

AMERICAN UNIVERSITY OF BEIRUT

EXPLORING INNOVATIVE METHODS FOR ONLINE  
NUTRITION EDUCATION: A SCOPING REVIEW AND  
QUALITATIVE STUDY TO PROMOTE BEHAVIORAL  
CHANGE AMONG SCHOOL-AGED CHILDREN IN BEIRUT,  
LEBANON

by  
RABAB ALI SWAIDAN

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# ABSTRACT OF THE THESIS OF

Rabab Ali Swaidan

for

Master of Science  
Major: Nutrition

Title: Exploring Innovative Methods for Online Nutrition Education: A Scoping Review and Qualitative Study to Promote Behavioral Change Among School-Aged Children in Beirut, Lebanon

**Background:** Pediatric obesity remains one of the most serious global public health challenges of the 21<sup>st</sup> century that causes adverse consequences on children's health and wellbeing in the short and long-term. The increase in obesity rates is particularly alarming in resource-poor settings. Schools have been long shown to be adequate settings to prevent pediatric obesity through promoting healthy eating and lifestyle behaviors among children using nutrition education (NE). Scientific literature shows the effectiveness of traditional NE programs and health promotion strategies in improving children's eating and lifestyle behaviors, and in recent years, there has been an increase in the use of digital tools in health promotion and NE purposes. Over the last two years, the COVID-19 pandemic caused serious interruptions to the school year and accelerated the shift to online learning and the use of different digital tools to deliver educational material. However, there have been limited studies exploring the effectiveness of using digital interventions in promoting behavioral changes among school-aged children in Low-to-Middle-Income countries (LMICs)

In Lebanon, as with other countries the Middle East and North Africa (MENA) region, there has been evidence documenting shifts in dietary intake of school-aged children and concomitant increase in sedentary behaviors contributing to the rise in childhood obesity over the last few decades. Lebanon has also been witnessing multiple economic, political, and health crises over the past two years that have been posing additional threats to the dietary habits of children and youth, which calls for effective and evidence-based interventions aimed at promoting children's health and wellbeing.

**Purpose:** The aim of this study was to first explore the feasibility and effectiveness of using innovative online NE tools in promoting healthful dietary and lifestyle behaviors among school-aged children in LMICs and resource-poor settings, and to explore the perceptions and experiences of teachers towards using online NE in Lebanon.

**Methods:** The study was comprised of two phases: phase (1) was a scoping review and phase (2) was a qualitative exploratory study.

The scoping review aimed at identifying NE interventions that (1) aimed at improving children's knowledge, attitudes, and practices related to healthy eating and active lifestyle behaviors, in an attempt to prevent excessive weight gain and obesity; (2) were delivered using online digital tools; and (3) were implemented among children from poor-resource settings or LMICs. A systematic search was conducted on three databases, namely Scopus, Embase, and Medline Ovid for relevant studies and the PRISMA protocol was followed. In addition, included studies and interventions in the scoping review were evaluated for data quality using critical appraisal tools. Results from the scoping review helped inform phase 2 of the study that further explored the perceptions of teachers towards using online NE in Lebanon. Phase 2 included an exploratory qualitative design using semi-structured interviews with key informants from public and private schools in Lebanon. A convenience sampling approach was adopted to recruit teachers and representatives from public and private schools in Lebanon. Interviews were conducted either via phone calls or through virtual platforms (ex. Microsoft Teams). Recordings of the interviews were transcribed verbatim and translated to English, as needed. The transcripts were coded and thematically analyzed using Dedoose software.

**Results:** For phase 1, a total of 16 studies met the scoping review criteria after removing the duplicates from the three databases and screening studies based on the pre-set inclusion criteria. The interventions included in the review adopted different digital interventions and varied in duration, sample size, and outcomes of interest. The digital tools used in these interventions included educational videos, websites, games, or the use of multicomponent approaches. Narrative synthesis showed that improvements in the knowledge, attitudes, eating behaviors, and lifestyle habits of school-aged children were evident in 15 out of 16 interventions. Three studies were identified in this scoping review that explored the impact of digital NE interventions in obesity prevention, yet none of these interventions contributed to significant decrease in body weight or waist circumference among school-aged children, whether they were of normal weight, overweight, or obese at baseline. Studies included in the scoping review were also assessed for their quality showing that 10 out of the 16 interventions were of moderate quality, three were of high quality, and remaining three were of low quality.

