks the students every week if they were able to overcome the challenges.</p> <p><b>Direct experience</b> (A1 of outcome 10): Adolescents receive a sample of roasted nuts with no salt and no added oil and try it as an example of healthy snack option that they can bring to school. As they eat it together, they feel more positive and become more willing to repeat this experience.</p> <p><b>Repeated exposure</b> (A1 of outcomes 7, 9, and 10): Adolescents are repeatedly exposed to posters and educational material to remind them of healthy eating.</p>

Table S1-C. (continued).

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<b>Change objectives for behavioral outcome 13</b>	
<i>K1: List at least two benefits of drinking enough fluids</i>	<b>Active learning (K1):</b> Participants learn the recommended intake of water per day and the corresponding benefits.
<i>S2: Demonstrate ability to replace high sugar beverages with water</i>	<b>Discussion (K1):</b> Adolescents compare their current water intake to the guidelines.
<i>S3: Demonstrate ability to monitor the number of cups of water drank per day</i>	<b>Guided practice and self-monitoring (S3):</b> The educator demonstrates how to use the water tracker in the booklet and to adjust the intake to reach the recommended level.
	<b>Cue altering (S2):</b> Adolescents bring a bottle of water to school every day to drink water when they feel thirsty (instead of any other beverage) and to drink the recommended amount per day.

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**Table S1-D:** List of parameters of each method and their applications.

<b>Method</b>	<b>Parameters [224]</b>	<b>Applications</b>
<i>Active learning</i>	Time, information, and skills	<p>-First, health promoters need to use meaningful and relevant instructional material (185). In Sahtak bi Sahnak, we included information that was relevant to issues encountered by adolescents such as maintaining a healthy weight, dieting, improving their academia performance, etc.</p> <p>-Second, when applying active learning, each participant must apply constructed knowledge and skill. Therefore, after explaining and discussing the nutrition recommendations, adolescents had to apply the acquired knowledge to plan their own menu for lunch and dinner by suggesting healthy meals.</p> <p>-Third, active learning means moving towards a “learner-centered” approach (instead of a lecture-based teaching approach) that requires applying discussion. In Sahtak bi Sahnak, discussion was applied in all sessions to engage adolescents in the learning process. For instance, after talking about the benefits of breakfast consumption, adolescents were asked about their own breakfast habits and whether they skipped this particular meal. Then, a solution was proposed to avoid skipping breakfast. Participants were also encouraged to suggest solutions for their peers.</p>
<i>Verbal persuasion</i>	Credible source	All the lessons were designed and administered by an experienced licensed dietitian and reviewed by health promotion experts.
<i>Guided practice</i>	Subskill demonstration instruction, and enactment with individual feedback; requires supervision by an experienced person	<p>To evaluate their nutritional status (underweight, healthy, or overweight/obese), participants were taught how to interpret their BMI-for-age using the growth charts in the booklet. The dietitian (implementer) explains how to calculate the BMI, and then how to plot it on the right BMI-for-age growth chart and interpret the result.</p> <p>Next, adolescents used the growth charts on the booklet to evaluate their weight status. The dietitian passed by each participant to supervise their work and correct any mistake.</p>
<i>Feedback</i>	Feedback needs to be individual, follow the behavior in time, and be specific	The educator checks the food tracker and gives positive feedback for good progress. As for the students who are not following the guidelines, the educator tries to find solutions that suit them.

Table S1-D. (continued).

<b>Method</b>	<b>Parameters [224]</b>	<b>Applications</b>
<i>Self-reevaluation</i>	Stimulation of both cognitive and affective appraisal of self-image.	Adolescents share their feelings and experiences after eating meals regularly vs. skipping meals and reevaluate what can be improved.
<i>Self-monitoring</i>	The monitoring must be of the specific behavior. The data must be interpreted and used. The reward must be reinforcing to the individual.	Participants use the food tracker in the booklet to monitor their daily intake of fruits and vegetables. At the end of the day, they use the obtained results to adjust their intake for the next day. If the intake of fruits and vegetables was low, then they need to increase it.
<i>Repeated exposure</i>	Neutrality of original attitude	Adolescents are repeatedly shown posters and educational material about the importance of fruits and vegetables consumption.
<i>Cue altering</i>	Existing positive intention	Adolescents replace unhealthy snacks with fruits and vegetables by putting them in the same places at home and bringing them to school.
<i>Direct experience</i>	Rewarding outcomes from the individual's experience with the behavior or assurance that the individual can cope with and reframe negative outcomes	-Adolescents receive a sample of roasted nuts with no salt and no added oil and try it as an example of healthy snack option that they can bring to school. As they eat it together, they feel more positive and become willing to repeat this experience. - Adolescents bring fruits and vegetables to school and share them with friends. This allows them to share their thoughts of their preferred fruit and vegetable and allows their friends to try new ones.
<i>Using imagery</i>	Familiar physical or verbal images as analogies to a less familiar process	Using familiar examples from the adolescents' daily life and practice to explain complex information. For example, obstructed blood vessels can be compared to blocked pipes, and bones can be compared to a sponge, the more wholes it contains, the more fragile it becomes.

## Chapter 4

**Table S1-E.** Description of the lessons included in the educational material

<b>Lesson/ Duration</b>	<b>Purpose</b>	<b>Discussed topics</b>
Benefits of Healthy Eating (20 minutes)	Introduction Motivation	Defining healthy eating first and then listing and discussing all the benefits related to healthy eating
Principles of Healthy Eating (40 minutes)	Familiarization with the basic nutrition concepts such as the food pyramids, MyPlate, and food groups	Introducing adolescents to the most popular and latest food guides starting with the oldest and the most familiar food guide pyramid developed in 1992 to the latest MyPlate. Getting to know food groups and the importance of each one of them Learning how to make the right choice in each food group
Activity (5 minutes)	Identifying foods high in fibers	Using a crossword to find high fiber foods
Lipids (30 minutes)	Differentiation of different types of fat Discussing some misconceptions related to fats and nutrition	Learning about the different types of fat and their health effect Learning about functions of fat in our body
Physical Activity (30 minutes)	Recognizing the importance of PA Selecting adequate physical activities and practice them regularly Monitoring own level of PA Discussing misconceptions related to PA practice and nutrition	Citing benefits of PA Discovering ways to making PA a daily habit Relating different types of PA to own lifestyle and environment Discussing popular misconceptions related to supplement intake, the right ways to practice PA, and the correlation between nutrition and performance
Healthy Weight (20 minutes)	Introducing the healthy weight concept Evaluation of own's weight	Defining healthy weight Familiarization with BMI concept and how to classify own's weight Discovering factors that influence own's weight
Challenges of Healthy Eating and PA Practice (20 minutes)	Recognizing the reasons behind bad eating habits Learning how to cope with barriers	Discussing obstacles facing healthy eating and PA practice Searching for ways to cope with corresponding challenges
Vitamins and Minerals (20 minutes)	Recognizing the importance of a varied diet	Learning the importance of a varied diet through the different roles of some vitamins and minerals present in different food items
Importance of Water (20 minutes)	Recognizing the importance of drinking enough water	Understanding some water functions in our body Learning the recommended intake of water per day Monitoring own's intake of water Understanding the consequences of thirst
Nutrition Facts Label (10 minutes)	Familiarization with the nutrition facts label Choosing the right food item based on the label	Introducing nutrition facts label Interpreting the label to make the right choice Comparing different labels

Table S1-E. (continued).

<b>Lesson/ Duration</b>	<b>Purpose</b>	<b>Discussed topics</b>
Activity (5 minutes)	Choosing the healthier option based on nutrition facts label	Comparing two labels and choosing the healthier option
Food safety (10 minutes)	Recognizing health risks of foodborne illness and learning how to avoid them	Understanding foodborne illness and how to avoid it Familiarization with “bio” food products Learning how to reduce pesticide consumption from food
Diets (10 minutes)	Discussing appropriate and trustful sources to obtain nutritional advice Identifying health risks related to unhealthy diets	Learning how to recognize a trustful source of nutritional advice Understanding health problems resulting from following unhealthy diet advice
Activity (40 minutes)	Planning a healthy menu	Practicing menu planning Participating in choosing own’s healthy meals Learning how to prepare own’s snack
Activity (10 minutes)	Monitoring own’s intake and PA level	Checklist

## Chapter 4

**Table S1-F.** Theoretical methods and practical applications related to the adoption and implementation of the program (41).

Change objectives	Methods	Applications
<b>Adoption</b>		
K1-a: Define common health risks related to overweight, obesity, and sedentary lifestyle among Lebanese adolescents	Persuasive communication	The PI meets the school principals and presents the current health problem among Lebanese adolescents which is obesity and overweight caused by unhealthy eating habits and sedentary lifestyle.
K1-b: List at least 2 factors affecting eating behaviors among Lebanese adolescents		The PI then explains the reasons behind these unhealthy behaviors and the benefits of participating in this program to alleviate the problem.
K1-c: List at least 2 factors affecting PA practice among Lebanese adolescents		
K2-a: Read the information letter related to the <i>Sahtak bi Sahmak</i> program provided by the PI during the first meeting	Tailoring Individualization	After explaining orally all the details related to the program (objectives, methods, procedures, and expected outcomes), the PI presents MEHE's approval, the consent form and the information letter. Sufficient time was given to read it, sign it, and ask any questions related to the intervention. The PI meets individually with each school principal and helps to fit the program to the school's schedule and setting (e.g., number of students, number of classes, schedule availability, etc.).
K2-b: Read the consent document of the Lebanese Ministry of Education (allowing public schools to participate) provided by the PI during their first meeting	Persuasive communication Advance organizers	
K2-c: Read the consent letter provided by the PI to the school principal on their first meeting		The information letter provided information related to the research team and their positions. Details about the objectives of the study as a whole and of the intervention, procedures related to the delivery of information, time-frame, the right to refuse participation, and contact information of the PI.
K2-d: List at least 2 objectives of the intervention		The PI emphasizes the fact that this intervention was particularly designed for Lebanese adolescents and that it was reviewed by the Orientation and Guidance Department at MEHE and that it takes into consideration all the cultural aspects and Lebanese lifestyles into consideration.
K2-e: Recall at least 2 benefits of the intervention		
K3-a: Recognize the consent letter presented by the PI		
K3-b: Recognize the information letter presented with the consent letter by the PI		
A3: Express positive feelings about signing the consent form to participate in the program	Arguments	The PI suggests that adding this program as part of their school activities will positively influence the reputation of the school compared to others and will show how interested and thoughtful the administration is about the health of its students

Table S1-F. (continued).

Change objectives	Methods	Applications
<b>Implementation</b>		
K2: Recall the content of the lessons and activities of the program	Advance organizers Using imagery Elaboration	The PI asks in advance about the number of students in each class, writes all the numbers on a paper, and prepares the booklet boxes for each class in advance of the intervention.
K3: Ascertain the number of required booklets to provide in each class during the first week of the intervention		The PI distributes all the booklets during the first week after starting the intervention. Later, posters are hung in the schools, and booklets distributed to the students.  The PI prepares an outline of the chapters and activities to explain during each session in advance. This outline is used to keep in mind what to explain and when.
A2: Express positive attitude about implementing the lessons according to the <i>Sahtak bi Sahnak</i> program objectives	Direct experience	The implementer listens and reads feedback of participants collected during and after the intervention. Negative comments are used to improve the program for the future.
S2: Demonstrate good communication skills to effectively explain the lessons	Self-monitoring of behavior	The implementer keeps records about the material covered and the feedback and questions of the students and takes them into consideration when delivering the next lessons
SE2: Express confidence in implementing the intervention	Public commitment	The implementer signs the consent letter and provides the intervention to the assigned classes during the intervention period

Table S1-G. Brief evaluation plan for the program

Variable	Evaluation question	Indicator	Measure	Timing
Dietary adherence	Did the intervention increase the number of students who adhere to the nutritional guidelines?	Increased total adherence score in the intervention group	Dietary Adherence Questionnaire	Baseline and post-intervention
Dietary knowledge	Did the intervention increase the students' level of dietary knowledge regarding eating recommendations?	Knowledge about nutrition recommendations	Dietary Knowledge Questionnaire	Baseline and post-intervention

## Chapter 4

**Table S1-H.** Process evaluation questions for the Sahtak bi Sahnak program (component definitions based on Linnan and Steckler (215))

Components	Questions	Indicators	Method
Context: aspects of the larger social environment that may affect implementation	During program implementation, has the context changed for the intervention?	Outline of the intervention material	Meeting the objectives of each lesson by explaining the lessons and activities according to the established plan
Reach: the proportion of the intended audience to whom the program is actually delivered	To what extent is the program reaching the intended participants? Is there any group missed or unintended groups taking part?	Percentage of intended participants	Data collection records
Dose delivered: the number of intended units of each program component that is delivered	How much of the program is being delivered? Are there any parts being omitted?	List of the lessons covered in each class	Records of the covered lessons
Dose received: the extent to which participants engage with program	Did the participants in the intervention group score higher compared to their baseline scores?	Dietary knowledge score	Dietary knowledge questionnaire
Fidelity: the extent to which the intervention was delivered as intended		Degree to which the interventional material matches the matrices of change	Comparing the IM matrices (Appendix S1) with the intervention material  Tracking the outline of the lessons and activities based on the provided chart where the titles and the corresponding time and duration are indicated

Note: All supplementary files are available at:

<https://www.healthpsychologybulletin.com/articles/10.5334/hpb.27/>





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# Chapter 5

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## **Effect Evaluation of *Sahtak bi Sahnak*, a Lebanese Secondary School-Based Nutrition Intervention: a Cluster Randomised Trial**

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## Chapter 5

### **Abstract**

**Objective:** To evaluate the effectiveness of Sahtak bi Sahnak on dietary knowledge and adherence to dietary guidelines in Lebanese adolescents

**Design/setting:** A cluster randomised controlled trial was conducted in public and private secondary schools located in urban and rural regions in Lebanon

**Participants:** Sixteen secondary schools including 1572 adolescents were randomly assigned to the intervention (n=739) or control group (n=833).

**Intervention:** Sahtak bi Sahnak is an educational school-based intervention dedicated to improving dietary adherence to nutritional guidelines, increasing the level of dietary knowledge, and preventing the development of obesity during adolescence. It was systematically designed based on the Intervention Mapping framework. The total length of the intervention was around seven educational sessions, until all of the 11 lessons were covered. Each education session lasted 20 to 40 minutes.

**Main Outcome Measures:** Dietary knowledge and adherence levels were measured at baseline and post-intervention using validated questionnaires.

**Statistical Analysis:** Multivariate multilevel regression models were used to examine intervention effects on outcomes, controlled for background characteristics (i.e., age, gender, location, type of school, grade, BMI z-score).

**Results:** The intervention group showed significant improvements in total dietary knowledge (B=12.74,  $p < 0.001$ ) and intake of healthy items (B=1.89,  $p < 0.001$ ), compared to the control group. Intake of unhealthy items decreased significantly (B= - 1.43,  $p < 0.001$ ), compared to the control group. These results were adjusted for age, gender, type of school, location, BMI z-score, study group, and score at baseline.

**Conclusions and Implications:** Sahtak bi Sahnak is an effective and culturally appropriate school-based intervention for targeting diet among a variety of Lebanese adolescents.

## Introduction

According to the World Health Organization (10), paediatric obesity is one of the most serious global health problems of the current century. In the last 40 years, the number of obese children and adolescents increased by more than 11 times, reaching a total of 124 million in 2016 (11). The Arab countries are no exception as the paediatric obesity prevalence reached 22.8% in Kuwait and 7.5% in Tunisia among 10-19-year-old adolescents in 2016 (12). In Lebanon, the prevalence of obese adolescents of the same age category increased from 7.9% in 2000 to 12.2% in 2016 (12). Childhood obesity can lead to several physical (e.g., insulin resistance, cardiovascular diseases, etc.) and mental complications (e.g., low self-esteem, depression, etc.), sometimes lasting into adulthood (8, 168). It is often caused by an imbalance between energy intake and energy expenditure (168). Still, efforts to resolve this epidemic have not yet been able to reverse the growth of this problem (141).

Health experts have elaborated several comprehensive recommendations and strategic objectives to plan and implement effective interventions addressing paediatric obesity. This includes specifying the intervention setting and determinants to be changed. Researchers confirm that obesity prevention efforts should target children and that such interventions should be based on appropriate theoretical frameworks (216, 217). In addition, the Commission on Ending Childhood Obesity recommends implementing programmes to promote healthy eating habits and reducing the intake of unhealthy foods and sugar-sweetened beverages by children and adolescents (218). As for the intervention setting, schools play an important role in nutrition education as they can improve healthy eating habits for lifetime prevention of obesity (218). In addition, integrating nutrition education as part of the school's curriculum and improving nutrition literacy is in line with schools' pedagogical mission (71). Several studies showed that school-based nutrition interventions improved dietary knowledge (72, 73), eating patterns (72, 74) and reduced overweight and obesity (74, 75). Cluster randomised trials (CRT) are widely used to evaluate health promotion interventions (219). They present several advantages as they are applicable in school settings and tend to reduce the exchange of information between the research groups (intervention and control group; 220).

When designing an effective obesity prevention intervention in a school setting, it is important to consider an appropriate theoretical framework, relevant and modifiable determinants, and appropriate application methods. The Intervention Mapping (IM) (41) provides a logical and evidence-based process to develop, implement, and evaluate a health promotion intervention. It also allows the health promoters to select the appropriate theoretically informed method to influence the causal determinants that regulate the eating habits. The literature identified a broad range of determinants influencing eating habits

## Chapter 5

(e.g., individual factors, parental influence, etc.) (40). The needs assessment in IM revealed that the most relevant and modifiable determinants related to eating habits among adolescents are dietary knowledge, self-efficacy, attitude, and skills (221). Dietary knowledge (also known as nutrition knowledge) is an important and modifiable determinant of eating habits (40). It may also serve as a pre-requisite for other mentioned determinants (e.g., skills). Several studies have shown that higher levels of nutrition knowledge are significantly and positively correlated with healthier eating habits (42-44). In Lebanon, a previous study reported that Lebanese adolescents had relatively low levels of dietary knowledge and adherence to dietary recommendations (52, 222). Despite the alarming obesity rates and the low dietary knowledge and adherence levels among Lebanese adolescents, very few interventions have aimed to prevent paediatric obesity in Lebanon, focusing solely on children aged 9-11 years using a three-month school-based programme (73, 88). To our knowledge, no nutrition interventions have yet been implemented in Lebanese high schools, and none focused on both urban and rural regions. Therefore, we developed *Sahtak bi Sahnak* (صحتك بصحنك; in English: “Your health on your plate”), the first educational school-based nutrition intervention targeting Lebanese adolescents aged 15-18 years, living in urban and rural regions, to prevent obesity (221). This is also the first theory- and evidence-based obesity-prevention intervention following the Intervention Mapping framework in the Arab world. The purpose of the current paper is to evaluate the effectiveness of *Sahtak bi Sahnak* in improving both dietary knowledge and dietary adherence levels in a cluster randomised controlled trial. The study objectives pertain to the individual participant level.