Phase 2: Six semi-structured interviews were conducted with key informants from public and private schools in Lebanon. A total of 4 themes and 12 subthemes emerged from the data analysis, mainly related to the teachers' perceptions of the need for and importance of NE in schools, the challenges faced with the use of online tools, their perceptions of the use of digital learning tools vs traditional classroom learning, and recommendations for effective digital NE implementation within the Lebanese schools. Findings showed that teachers support NE at schools and find videos helpful for message delivery and time-effective, contingent on the ability to secure internet, electricity, and needed devices for children in the local context. The key informant representing public schools highlighted the importance and effectiveness of previous NE interventions in public schools and stressed on the importance of collaborations across various governmental ministries in addition to academic institutions to facilitate the implementation of digital NE.

**Conclusion:** Results from the scoping review conducted as part of this study highlight promising findings regarding the effectiveness of online NE in improving school-aged children's eating and lifestyle knowledge, attitudes, and behaviors, albeit limited evidence on changes in weight status and other anthropometric measures. Worth noting that the data on digital NE interventions and their impact on the dietary and nutrition outcomes of school-aged children remains rather low from LMIC, with none identified from the MENA region. Findings from the exploratory qualitative phase of the study showed the acceptability of teachers and key informants towards the use of digital NE interventions in a context like Lebanon. Digital interventions such as educational videos to complement the educational curriculum along with the use of games and interactive modes of teaching were considered as interactive and fun methods of learning for children in the post COVID-19 era. Nevertheless, persistent technical, logistical, and financial challenges remain key challenges in Lebanon, amidst the multiple crises facing the country, and that need to be addressed. The study also highlights the need for future digital NE interventions that can help explore different modalities to overcome some of the raised challenges while also ensuring the buy-in of students, parents, teachers, and school administrators to the use of online digital tools and explore their effectiveness in preventing pediatric obesity within resource-poor settings.

## ABBREVIATIONS

BMI: Body mass index

BP: Blood Pressure

CG: Control Group

FV: Fruit and vegetable

IG: Intervention Group

JBI: Joanna Briggs Institute

MPVA: moderate-to-vigorous physical activity

MT: Mobile technology

NE: Nutrition education

PA: Physical activity

RCT: Randomized controlled trial

SCT: Social cognitive theory

SSB: Sugar-sweetened beverages

WHO: World Health Organization



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# CHAPTER I

## LITERATURE REVIEW

Childhood obesity is a growing public health concern worldwide. The prevalence rates show a dramatic increase during the past three decades, where 5-7% of US children were obese during the 1970s, compared to an estimated 19.3% today [1] According to the World Health Organization (WHO), 39 million children under the age of 5 were overweight or obese in 2020 [2]. In addition, more than 340 million children and adolescents aged 5-19 who were overweight or obese in 2016 [2].

### **A. Childhood Obesity: Health and economic burden**

The threat that childhood obesity poses to public health emerges from its link to morbidity and mortality, as it was shown that childhood obesity is associated with an increased premature death risk [3, 4]. In addition, childhood obesity has been linked to an increase in cardiovascular risk in adulthood, pre-diabetes and diabetes risk, hypertension, and other metabolic disorders [5, 6] . Furthermore, childhood obesity has been linked to several negative psychological consequences, including increased depression and decreased self-confidence among school-aged children [7].

One of the major risks that childhood obesity poses to an individual's health emerges from it being a strong indicator to obesity in adulthood [8, 9]. According to a systematic review conducted by Simmonds et al., children and adolescents who were obese had 5 times greater risk of become obese in adulthood [10]. This is mainly attributed to the eating and lifestyle habits that children develop at an early stage, and that have been shown to continue with them during adulthood.

Pediatric obesity can increase the risk of co-morbidities including diabetes, hypertension and other chronic diseases on the short and long-run. A recent meta-analysis conducted by Wuhl et al. has shed light on obesity-related hypertension, with body weight and blood pressure being found closely correlated [11]. Other findings highlighted the relation between pediatric obesity and cardiovascular disease, particularly high left ventricular mass [12].