## Materials and Methods

### 1. Study Design and Participants

The current cluster randomised controlled trial was conducted between October 2017 and March 2018 and targeted 15- to 18-year-old Lebanese adolescents attending public and private high schools in Beirut (urban region), Baalbeck and Rayak (both rural regions) in Lebanon. Beirut represents the urban region as it is the capital and largest city of Lebanon. Baalbeck and Rayak represent the rural region, located in the Bekaa region, which is considered Lebanon’s most important agricultural region. Schools, representing the cluster unit, were randomly selected from the 96 high schools located in the selected regions with standard day-time schedules (classes finishing by 15:00 in the afternoon at the latest). During the recruitment phase, the schools were divided according to the indicated study location (rural vs. urban) and type of school (public vs. private). All the public secondary schools located in the rural region (i.e., Baalbeck and Rayak; n=4), agreed to participate. In parallel, private schools from the rural region were randomly selected and approached until four of them accepted to participate. Similarly in the urban region (i.e., Beirut), public

schools were randomly selected and approached. The recruitment of public schools in Beirut was stopped when the required sample size of six schools was met. As for the urban private schools, two private schools accepted to participate.

Based on the pre-determined required sample size, a total of 16 schools were recruited. The required sample size ( $n$ ) was calculated based on an expected mean change in nutrition knowledge (one of the main outcomes) based on previous literature of 18.2% with a standard deviation of 0.54 (223), a power level of 80%, and a significance level of 5%. This resulted in  $n= 139$  per group (224), equalling  $n= 278$  for both groups. However, it is important to note that schools differ in the numbers of students per school and per class. Thus, to obtain a diverse sample with participants from both regions (urban and rural), from both common types of schools in Lebanon (private and public) and from both selected grades (grades 10 and 11) in both study groups, we recruited more participants and ended up with a total of 1572 adolescents from 16 schools (see Figure 1). The type of school is also interpreted as an indicator for the socio-economic status of the participants, as private schools have higher tuition fees compared to public schools.

The 16 schools (representing 50% of public high schools and 8% of private high schools) that accepted the invitation to participate were randomly divided into 2 groups (intervention and control), with the restriction of balancing public and private high schools as the number of public schools was higher compared to private ones (see Figure 1). During the recruitment phase, the lists of public and private secondary schools located in Beirut city, Baalbeck, and Rayak were obtained from the Lebanese Ministry of Education and Higher Education (MEHE). The principal investigator (PI) randomly selected the schools from the list and visited them to meet the school principal in person. After receiving the consent of the school principal (i.e., by signing the consent letter after reading the information letter (221)), all students present at the moment of data collection were approached. Participation was voluntary. No incentive nor compensation was offered to schools or participants. None of the students refused to participate. However, the number of participants differed at different data collection moments due to student absenteeism. Inclusion criteria for the participating adolescents included: (1) having a Lebanese nationality and being enrolled in a Lebanese public or private high school located in Beirut, Baalbeck, or Rayak; (2) aged 15–18 years; (3) having full cognitive, psychiatric and physical ability to communicate (as reported by parents or by school administration); (4) not having any chronic or genetic diseases (as reported by parents or by school administration).

To avoid bias, participants were not pre-informed about any data collection moment. During the first meeting with adolescents, the PI explained the research goals and the procedure related to data collection. Students' consent was also orally confirmed by the PI

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before administering the questionnaire. The questionnaire further clearly stated that once it was filled in and handed in, this meant that the adolescent accepted and assented to participate in the study. The study was conducted in accordance with the Declaration of Helsinki, and the protocol was approved by the Lebanese Ministry of Education and Higher Education (15465/3/2016; date: 06/10/2017) and the Institutional Review Board of the Lebanese International University (LIUIRB-171212-LS1).

Several measures were considered to decrease the risk of exposing the control group to the intervention and subsequent bias. Randomisation into the intervention and control group was conducted by the PI (first author) at the school level, so that participants from the same school would be exposed to the same information (225), following stratified randomisation procedures (toss of a coin) with a 1:1 allocation. The intervention schools received the intervention, while the control schools provided their education according to the regular curriculum.

### *2. Data Collection*

#### *2.1. Instruments*

##### **2.1.1. Background characteristics.**

The socio-demographic information was assessed at baseline and included the following: date of birth to calculate the age in years; gender (boys/girls); school class (grade 10/grade 11); school's name to determine type of school (public or private); and school address to determine region (urban or rural).

##### **2.1.2. Anthropometric measurements.**

At baseline, adolescents were weighed with light clothes and no shoes on, to the nearest 0.1 kg, using a digital weight scale (EKS). Height was measured without shoes and recorded to the nearest 0.1 cm, using a portable stadiometer (Numed). Weight and height were measured using standardised protocols and procedures (147) and calibrated equipment. In the current study, the gender- and age-specific BMI z-scores were calculated using the WHO AnthroPlus software (151). The BMI is a relatively inexpensive, easy-to-obtain, non-invasive and quick method for detecting obesity (14, 104). However, as it is not an accurate tool for monitoring change in adiposity in children and adolescents (13), and due to the relatively short duration of the intervention, the BMI was measured at baseline only, and not taken into account as an outcome.

##### **2.1.3. Dietary Knowledge.**

A validated dietary knowledge questionnaire (DKQ) was administered to adolescents at baseline ( $T_0$ ) and post-intervention ( $T_1$ ). The DKQ includes 23 questions divided to five parts (144): (1) knowledge of dietary recommendations; (2) knowledge of nutrient sources; (3) knowledge of common misconceptions in nutrition; (4) using knowledge of nutrition to make dietary choices; (5) knowledge of associations between nutrition and diseases. Each

question has three to five answer options and only one correct answer. The maximum possible score is 56, reflecting an extremely high level of dietary knowledge, and the minimum score is zero. The questionnaire showed an acceptable internal reliability (226), as Cronbach's alpha was 0.82 (222).

#### 2.1.4. *Dietary Adherence.*

A validated self-reported dietary adherence questionnaire (DAQ) (144) was administered to adolescents at baseline (T<sub>0</sub>) and post-intervention (T<sub>1</sub>), to assess their level of adherence to the dietary recommendations from the American Heart Association (111) and the Dietary Reference Intakes (146), as Lebanese equivalents are lacking. The DAQ included 30 questions. Two scores were calculated: a healthy items score (ranging from 0 to 37) and an unhealthy items score (ranging from 1 to 38). The internal reliability was acceptable, as Cronbach's alpha was 0.64 for healthy items and 0.61 for unhealthy items (222). Examples of healthy items include healthy food choices (e.g., wholemeal bread, vegetables, fruits) and healthy meal patterns (e.g., breakfast consumption, eating three meals). Unhealthy items include unhealthy food choices (e.g., soft drinks, sweets, fried meat) and unhealthy meal patterns (e.g., eating outside of the home).

#### 2.2. *Data collection procedures.*

The school-based data collection was performed by a dietitian (PI) and a trained research assistant. The questionnaires, administered in Arabic (native language of the participants), were specifically designed to suit the Lebanese adolescent population, having been pre-tested and validated using qualitative (i.e., cognitive interview) and quantitative methods among Lebanese adolescents (144). In addition, quality control measures regarding the training, data collection and data entry monitoring (e.g., data curation, double entry, range checks for data values) were applied and complied with the CONSORT guidelines (see supplementary file). The collected data, at baseline (T<sub>0</sub>) and after 45-90 days of follow-up (T<sub>1</sub>), are described in more detail below. The follow-up moment corresponded to one week after completing the intervention.

### 3. *Intervention*

The *Sahtak bi Sahnak* intervention (صحتك بصحتك) was a school-based intervention targeting Lebanese adolescents. *Sahtak bi Sahnak* was developed using the Intervention Mapping framework (41), enabling the development and evaluation of theory and evidence-based health promotion programmes. Its main aim was to prevent the development of obesity during adolescence. The sub aims were: (1) to improve dietary adherence to nutritional guidelines (111, 146); and (2) to increase the level of dietary knowledge. The implementer of the intervention was a dietitian who delivered the intervention directly to adolescents in classroom settings at the participating schools. The educational material was specifically

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designed to suit our target population. It was written in Arabic language, which is the native language of the participants, and it took into consideration their cultural and traditional values and dietary patterns. The intervention lessons covered various topics including 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, nutrition facts label, diets, and food safety. The development and design of the intervention are described elsewhere in more detail (221).

Once the school was enrolled in the programme, each school principal designated one or two sessions per week, depending on the school's courses, exam schedule, and holidays. The total length of the intervention was around seven educational sessions, until all the 11 lessons were covered, spread over an average of 2 months. Each education session lasted 20-40 minutes. Each lesson tackled a different topic about nutrition. An interactive discussion followed the lesson explanation to answer any additional questions and to recapitulate what was learnt. The current intervention targeted several types of knowledge, such as declarative knowledge (i.e., awareness) and procedural knowledge (i.e., learning how to make the right choices) (41). In addition, attitude, skills (e.g., learning to plan a healthy lunch menu), and self-efficacy were addressed, as well. The education sessions focused on a healthy lifestyle rather than explicitly on obesity, to target participants with different BMI z-scores, as 10.7% of the target group are underweight (222) and would also benefit from a healthy lifestyle. In addition, this helped in avoiding weight stigma among teenagers. Hence, the main focus of this intervention was to promote healthy eating patterns. In addition to the classroom lessons, reader-friendly, attractive, and informative booklets were distributed to each participant to reinforce the learning process. At the end of the study and for ethical reasons, the control group received the nutrition education after completing the data collection at T<sub>1</sub> (post-intervention).

### 4. *Statistical Analyses*

Data were entered and analysed using the Statistical Package for Social Sciences (IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp). Descriptive statistics were used to analyse the participants' characteristics and outcomes. There were three dependent variables: (1) healthy items score, post-intervention; (2) unhealthy items score, post-intervention; and (3) total knowledge score, post-intervention. The independent variables included the following: (1) age; (2) gender; (3) grade (grade 10/11); (4) type of school (public/private); (5) location (urban/rural); (6) BMI z-score; (7) study group (intervention/control); and (8) score at baseline. Chi-square tests were applied to analyse the variation in frequency of the categorical background characteristics (e.g., gender) between the intervention and control group. Independent t-tests were used to compare differences between groups (intervention vs. control) at baseline for continuous variables (e.g., BMI z-

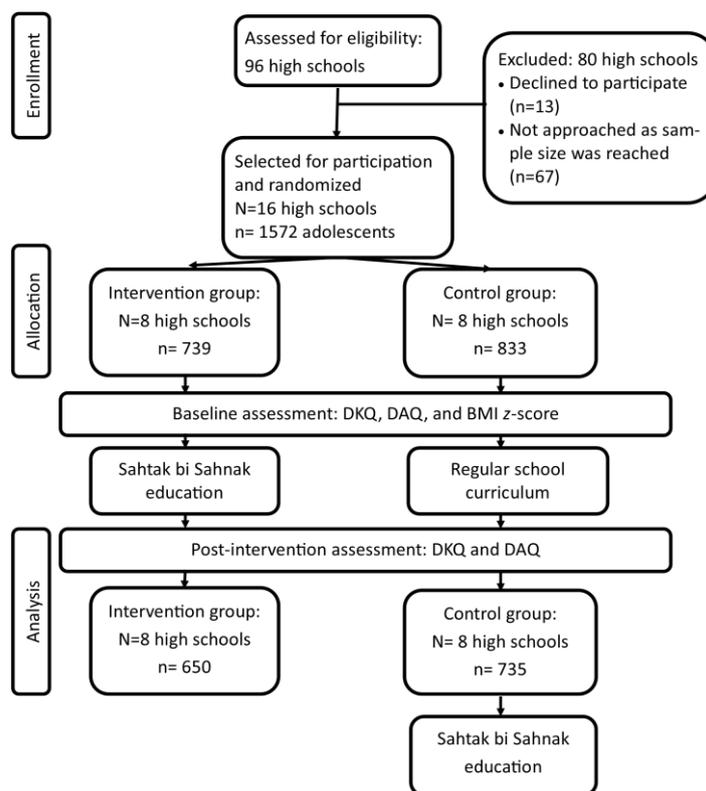
scores). The intervention effect was analysed using a multilevel analysis with random intercepts, adjusting for significant covariates found in the baseline analysis as well as baseline scores for the outcome variables, with total dietary knowledge and healthy items scores as dependent variables. As these analyses were adjusted for baseline scores, the reported regression coefficients reflect difference between intervention and control group in the change between baseline and follow-up. Three levels were included: (i) level 1: adolescents; (ii) level 2: schools; and (iii) level 3: location (Beirut/ Baalbeck/ Rayak). Where the random intercept was non-significant in the multilevel analysis, a multivariate regression model was performed to test the intervention effect, adjusting for the same significant covariates. In addition, a multilevel analysis was performed to evaluate the interaction between background variables and the intervention variable associated with the dependent variables (i.e., post-intervention scores of dietary knowledge, healthy items, and unhealthy items). Separate multivariate regression analyses were conducted to evaluate the intervention effect in different subgroups (based on gender, location, type of school, grade, weight status, and score at baseline), for which continuous variables were recoded into categories as follows: BMI z-score was classified into: <-3 indicating severe malnutrition; -2 to -2.9 indicating moderate malnutrition; -1 to -1.99 indicating mild malnutrition (152); -0.99 to 1.03 indicating normal weight; 1.04 to 1.63 indicating overweight; 1.64 to 2.32 indicating obesity; and  $\geq 2.33$  indicating severe obesity (15). Knowledge score was recoded into: 1 (=low), range 0-28; and 2 (= acceptable), range 29-56. All models were adjusted for age, gender, class/grade, type of school (public vs. private), location (urban vs. rural), BMI z-score, and score at baseline. The regression method used was forced entry, and missing values were excluded listwise. Prior to conducting the regression analysis, the data was checked to meet the following assumptions: (1) the relationship between the independent and dependant variables was linear; (2) there was no multicollinearity in the data; (3) the values of the residuals were independent; (4) the variance of the residuals was constant; (5) the values of the residuals were normally distributed; and (6) there were no influential cases biasing the model. P values below 0.05 were considered statistically significant.

## Results

The school recruitment phase lasted from January till September 2017, while the data collection started in October 2017 and ended in March 2018. The background characteristics of the 1572 participating adolescents are shown in Table 1. Overall, there were more girls (66.1%) than boys, more participants from the rural regions (68.1%) compared to urban regions, and more students from public high schools (71.2%) than from private schools. A total of 16 secondary schools participated in the study of which 8 schools were located in

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Beirut (6 public and 2 private), 6 schools were located in Baalbeck (3 public and 3 private), and 2 schools in Rayak (1 public and 1 private).



**Figure 1.** Flow chart of the study design. Abbreviations: DKQ: Dietary knowledge questionnaire; DAQ: Dietary adherence questionnaire; BMI: Body mass index

**Table 1.** Background Characteristics of the Participants.

	Intervention (N = 739)	Control (N = 833)	Total (N= 1572)
Age, mean (SD)	15.8 (0.8)	15.8 (0.8)	15.8 (0.8)
Gender <sup>***</sup> , n (%)			
Boys	390 (52.8)	143 (17.2)	533 (33.9)
Girls	349 (47.2)	690 (82.8)	1039 (66.1)
Location <sup>***</sup> , n (%)			
Beirut (U)	327 (44.2)	174 (20.9)	501 (31.9)
Baalbeck (R)	346 (46.8)	517 (62.1)	863 (54.9)
Rayak (R)	66 (8.9)	142 (17.0)	208 (13.2)
Type of school <sup>***</sup> , n (%)			
Public	390 (52.8)	729 (87.5)	1119 (71.2)
Private	349 (47.2)	104 (12.5)	453 (28.8)
Grade <sup>***</sup> , n (%)			
Grade 10	383 (52.3)	514 (61.9)	897 (57.4)
Grade 11	349 (47.7)	316 (38.1)	665 (42.6)
BMI z-score <sup>**</sup> , mean (SD)	0.5 (1.2)	0.4 (1.1)	0.4 (1.2)

Note: Percentages are calculated according to the number of participants with non-missing values for each item. Chi-square tests and independent *t*-tests were performed to detect statistical differences between groups at baseline. Abbreviations: U: Urban; R: Rural; SD: Standard deviation. \*  $p < 0.05$ ; \*\*  $p < 0.01$ ; \*\*\*  $p < 0.001$

When comparing the intervention and control group at baseline, there were significant differences in terms of gender ( $p < 0.001$ ), location ( $p < 0.001$ ), type of school ( $p < 0.001$ ), and grade ( $p < 0.001$ ). There was a significant difference in the average BMI z-score between the

intervention (M=0.5, SD=1.2) and the control group (M=0.4, SD=1.1);  $t(1338)=-2.72$ ,  $p=0.007$ . Additionally, there was a significant difference in the baseline total knowledge score between the intervention (M=26.18, SD=8.10) and the control (M=27.56, SD=6.8) groups;  $t(1417)=3.60$ ,  $p<0.001$ . There was also a significant difference in the baseline healthy items score between the intervention (M=8.38, SD=3.76) and the control group (M=9.22, SD=3.48);  $t(1440)=-4.42$ ,  $p<0.001$ . Furthermore, the average unhealthy items score at baseline of the intervention group (M=6.71, SD=3.23) was significantly higher compared to the control group (M=6.08, SD=3.12);  $t(1436)=3.72$ ;  $p<0.001$  (Table 1 and 2). Therefore, these variables were adjusted for in the multiple regression and multilevel analyses.