In addition to the well-documented evidence relating childhood obesity to detrimental health consequences, the economic burden of obesity cannot be overlooked. According to several reports from different countries, the economic burden of obesity is huge. For instance, in 2014, the obesity-related economic cost was estimated at \$2.0 trillion [13]. When it comes to childhood obesity in particular, it was estimated that the annual direct cost of childhood obesity is \$14.3 billion in the US alone [14]. The economic burden childhood obesity poses appears both in the short and long terms. In the short term, increased utilization of health-care services has been highlighted as the major consequence of pediatric obesity [15]. Overweight and obese children have shown to have higher outpatient expenditures, higher drug prescriptions expenditures, and higher emergency room expenditure [16]. In the long term, the cost of childhood obesity appears mostly due to the fact that obese children are more likely to become obese adults, in addition to the mentioned comorbidities associated with increased weight.

### **B. Factors contributing to childhood obesity**

Myriad of factors contribute to the complex problem of childhood obesity. Predominantly, these factors lead to either an increase in energy intake or a decrease in

energy expenditure, sometimes both. One of the non-modifiable factors associated with childhood obesity is genetic predisposition. Observational and experimental evidence shows that early environmental exposures largely affect children's behavior and obesity risk [17]. This huge effect stems from the parenteral role in providing for the children, as parents own their children's food choices and have a great influence on their developed preference [18]. Children will consume what is made available by their parents, and they are influenced by what their parents actually like and prefer.

However, modifiable factors, including dietary, lifestyle, and environmental ones play a major role in mediating the hereditary effect and can have direct effect on obesity.

On the dietary level, increased consumption of sugar-sweetened beverages (SSBs) and caloric-dense snacks has been shown to be responsible for excessive caloric intake among children [19, 20]. In addition, increased consumption of fast food further adds a huge amount of calories to the children's total energy intake.

Another major dietary factor is breakfast, as studies have shown that children who eat breakfast can reduce their risk of childhood obesity [21]. Low consumption of fruits and vegetables, in addition to milk and dairy, has been also linked to the increase in obesity among children [22].

Along with the increased energy intake presented above, decreased energy expenditure is a major risk factor for obesity as it further contributes to a net positive energy balance.

Decreased physical activity and increased sedentary behaviors witnessed over the last few decades as part of the nutrition transition further contributes to the positive energy balance and childhood obesity worldwide. The increases in screentime, whether



through television, social media accounts, or video games, has led to an overall sedentary lifestyle adopted by children. Not only does this lead to increased energy expenditure, but screen time has also been associated with the consumption of caloric-dense snacks [23]. Sleeping is another factor that contributes to the childhood obesity problem, where less than 10-11 hours of sleep were associated with increased weight gain among children [19].

In addition to the mentioned individual and lifestyle behaviors, both income and education levels can influence the weight status. In the US, an inverse correlation was found between wealth and obesity, with citizens at or below the level of poverty showing highest obesity rates [24]. Interestingly, in LMICs, with the transition to a wealthier status, the levels of obesity were shown to depend on the education level. For instance, in Egypt, Peru, Jordan and Columbia, women with low levels of education showed 9-40% higher odds of obesity with increased income, while a relation between income levels and obesity was not found among educated women [25].

When it comes to food insecurity, there is mixed evidence on its relation with childhood overweight and obesity. While some studies suggest that increased household food insecurity is associated with childhood obesity due to lower access to nutritious food [26], others highlight stunting and underweight among children as a main consequence [27]. It is suggested that the severity of food insecurity, and whether hunger is involved, are major mediators of the effect on children's weight status. Katsaras et al. concluded, for instance, that long-term household food insecurity without hunger is associated with childhood obesity among 2-5 year olds and requires early intervention [28].

### **C. Childhood obesity in LMICs**

As presented above, childhood obesity is a major threat to public health.

However, the consequences of obesity, whether health or economic related, vary in severity between countries, as those with poor resources face multi-level challenges when it comes to the risk factors of childhood obesity.

In LMICs, the nutrition transition that occurred during the last few decades of the 20<sup>th</sup> century has greatly influenced the dietary habits of their populations [29], as manifested in an increase in the consumption of diets high in saturated fats, sugar, and low in fiber, commonly referred to as a westernized diet. The increase in those dietary behaviors have been combined with decreased physical activity and increased sedentary behaviors.

This effects of the nutrition transition on children's weight status has been documented in different LMICs, were combination between a sedentary lifestyle and changes in dietary practices has been shown to drive an increase in childhood obesity among children aged 5-19 years old [30]. Trends in childhood obesity in these countries are particularly alarming: 4.1 to 13.9% in Brazil during 1974–1997; 12.2 to 15.6% in Thailand during 1991–1993; and 9.8 to 11.7% in India during 2006–2009 [30]. Additionally, obesity, although increasing globally, has been shown to pose a greater risk among young people in the Middle East and North Africa (MENA) region [31]. The highest percentages of overweight and obesity among children and adolescents in 2015 were that of Kuwait (60.4% for males; 41.3% for females); KSA (43.6% for males; 34.8% for females); Egypt (36.8% for males; 35.8% for females); and Qatar (31.7% for males; 33.7% for females) [31].