Based on the adjusted multilevel models, the intervention group showed significant improvements in total dietary knowledge (B=12.74,  $p<0.001$ ) and in the healthy adherence score specifically (B=1.89,  $p<0.001$ ) compared to the control group (Table 2). The total dietary knowledge score of the intervention group increased by 48.6% and the healthy adherence score increased by 19.6%, while they both decreased in the control group. The unhealthy adherence score significantly decreased (B= - 1.43,  $p<0.001$ ) in the intervention group compared to the control group. The unhealthy adherence score decreased by 27.7% in the intervention group. Changes in separate DAQ items are shown in the supplementary file.

**Table 2.** Means and Standard Deviations (SD) of the Total Dietary Knowledge Score, Healthy Items Score, and Unhealthy Items Score and the Intervention Effect on the Three Scores.

	Intervention		Control		B	95% CI
	Unadjusted mean (SD)		Unadjusted mean (SD)			
	T <sub>0</sub>	T <sub>1</sub>	T <sub>0</sub>	T <sub>1</sub>		
<i>Dietary knowledge score</i>	26.18 (8.10) <sup>a</sup>	38.90 (7.88)	27.56 (6.8) <sup>a</sup>	26.51 (7.83)	12.74 ***	10.36-15.12
<i>Healthy items adherence score</i>	8.38 (3.76) <sup>b</sup>	10.02 (2.97)	9.22 (3.48) <sup>b</sup>	8.31 (3.11)	1.89 ***	0.97-2.81
<i>Unhealthy items adherence score</i>	6.71 (3.23) <sup>c</sup>	4.85 (2.34)	6.08 (3.12) <sup>c</sup>	5.74 (2.53)	-1.43 ***	(-1.75) - (-1.11)

Note: Score ranges: Dietary knowledge score: 0-56, healthy adherence score: 0-37, and unhealthy adherence score: 1-38. Multilevel analyses, with random intercepts and including three levels (level 1: adolescents; level 2: schools; level 3: location), were used to analyse the intervention effect on the total dietary knowledge and healthy items scores. Multivariate regression model was performed to test the intervention effect on the unhealthy items score. All models were adjusted for gender, class, type of school (public vs. private), location (urban vs. rural), BMI z-score, and score at baseline. <sup>a,b,c</sup>: values with the same superscripts are significantly different by study group (intervention vs. control) at baseline and  $p<0.001$ ; \*\*\*:  $p<0.001$  between the intervention and control group at T<sub>1</sub>. Abbreviations: SD: Standard deviation; CI: Confidence interval; T<sub>0</sub>: baseline; T<sub>1</sub>: post-intervention

In addition, when analysing the total dietary knowledge score, significant interactions were found between the intervention and the following background variables: grade ( $p= 0.019$ ), knowledge score at baseline ( $p< 0.001$ ), and weight status ( $p= 0.045$ ). Subgroup analyses based on significant interaction between the intervention and background variables (see Table 3) showed that the intervention led to larger improvements

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in knowledge among the oldest children, underweight children, and children with a low baseline score. As regards healthy items adherence, a significant interaction was found between the intervention and location ( $p= 0.011$ ). The intervention showed larger improvements among adolescents from rural regions, compared to urban regions. There was no significant differential intervention effect among public and private schools. Table 3 shows the intervention effects among subgroups having a significant interaction with the intervention (see Table S1 for the full list of intervention effects in subgroups).

**Table 3.** Intervention Effects on the Total Knowledge Score and Healthy Items Adherence Score of the Indicated Subgroups.

	<b>B</b>	<b>CI 95%</b>
<b>Total dietary knowledge score</b>		
Grade <sup>a</sup>		
Grade 10	11.13***	9.89-12.36
Grade 11	13.65***	12.52-14.78
Weight status <sup>a</sup>		
Underweight	15.36***	12.82-17.89
Healthy weight	12.52***	11.41-13.62
Overweight/obese	10.61***	9.03-12.19
Knowledge score at baseline <sup>b</sup>		
Low	13.48***	12.26-14.70
Acceptable	9.87***	8.42-11.32
<b>Healthy items adherence score</b>		
Location <sup>a</sup>		
Urban	3.26***	2.68-3.85
Rural	0.77**	0.26-1.29

Note: Multivariate regression model was performed to test the intervention effect on the total knowledge score, healthy items score, and unhealthy items score in the indicated subgroups. All models were adjusted for age, gender, class, type of school (public vs. private), location (urban vs. rural), BMI z-score, and score at baseline. BMI classification: adolescents with a BMI z-score  $\leq -1$  were classified as underweight; adolescents with  $-0.99 \leq \text{BMI z-score} \leq 1.03$  were classified as having a healthy weight; and adolescents with a BMI z-score  $\geq 1.04$  were considered overweight/obese. Adolescents with an acceptable baseline knowledge score correctly answered  $>50\%$  of questions, and adolescents with a low baseline knowledge score had  $<50\%$  of correct answers. The interaction between background variables and the intervention variable was found to be significantly associated with the dependent variables (i.e., knowledge score and healthy items score) with <sup>a</sup>  $p < 0.05$  and <sup>b</sup>  $p < 0.001$ ; CI: Confidence interval.

## Discussion

The present study evaluated the effectiveness of *Sahtak bi Sahnak* in improving both dietary knowledge and self-reported adherence levels in a cluster randomised controlled trial among Lebanese adolescents in both urban and rural regions. The results showed significant improvements in both dietary knowledge and dietary adherence, across various subgroups.

Our intervention significantly and substantially increased dietary knowledge by 48.6% in the intervention group. Our effects are larger compared to another Lebanese intervention for younger children (9-11 years) (73, 88). Another educational intervention conducted in India showed that nutrition knowledge improved significantly in participants

aged 15-18 years enrolled in public schools, but not in private ones (227). This could be due to the higher baseline knowledge scores of the adolescents in private schools in their sample, creating a ceiling effect in private schools (227). The current study did not show differential intervention effects among public and private schools. However, no significant baseline differences were found between the knowledge scores from private and public schools in the current sample (222), potentially explaining the lack of differential effects in the current study as there were no ceiling effects. Alternatively, the current intervention might have been more suitable for adolescents from private schools in addition to public schools, compared to the Indian intervention.

Our results also suggest that, although the intervention was effective for both grades, it was more effective in increasing dietary knowledge among grade 11 adolescents compared to grade 10 adolescents. This could be due to the generally smaller number of students per class in grade 11, enabling better management of the students (i.e., less noise) and improving the delivery of the intervention. In addition, *Sahtak bi Sahnak* was more effective in impacting the dietary knowledge of participants with a lower baseline score. This is a positive outcome because during the intervention design, specific attention was paid to simplify the nutrition information and key terms as much as possible to make it suitable for participants of all dietary knowledge levels. The intervention appears to have succeeded in this, having significant effects on adolescents with low as well as with acceptable knowledge level. Nonetheless, adolescents with an acceptable baseline knowledge level were also able to significantly benefit from the intervention. Furthermore, and surprisingly, the intervention seems to present a larger improvement among underweight adolescents compared to overweight/obese ones, even though it was initially intended to prevent paediatric obesity. This could be related to the baseline knowledge scores, as a higher BMI z-score was significantly positively correlated with higher knowledge score (222). The higher baseline dietary knowledge score among overweight and obese children may be attributed to a higher interest in nutrition compared to other children (21).

In addition to improving knowledge, the current intervention succeeded in significantly improving self-reported dietary adherence by increasing the healthy items score and decreasing the unhealthy items score. This is partially in line with an intervention for Tunisian adolescents (80), which showed an improvement related to the consumption of the recommended amount of fruits and vegetables. Another nutrition intervention for adolescents based on the Intervention Mapping framework, conducted in Ecuador, significantly reduced the intake of added sugars and unhealthy snacks. However, the breakfast and fat intake did not change (74). Our results additionally suggest that the

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intervention was more effective in improving the healthy items score among urban adolescents compared to rural participants, which may be caused by a reduced food availability in some rural regions (228). This could be also due to the significant difference of the healthy items score at baseline between both groups, in addition to the higher number of adolescents per class in rural schools (222).

The current study has several strengths. First, the sample size is large and diverse, covering both urban and rural areas with different socioeconomic backgrounds. Second, this is the first study in the region to evaluate the effect of an intervention that was systematically developed based on Intervention Mapping (41), aiming to prevent obesity. This elaborate framework allows researchers to develop interventions based on the latest findings related to theories and empirical findings, instead of randomly selecting a behaviour change approach (229). Third, data collection was performed according to standardised procedures and included valid and pre-tested questionnaires specifically designed for Lebanese adolescents (144). Fourth, the effect of *Sahtak bi Sahnak* was demonstrated using advanced and rigorous statistical tests to evaluate its effectiveness, adjusting for relevant background characteristics and the multilevel structure of the data. Fifth, the applied randomisation guarantees the internal validity for statistical tests of significance that are used to compare the intervention effects (230). Sixth, unlike other programmes (74), the current intervention can be adopted in Lebanese public and private secondary schools located in both urban and rural regions.

Some limitations should be also considered. First, the sample did not include participants from all the Lebanese regions, and thus generalizability to the rest of Lebanon might be limited, despite the significant effects in the various subgroups examined. In addition, sampling was not stratified at the individual level, e.g., for gender. However, the study did include both rural and urban regions, and both public and private schools. Second, significant differences were found between the intervention and control groups at baseline (e.g., gender, classes, location, etc.). These differences were, however, adjusted for in the statistical analyses. The analyses were not, however, adjust for class size, although class size is related to grade in Lebanon, and the analyses were adjusted for grade. Third, the dietary knowledge and adherence variables were based on self-reports rather than on objective assessment, potentially resulting in social desirability bias. However, direct objective measurements are not feasible in studies with large populations (157). In addition, recall bias might have affected the healthy and unhealthy items scores as they assess dietary intake during the previous day.

*Sahtak bi Sahnak* was administered and evaluated in 16 public and private secondary schools located in urban and rural regions in Lebanon, including a diverse sample.

However, future studies should focus on including participants from all Lebanese regions to be able to generalise the obtained results on the whole population.

### *Implications for Research, Practice, and Policy Making*

*Sahtak bi Sahnak* showed substantial positive effects on the dietary behaviours and knowledge of diverse Lebanese adolescents, an understudied population. Given the great potential of the intervention, further dissemination in Lebanon and the region is recommended. The intervention can be easily integrated into the Lebanese school curriculum, and can be directly applied in schools within the context of an adolescent's natural environment (210). This study was planned carefully to suit all Lebanese adolescents with different nutritional statuses. As 10.7% of the sample were underweight (222), the intervention focused on healthy eating habits and healthy weight concepts rather than on obesity and ideal weight. The findings may further be taken into consideration for future school-based obesity prevention programmes. Future studies should further monitor the implementation process when the intervention is disseminated to other schools, as well as the longer term effectiveness of the intervention.

## **Conclusion**

The current study presents the effect evaluation of a school-based intervention designed according to the Intervention Mapping framework, targeting Lebanese adolescents from different geographical regions. *Sahtak bi Sahnak* demonstrated its effectiveness in improving the dietary knowledge and, consequently, the dietary adherence levels of Lebanese adolescents. It also showed that this theory-based intervention is feasible to implement in public and private schools located in urban and rural areas, as the intervention succeeded in reaching our aims and in completing the intervention as planned. In addition, none of the participating schools withdrew from the programme. Future studies targeting environmental (e.g., access to healthy and unhealthy foods) and school policy changes are needed to improve eating patterns and physical activity levels at the same time.

## Appendices- Chapter 5

**Table S1.** Intervention effects on the total knowledge score, healthy items score, and unhealthy items score of the indicated subgroups.

	<b>B</b>	<b>CI 95%</b>	<b>p</b>
<b>Total dietary knowledge score</b>			
<i>Gender</i>			
Boys	11.33	9.69-12.96	<0.001
Girls	12.76	11.74-13.77	<0.001
<i>Location</i>			
Urban	15.50	14.38-16.62	<0.001
Rural	10.57	9.40-11.74	<0.001
<i>Type of school</i>			
Public	12.79	11.75-13.82	<0.001
Private	9.34	7.68-11.00	<0.001
<i>Grade <sup>a</sup></i>			
Grade 10	11.13	9.89-12.36	<0.001
Grade 11	13.65	12.52-14.78	<0.001
<i>Nutritional status <sup>a</sup></i>			
Underweight	15.36	12.82-17.89	<0.001
Healthy weight	12.52	11.41-13.62	<0.001
Overweight/ obese	10.61	9.03-12.19	<0.001
<i>Dietary knowledge level at baseline <sup>b</sup></i>			
Low	13.48	12.26-14.70	<0.001
Acceptable	9.87	8.42-11.32	<0.001
<b>Healthy items score</b>			
<i>Gender</i>			
Boys	1.28	0.64-1.93	<0.001
Girls	2.13	1.61-2.64	<0.001
<i>Location <sup>a</sup></i>			
Urban	3.26	2.68-3.85	<0.001
Rural	0.77	0.26-1.29	0.003
<i>Type of school</i>			
Public	1.64	1.17-2.11	<0.001
Private	2.13	1.35-2.90	<0.001
<i>Grade</i>			
Grade 10	1.44	0.88-1.99	<0.001
Grade 11	1.97	1.43-2.52	<0.001
<i>Nutritional status</i>			
Underweight	1.29	0.20-2.38	0.021
Healthy weight	1.75	1.24-2.27	<0.001
Overweight/ obese	1.92	1.19-2.65	<0.001

**Table S1.** (continued).

	<b>B</b>	<b>CI 95%</b>	<b>p</b>
<b><i>Unhealthy items score</i></b>			
<i>Gender</i>			
Boys	-1.92	(-2.46) - (-1.38)	<0.001
Girls	-1.14	(-1.54) - (-0.73)	<0.001
<i>Location</i>			
Urban	-1.53	(-2.03) - (-1.03)	<0.001
Rural	-1.30	(-1.70) - (-0.89)	<0.001
<i>Type of school</i>			
Public	-1.60	(-1.98) - (-1.21)	<0.001
Private	-0.85	(-1.48) - (-0.23)	0.008
<i>Grade</i>			
Grade 10	-1.51	(-1.96) - (-1.07)	<0.001
Grade 11	-1.38	(-1.83) - (-0.93)	<0.001
<i>Nutritional status</i>			
Underweight	-0.88	(-1.84) - (0.08)	0.073
Healthy weight	-1.26	(-1.69) - (-0.84)	<0.001
Overweight/ obese	-1.86	(-2.41) - (-1.31)	<0.001

Note: Multivariate regression model was performed to test the intervention effect on the total knowledge score, healthy items score, and unhealthy items score in the indicated subgroups. All models were adjusted for age, gender, class, type of school (public vs. private), location (urban vs. rural), BMI z-score, and score at baseline. BMI classification: adolescents with a BMI z-score  $\leq -1$  were classified as underweight; adolescents with  $-0.99 \leq \text{BMI z-score} \leq 1.03$  were classified as having a healthy weight; and adolescents with a BMI z-score  $\geq 1.04$  were considered overweight/obese. The interaction between background variables and the intervention variable was found to be significantly associated with the dependent variables (i.e., knowledge score and healthy items score) with <sup>a</sup> $p < 0.05$  and <sup>b</sup> $p < 0.001$ . Abbreviations: CI: Confidence interval.

**Table S2.** Intervention effects of the separate items of the Dietary Adherence Questionnaire.

DAQ items	B	CI 95%	<i>p</i>
Lean meat	0.16	0.08-0.24	<0.001
High fat meat	-0.25	-0.33-0.17	<0.001
Unhealthy snacks	-0.15	-0.23-(-0.07)	<0.001
Low-fat dairy products	0.06	-0.02-0.14	0.119
Medium fat dairy products	0.02	-0.04-0.07	0.573
High-fat dairy products	-0.07	-0.16-0.01	0.086
Whole milk	0.09	0.03-0.15	0.004
Skimmed milk	-0.005	-0.01-0.003	0.264
Refined bread	-0.13	-0.25-(-0.01)	0.027
Whole bread	0.04	-0.01-0.09	0.089
French fries	-0.13	-0.19-(-0.06)	<0.001
Beans	0.04	-0.02-0.10	0.163
Vegetables	0.11	0.02-0.20	0.016
Fruits	-0.001	-0.08-0.08	0.985
Natural juices	-0.001	-0.04-0.04	0.957
Commercial juices	-0.14	-0.19-(-0.08)	<0.001
Soft drinks	-0.20	-0.28-(-0.12)	<0.001
Diet soft drinks	-0.01	-0.02-0	0.059
Energy drinks	-0.01	-0.04-0.01	0.419
Sweets	-0.18	-0.26-(-0.09)	<0.001
Arabic sweets	0.01	-0.01-0.04	0.210
Breakfast	0.29	0.23-0.35	<0.001
Number of meals	0.24	0.14-0.33	<0.001
Number of snacks	-0.29	-0.41-(-0.18)	<0.001
Number of meals outside	-0.09	-0.14-(-0.04)	<0.001
PA at school	-0.10	-0.06-0.02	0.359
PA outside of the school	-0.02	0.15-0.26	<0.001
PA weekly hours	0.26	0.17-0.36	<0.001
Screen-viewing duration	-0.47	-0.68-(-0.25)	<0.001
Smoking	-0.03	-0.07-0.01	0.129

Multivariate regression model was performed to test the intervention effect on the separate items of the dietary adherence questionnaire. All models were adjusted for age, gender, class, type of school (public vs. private), location (urban vs. rural), BMI z-score, and score at baseline. Abbreviations: CI: Confidence interval, DAQ: Dietary adherence questionnaire, PA: Physical activity

Note: The full supplementary material is available at:

<https://www.frontiersin.org/articles/10.3389/fnut.2022.824020/full>





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# Chapter 6

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## General Discussion

## Chapter 6

The overall aim of this dissertation was to develop, implement, and evaluate Sahtak bi Sahnak, a school-based educational programme to promote healthy eating habits among Lebanese adolescents aged 15 to 18 years. This chapter summarises the main findings of the studies, then discusses some strengths, methodological limitations, implications, and finally presents a general conclusion.

### **Main findings**

Obesity and overweight are serious conditions leading to several chronic diseases and affecting more than 40% of Lebanese adolescents aged 10-19 years (8, 231, 232). According to the regional and international recommendations to prevent obesity (77, 78), integrating nutrition education as part of the school's curricula is an essential step towards healthier eating patterns among children and adolescents. However, prior to implementing any nutrition programme, it is crucial to assess the current dietary knowledge and adherence levels using valid and reliable instruments that may be administrated in school settings. Therefore, at first two questionnaires were developed to assess the dietary knowledge and adherence of Lebanese adolescents and their parents (Chapter 2). The feasibility and internal reliability of the questionnaires in the target population were also examined. The development process included three phases: (1) literature review and questionnaire construction; (2) pre-pilot testing; and (3) pilot testing of the questionnaires. Next, several scores were developed to reflect dietary knowledge and adherence such as the total dietary knowledge score, total dietary adherence index, healthy items adherence score, and unhealthy items adherence score of the adolescents and their parents. These scores had two main functions: to quantify the levels of dietary knowledge and adherence and to be able to investigate the association between dietary knowledge and dietary adherence (and the BMI z-score of the adolescents later on, see chapter 3). The internal reliability for almost all scores, except for the healthy items score of the parents, was acceptable, and the questionnaires were considered feasible. As a result, we obtained brief and relatively inexpensive instruments to assess dietary knowledge and adherence, which are suitable for administration in Lebanese school settings. The Dietary Knowledge Questionnaire (DKQ) and Dietary Adherence Questionnaire (DAQ) are the first dietary knowledge and adherence questionnaires to be systematically developed and evaluated in the Arab world. In terms of dietary knowledge, the overall average among the adolescents was relatively low, suggesting the need of a nutrition education programme. In terms of participation, this study showed encouraging participation rates among adolescents (100%), but low rates among their parents (40.5-49%). The low parental response to the questionnaires significantly influenced our decisions regarding parental involvement in Sahtak bi Sahnak later on.

A cross-sectional study was conducted to evaluate the current dietary knowledge and adherence among Lebanese adolescents and their parents, as well as their association

with the BMI z-score of the adolescents, parents' levels of dietary knowledge and adherence, and with other health behaviours (Chapter 3). This study indicated that more than half (59%) of the adolescents had a low total dietary knowledge score. The latter was also directly associated with dietary adherence. This suggested the need to implement a nutrition intervention and the potential positive effect of such a programme. Furthermore, the results showed that the dietary knowledge level of the parents was indirectly associated with the adolescents' dietary adherence, as the total dietary knowledge score of the parents was significantly associated with the total dietary knowledge score of the adolescents, but not with any of the dietary adherence indicators (i.e., healthy and unhealthy items score and total adherence index). Therefore, parents may influence their children's dietary knowledge, which in turn may affect their eating behaviour. Interestingly, there was a difference between adolescents and their parents in the associations between dietary knowledge and dietary intake. There was a significant correlation between dietary knowledge of the adolescents and their healthy and unhealthy items adherence scores, but the dietary knowledge score of the parents was only associated with their unhealthy items score. This could potentially indicate that with age, dietary knowledge becomes more of an inhibitor of unhealthy eating rather than a stimulator of healthy eating. Other studies have reported controversial results regarding this association. Some researchers have reported the existence of an association between dietary knowledge and both healthy and unhealthy food consumptions (137), others between dietary knowledge and a higher score on the Healthy Eating Index (233). However, other researchers did not find a significant correlation between the dietary knowledge and unhealthy dietary behaviours such as sweets consumption (234). These different results could be attributed to the use of different tools to evaluate the dietary behaviours. As regards to the total dietary adherence index, the current findings showed that the majority of adolescents had an overall favourable index, yet the average healthy items score suggested that there is room for improvement. As for the parental dietary adherence, we noticed this was significantly correlated with both healthy and unhealthy scores of the adolescents. This correlation was partly predicted as they both eat in the same household (235).

When looking at the DAQ items separately (Chapter 3), the results show some positive results, as well as some serious red flags. On the positive side, 92.3% of the adolescents did not drink any energy drinks, protecting them from several adverse effects (236). On the other hand, adolescents were not consuming enough high fibre sources, as more than half of them (52%) did not eat any vegetables, fruits (53%) or natural fruit juices (90%). Additionally, the majority of adolescents did not eat any beans (86%), and whole wheat bread (91%). These findings were also confirmed by the 24h recall analysis conducted on the same sample (unpublished data). Furthermore, a large proportion skipped breakfast (42%) and did not drink any regular milk or milk alternatives (such as laban, 79%). The latter was also confirmed by the 24h recall analysis (unpublished data) as the average calcium

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intake only represented 53.6% of the estimated average requirements (EAR) (237). This emphasizes the need of dietary education to improve their food choices. Interestingly, parents appeared to have a better adherence with regard to some aspects of their diet. For instance, only 18% and 14.5% of the parents skipped their breakfast and fruits, respectively.

As for the clustered behaviours (Chapter 3), the results showed that breakfast intake was significantly and negatively associated with several unhealthy behaviours such as high fat meat intake, commercial juice intake, and increased duration of screen-viewing time. Furthermore, the number of meals consumed outside of the house was significantly and positively correlated with numerous unhealthy eating behaviours such as the consumption of high fat meat, unhealthy snacks, French fries, commercial juices, soft drinks (both regular and sugar-free), energy drinks, and sweets of all types. This suggests the importance of focusing on these particular eating patterns to address several other unhealthy behaviours in parallel. The application of such a strategy may be of great importance at schools with limited time for addressing healthy behaviour and busy schedules.

A comprehensive, school-integrated, theory-based, culturally appropriate, and low-cost intervention was developed (Chapter 4). Sahtak bi Sahnak is based on the Intervention Mapping (IM) framework, and it is the first nutrition intervention targeting Lebanese adolescents in secondary schools. The overall programme goals were the following: (1) to increase participants' level of dietary knowledge; (2) to improve the dietary adherence to nutritional guidelines; and (3) to prevent the development of obesity among Lebanese adolescents. The needs assessment conducted at the beginning of the intervention development highlighted the most relevant and modifiable determinants that the programme should focus on (i.e., knowledge, skills, self-efficacy, and attitude). Various methods were selected to match the previously indicated determinants such as active learning, verbal persuasion, guided practice, counterconditioning, stimulus control, self-reevaluation, and feedback (185, 187, 188, 190, 191, 238). The intervention also taught adolescents how to adapt healthy lifestyles to their circumstances when they cannot change their environment. Sahtak bi Sahnak was adopted by 16 public and private secondary schools located in Beirut, Baalbeck, and Rayak. It was implemented by a dietitian and delivered directly to the students in classrooms. The secondary schools and the teachers were therefore not required to adopt new responsibilities, which decreased the burden of the intervention, and thus encouraged schools' participation. The last step of the study protocol included a detailed evaluation plan of the designed intervention.

Once the implementation of Sahtak bi Sahtak was complete, an effect evaluation was conducted (Chapter 5). The findings of the clustered randomised controlled trial showed that the intervention significantly improved both dietary knowledge and adherence levels in both public and private schools located in urban and rural areas. In terms of meal skipping, Sahtak bi Sahnak was able to improve breakfast and meal consumption. This was

an important achievement, as Chapter 3 showed the additional healthy behaviours associated with regular breakfast intake. In line with this, the number of meals consumed outside of the house decreased significantly as well. This reflected a positive effect as eating outside the house is associated with unhealthy dietary intake (239, 240). No effects of the intervention were found on the consumption of dairy products, skimmed milk, whole bread, beans, fruits, natural juices, diet soft drinks, energy drinks, and Arabic sweets.

## **Strengths, limitations, and methodological considerations**

One of the main strengths of the current thesis is that all the manuscripts (Chapters 2-5) were published at open access journals. Furthermore, the questionnaires and educational materials are available in both English and Arabic language, and detailed results and tables were all published as part of the supplementary material accompanying the papers. This provides researchers from all over the world, including both developed and developing countries, the resources to replicate the intervention, the tools to collaborate and improve the findings, and to build the framework for more equitable participation and distribution of knowledge (241).

The studies described in this dissertation had additional strengths, limitations, and methodological considerations, which are discussed in this section.

### *1- Sampling strengths and limitations*

In terms of internal validity, the number of adolescents included in the studies was sufficient to validate the questionnaires, evaluate the Sahtak bi Sahnak programme and to determine the correlation between the measurements, based on power calculation level of 80% and a significance level of 5%. However, the overall sample, as well as the intervention and control groups separately, did not include equal proportions of demographic subgroups (e.g., based on gender, location, type of school). This was due to the large differences between schools in terms of number of schools per city/town, overall number of enrolled students per school, number of students per class, and gender, as some secondary schools are for girls only, while the others are mixed. For instance, five schools, including 610 girls and representing around 39% of the total number of participating adolescents, were girls only schools. To avoid confounding by such variables, the effect analyses was adjusted for these demographic variables.

All participating schools were randomly selected. It is important to note that once the approval of the Lebanese Ministry of Education and Higher Education (MEHE) was obtained, this allowed direct access to public schools and full participation of each public school that was approached. The private schools, on the other hand, had the right to refuse. Nonetheless, all private schools located in Baalbeck, along with the public schools, instantly accepted to participate once approached. The recruitment of other private schools located in Beirut and Rayak was more challenging. Some schools did not justify their refusal to

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participate, while others blamed the busy education schedules. The willingness of schools to participate might have influenced the results, as it means that the sample might include the more motivated schools, resulting in selection bias. Yet, the number of public schools in our sample was higher than the private ones (10 public vs. 6 private schools), minimising the effect of the bias in question.

### *2- Measurement strengths and limitations*

To our knowledge, the paper presented in chapter 2 was the first paper to publish the development and validation process of Arabic dietary knowledge and adherence questionnaires. The DKQ and DAQ were tested using a systematic mixed methods approach (i.e., combining qualitative and quantitative analyses) based on an appropriate sample size from different regions in Lebanon. The food-intake-related questions of the DAQ were further validated against the 24h recall among 272 adolescents (unpublished data).

The first limitation pertaining to the questionnaires is that both DKQ and DAQ were self-administered, potentially introducing memory and reporting errors (242). As all measures present some degree of error, researchers have to find the instruments that suits best their target population and study outcomes. So, the goal of the questionnaires was to distinguish meaningful patterns (243), hence to detect a change in the intervention group, compared to the control group, that could be attributed to the developed programme. It is also important to note that self-reported questionnaires are more cost-effective for large scale studies (244). In addition, and to lessen the extent of this bias, a 24h recall was administered (unpublished data) in parallel to the DAQ to further validate the DAQ and compare the changes of dietary intake during both pre- and post-intervention phases, demonstrating that the DAQ is an efficient instrument to assess healthy and unhealthy adherence patterns.

The second limitation is related to 24h recalls, which were used to validate the DAQ and assess the dietary intake of the adolescents. The absence of detailed Lebanese food composition tables and suitable software made it extremely hard to estimate the dietary intake of all the participants, as it required calculating all intake values by hand for more than 1500 adolescents twice, at baseline and post-intervention. It is also important to note that the used food composition tables (245, 246) did not include the nutrient content for all consumed food items (e.g., saturated fatty acids and added sugars).

The third limitation related to the DAQ is that it refers to the food consumption during the previous day and may not reflect the typical diet of the participants. However, as the sample size was large, the normal random variation among all participants produces an average intake that accurately reflects the intake of the whole group (247, 248).

The fourth limitation is that the first part of the DAQ relies on the frequency of consumption but does not take the amount of food or portions consumed into account. The portion sizes and food amounts were omitted from the questionnaire for two reasons: (1) to simplify the questions as adolescents may not have the required skills to estimate portion sizes (249); and (2) to shorten the questionnaire as long questionnaires may affect the respondent's attention and motivation, resulting in potentially invalid or unreliable responses (131). However, this may lead to over- or underestimations in the healthy or unhealthy items score. For instance, adolescents eating half an apple or two apples a day received the same points for fruits, although they did not eat the same amount. Therefore, a 24h recall was administered in parallel to make sure that the DAQ does not over- or underestimate the intake.

### *3- Intervention strengths and limitations*

Sahtak bi Sahnak is the first IM-based intervention in the Arab world. The IM framework allowed systematically creating a comprehensive, school-integrated, theory-based, culturally appropriate, and low-cost intervention that suits the Lebanese school setting. The programme covered various nutrition topics starting from the general nutritional guidelines and food guides (MyPlate, MyPyramid, etc.) (250-252) to the importance of macro- and micronutrients, in addition to physical activity and weight assessment. By answering the adolescents' questions during the intervention implementation, we noticed that all their main interests were covered by the educational material. This means that the educational material covered their main topics of interest. The intervention was delivered during regular school-hours meaning that it did not require the adolescents to invest extra time after school. The intervention was administered in Arabic language (native language of the target population), and it was written in simple and comprehensible language. In addition, and to be able to implement the intervention equally among all groups, Sahtak bi Sahnak took into consideration the limited financial resources of some schools. For instance, we used printed booklets as the main educational tool since some schools did not have LCD projectors in their classes and all students were not allowed to bring their tablets and phones to class. It is also important to note that the adolescents, as well as their parents and school principals, were involved in the design of the intervention by taking into account their feedback during the feasibility study and by using previous experiences with the target group. For instance, the research dietitian presented several lectures to encourage children, adolescents, and their parents to improve eating habits, prior to development of the intervention. The main concerns and questions that were repeatedly asked by the students and their parents in these lectures (results not published) were added to the educational material.

The current intervention was effective in improving both dietary knowledge and adherence among adolescents of various socioeconomic statuses enrolled in public and

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private secondary schools. SES is one of the least modifiable determinants of eating among children (40). However, some researchers reported that health literacy may act as a modifiable risk factor of SES disparities in health (253). Therefore, improving the level of health literacy or making the health services more accessible to individuals with low health literacy levels may allow reaching a greater equity in health (253). This may explain why Sahtak bi Sahnak was effective in both lower and higher SES groups, as it empowered participants with the necessary dietary knowledge, allowing individuals to start making the right choices concerning their diet. In the current studies, the number of private schools participating in the current intervention was lower compared to the public ones. This was, however, adjusted for when conducting the statistical analyses.

As for the intervention duration, earlier studies revealed that relatively few hours of instruction can produce large effects for knowledge, but more hours are required for obtaining effect on attitude and practice, which need about 40-50 classroom hours (254). Due to time limits at schools, we did not reach the recommended duration, but rather adapted the programme to suit the target schools, resulting in a programme lasting between seven and 10 classroom hours.

In addition, although the intervention focused on several determinants of dietary intake (e.g., knowledge, skills, attitude, and self-efficacy), the evaluation only focused on dietary knowledge as a determinant. This was mainly due to the limited available time as evaluating self-efficacy, skills, and attitude would require additional time (e.g., separate questionnaire development and validation, longer questionnaire administration time, etc.) and burden on students. Furthermore, one of the main purposes of the current research project was to evaluate the level of dietary knowledge among the Lebanese adolescents (as justified in Chapter 4).

### *4- Evaluation strengths and limitations*

Sahtak bi Sahnak was evaluated using a clustered randomised controlled trial (CRT) design. Such a type of study is particularly popular to evaluate non-therapeutic interventions such as health promotion and prevention interventions (219). The main advantage is the reduction of contamination bias as the clusters are separated in different schools (219). On the other hand, CRTs require larger sample sizes compared to individual randomisation and more rigorous statistical analysis (255, 256) In the current studies, the sample size exceeded the minimal required sample size, and the effect evaluation was performed using advanced statistical tests, adjusting for relevant background characteristics and the multilevel structure of the data. In addition, the intervention effects were further evaluated using 24h recall analysis among 670 adolescents, with the findings confirming those presented in the current dissertation (unpublished data).

Although the effect evaluation showed some promising results, there were some limitations related to the duration of the intervention and the evaluation period. In the

current thesis, we did not investigate the long-term effects of Sahtak bi Sahnak, for several reasons: (1) limited time and funding of the study; (2) limited access to participants: most of the schools do not accept involving grade 12 students in extra-curricular activities, including research projects, as they should focus on the national exams. Therefore, it would not be possible to evaluate the grade 11 participants on the longer-term. In addition, intervention and control participants were located in separate schools, thus minimising the information contamination bias.

### *5- External validity*

The intervention and questionnaires used in Sahtak bi Sahnak were implemented and administered in 16 public and private secondary schools located in urban and rural regions in Lebanon. The sample included both boys and girls, students with different socioeconomic statuses (SES), and having different nutritional statuses (i.e., underweight, normal nutritional status, and overweight/obese). Yet, as adolescents from other Lebanese governorates were not included, future studies should focus on including participants from all Lebanese regions to be able to generalise the obtained results on the whole population.

## **Implications and recommendations**

The findings from the studies presented in this research have several implications and result in several recommendations for the future, discussed below.

### *1- Theoretical implications*

Sahtak bi Sahnak was based on the Intervention Mapping framework and its contribution to the available literature is twofold. First, the results presented in this dissertation provide support for the effectiveness of IM in developing intervention for improving the dietary knowledge and adherence among Lebanese adolescents. Most of the previously published studies involving IM were conducted in Europe and USA. The current dissertation extends this by providing an example of application of IM in the Arab region. It is important to raise global awareness and include more training on the use of IM in disease prevention in different parts of the world (92). As this is the first nutrition intervention based on IM in the region, the detailed protocol of the programme involving the six steps, including the educational material, was published in an open access journal with the possibility of being replicated and updated in the future.

Second, the use of the IM approach highlighted the gaps related to the nutrition of Lebanese adolescents (e.g., determinants of eating, application of behaviour change theories in the Lebanese setting, official nutritional recommendations for Lebanese children and adolescents). Therefore, studies targeting these gaps should be conducted in the future (257). This will allow an updated and more elaborate needs assessment, to further increase our understanding of the behaviour of this target population. It is important to note that the translation of theories into practice is not as simple as it may seem. For instance, some

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schools, regardless of their willingness to participate or their cooperation level, are not capable of changing some environmental aspects such as the school kiosks (134). Other schools do not have a PE teacher (as reported by one of the school principals). Therefore, future interventions should consider tailoring the programme based on the school's needs and available resources, rather than just basing it on the theory and previous research findings. However, using IM increases the ability to take into account the participants' needs, overcome the barriers, and take advantage of the facilitators and resources of implementation. Thus, IM can address such knowledge and practice gap when it comes to implementing health promotion interventions (257).