#### **D. Childhood obesity challenges in poor resourced settings**

In the discussion of challenges that face LMICs as countries with poor resources, low-income communities in high-income countries (HIC) should be also highlighted, as they still face complex health challenges, including those related to childhood obesity. Eagle et al. (2012) investigated the association between childhood obesity and household income level to explore if the income level contributes to the promotion of obesity inducing behaviors. The BMI of 109,634 children was assessed, and results have shown that as the household income dropped, the percentage of overweight/obese children increased [32]. This relation is mediated by several factors, mainly the poor dietary and lifestyle habits adopted by children in these settings. The built-in environment plays an imperative role in either promoting or hindering physical activities. Children can often find themselves unable to gather in a playground or recreational parks to perform any type of physical activity. In addition, low access to healthful food is a major issue in low-income settings, combined with easy access to fast food and other non-nutrient dense food products [33].

Another issue when addressing obesity in HIC is related to sociocultural variables and environmental contexts. Food and fitness resources vary among neighborhoods in HIC, with the minority racial and ethnic group settings facing burdening obstacles in this regard [34]. In addition to these poor resources, safety is a major concern with crime rates being particularly high [35], thus hindering the access to an already limited outdoor space. Structured racism further contributes to the problem, with evidence showing fewer grocery stores in addition to reduced access to fresh produce and more fast food restaurants in areas that have a higher percentage of Black residents [36]. The effect of structured racism further extends to the health care system,

with people of color suffering from limited access to obesity interventions and treatments [37]. Overall, persons dealing with racism have reduced power to navigate the factors contributing to placing them at increased risk for obesity and its associated deleterious health outcomes.

### **E. School-based interventions that address childhood obesity**

Given the huge burden that childhood obesity poses, whether on the individuals, health systems, or countries' economies, efforts have been focused on its prevention and control. In that domain, public health professionals have designed and implemented numerous school-based interventions that target children with the aim of achieving positive health outcomes. Scientific evidence, from both HICs and LMICs, showed improved health outcomes among children who took part in school-based NE interventions [38-40]. These interventions encompassed different approaches, but the general guidelines for a successful NE intervention included: interactive NE lectures, hands-on activities, and engaging both parents and school administration to ensure healthy home and school environment.

The presented evidence that supports the success of school-based interventions in improving the eating and lifestyle habits of children is explained by several characteristics. First, the schools provide an unmatched opportunity to reach the great proportion of children and adolescents. This convenient setting presents schools as a major site for health promotion, especially given the long hours that students spend there. In addition, the food environment at schools presents a great opportunity for health professionals to intervene. Controlling the food availability in the school setting has been reported as an important factor for improving children's eating habits [41, 42].

For that reason, several meal providing programs have chosen to implement their interventions in schools [43]. Also, the school offers a convenient setting for increasing physical activity, through regular sports sessions that motivate children to engage in different sports activities that they find fun and enjoyable. The peer support present at school is also a factor that has been shown to increase children's motivation and facilitate their engagement in physical activities [44]. The role of educators is an additional factor favoring the school setting for health promotion and NE program, as their support and encouragement have shown to influence children's behavior and choices [45, 46].

It is important to note here that poor-resourced settings present challenges to the success of the different school-based interventions components. For instance, the willingness of children to engage in different physical activities, as advocated in school-based NE and health promotion programs could be hindered by poor infrastructure and built-in environment that facilitates such activities [47]. Children often find themselves with a lot of free time, limited places to play, and one or more technological devices that further contribute to physical inactivity. The access to healthful food is another issue in low-income and poor-resourced settings. The available food is usually cheap fast food, high salt packaged snacks, and SSBs, which are both preferred by children and convenient to purchase [48, 49]. Combined, limited spaces for physical activity engagement, and availability of non-nutrient dense food, are major barriers for the implementation of NE programs recommendations. Other factors that can contribute to the limited impact of some of the school-based interventions extend beyond the school environment to highlight poor food environments in communities and neighborhoods of people with color or from underprivileged communities. Family, individual, and