### *2- Programme-related recommendations*

Based on the current effects of Sahtak bi Sahnak, we recommend a larger dissemination of the programme as part of the school extra-curricular activities. This would increase reach, as well as allow for further process and effect evaluation of the intervention. We hereby propose four research recommendations in this respect: (1) Needs assessment: conducting an updated needs assessment to evaluate the teachers' willingness to participate in such a programme and to find the most appropriate way to integrate Sahtak bi Sahnak in classrooms (e.g., as part of the science classes or as part of additional extra-curricular activities, possibility of dividing the programme among two courses or subjects); (2) Teachers training: Teachers should be trained by dietitians or by trained staff with enough knowledge and experience in nutrition and in dealing with adolescents. An integrated implementation strategy must be developed, including informing teachers of the results of the studies presented in this thesis to further convince them of the impact of the programme and to have realistic prior expectations (e.g., degree of improvement, participation rate, etc.); (3) Programme revision: To increase the effects of Sahtak bi Sahnak and taking into consideration the limited amount of time and busy school schedules, the programme should be continuously revised and updated according to the most problematic modifiable dietary behaviours among the adolescents. In addition, previous revisions of similar nutrition programmes can inform such revisions (258, 259). It is important to note that to make the intervention part of the secondary school curriculum, new legislation should be issued to update the current school curriculum, which is not feasible without proving the efficacy of such a change. This might also require another large-scaled experimental study, focusing more on the legislation aspect and policy making by involving school principals, teachers, and student representatives. In terms of program format, we recommend developing an online version of Sahtak bi Sahnak, taking into consideration the recent changes to online activities in education due to the Covid19 pandemic (260). This will also allow adding suitable content in the form of videos and online games, appealing to the target group.

In addition, future improvements and revisions of the programme may consider targeting the environment and school policy, as the IM protocol revealed that these factors were among the determinants influencing nutrition among adolescents. Schools should

reinforce and support the nutrition concepts throughout the school environment (261). This could be done by offering more healthy options at school (such as ready prepared fruit salads) and limiting access to competitive food such as (high sugar drinks). It is important to note that such radical environmental interventions require significant funding as many school kiosks do not have the spatial capacity to prepare food (262), nor do they have the appropriate facilities to store large amounts of food. Therefore, evaluating all food safety measures before implementing such an intervention targeting the availability and accessibility of foods at school is another crucial aspect to consider. As for school policy change, this should start with a thorough needs assessment involving school principals, teachers, students, and other relevant stakeholders. This is important because students may disagree with the school policy change, and teachers may under prioritise it (263). Some studies even found that changes in fruits and vegetable intake was higher in schools with no school policy and the children's nutrition knowledge was not significantly different between schools with or without school policy (264, 265). Therefore, a careful planning and implementation of intervention components focusing on policies must be considered to obtain positive outcomes. In addition, long-term funding is also essential to ensure the success of policy implementation (262).

### *3- Evaluation implications and recommendations*

During the initial phases of the project, we developed the DKQ and DAQ and conducted a feasibility study to pilot-test them (Chapter 2). These questionnaires are a useful addition to the existing dietary assessment methods, especially since they were developed specifically to suit the target population. They are inexpensive, timesaving compared to the methods involving direct interviews (e.g., 24h recall), and present a low participant burden, making them appropriate to administer in school settings. These evaluation tools can be used by health promoters in the future to assess the levels of dietary knowledge and adherence of the Lebanese adolescents and to evaluate the programme effectiveness. We also recommend developing an online version of the questionnaires to administer them online and to be compatible with a potential online version of Sahtak bi Sahnak, taking into consideration the current shift to online education due to the Covid19 pandemic (260).

A process evaluation for the programme was not conducted as it was not part of the aims of the study. Therefore, when the intervention is further disseminated, the number of implementers increases, and the format and delivery of the programme is finalised, it would be wise to conduct a process evaluation to assess: (1) the implementation of the programme including recruitment, reach, and intervention quality and fidelity; (2) the sustainability of the programme including adoption and financing (266). This will help in gaining a comprehensive insight of the intervention, implementation process, and how to obtain the best outcomes. It will also facilitate the work of future implementors (262). This may be of interest to health promoters and policy makers on future quality improvements (267).

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Additionally, although the intervention targeted several determinants, the effect evaluation assessed dietary knowledge, only. We recommend evaluating the other target determinants by developing new or adopting existing questionnaires to assess self-efficacy, attitude, and skills. This will determine whether Sahtak bi Sahnak succeeded in following a multidimensional approach (268), or not. Yet, using more questionnaires means that the evaluation will take more time which might be a challenge in schools. Therefore, in such a case, it would be wise to evaluate intervention effects on different determinants in different samples.

In terms of evaluation, the current study evaluated the short-term effects of the intervention, only. Yet, evaluating the longer-term effects of the programme will help in determining the required frequency and duration of programme implementation. In other words, it will help in deciding whether the nutrition education should be repeated yearly or given once during secondary school years.

## General conclusion

The current thesis presents the development, implementation, and effect evaluation of a school-based nutrition intervention designed according to the Intervention Mapping framework, targeting Lebanese adolescents from different geographical regions. Sahtak bi Sahnak is a theory-based, school-integrated, comprehensive, culturally appropriate, and low-cost intervention. It serves as a valuable asset in the nutrition education field as the effect evaluation of the programme demonstrated its effectiveness in improving the dietary knowledge and, consequently, the dietary adherence levels of Lebanese adolescents.

This study confirmed the need to improve the dietary patterns of Lebanese adolescents, as well as the possibility of integrating nutrition education in school settings. Overall, Sahtak bi Sahnak can be considered a promising initiative in secondary schools in Lebanon to improve dietary adherence in urban and rural regions. Future studies must focus on programme improvements and updates to integrate it as part of school education.



## Impact paragraph

Johann Wolfgang von Goethe once said that “knowing is not enough, we must apply. Willing is not enough, we must do”. When it comes to paediatric obesity, we do *know* for sure that it is a serious health problem affecting 12.2% of Lebanese adolescents aged 10 to 19 years, and over 340 million children and adolescents worldwide (1). Yet, few national efforts were undertaken in the Arab world, and the problem is still not resolved. The aim of this dissertation was to develop, implement, and evaluate of the first nutrition intervention targeting Lebanese adolescents enrolled in secondary schools. Sahtak bi Sahnak is a theory-based, school-integrated, comprehensive, culturally appropriate, and low-cost intervention. Its primary objectives are to improve dietary knowledge, adherence, and consequently prevent paediatric obesity among 15-18-year-old adolescents living in urban and rural regions in Lebanon and enrolled in public and private secondary schools. Sahtak bi Sahnak was developed using the Intervention Mapping framework and implemented by a research dietitian. In addition, dietary knowledge and adherence questionnaires were developed as assessment tools to evaluate the outcomes of the intervention and the correlation between the parental and adolescents’ dietary knowledge and adherence levels, as well as to detect clustered behaviours.

For the current research project, 16 secondary schools located in Beirut, Baalbeck, and Rayak have participated. The schools were divided into two groups: intervention and control. The study showed that the developed intervention significantly increased both dietary knowledge and adherence levels of the intervention participants, compared to the control group. Such positive outcomes should be considered as a starting point to further integrate similar nutrition programmes in school settings to improve eating habits of children and adolescents, and consequently take a step forward in battling paediatric obesity.

This dissertation has both scientific and practical value, and the lessons learned from Sahtak bi Sahnak may help future researchers and health promoters in improving the overall health of Lebanese adolescents. First, the current intervention is the first nutrition intervention for secondary schools in the Arab world, and the first nutrition intervention based on the IM framework applied in an Arab country. The dissertation provided an insight in the role of IM in developing nutrition intervention implemented in school settings. Researchers and health promoters may consider applying Sahtak bi Sahnak in other Arab countries to improve the eating habits of adolescents and further test its application across the border. Sahtak bi Sahnak resulted in positive outcomes on both dietary knowledge and adherence levels of Lebanese adolescents aged 15 to 18 years old. This intervention represents the cornerstone for future dissemination of nutrition interventions targeting secondary schools in Lebanon and potentially in the region as the material and instruments were culturally adapted and are fully available online in both English and Arabic.

## Impact paragraph

Additionally, the programme can be easily integrated into the Lebanese school setting within the context of the adolescents' natural environment (210). The elaborate protocol and methodology of the intervention development and implementation following all the six steps of Intervention Mapping are published in an open access journal, making them available to researchers and to the general public. Health promoters from other countries may easily modify, duplicate, or adapt the intervention according to the desired setting and context.

Second, the programme was planned to suit Lebanese adolescents living in both urban and rural regions, and enrolled in both public and private schools (reflecting individuals with different socioeconomic statuses) (73). Furthermore, it suits children and adolescents with different nutritional statuses as 18.5% of children and adolescents aged 5 to 19 years were underweight in 2015 (269).

Third, the project resulted in two dietary assessment tools: DKQ and DAQ. Both questionnaires may be used to evaluate the outcomes of nutrition intervention among adolescents and adults, as well as by nutrition professionals and dietitians to evaluate levels of dietary knowledge and adherence. The questionnaires are inexpensive, timesaving compared to other dietary assessment methods such as the 24h recall, and present a low burden on both the participant and interviewer as they do not take more than 20 minutes to complete.

Fourth, as dietary knowledge is a broad topic, the DKQ's sections may help in identifying the areas to focus on and this can guide future nutrition intervention and education strategies, and save time and resources. Similarly, the DAQ can be also used by health promoters and researchers to assess current nutrition adherence for adolescents (and potentially adults) by checking the overall dietary adherence index, looking at the healthy and unhealthy items score, or evaluating the separate DAQ items. This can help in evaluating the overall changes in dietary knowledge and adherence, as well as identifying the concrete problem.

Overall, Sahtak bi Sahnak represents a small step in the thousand miles' journey. It may not end the paediatric obesity in Lebanon overnight, but it is a starting point towards the right direction. The programme empowered adolescents by providing them with the necessary knowledge to make the right food choices and contributed to the general wellness of the society as a whole, knowing that today's adolescents are tomorrow's adults. We hope that the knowledge gained from this research project, in addition to the existing literature and suggested recommendations, helps researchers, health promoters, policy makers, and the Lebanese youth in improving health in the future.





## References

1. WHO. Obesity and overweight 2018 [Available from: <https://www.who.int/en/news-room/fact-sheets/detail/obesity-and-overweight>
2. Merriam-Webster. Obesity 2021 [Available from: <https://www.merriam-webster.com/dictionary/obesity>.
3. Bray GA. Obesity Has Always Been with Us. A Historical Introduction. In: Bray GA, editor. *Handbook of Obesity -- Volume 1: Epidemiology, Etiology, and Physiopathology*. 3rd ed. London: CRC Press; 2014. p. 3-17.
4. Eknoyan G. A History of Obesity, or How What Was Good Became Ugly and Then Bad. *Advances in Chronic Kidney Disease*. 2006;13(4):421-7.
5. Ferrucci L, Studenski SA, Alley DE, Barbagallo M, Harris TB. Obesity in Aging and Art. *The Journals of Gerontology: Series A*. 2009;65A(1):53-6.
6. Valerio G, Maffei C, Saggese G, Ambruzzi MA, Balsamo A, Bellone S, et al. Diagnosis, treatment and prevention of pediatric obesity: consensus position statement of the Italian Society for Pediatric Endocrinology and Diabetology and the Italian Society of Pediatrics. *Italian Journal of Pediatrics*. 2018;44(1):88.
7. Wharton S, Lau DCW, Vallis M, Sharma AM, Biertho L, Campbell-Scherer D, et al. Obesity in adults: a clinical practice guideline. *Canadian Medical Association Journal*. 2020;192(31):E875-E91.
8. Lobstein T, Baur L, Uauy R. Obesity in children and young people: a crisis in public health. *Obesity Reviews*. 2004;5(s1):4-85.
9. Institute of Medicine Committee on Prevention of Obesity in Children and Youth. *The National Academies Collection: Reports funded by National Institutes of Health*. In: Koplan JP, Liverman CT, Kraak VI, editors. *Preventing Childhood Obesity: Health in the Balance*. Washington (DC): National Academies Press (US) Copyright © 2005, National Academy of Sciences.; 2005.
10. World Health Organization. *Taking action on childhood obesity*. Geneva: World Health Organization; 2018. Contract No.: WHO/NMH/PND/ECHO/18.1.
11. NCD-RisC. Worldwide trends in body-mass index, underweight, overweight, and obesity from 1975 to 2016: a pooled analysis of 2416 population-based measurement studies in 128.9 million children, adolescents, and adults. *Lancet*. 2017;390(10113):2627-42.
12. WHO. Prevalence of obesity among children and adolescents, BMI>+2 standard deviation above the median, crude estimates by country, among children aged 5-19 years 2016 [updated 2017. Available from: <http://apps.who.int/gho/data/node.main.BMIPLUS2C?lang=en>.
13. Vanderwall C, Randall Clark R, Eickhoff J, Carrel AL. BMI is a poor predictor of adiposity in young overweight and obese children. *BMC Pediatrics*. 2017;17(1):135.
14. Nihiser AJ, Lee SM, Wechsler H, McKenna M, Odom E, Reinold C, et al. Body mass index measurement in schools. *J Sch Health*. 2007;77(10):651-71; quiz 722-4.
15. Hoelscher DM, Kirk S, Ritchie L, Cunningham-Sabo L. Position of the Academy of Nutrition and Dietetics: Interventions for the Prevention and Treatment of Pediatric Overweight and Obesity. *Journal of the Academy of Nutrition and Dietetics*. 2013;113(10):1375-94.
16. Taylor ED, Theim KR, Mirch MC, Ghorbani S, Tanofsky-Kraff M, Adler-Wailes DC, et al. Orthopedic Complications of Overweight in Children and Adolescents. *Pediatrics*. 2006;117(6):2167-74.
17. Schwimmer JB, Burwinkle TM, Varni JW. Health-Related Quality of Life of Severely Obese Children and Adolescents. *JAMA*. 2003;289(14):1813-9.
18. Must A, Strauss RS. Risks and consequences of childhood and adolescent obesity. *International Journal of Obesity*. 1999;23(2):S2-S11.
19. Hagman E, Besor O, Hershkop K, Santoro N, Pierpont B, Mata M, et al. Relation of the degree of obesity in childhood to adipose tissue insulin resistance. *Acta Diabetol*. 2019;56(2):219-26.
20. Llewellyn A, Simmonds M, Owen CG, Woolacott N. Childhood obesity as a predictor of morbidity in adulthood: a systematic review and meta-analysis. *Obesity reviews : an official journal of the International Association for the Study of Obesity*. 2016;17(1):56-67.

## References

21. Ayer J, Charakida M, Deanfield JE, Celermajer DS. Lifetime risk: childhood obesity and cardiovascular risk. *Eur Heart J*. 2015;36(22):1371-6.
22. Finkelstein EA, Graham WCK, Malhotra R. Lifetime Direct Medical Costs of Childhood Obesity. *Pediatrics*. 2014;133(5):854-62.
23. Lehnert T, Sonntag D, Konnopka A, Riedel-Heller S, König H-H. Economic costs of overweight and obesity. *Best Practice & Research Clinical Endocrinology & Metabolism*. 2013;27(2):105-15.
24. Kilpi F, Webber L, Musaigner A, Aitsi-Selmi A, Marsh T, Rtveldze K, et al. Alarming predictions for obesity and non-communicable diseases in the Middle East. *Public Health Nutrition*. 2014;17(5):1078-86.
25. Rtveldze K, Marsh T, Barquera S, Sanchez Romero LM, Levy D, Melendez G, et al. Obesity prevalence in Mexico: impact on health and economic burden. *Public Health Nutr*. 2014;17(1):233-9.
26. Anderson AS, Key TJ, Norat T, Scoccianti C, Cecchini M, Berrino F, et al. European Code against Cancer 4th Edition: Obesity, body fatness and cancer. *Cancer Epidemiology*. 2015;39:S34-S45.
27. Lim S, Zoellner JM, Lee JM, Burt BA, Sandretto AM, Sohn W, et al. Obesity and Sugar-sweetened Beverages in African-American Preschool Children: A Longitudinal Study. *Obesity*. 2009;17(6):1262-8.
28. Klesges RC, Klesges LM, Eck LH, Shelton ML. A Longitudinal Analysis of Accelerated Weight Gain in Preschool Children. *Pediatrics*. 1995;95(1):126-30.
29. Moore LL, Bradlee ML, Gao D, Singer MR. Low Dairy Intake in Early Childhood Predicts Excess Body Fat Gain. *Obesity*. 2006;14(6):1010-8.
30. Al Junaibi A, Abdulle A, Sabri S, Hag-Ali M, Nagelkerke N. The prevalence and potential determinants of obesity among school children and adolescents in Abu Dhabi, United Arab Emirates. *Int J Obes (Lond)*. 2013;37(1):68-74.
31. Al-Hazaa HM, Abahussain NA, Al-Sobayel HI, Qahwaji DM, Musaiger AO. Lifestyle factors associated with overweight and obesity among Saudi adolescents. *BMC Public Health*. 2012;12(1):354.
32. Toschke AM, Küchenhoff H, Koletzko B, Von Kries R. Meal Frequency and Childhood Obesity. *Obesity research*. 2005;13(11):1932-8.
33. Szajewska H, Ruszczyński M. Systematic Review Demonstrating that Breakfast Consumption Influences Body Weight Outcomes in Children and Adolescents in Europe. *Critical Reviews in Food Science and Nutrition*. 2010;50(2):113-9.
34. Tripicchio GL, Kachurak A, Davey A, Bailey RL, Dabritz LJ, Fisher JO. Associations between Snacking and Weight Status among Adolescents 12–19 Years in the United States. *Nutrients*. 2019;11(7):1486.
35. Flint E, Cummins S. Active commuting and obesity in mid-life: cross-sectional, observational evidence from UK Biobank. *The Lancet Diabetes & Endocrinology*. 2016;4(5):420-35.
36. Ren H, Zhou Z, Liu WK, Wang X, Yin Z. Excessive homework, inadequate sleep, physical inactivity and screen viewing time are major contributors to high paediatric obesity. *Acta Paediatr*. 2017;106(1):120-7.
37. Kremers SP, de Bruijn G-J, Visscher TL, van Mechelen W, de Vries N, Brug J. Environmental influences on energy balance-related behaviors: A dual-process view. *International Journal of Behavioral Nutrition and Physical Activity*. 2006;3(9).
38. Ajzen I. The theory of planned behavior. *Organizational behavior and human decision processes*. 1991;50(2):179-211.
39. Fishbein M. The role of theory in HIV prevention. *AIDS care*. 2000;12(3):273-8.
40. Stok M, Hoffmann S, Volkert D, Boeing H, Ensenaer R, Stelmach-Mardas M, et al. The DONE framework: Creation, evaluation, and updating of an interdisciplinary, dynamic framework 2.0 of determinants of nutrition and eating. *PLOS ONE*. 2017;12(2):e0171077.
41. Bartholomew-Eldredge LK. *Planning health promotion programs : an intervention mapping approach*. San Francisco, CA: Jossey-Bass & Pfeiffer Imprints, Wiley; 2016.
42. Al-Yateem N, Rossiter R. Nutritional knowledge and habits of adolescents aged 9 to 13 years in Sharjah, United Arab Emirates: a cross-sectional study. *East Mediterr Health J*. 2017;23(8):551-8.
43. Kresic G, Kendel Jovanovic G, Pavicic Zesel S, Cvijanovic O, Ivezic G. The effect of nutrition knowledge on dietary intake among Croatian university students. *Collegium antropologicum*. 2009;33(4):1047-56.
44. Wardle J, Parmenter K, Waller J. Nutrition knowledge and food intake. *Appetite*. 2000;34(3):269-75.