neighborhood-related factors come to play when addressing the challenges to the successful implementation of such interventions. These factors, as addressed by Black et al. (2010), include stressors related to poverty, such as low availability of healthful food options in underprivileged neighborhoods, few opportunities for physical activity, in addition to community violence, discrimination, and housing insecurity [50]. Parents tend to prohibit their children from engaging in outdoor activities due to poor security and increased crime. This fear is exacerbated among ethnic minorities and immigrants, where stigmatization and stereotyping put these communities at major safety risks, with children being no exception, and in some cases, easier and more vulnerable targets [51]. These issues shall not be left unaddressed when designing and implementing school and community based interventions to ensure recommendations are attainable and feasible to adapt by the intended target population.

#### **F. Transition to online learning**

During the last decade, an increased attention is being given to nutrition and health promotion interventions that use digital tools [52], and a recent systematic review was published on web-based NE interventions that target young adults [53]. This transition was mediated by several benefits that place digital tools as an educational tool in general, and for health promotion in particular. Expanding access to health education so that it reaches at risk populations is one important benefit. This wide reach that digital tools provide, manifested by more than 20,000 health-care related videos on YouTube alone, has made health related information widely accessible [54]. The use of social media to spread awareness is also another evidence of the use of digital tools in health literacy. This has recently been experienced with the COVID-19 pandemic, where

WHO and other health organizations using their social media platforms to increase awareness on preventative measures and importance of vaccination.

Another benefit of digital tool use in health promotion is the low cost, whether for the institutions designing the programs or the target populations receiving the information or intervention. It was estimated that the U.S. health care system would be saved \$7 billion if digital health promotion applications were adopted in five patient populations [55]. Finally, increased engagement and receptivity has been presented as an additional advantage of using digital tools. This is ensured through reminders and notifications sent on individual's smart phones, as they are the main devices they keep in reachable access most of the time. This feature can be utilized to promote healthier eating habits, such as reminders to drink water, walk more steps, or even to deliver awareness messages on specific emerging health issues.

Although the use of digital tools has not been widely available in LMICs, during the past three years, the COVID-19 pandemic drastically affected the school-based approaches to health promotion programs. These programs faced major challenges that required radical changes in their delivery strategies to using digital tools. This shift was accompanied by several challenges related to the unpreparedness of the school staff, the limited availability of digital tools to deliver material, in addition to technical issues that posed additional burdens to the learning process.

### **G. Our study: Aim and Rationale**

Although the pandemic is being gradually controlled and educational life is set to be back to normal, some researchers and educators demand online education to become the norm, for it has shown to be more efficient [56]. While the effectiveness of

school-based NE interventions has been well-documented, and the digital interventions have been studied in high income settings [57, 58], to our knowledge, no previous reviews have been conducted on such interventions among children in LMIC and were directed toward school-aged children and adolescents. Thus, we want to take a closer look at the NE interventions that used digital tools, targeted school-aged children and adolescents in low- to middle-income settings. Since the topic is emerging, and evidence is not well-established especially in the targeted settings, we decided to conduct a scoping review to map the literature around the topic, summarize the goals, methodologies, and outcomes of online NE interventions, and identify research gaps to inform practice, future research, and policy making [59].

Additionally, in Lebanon, a small middle eastern country, obesity rates are particularly worrying, amid a cluster of economic and political crises. Between the years 1997 and 2009, the prevalence of obesity increased significantly among 6-19 year olds (7.3% v. 10.9%) [60]. This increase can be attributed to several factors, with the diet quality having a major influence. Particularly, a western dietary pattern was shown to be associated with overweight and obesity in Lebanese adolescents (13-19 years) [61]. Added to this, Lebanon has been witnessing an unprecedented financial crisis since 2019 that imposed an emerging challenge to the population's dietary and lifestyle behaviors, with child health facing multiple challenges and put at huge risk [62]. With all the health, economic and political challenges overlapping, the Lebanese children and youth, a group that is particularly sensitive to change, are subject to dramatic alterations that can have both short- and long-term effects on eating choices and behaviors. For this reason, and to facilitate the delivery of NE necessary to educate children and help them maintain a healthy lifestyle, another aim for our study was to examine the barriers and



facilitators facing teachers and health coordinators within Lebanese schools in administering innovative online NE tools and resources as part of the curriculum.