45. Menezes MC, Diez Roux AV, Souza Lopes AC. Fruit and vegetable intake: Influence of perceived food environment and self-efficacy. *Appetite*. 2018;127:249-56.
46. Sharma S, Akhtar F, Singh RK, Mehra S. Relationships between nutrition-related knowledge, attitude, and self-efficacy among adolescents: A community-based survey. *Journal of family medicine and primary care*. 2019;8(6):2012-6.
47. El-Kassas G, Itani L, El Ali Z. Obesity risk factors among Beirut Arab university students in Tripoli-Lebanon. *Journal of Nutrition & Food Sciences*. 2015;5(6):1.
48. Swinburn B, Egger G, Raza F. Dissecting Obesogenic Environments: The Development and Application of a Framework for Identifying and Prioritizing Environmental Interventions for Obesity. *Preventive Medicine*. 1999;29(6):563-70.
49. Molaison EF, Connell CL, Stuff JE, Yadrick MK, Bogle M. Influences on fruit and vegetable consumption by low-income black American adolescents. *Journal of nutrition education and behavior*. 2005;37(5):246-51.
50. Viggiano A, Viggiano E, Di Costanzo A, Viggiano A, Andreozzi E, Romano V, et al. Kaledo, a board game for nutrition education of children and adolescents at school: cluster randomized controlled trial of healthy lifestyle promotion. *Eur J Pediatr*. 2015;174(2):217-28.
51. Naja F, Hwalla N, Itani L, Karam S, Sibai AM, Nasreddine L. A Western dietary pattern is associated with overweight and obesity in a national sample of Lebanese adolescents (13-19 years): a cross-sectional study. *The British journal of nutrition*. 2015;114(11):1909-19.
52. Nasreddine L, Naja F, Akl C, Chamieh MC, Karam S, Sibai A-M, et al. Dietary, Lifestyle and Socio-Economic Correlates of Overweight, Obesity and Central Adiposity in Lebanese Children and Adolescents. *Nutrients*. 2014;6(3):1038-62.
53. Nabhani-Zeidan M, Naja F, Nasreddine L. Dietary Intake and Nutrition-Related Knowledge in a Sample of Lebanese Adolescents of Contrasting Socioeconomic Status. *Food and Nutrition Bulletin*. 2011;32(2):75-83.
54. Mandic S, Bengoechea EG, Coppel KJ, Spence JC. Clustering of (Un)Healthy Behaviors in Adolescents from Dunedin, New Zealand. *American Journal of Health Behavior*. 2017;41(3):266-75.
55. Gherasim A, Arhire LI, Niță O, Popa AD, Graur M, Mihalache L. The relationship between lifestyle components and dietary patterns. *Proc Nutr Soc*. 2020;79(3):311-23.
56. Birch LL, Fisher JO, Grimm-Thomas K, Markey CN, Sawyer R, Johnson SL. Confirmatory factor analysis of the Child Feeding Questionnaire: a measure of parental attitudes, beliefs and practices about child feeding and obesity proneness. *Appetite*. 2001;36(3):201-10.
57. Johnson SL, Birch LL. Parents' and Children's Adiposity and Eating Style. *Pediatrics*. 1994;94(5):653-61.
58. Cooke L. The development and modification of children's eating habits. *Nutrition Bulletin*. 2004;29(1):31-5.
59. Scaglioni S, Arizza C, Vecchi F, Tedeschi S. Determinants of children's eating behavior. *The American Journal of Clinical Nutrition*. 2011;94(suppl\_6):2006S-11S.
60. Patrick H, Nicklas TA. A Review of Family and Social Determinants of Children's Eating Patterns and Diet Quality. *Journal of the American College of Nutrition*. 2005;24(2):83-92.
61. Kremers SPJ, Brug J, de Vries H, Engels RCME. Parenting style and adolescent fruit consumption. *Appetite*. 2003;41(1):43-50.
62. Gibbs HD, Kennett AR, Kerling EH, Yu Q, Gajewski B, Ptomey LT, et al. Assessing the Nutrition Literacy of Parents and Its Relationship With Child Diet Quality. *Journal of nutrition education and behavior*. 2016;48(7):505-9.e1.
63. Chari R, Warsh J, Ketterer T, Hossain J, Sharif I. Association between health literacy and child and adolescent obesity. *Patient Education and Counseling*. 2014;94(1):61-6.
64. Johannsen DL, Johannsen NM, Specker BL. Influence of Parents' Eating Behaviors and Child Feeding Practices on Children's Weight Status. *Obesity*. 2006;14(3):431-9.
65. Hayek J, Tueni M, Schneider F, de Vries H. Parenting style as longitudinal predictor of adolescents' health behaviors in Lebanon. *Health Educ Res*. 2021;36(1):100-15.

## References

66. Naja F, Itani L, Hamade R, Chamieh MC, Hwalla N. Mediterranean Diet and Its Environmental Footprints Amid Nutrition Transition: The Case of Lebanon. *Sustainability*. 2019;11(23):6690.
67. Aboul-Enein BH, Bernstein J, Neary AC. Dietary transition and obesity in selected Arabic-speaking countries: a review of the current evidence. *Eastern Mediterranean Health Journal*. 2016;22(10).
68. Salamoun MM, Kizirian AS, Tannous RI, Nabulsi MM, Choucair MK, Deeb ME, et al. Low calcium and vitamin D intake in healthy children and adolescents and their correlates. *European Journal of Clinical Nutrition*. 2005;59(2):177-84.
69. FAO. Nutrition Country Profile - Lebanese Republic 2007.
70. Gonzalez-Suarez C, Worley A, Grimmer-Somers K, Dones V. School-Based Interventions on Childhood Obesity: A Meta-Analysis. *American Journal of Preventive Medicine*. 2009;37(5):418-27.
71. Story M, Kaphingst KM, French S. The role of schools in obesity prevention. *Future Child*. 2006;16(1):109-42.
72. Ardic A, Erdogan S. The effectiveness of the COPE healthy lifestyles TEEN program: a school-based intervention in middle school adolescents with 12-month follow-up. *Journal of Advanced Nursing*. 2017;73(6):1377-89.
73. Habib-Mourad C, Ghandour LA, Moore HJ, Nabhani-Zeidan M, Adetayo K, Hwalla N, et al. Promoting healthy eating and physical activity among school children: findings from Health-E-Pals, the first pilot intervention from Lebanon. *BMC Public Health*. 2014;14(940).
74. Ochoa-Avilés A, Verstraeten R, Huybregts L, Andrade S, Van Camp J, Donoso S, et al. A school-based intervention improved dietary intake outcomes and reduced waist circumference in adolescents: a cluster randomized controlled trial. *Nutrition Journal*. 2017;16(1):79.
75. Jiang J, Xia X, Greiner T, Wu G, Lian G, Rosenqvist U. The effects of a 3-year obesity intervention in schoolchildren in Beijing. *Child Care Health Dev*. 2007;33(5):641-6.
76. CAS, ILO, EU. Labour Force and Household Living Conditions Survey 2018-2019 Lebanon. Beirut; 2020.
77. Centers for Disease Control and Prevention. School Health Guidelines to Promote Healthy Eating and Physical Activity. Atlanta, GA 30333; 2011. Report No.: 60.
78. Arab Center for Nutrition. Abu-Dhabi Declaration to Promote Healthy Nutrition in the Arab Countries 2007 [Available from: <https://www.acnut.com/v/images/stories/pdf/2ea.pdf>].
79. Al-Haifi AR, Al-Fayez MA, Al-Nashi B, Al-Athari BI, Bawadi H, Musaiger AO. Right Diet: a television series to combat obesity among adolescents in Kuwait. *Diabetes Metab Syndr Obes*. 2012;5:205-12.
80. Maatoug J, Msakni Z, Zammit N, Bhiri S, Harrabi I, Boughammoura L. School-Based Intervention as a Component of a Comprehensive Community Program for Overweight and Obesity Prevention, Sousse, Tunisia, 2009-2014. *Preventing Chronic Disease*. 2015;12:E160.
81. Boodai SA, McColl JH, Reilly JJ. National Adolescent Treatment Trial for Obesity in Kuwait (NATTO): project design and results of a randomised controlled trial of a good practice approach to treatment of adolescent obesity in Kuwait. *Trials*. 2014;15(1):234.
82. Kebaili R, Harrabi I, Maatoug J, Ghammam R, Slim S, Ghannem H. School-based intervention to promote healthy nutrition in Sousse, Tunisia. *Int J Adolesc Med Health*. 2014;26(2):253-8.
83. Hassan N, Zaki S, El-Masry S, Mohsen MA, Elashmawy E, editors. Impact of Balanced Caloric Diet and Physical Activity on Body Composition and Fat Distribution of Obese Egyptian Adolescent Girls 2011.
84. Bani Salameh A, Al-sheyab N, El-hneiti M, Shaheen A, Williams LM, Gallagher R. Effectiveness of a 12-week school-based educational preventive programme on weight and fasting blood glucose in "at-risk" adolescents of type 2 diabetes mellitus: Randomized controlled trial. *International Journal of Nursing Practice*. 2017;23(3):e12528.
85. Stanley ZD, Asfour LW, Weitzman M, Sherman SE. Implementation of a peer-mediated health education model in the United Arab Emirates: addressing risky behaviours among expatriate adolescents. *East Mediterr Health J*. 2017;23(7):480-5.
86. Selmi S, Daghsh G, Mathis S, Nahas K, Wilbur K. A program for obese youth at-risk for diabetes in Qatar. *Avicenna*. 2015;2015(1).

87. Ghammam R, Maatoug J, Zammit N, Kebaili R, Boughammoura L, Al'Absi M, et al. Long term effect of a school based intervention to prevent chronic diseases in Tunisia, 2009-2015. *Afr Health Sci.* 2017;17(4):1137-48.
88. Habib-Mourad C, Ghandour LA, Maliha C, Awada N, Dagher M, Hwalla N. Impact of a one-year school-based teacher-implemented nutrition and physical activity intervention: main findings and future recommendations. *BMC public health.* 2020;20(1):1-7.
89. Habib-Mourad C, Ghandour LA, Maliha C, Dagher M, Kharroubi S, Hwalla N. Impact of a Three-Year Obesity Prevention Study on Healthy Behaviors and BMI among Lebanese Schoolchildren: Findings from Ajyal Salima Program. *Nutrients.* 2020;12(9):2687.
90. Center for Educational Research and Development. Statistical bulletin for the academic year 2017-2018. Center for Educational Research and Development; 2018.
91. Brug J, Oenema A, Ferreira I. Theory, evidence and Intervention Mapping to improve behavior nutrition and physical activity interventions. *International Journal of Behavioral Nutrition and Physical Activity.* 2005;2(1):2.
92. Garba RM, Gadanya MA. The role of intervention mapping in designing disease prevention interventions: A systematic review of the literature. *PLOS ONE.* 2017;12(3):e0174438.
93. Ten Hoor GA, Kok G, Rutten GM, Ruiters RAC, Kremers SPJ, Schols AMJW, et al. The Dutch 'Focus on Strength' intervention study protocol: programme design and production, implementation and evaluation plan. *BMC Public Health.* 2016;16(1):496.
94. van Nassau F, Singh AS, van Mechelen W, Brug J, Chin APMJ. In preparation of the nationwide dissemination of the school-based obesity prevention program DOiT: stepwise development applying the intervention mapping protocol. *J Sch Health.* 2014;84(8):481-92.
95. Fassier JB, Lamort-Bouche M, Sarnin P, Durif-Bruckert C, Peron J, Letrilliart L, et al. [The intervention mapping protocol: A structured process to develop, implement and evaluate health promotion programs]. *Revue d'épidémiologie et de sante publique.* 2016;64(1):33-44.
96. Hosking JD, Newhouse MM, Bagniewska A, Hawkins BS. Data collection and transcription. *Controlled Clinical Trials.* 1995;16(2, Supplement):66-103.
97. Gleason PM, Harris J, Sheean PM, Boushey CJ, Bruemmer B. Publishing Nutrition Research: Validity, Reliability, and Diagnostic Test Assessment in Nutrition-Related Research. *Journal of the American Dietetic Association.* 2010;110(3):409-19.
98. Choi BCK, Pak AWP. A catalog of biases in questionnaires. *Preventing chronic disease.* 2004;2(1):A13-A.
99. Trakman GL, Forsyth A, Hoyer R, Belski R. Developing and validating a nutrition knowledge questionnaire: key methods and considerations. *Public Health Nutrition.* 2017;20(15):2670-9.
100. Parmenter K, Wardle J. Development of a general nutrition knowledge questionnaire for adults. *European Journal of Clinical Nutrition.* 1999;53:298-308.
101. Portney LG. *Foundations of clinical research: applications to evidence-based practice*: FA Davis; 2020.
102. Hardy L, King L, Espinel P, Cosgrove C, Bauman A. NSW Schools Physical Activity and Nutrition Survey (SPANS): Short Report. Sydney: NSW Ministry of Health; 2010.
103. Institute of Medicine. *Dietary Reference Intakes: Applications in Dietary Assessment*. Washington, DC: The National Academies Press; 2000. 305 p.
104. Stewart L. Obesity. In: Shaw V, editor. *Clinical paediatric dietetics*. 4th ed. ed. West Sussex, PO19 8SQ, UK: John Wiley & Sons, Ltd; 2015. p. 798-808.
105. Gungor NK. Overweight and obesity in children and adolescents. *Journal of clinical research in pediatric endocrinology.* 2014;6(3):129-43.
106. Yanovski JA. Pediatric obesity. An introduction. *Appetite.* 2015;93:3-12.
107. Musaiger AO, Hassan AS, Obeid O. The Paradox of Nutrition-Related Diseases in the Arab Countries: The Need for Action. *International Journal of Environmental Research and Public Health.* 2011;8(9):3637.
108. Kremers SPJ, Visscher TLS, Seidell JC, van Mechelen W, Brug J. Cognitive Determinants of Energy Balance-Related Behaviours. *Sports Medicine.* 2005;35(11):923-33.

## References

109. Bixby H, Bentham J, Zhou B, Di Cesare M, Paciorek CJ, Bennett JE, et al. Rising rural body-mass index is the main driver of the global obesity epidemic in adults. *Nature*. 2019;569(7755):260-4.
110. Yadav K, Krishnan A. Changing patterns of diet, physical activity and obesity among urban, rural and slum populations in north India. *Obesity reviews : an official journal of the International Association for the Study of Obesity*. 2008;9(5):400-8.
111. Gidding SS, Dennison BA, Birch LL, Daniels SR, Gilman MW, Lichtenstein AH, et al. Dietary Recommendations for Children and Adolescents A Guide for Practitioners: Consensus Statement From the American Heart Association. *Circulation*. 2005;112(13):2061-75.
112. Batis C, Aburto TC, Sanchez-Pimienta TG, Pedraza LS, Rivera JA. Adherence to Dietary Recommendations for Food Group Intakes Is Low in the Mexican Population. *The Journal of nutrition*. 2016;146(9):1897s-906s.
113. Milosavljević D, Mandić ML, Banjari I. Nutritional knowledge and dietary habits survey in high school population. *Collegium antropologicum*. 2015;39(1):101-7.
114. Argolo D, Borges J, Cavalcante A, Silva G, Maia S, Moraes A, et al. Poor dietary intake and low nutritional knowledge in adolescent and adult competitive athletes: a warning to table tennis players. *Nutricion hospitalaria*. 2018;35(5):1124-30.
115. Story M, Neumark-Sztainer D, French S. Individual and Environmental Influences on Adolescent Eating Behaviors. *Journal of the American Dietetic Association*. 2002;102(3, Supplement):S40-S51.
116. Ball GDC, Mushquash AR, Keaschuk RA, Ambler KA, Newton AS. Using Intervention Mapping to develop the Parents as Agents of Change (PAC©) intervention for managing pediatric obesity. *BMC Research Notes*. 2017;10(1):43.
117. Romanos-Nanclares A, Zazpe I, Santiago S, Marin L, Rico-Campa A, Martin-Calvo N. Influence of Parental Healthy-Eating Attitudes and Nutritional Knowledge on Nutritional Adequacy and Diet Quality among Preschoolers: The SENDO Project. *Nutrients*. 2018;10(12).
118. McPherson RS, Hoelscher DM, Alexander M, Scanlon KS, Serdula MK. Dietary Assessment Methods among School-Aged Children: Validity and Reliability. *Preventive Medicine*. 2000;31(2):S11-S33.
119. Wilson A, Magarey A, Mastersson N. Reliability of Questionnaires to Assess the Healthy Eating and Activity Environment of a Child's Home and School. *Journal of Obesity*. 2013;2013:720368.
120. World Health O. Foodborne disease outbreaks : guidelines for investigation and control. Geneva: World Health Organization; 2008.
121. Sapp SG, Jensen HH. Reliability and Validity of Nutrition Knowledge and Diet-Health Awareness Tests Developed from the 1989–1991 Diet and Health Knowledge Surveys. *Journal of Nutrition Education*. 1997;29(2):63-72.
122. Kothari C. Research methodology: Methods and techniques. 2nd ed: New Delhi: New Age International; 2004.
123. Guillemin F, Bombardier C, Beaton D. Cross-cultural adaptation of health-related quality of life measures: Literature review and proposed guidelines. *Journal of Clinical Epidemiology*. 1993;46(12):1417-32.
124. Quaidoo EY, Ohemeng A, Amankwah-Poku M. Sources of nutrition information and level of nutrition knowledge among young adults in the Accra metropolis. *BMC Public Health*. 2018;18(1):1323.
125. Jordao LMR, Malta DC, Freire M. Clustering patterns of oral and general health-risk behaviours in Brazilian adolescents: Findings from a national survey. *Community dentistry and oral epidemiology*. 2018;46(2):194-202.
126. Hinds JT, 3rd, Loukas A, Chow S, Pasch KE, Harrell MB, Perry CL, et al. Using Cognitive Interviewing to Better Assess Young Adult E-cigarette Use. *Nicotine & tobacco research : official journal of the Society for Research on Nicotine and Tobacco*. 2016;18(10):1998-2005.
127. Miller K. Cognitive interviewing methodology. 2014.
128. Center for Educational Research and Development. Statistical bulletin for the academic year 2016-2017. Center for Educational Research and Development; 2017.
129. Hulley SB, Cummings SR, Browner WS, Grady D, Newman TB. Designing Clinical Research. Philadelphia: LWW; 2013.

130. Asaad G, Sadegian M, Lau R, Xu Y, Soria-Contreras DC, Bell RC, et al. The Reliability and Validity of the Perceived Dietary Adherence Questionnaire for People with Type 2 Diabetes. *Nutrients*. 2015;7(7):5484-96.
131. Portney LG, Watkins MP. *Foundations of Clinical Research: Applications to Practice*: F. A. Davis Company; 2015.
132. Shepherd J, Harden A, Rees R, Brunton G, Garcia J, Oliver S, et al. Young people and healthy eating: a systematic review of research on barriers and facilitators. *Health Education Research*. 2005;21(2):239-57.
133. Hoelscher DM, Day RS, Kelder SH, Ward JL. Reproducibility and validity of the secondary level School-Based Nutrition Monitoring student questionnaire. *Journal of the American Dietetic Association*. 2003;103(2):186-94.
134. Habib-Mourad C, Ghandour LA. Time to Act: Lessons Learnt from the First Pilot School-Based Intervention Study from Lebanon to Prevent and Reduce Childhood Obesity. *Frontiers in public health*. 2015;3(56).
135. Itani L, Chatila H, Dimassi H, El Sahn F. Development and validation of an Arabic questionnaire to assess psychosocial determinants of eating behavior among adolescents: a cross-sectional study. *Journal of Health, Population and Nutrition*. 2017;36(1):10.
136. Wong JE, Parnell WR, Howe AS, Black KE, Skidmore PML. Development and validation of a food-based diet quality index for New Zealand adolescents. *BMC public health*. 2013;13:562-.
137. Grosso G, Mistretta A, Turconi G, Cena H, Roggi C, Galvano F. Nutrition knowledge and other determinants of food intake and lifestyle habits in children and young adolescents living in a rural area of Sicily, South Italy. *Public Health Nutrition*. 2013;16(10):1827-36.
138. Scaglioni S, Salvioni M, Galimberti C. Influence of parental attitudes in the development of children eating behaviour. *British Journal of Nutrition*. 2008;99(S1):S22-S5.
139. Oldewage-Theron W, Egal A, Moroka T. Nutrition knowledge and dietary intake of adolescents in Cofimvaba, Eastern Cape, South Africa. *Ecology of food and nutrition*. 2015;54(2):138-56.
140. National Academies of Sciences E, and Medicine. *The Promise of Adolescence: Realizing Opportunity for All Youth*. Washington, DC; 2019.
141. WHO. *Report of the commission on ending childhood obesity*. Switzerland World Health Organization 2016.
142. Alberga AS, Sigal RJ, Goldfield G, Prud'homme D, Kenny GP. Overweight and obese teenagers: why is adolescence a critical period? *Pediatric obesity*. 2012;7(4):261-73.
143. Gevers DW, Kremers SP, de Vries NK, van Assema P. Intake of energy-dense snack foods and drinks among Dutch children aged 7-12 years: how many, how much, when, where and which? *Public Health Nutr*. 2016;19(1):83-92.
144. Said L, Gubbels JS, Kremers SPJ. Development of Dietary Knowledge and Adherence Questionnaires for Lebanese Adolescents and Their Parents. *International Journal of Environmental Research and Public Health*. 2019;17(1):147.
145. Bartlett J, Kotrlik J, Higgins C. *Organizational Research: Determining Appropriate Sample Size in Survey Research*. *Information Technology, Learning, and Performance Journal*. 2001;19(1).
146. Institute of Medicine. *Dietary Reference Intakes for Water, Potassium, Sodium, Chloride, and Sulfate*. Washington, DC: The National Academies Press; 2005. 638 p.
147. Lee R, Nieman D. *Nutritional Assessment*. 6th ed: McGraw-Hill Higher Education; 2012.
148. Shaw V. *Clinical paediatric dietetics*. 2015.
149. Anderson LN, Carsley S, Lebovic G, Borkhoff CM, Maguire JL, Parkin PC, et al. Misclassification of child body mass index from cut-points defined by rounded percentiles instead of Z-scores. *BMC Res Notes*. 2017;10(1):639.
150. Must A, Anderson SE. Body mass index in children and adolescents: considerations for population-based applications. *International Journal of Obesity*. 2006;30(4):590-4.
151. de Onis M, Onyango AW, Borghi E, Siyam A, Nishida C, Siekmann J. Development of a WHO growth reference for school-aged children and adolescents. *Bull World Health Organ*. 2007;85(9):660-7.
152. Becker P, Carney LN, Corkins MR, Monczka J, Smith E, Smith SE, et al. Consensus statement of the Academy of Nutrition and Dietetics/American Society for Parenteral and Enteral Nutrition: indicators

## References

- recommended for the identification and documentation of pediatric malnutrition (undernutrition). *Nutr Clin Pract.* 2015;30(1):147-61.
153. Field A. *Discovering Statistics Using IBM SPSS Statistics*: SAGE Publications; 2013.
154. Al-Yateem N RR. Nutritional knowledge and habits of adolescents aged 9 to 13 years in Sharjah, United Arab Emirates: a cross-sectional study.
155. Zarnowiecki D, Sinn N, Petkov J, Dollman J. Parental nutrition knowledge and attitudes as predictors of 5-6-year-old children's healthy food knowledge. *Public Health Nutr.* 2012;15(7):1284-90.
156. Horta PM, Verly Junior E, Santos LCD. Usual diet quality among 8- to 12-year-old Brazilian children. *Cad Saude Publica.* 2019;35(2):e00044418.
157. Kovacs E, Siani A, Konstabel K, Hadjigeorgiou C, de Bourdeaudhuij I, Eiben G, et al. Adherence to the obesity-related lifestyle intervention targets in the IDEFICS study. *Int J Obes (Lond).* 2014;38 Suppl 2:S144-51.
158. Wong JE, Skidmore PM, Williams SM, Parnell WR. Healthy dietary habits score as an indicator of diet quality in New Zealand adolescents. *The Journal of nutrition.* 2014;144(6):937-42.
159. Al Thani M, Al Thani AA, Al-Chetachi W, Al Malki B, Khalifa SAH, Bakri AH, et al. Adherence to the Qatar dietary guidelines: a cross-sectional study of the gaps, determinants and association with cardiometabolic risk amongst adults. *BMC Public Health.* 2018;18(1):503.
160. Alkhalidy AA, Aljahdli ES, Mosli MH, Jawa HA, Alsahafi MA, Qari YA. Adherence to the Saudi dietary guidelines and its relation to colorectal polyps: A university hospital-based study. *J Taibah Univ Med Sci.* 2020;15(1):25-31.
161. Abu Baker NN, Daradkeh SM. Prevalence of overweight and obesity among adolescents in Irbid governorate, Jordan. *East Mediterr Health J.* 2010;16(6):657-62.
162. Aounallah-Skhiri H, Romdhane HB, Traissac P, Eymard-Duvernay S, Delpuech F, Achour N, et al. Nutritional status of Tunisian adolescents: associated gender, environmental and socio-economic factors. *Public Health Nutrition.* 2008;11(12):1306-17.
163. Fernandez A, Martínez R. *The Cost of the Double Burden of Malnutrition: Social and Economic Impact - Summary of the Pilot Study in Chile, Ecuador and Mexico*. Research, reports and studies. World Food Programme; 2017.
164. El-Nmer F, Salama A, Elhawary D. Nutritional knowledge, attitude, and practice of parents and its impact on growth of their children. *Menoufia Medical Journal.* 2014;27(3):612-6.
165. Savage JS, Fisher JO, Birch LL. Parental influence on eating behavior: conception to adolescence. *J Law Med Ethics.* 2007;35(1):22-34.
166. Subih HS, Abu-Shquier Y, Bawadi H, Al-Bayyari N. Assessment of body weight, maternal dietary knowledge and lifestyle practices among children and adolescents in north Jordan. *Public Health Nutrition.* 2018;21(15):2803-10.
167. Maia EG, Silva L, Santos MAS, Barufaldi LA, Silva SUD, Claro RM. Dietary patterns, sociodemographic and behavioral characteristics among Brazilian adolescents. *Rev Bras Epidemiol.* 2018;21(suppl 1):e180009.
168. Hruby A, Hu FB. The Epidemiology of Obesity: A Big Picture. *Pharmacoeconomics.* 2015;33(7):673-89.
169. WHO. *Report of the Commission on Ending Childhood Obesity: implementation plan: executive summary*. Geneva; 2017. Report No.: WHO/NMH/PND/ECHO/17.1.
170. Styne DM, Arslanian SA, Connor EL, Farooqi IS, Murad MH, Silverstein JH, et al. Pediatric Obesity-Assessment, Treatment, and Prevention: An Endocrine Society Clinical Practice Guideline. *J Clin Endocrinol Metab.* 2017;102(3):709-57.
171. CAS., UNICEF. *Multiple-Indicators Cluster Survey 3 Lebanon*. Beirut, Lebanon: Central Administration of Statistics and UNICEF, 2009; والأطفال ماء.
172. Kok G, Schaalma H, Ruiters RA, van Empelen P, Brug J. Intervention mapping: protocol for applying health psychology theory to prevention programmes. *Journal of health psychology.* 2004;9(1):85-98.
173. Bartholomew LK, Parcel GS, Kok G. *Intervention Mapping: A Process for Developing Theory and Evidence-Based Health Education Programs*. *Health Education & Behavior.* 1998;25(5):545-63.

174. Ogden CL, Flegal KM. Changes in terminology for childhood overweight and obesity. *Natl Health Stat Report*. 2010(25):1-5.
175. Nasreddine L, Naja F, Chamieh MC, Adra N, Sibai A-M, Hwalla N. Trends in overweight and obesity in Lebanon: evidence from two national cross-sectional surveys (1997 and 2009). *BMC public health*. 2012;12:798-.
176. Chacar HR, Salameh P. Public schools adolescents' obesity and growth curves in Lebanon. *Le Journal medical libanais The Lebanese medical journal*. 2011;59(2):80-8.
177. Wen Ng S, Zaghoul S, Ali H, Harrison G, Yeatts K, El S, Mohamed, et al. Nutrition transition in the United Emirates (UAE). *Eur J Clin Nutr*. 2011;65(12):1328-37.
178. Must A, Jacques PF, Dallal GE, Bajema CJ, Dietz WH. Long-Term Morbidity and Mortality of Overweight Adolescents. *New England Journal of Medicine*. 1992;327(19):1350-5.
179. Wang D, Stewart D. The implementation and effectiveness of school-based nutrition promotion programmes using a health-promoting schools approach: a systematic review. *Public Health Nutr*. 2013;16(6):1082-100.
180. Stok F, Renner B, Clarys P, Lien N, Lakerveld J, Deliëns T. Understanding Eating Behavior during the Transition from Adolescence to Young Adulthood: A Literature Review and Perspective on Future Research Directions. *Nutrients*. 2018;10(6).
181. Sallis JF, Prochaska JJ, Taylor WC. A review of correlates of physical activity of children and adolescents. *Medicine and science in sports and exercise*. 2000;32(5):963-75.
182. Condello G, Ling FC, Bianco A, Chastin S, Cardon G, Ciarapica D, et al. Using concept mapping in the development of the EU-PAD framework (EUropean-Physical Activity Determinants across the life course): a DEDIPAC-study. *BMC Public Health*. 2016;16(1):1145.
183. Mozaffarian D. Dietary and Policy Priorities for Cardiovascular Disease, Diabetes, and Obesity. *Circulation*. 2016;133(2):187-225.
184. Ruiters RAC, Crutzen R. Core Processes: How to Use Evidence, Theories, and Research in Planning Behavior Change Interventions. *Frontiers in public health*. 2020;8(247).
185. Gleason BL, Peeters MJ, Resman-Targoff BH, Karr S, McBane S, Kelley K, et al. An Active-Learning Strategies Primer for Achieving Ability-Based Educational Outcomes. *American Journal of Pharmaceutical Education*. 2011;75(9):186.
186. Bandura A. Health promotion from the perspective of social cognitive theory. *Psychology and Health* 1998;13:623-49.
187. Jackson C. Behavioral science theory and principles for practice in health education. *Health Education Research*. 1997;12(1):143-50.
188. Glanz K, Rimer BK, Viswanath K. *Health Behavior and Health Education: Theory, Research, and Practice*. Glanz K, Rimer BK, Viswanath K, editors: Wiley; 2008. xxxiii, 552-xxxiii, p.
189. Glanz K, Schwartz MD. *Stress, Coping, and Health Behavior* In: Glanz K, Rimer BK, Viswanath K, editors. *Health Behavior and Health Education: Theory, Research, and Practice*. 4th ed. San Francisco Wiley; 2008.
190. Bouton ME. A learning theory perspective on lapse, relapse, and the maintenance of behavior change. *Health Psychology*. 2000;19(1, Suppl):57-63.
191. Prochaska J, Redding C, Evers K. THE TRANSTHEORETICAL MODEL AND STAGES OF CHANGE. In: Glanz K, Rimer B, Viswanath K, editors. *Health behavior and health education : theory, research, and practice*. 4th ed: Jossey-Bass A Wiley Imprint; 2008.
192. Bandura A. Social Cognitive Theory: An Agentic Perspective. *Asian Journal of Social Psychology*. 1999;2(1):21-41.
193. Bandura A. Health Promotion by Social Cognitive Means. *Health Education & Behavior*. 2004;31(2):143-64.
194. Prochaska JO, DiClemente CC, Norcross JC. In search of how people change. Applications to addictive behaviors. *Am Psychol*. 1992;47(9):1102-14.

## References

195. Briggs M, Fleischhacker S, Mueller CG. Position of the American Dietetic Association, School Nutrition Association, and Society for Nutrition Education: Comprehensive School Nutrition Services. *Journal of Nutrition Education and Behavior*. 2010;42(6):360-71.
196. Polivy J, Herman CP. Causes of eating disorders. *Annual review of psychology*. 2002;53(1):187-213.
197. Van Cauwenberghe E, Maes L, Spittaels H, van Lenthe FJ, Brug J, Oppert JM, et al. Effectiveness of school-based interventions in Europe to promote healthy nutrition in children and adolescents: systematic review of published and 'grey' literature. *The British journal of nutrition*. 2010;103(6):781-97.
198. Bergström H, Haggård U, Norman Å, Sundblom E, Schäfer Elinder L, Nyberg G. Factors influencing the implementation of a school-based parental support programme to promote health-related behaviours--interviews with teachers and parents. *BMC public health*. 2015;15:541-.
199. Nollen NL, Befort CA, Snow P, Daley CM, Ellerbeck EF, Ahluwalia JS. The school food environment and adolescent obesity: qualitative insights from high school principals and food service personnel. *Int J Behav Nutr Phys Act*. 2007;4:18.
200. van den Berg V, Salimi R, de Groot RHM, Jolles J, Chinapaw MJM, Singh AS. "It's a Battle... You Want to Do It, but How Will You Get It Done?": Teachers' and Principals' Perceptions of Implementing Additional Physical activity in School for Academic Performance. *Int J Environ Res Public Health*. 2017;14(10).
201. Townsend N, Williams J, Wickramasinghe K, Karunaratne W, Olupeliyawa A, Manoharan S, et al. Barriers to healthy dietary choice amongst students in Sri Lanka as perceived by school principals and staff. *Health promotion international*. 2017;32(1):91-101.
202. Atkins L, Francis J, Islam R, O'Connor D, Patey A, Ivers N, et al. A guide to using the Theoretical Domains Framework of behaviour change to investigate implementation problems. *Implementation Science*. 2017;12(1):77.
203. Bessems KMH, van Assema P, de Vries NK, Paulussen TWGM. Exploring determinants of completeness of implementation and continuation of a Dutch school-based healthy diet promotion programme. *International Journal of Health Promotion and Education*. 2014;52(6):315-27.
204. Durlak JA, DuPre EP. Implementation matters: a review of research on the influence of implementation on program outcomes and the factors affecting implementation. *Am J Community Psychol*. 2008;41(3-4):327-50.
205. Hurley DA, Murphy LC, Hayes D, Hall AM, Toomey E, McDonough SM, et al. Using intervention mapping to develop a theory-driven, group-based complex intervention to support self-management of osteoarthritis and low back pain (SOLAS). *Implementation Science*. 2016;11(1):56.
206. Boyle MA, Holben DH. *Community nutrition in action: an entrepreneurial approach*. 6th ed: Cengage Learning; 2012.
207. Gibson RS. *Principles of nutritional assessment*. New York: Oxford University Press; 1990.
208. Wisdom J, Creswell J. *Mixed Methods: Integrating Quantitative and Qualitative Data Collection and Analysis While Studying Patient-Centered Medical Home Models*, Rockville, MD: Agency for Healthcare Research and Quality, AHRQ Publication No. 13-0028-EF. Rockville, MD: Agency for Healthcare Research and Quality; 2013. Contract No.: AHRQ Publication No. 13-0028-EF.
209. Kwak L, Kremers SP, Werkman A, Visscher TL, van Baak MA, Brug J. The NHF-NRG In Balance-project: the application of Intervention Mapping in the development, implementation and evaluation of weight gain prevention at the worksite. *Obesity reviews : an official journal of the International Association for the Study of Obesity*. 2007;8(4):347-61.
210. Hoelscher DM, Evans A, Parcel G, Kelder S. Designing Effective Nutrition Interventions for Adolescents. *Journal of the American Dietetic Association*. 2002;102(3, Supplement):S52-S63.
211. Gracey D, Stanley N, Burke V, Corti B, Beilin LJ. Nutritional knowledge, beliefs and behaviours in teenage school students. *Health Education Research*. 1996;11(2):187-204.
212. Somerset S, Markwell K. Impact of a school-based food garden on attitudes and identification skills regarding vegetables and fruit: a 12-month intervention trial. *Public Health Nutr*. 2009;12(2):214-21.
213. Mann CM, Ward DS, Vaughn A, Benjamin Neelon SE, Long Vidal LJ, Omar S, et al. Application of the Intervention Mapping protocol to develop Keys, a family child care home intervention to prevent early childhood obesity. *BMC Public Health*. 2015;15(1):1227.