### **H. Study purpose and specific objectives**

This study aimed to review previous online NE interventions and examine their effectiveness in promoting dietary and lifestyle behavioral change among school-aged children, specifically LMICs and similar resource-poor settings. Additionally, it aimed to assess the perceptions and experiences of teachers towards innovative online NE tools .

The specific objectives of this study were to:

- 1- Conduct a scoping review to examine the effectiveness of educational and behavioral interventions using online NE tools in promoting changes in dietary and lifestyle knowledge, attitudes and behaviors of among school-aged children in LMICs and resource-poor settings.
- 2- Explore the perceptions and experiences of teachers toward the use of digital tools for NE in Lebanon, and examine the barriers and facilitators facing educators within Lebanese schools in administering innovative online NE tools and resources as part of the curriculum.

## CHAPTER II

### METHODOLOGY

#### **A. Scoping Review Methodology**

##### ***1. Protocol***

The scoping review protocol followed methodology guidelines mentioned by Levac et al. [63]. In summary, the steps of conducting a scoping review included (1) identifying the research question, (2) database search for relevant studies, (3) selection of studies based on inclusion criteria, (4) data charting, and (5) collating, summarizing, and reporting the results. PRISMA extension for scoping review (PRISMA-Sc) was used to guide the reporting data in the review [64].

##### ***2. Search Strategy***

A detailed search strategy was first developed that included the main concepts of the study's research question. A medical librarian experienced in the health science field provided the graduate student and research team with assistance in refining the search strategy. The search was restricted to the subject heading, title, and abstract. Next, we conducted an extensive online database search through the following databases from August till November 2021: MEDLINE, EMBASE, and SCOPUS. The full literature search strategy for each database can be found in the supplementary material (Appendix D). Search was limited to articles published for the period extending between 2010 till September 2021. The results of the search were imported to EndNote software which was used for screening by the graduate student. Articles identified from different websites and handpicked ones through references were also included in the review (see flow diagram).

### ***3. Inclusion criteria***

The inclusion criteria for the articles were: a) the main goal of the intervention should be to deliver nutrition-related education, b) the intervention should target children and adolescents, c) the intervention must be delivered online or using digital tools, d) the intervention should be implemented in a low- to middle- income setting and e) the intervention outcome should be nutrition-related. More details on the exclusion and inclusion criteria are provided in Table 1. In our initial search, we included only LMIC as settings of choice, but that gave us minimal results. Consequently, we added ‘low-income’ and ‘middle income’ to our terms to cover those settings that exist in developed countries, as they share characteristics and challenges with low- to middle- income setting.

The eligible study designs were randomized-controlled trials (RCTs), quasi-experimental designs, pre-and post-test design, product development testing, and observational studies.

### ***4. Screening process***

After retrieving the initial count, one member of the research team removed the duplicates, after which they screened by the title and abstract the remaining count. Next, the remaining articles were screened by full text for the study’s inclusion criteria. More details on the selection process are provided in Figure 1.

## 5. Quality appraisal

**Table 1. PICOS criteria for study selection.**

Category	Inclusion criteria	Exclusion criteria
<b>P: Participants</b>	School-aged children and adolescents	Individuals above 18
<b>I: Intervention</b>	Online nutrition education interventions; nutrition education interventions that use online tools	Face-to-face nutrition education interventions
<b>C: Comparator</b>	No intervention OR In school interventions	None
<b>O: Outcomes</b>	Primary outcomes: dietary intakes, knowledge, preferences, attitudes, behaviors, self-efficacy; cultural nutrition awareness factor; dietary diversity score; physical activity (time, attitudes, behaviors); or food and beverage availability at schools. Secondary outcomes: anthropometric measurements (eg, body mass index, waist circumference, etc); biochemical measurements (eg, glycemia, lipid profile, etc).	No nutrition-related outcomes; outcomes measured only in children with pre-existing medical conditions
<b>S: Study design</b>	Controlled trials, quasi-experimental designs, observational studies, qualitative studies	Meta-analyses and systematic reviews

We used the Joanna Briggs Institute (JBI) critical appraisal tool [65] to assess the studies' quality. As our review includes more than one study design, we used three different tools from the same mentioned resource: quality score of RCTs based on JBI critical appraisal tool for RCTs, quality score of quasi-experimental designs based on JBI critical appraisal tool for quasi-experimental designs, and quality score for qualitative studies based on JBI critical appraisal tool for qualitative studies. In

summary, the RCT checklist was focused on randomization method, blinding methods, baseline participant characteristics, and reliability of the outcome measurements. For the quasi-experimental designs, the questions focused on the presence/absence of a control group, baseline participant characteristics, pre- and post- measurement of outcome, and reliability of outcome measurement. The detailed criteria for each tool can be found in supplementary material A, B, and C.

For the JBI checklist for qualitative research, the main focus was on whether there was congruity between the research question and the study methodology, as well as between the methodology and the data analysis. In addition, the checklist considered factors related to proper representation of participants' voices and ethical approval by an appropriate body.

## **B. Qualitative Study Methodology**

### ***1. Participants***

For private schools in Beirut, we conducted interviews with teachers of students from kindergarten through grade eight. We ensured reaching out to teachers from both high-fee and low-fee private schools to capture the socioeconomic level contribution to our topic. As for the public schools, we conducted an interview with representative on behalf of the Lebanese public schools. The key informant was approached given their lengthy and relevant experience in the public sector, particularly with programs aimed at promoting health and health education.

## ***2. Procedure***

Teachers were sampled through the convenience sampling method. Due to multiple challenges faced related to COVID-19 and the restrictions imposed by schools, the teachers were approached through the graduate student's network. The study objectives were explained to them to identify those who are interested to participate. Those who expressed their interest to participate were provided with the consent form, and upon securing their consent, a meeting was scheduled. All interviews were conducted via phone or through Microsoft Teams. The interviews took between 20-30 minutes. All interviews were audio-taped, and we transcribed them verbatim and then translated them into English.

## ***3. Interviews***

Interview guides were prepared to guide the semi-structured interviews with key informants (see Appendix D). The questions covered the following main points: Experience of teachers/schools with online education, their opinion on health education at their schools, the need for health education for children at schools, previous involvement in health promotion programs at their schools, and their perceptions of facilitators and barriers to implementing online NE. It is important to note that the interview guides were updated based on the scoping review findings, in terms of the digital interventions identified, and the challenges to their implementation in resource-poor settings.

The interview guides were semi-structured, with the main points of interest being phrased while leaving a room for probing accordingly with the key informants' input. The main questions prepared were related to the teachers' opinions and

perceptions on the importance of NE in schools, their experiences with the digital learning process, the challenges they faced with the use of digital tools, and the facilitators and barriers to digital NE implementation in Lebanese school setting.

#### ***4. Ethical Considerations***

The study was approved by the Institutional Review Board at the American University of Beirut (AUB) through a modified, expedited review (SBS-2019-0487). The interview guides used were also attached and approved by the IRB. Consent was sought from participants before any research activity took place (Appendix F). All the documentation of the interviews was stored in a password-protected folder to ensure the confidentiality and anonymity of the participants. As for the audio recordings from the interviews, they were saved on the password-protected PC of the PI and graduate student. The recording will be destroyed by the PI when all the information is fully transcribed and translated and after 5 years of the termination of the project.

Records will be monitored and may be audited by the IRB, however, measures were taken to make sure confidentiality is not being violated.

Researchers provided a digital copy of the consent forms to the participants as the forms contain the contact information of the principal investigator and the IRB committee, in case they had any related queries, comments, or concerns.

#### ***5. Data analysis***

Thematic deductive analytical approach was adopted for the interviews' analysis. The interviews were transcribed verbatim from either Arabic or English language. Each key informant was given an ID (KI.PR1,2,3 etc. for teachers from private schools and KI.PU for the key informant representing public schools).

Interviews that were conducted in Arabic (four out of 6) were translated to English. After that, all interviews were thematically analyzed according to the following phases: phase 1, the graduate student read the transcripts to familiarize herself with the content; phase 2, data coding started through highlighting excerpts from the interviews that were relevant to the study objectives (open coding); phase 3, the list of codes was revised with the P.I. of the study; phase 4, themes and sub-themes that emerged from the interviews were identified (axial coding); phase 5, the final themes and subthemes were revised and further refined with the P.I.; finally in phase 6 a narrative of the findings was provided. We supported these findings with relevant quotes for each theme and sub-theme.



## CHAPTER III

### RESULTS

#### **A. Scoping Review Results**

The initial search identified 7,458 articles from the three databases. 6,328 records remained after removing the duplicates and were screened by title and abstract for the study PICOS. Seventy -five articles eligible for full-text screening were identified. Eight of them were included in the scoping review based on the preset PICOS criteria. Eight additional articles were identified from website search and through articles' references, which brought the total number of included articles to sixteen. All hand-picked articles were included in our review. Figure 1 shows the detailed process for the search and screening process for this scoping review.