214. Stea TH, Haugen T, Berntsen S, Guttormsen V, Øverby NC, Haraldstad K, et al. Using the Intervention Mapping protocol to develop a family-based intervention for improving lifestyle habits among overweight and obese children: study protocol for a quasi-experimental trial. *BMC Public Health*. 2016;16(1):1092.
215. Linnan L, Steckler A. *Process evaluation for public health interventions and research*: Jossey-Bass San Francisco; 2002.
216. Jones RA, Lubans DR, Morgan PJ, Okely AD, Parletta N, Wolfenden L, et al. School-based obesity prevention interventions: Practicalities and considerations. *Obesity Research & Clinical Practice*. 2014;8(5):e497-e510.
217. Kelsey MM, Zaepfel A, Bjornstad P, Nadeau KJ. Age-Related Consequences of Childhood Obesity. *Gerontology*. 2014;60(3):222-8.
218. WHO. *Report of the Commission on Ending Childhood Obesity: implementation plan: executive summary*. Geneva: World Health Organization; 2017. Contract No.: WHO/NMH/PND/ECHO/17.1.
219. Dreyhaupt J, Mayer B, Keis O, Öchsner W, Muche R. Cluster-randomized Studies in Educational Research: Principles and Methodological Aspects. *GMS J Med Educ*. 2017;34(2):Doc26-Doc.
220. Chenot J-F. Cluster-randomisierte Studien: eine wichtige Methode in der allgemeinmedizinischen Forschung. *Zeitschrift für Evidenz, Fortbildung und Qualität im Gesundheitswesen*. 2009;103(7):475-80.
221. Said L, Schneider F, Kremers SPJ, Gubbels JS. Application of the Intervention Mapping Protocol to Develop Sahtak bi Sahnak, a School-Based Intervention to Prevent Pediatric Obesity among Lebanese Adolescents. *Health Psychology Bulletin*. 2021;5(1):20-38.
222. Said L, Gubbels JS, Kremers SPJ. Dietary Knowledge, Dietary Adherence, and BMI of Lebanese Adolescents and Their Parents. *Nutrients*. 2020;12(8):2398.
223. Oldewage-Theron WH, Egal A. The evaluation of a nutrition education programme on the nutrition knowledge of children aged six and seven years. *Journal of Consumer Sciences*. 2009;37.
224. Livingston EH, Cassidy L. Statistical power and estimation of the number of required subjects for a study based on the t-test: a surgeon's primer. *J Surg Res*. 2005;126(2):149-59.
225. Heagerty P, DeLong E. *Experimental Designs and Randomization Schemes: Cluster Randomized Trials* Bethesda, MD: NIH Health Care Systems Research Collaboratory; [updated July 21, 2020. *Rethinking Clinical Trials: A Living Textbook of Pragmatic Clinical Trials*: [Available from: <https://rethinkingclinicaltrials.org/chapters/design/experimental-designs-randomization-schemes-top/cluster-randomized-trials/>].
226. Ursachi G, Horodnic IA, Zait A. How Reliable are Measurement Scales? External Factors with Indirect Influence on Reliability Estimators. *Procedia Economics and Finance*. 2015;20:679-86.
227. Shah P, Misra A, Gupta N, Hazra DK, Gupta R, Seth P, et al. Improvement in nutrition-related knowledge and behaviour of urban Asian Indian school children: findings from the 'Medical education for children/Adolescents for Realistic prevention of obesity and diabetes and for healthy ageing' (MARG) intervention study. *British Journal of Nutrition*. 2010;104(3):427-36.
228. Naja F, Hwalla N, Fossian T, Zebian D, Nasreddine L. Validity and reliability of the Arabic version of the Household Food Insecurity Access Scale in rural Lebanon. *Public Health Nutrition*. 2015;18(2):251-8.
229. Kok G, Lo SH, Peters G-JY, Ruiter RAC. Changing energy-related behavior: An Intervention Mapping approach. *Energy Policy*. 2011;39(9):5280-6.
230. Suresh K. An overview of randomization techniques: An unbiased assessment of outcome in clinical research. *J Hum Reprod Sci*. 2011;4(1):8-11.
231. WHO. *Prevalence of obesity among children and adolescents, BMI>+2 standard deviation above the median, crude Estimates by country, among children aged 10-19 years 2017* [updated 2017. Available from: <https://apps.who.int/gho/data/view.main.BMIPLUS2C10-19v?lang=en>.
232. WHO. *Prevalence of overweight among children and adolescents, BMI>+1 standard deviation above the median, crude Estimates by country, among children aged 10-19 years 2017* [updated 2017. Available from: <https://apps.who.int/gho/data/view.main.BMIPLUS1C10-19v?lang=en>.
233. Nani MO. *Relationship between nutrition knowledge and food intake of college students*: Kent State University; 2016.

## References

234. Asakura K, Todoriki H, Sasaki S. Relationship between nutrition knowledge and dietary intake among primary school children in Japan: Combined effect of children's and their guardians' knowledge. *J Epidemiol.* 2017;27(10):483-91.
235. Zahid A, Davey C, Reicks M. Beverage Intake among Children: Associations with Parent and Home-Related Factors. *International journal of environmental research and public health.* 2017;14(8):929.
236. Seifert SM, Schaechter JL, Hershorin ER, Lipshultz SE. Health Effects of Energy Drinks on Children, Adolescents, and Young Adults. *Pediatrics.* 2011;127(3):511-28.
237. Institute of Medicine. Dietary Reference Intakes for Calcium and Vitamin D. Ross AC, Taylor CL, Yaktine AL, Del Valle HB, editors. Washington, DC: The National Academies Press; 2011. 1132 p.
238. Bandura A. Health promotion from the perspective of social cognitive theory. *Psychology and health.* 1998;13(4):623-49.
239. Smith KJ, McNaughton SA, Gall SL, Blizzard L, Dwyer T, Venn AJ. Takeaway food consumption and its associations with diet quality and abdominal obesity: a cross-sectional study of young adults. *International Journal of Behavioral Nutrition and Physical Activity.* 2009;6(1):29.
240. Burke SJ, McCarthy SN, O'Neill JL, Hannon EM, Kiely M, Flynn A, et al. An examination of the influence of eating location on the diets of Irish children. *Public Health Nutrition.* 2007;10(6):599-607.
241. PLOS. Benefits of Open. When science becomes more Open, we all advance. n.d. [Available from: <https://plos.org/open-science/why-open-access/>].
242. Althubaiti A. Information bias in health research: definition, pitfalls, and adjustment methods. *Journal of multidisciplinary healthcare.* 2016;9:211-7.
243. OECD. Methodological considerations OECD Guidelines on Measuring Trust. Paris: OECD Publishing; 2017.
244. Pérez Rodrigo C, Aranceta J, Salvador G, Varela-Moreiras G. Food frequency questionnaires. *Nutricion hospitalaria.* 2015;31 Suppl 3:49-56.
245. Pellett PL, Shadarevian S. Food composition; tables for use in the Middle East. Beirut: American University of Beirut; 1970.
246. U.S.D.A. FoodData Central. In: U.S.D.A. ARS, editor. 2019.
247. Vance VA, Woodruff SJ, McCargar LJ, Husted J, Hanning RM. Self-reported dietary energy intake of normal weight, overweight and obese adolescents. *Public Health Nutrition.* 2009;12(2):222-7.
248. Black AE, Goldberg GR, Jebb SA, Livingstone MB, Cole TJ, Prentice AM. Critical evaluation of energy intake data using fundamental principles of energy physiology: 2. Evaluating the results of published surveys. *Eur J Clin Nutr.* 1991;45(12):583-99.
249. Haraldsdóttir J, Tjønneland A, Overvad K. Validity of individual portion size estimates in a food frequency questionnaire. *Int J Epidemiol.* 1994;23(4):786-96.
250. Britten P, Marcoe K, Yamini S, Davis C. Development of food intake patterns for the MyPyramid Food Guidance System. *J Nutr Educ Behav.* 2006;38(6 Suppl):S78-92.
251. French L, Howell G, Haven J, Britten P. Designing MyPyramid for Kids Materials to Help Children Eat Right, Exercise, Have Fun. *Journal of Nutrition Education and Behavior.* 2006;38(6, Supplement):S158-S9.
252. USDA. MyPlate Washington, DC. [Available from: <https://www.choosemyplate.gov>].
253. Stormacq C, Van den Broucke S, Wosinski J. Does health literacy mediate the relationship between socioeconomic status and health disparities? Integrative review. *Health promotion international.* 2018;34(5):e1-e17.
254. Connell DB, Turner RR, Mason EF. Summary of findings of the School Health Education Evaluation: health promotion effectiveness, implementation, and costs. *J Sch Health.* 1985;55(8):316-21.
255. Hurley JC. How the Cluster-randomized Trial "Works". *Clinical Infectious Diseases.* 2019;70(2):341-6.
256. Hemming K, Haines TP, Chilton PJ, Girling AJ, Lilford RJ. The stepped wedge cluster randomised trial: rationale, design, analysis, and reporting. *BMJ : British Medical Journal.* 2015;350:h391.
257. Fernandez ME, Ruiters RAC, Markham CM, Kok G. Intervention Mapping: Theory- and Evidence-Based Health Promotion Program Planning: Perspective and Examples. *Frontiers in public health.* 2019;7:209-.

258. Martens M, van Assema P, Paulussen T, Schaalma H, Brug J. Krachtvoer: process evaluation of a Dutch programme for lower vocational schools to promote healthful diet. *Health Educ Res.* 2006;21(5):695-704.
259. Bessems KM, van Assema P, Martens MK, Paulussen TG, Raaijmakers LG, de Vries NK. Appreciation and implementation of the Krachtvoer healthy diet promotion programme for 12- to 14- year-old students of prevocational schools. *BMC Public Health.* 2011;11(1):909.
260. Li C, Lalani F. The COVID-19 pandemic has changed education forever. This is how.: *World Economic Forum*; 2020 [Available from: <https://www.weforum.org/agenda/2020/04/coronavirus-education-global-covid19-online-digital-learning/>].
261. Institute of Medicine. Preventing Childhood Obesity: Health in the Balance. Koplan JP, Liverman CT, Kraak VA, editors. Washington, DC: The National Academies Press; 2005. 434 p.
262. Muellmann S, Steenbock B, De Cocker K, De Craemer M, Hayes C, O'Shea MP, et al. Views of policy makers and health promotion professionals on factors facilitating implementation and maintenance of interventions and policies promoting physical activity and healthy eating: results of the DEDIPAC project. *BMC Public Health.* 2017;17(1):932.
263. McKenna ML. Issues in Implementing School Nutrition Policies. *Canadian Journal of Dietetic Practice and Research.* 2003;64(4):208-13.
264. Verdonschot A, de Vet E, van Rossum J, Mesch A, Collins CE, Bucher T, et al. Education or Provision? A Comparison of Two School-Based Fruit and Vegetable Nutrition Education Programs in the Netherlands. *Nutrients.* 2020;12(11):3280.
265. Battjes-Fries MC, van Dongen EJ, Renes RJ, Meester HJ, van't Veer P, Haveman-Nies A. Unravelling the effect of the Dutch school-based nutrition programme Taste Lessons: The role of dose, appreciation and interpersonal communication. *BMC Public Health.* 2016;16(1):1-8.
266. Bakker FC, Persoon A, Schoon Y, Olde Rikkert MG. Uniform presentation of process evaluation results facilitates the evaluation of complex interventions: development of a graph. *J Eval Clin Pract.* 2015;21(1):97-102.
267. Moore GF, Audrey S, Barker M, Bond L, Bonell C, Hardeman W, et al. Process evaluation of complex interventions: Medical Research Council guidance. *BMJ : British Medical Journal.* 2015;350:h1258.
268. Institute of Medicine. Improving Health in the Community: A Role for Performance Monitoring. Durch JS, Bailey LA, Stoto MA, editors. Washington, DC: The National Academies Press; 1997. 496 p.
269. Abarca-Gómez L, Abdeen ZA, Hamid ZA, Abu-Rmeileh NM, Acosta-Cazares B, Acuin C, et al. Worldwide trends in body-mass index, underweight, overweight, and obesity from 1975 to 2016: a pooled analysis of 2416 population-based measurement studies in 128.9 million children, adolescents, and adults. *The Lancet.* 2017;390(10113):2627-42.



## Summary

Sahtak bi Sahnak is the first Lebanese school-based nutrition programme targeting 15-18-year-old adolescents enrolled in public and private secondary schools, located in urban and rural regions. It aimed at improving the dietary knowledge and adherence levels of Lebanese adolescents, and to consequently prevent paediatric obesity. The programme was administered by a research dietitian in 16 secondary schools in the Lebanese regions Beirut, Baalbeck, and Rayak. Overall, the results of the effect evaluation were promising, suggesting a future larger dissemination across the country.

Chapter 2 described the development process of the dietary knowledge and adherence questionnaires for Lebanese adolescents and their parents. It also examined the feasibility and internal reliability of the questionnaires in the target population. As a result, we obtained brief and relatively inexpensive assessment questionnaires that may be administered in Lebanese school settings. In addition, the internal reliability for all scores, except for the healthy items score of the parents, was acceptable.

Chapter 3 presented the baseline characteristics of the participating adolescents and their parents, in addition to the correlation of dietary knowledge and adherence with the BMI z-score of the adolescents, their parents' levels of dietary knowledge and adherence, and with clustered behaviours. This study indicated that the prevalence of overweight and obesity has reached serious rates among Lebanese adolescents. In addition, it seems that the dietary knowledge of the adolescents directly influenced their dietary adherence, whereas the dietary knowledge level of their parents influenced their children's dietary adherence indirectly, mediated through the children's dietary knowledge.

Chapter 4 described the application of the Intervention Mapping (IM) to develop Sahtak bi Sahnak. The protocol of the intervention was described following all the six steps of IM, in details. The resulting intervention was a theory-based and culturally appropriate intervention, needing little resources, and which can be integrated in the educational curriculum of both public and private Lebanese secondary schools, located in urban and rural regions. This study provided an elaborate example of the application of the IM approach in the Lebanese secondary school context. Although 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.

Chapter 5 presented the effect evaluation of Sahtak bi Sahnak, assessing the effectiveness of the intervention in improving the levels of dietary knowledge and adherence of the participating adolescents. A cluster randomised controlled trial was conducted in public and private secondary schools. The results showed significant improvements in both dietary knowledge and adherence levels in the intervention schools, compared to the

## Summary

control schools. These positive outcomes were found among all participants of both genders, locations, types of school, and different BMI z-score categories.

The final chapter summarised the main findings of the studies, and then reviewed the strengths and limitations of the used methods. The chapter also reviewed the possible implications and suggested some recommendations for future research. We concluded that the current intervention is a promising nutrition programme targeting Lebanese adolescents in secondary schools.

# Dankwoord

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## **Dankwoord**

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## Curriculum vitae

Liliane Said is a licensed dietitian who earned her bachelor's degree in Nutrition and Dietetics, in 2010, and her master's degree in Human Nutrition, in 2012, from Saint Joseph University of Beirut. Within the next year, she was trained at the Hotel Dieu of France hospital in Beirut. After successfully passing the national colloquium exam in nutrition in 2013, she started working as the head of the dietary department at a local hospital, in addition to her own private practice. In 2014, she started teaching nutrition courses at the Lebanese International University. She is currently pursuing her PhD at the Health Promotion department at Maastricht University. As part of her PhD project, she developed a nutrition programme dedicated to Lebanese adolescents aged 15 to 18 years. She has also implemented and evaluated the intervention at several public and private secondary schools, located in urban and rural regions in Lebanon. Liliane Said speaks four languages and is currently a campus coordinator of the Nutrition and Food Sciences department at LIU.



# Publication List

## Publications in this thesis

Said L, Gubbels JS, Kremers SPJ. Effect Evaluation of Sahtak bi Sahnak, a Lebanese Secondary School-Based Nutrition Intervention: A Cluster Randomised Trial. *Frontiers in Nutrition*. 2022;9.

Said L, Schneider F, Kremers SPJ, Gubbels JS. Application of the Intervention Mapping Protocol to Develop Sahtak bi Sahnak, a School-Based Intervention to Prevent Pediatric Obesity among Lebanese Adolescents. *Health Psychology Bulletin*. 2021;5(1):20–38.

Said L, Gubbels JS, Kremers SPJ. Dietary Knowledge, Dietary Adherence, and BMI of Lebanese Adolescents and Their Parents. *Nutrients*. 2020;12(8):2398.

Said L, Gubbels JS, Kremers SPJ. Development of Dietary Knowledge and Adherence Questionnaires for Lebanese Adolescents and Their Parents. *International Journal of Environmental Research and Public Health*. 2019;17(1):147.

## Presentation

**ZoomForward 2022: Joint European Congress on Obesity of the European Association of the Study of Obesity and the International Federation for the Surgery of Obesity and Metabolic Disorders-European Chapter, 2022, Maastricht, Netherlands.**

**Poster:** Evaluation of *Sahtak bi Sahnak*, the first secondary school-based nutrition programme for Lebanese adolescents aged 15-18 years.