A total of eight articles with relevant digital nutrition interventions were included for further analysis. Description of the study characteristics were further presented based on the type of digital intervention, study setting, the digital tool intervention, the study design, the target group characteristics, and the primary outcomes of interest.

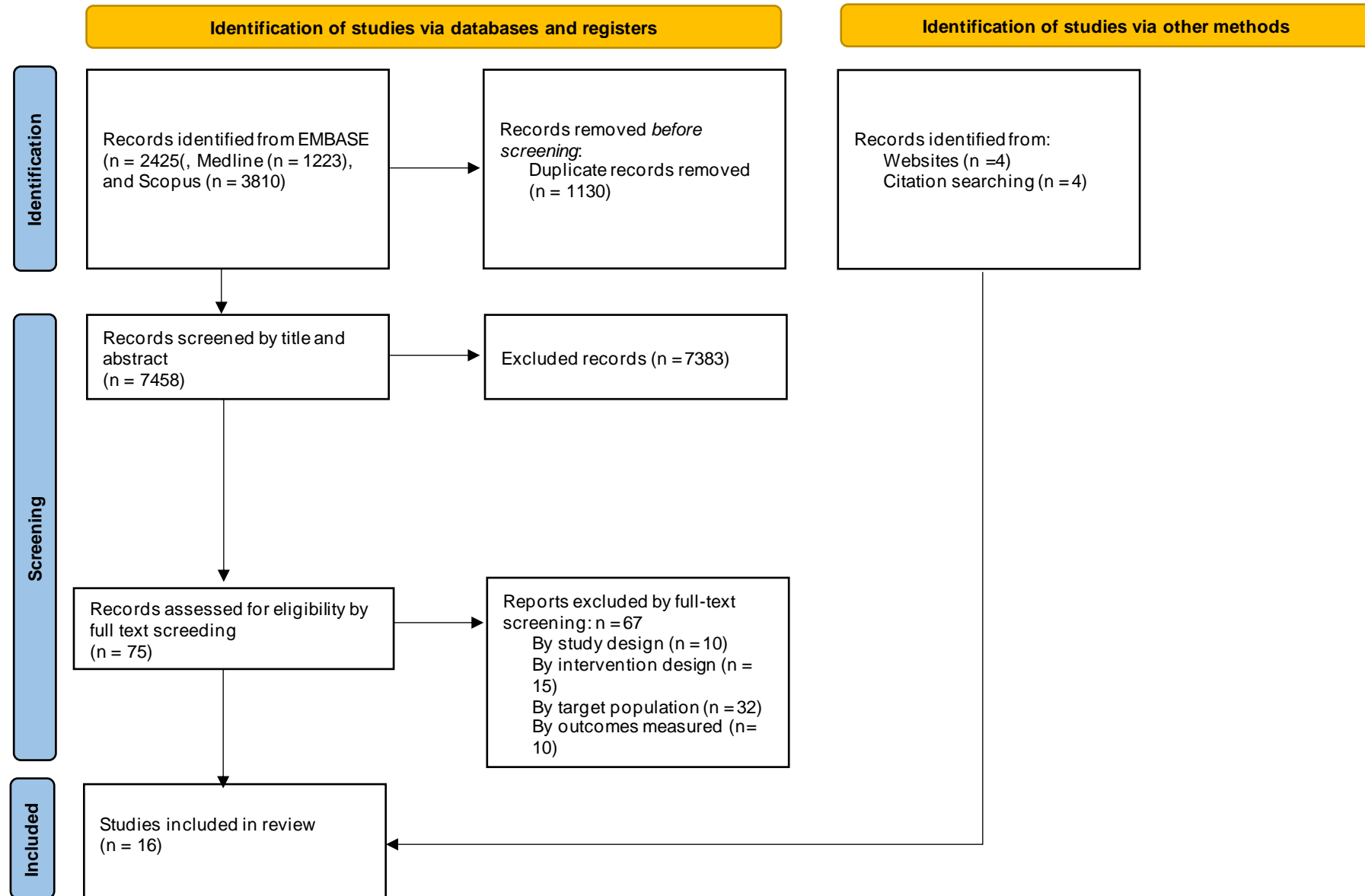
#### ***1. Characteristics of included interventions***

##### **a. By type of digital intervention**

The first digital nutrition education intervention article was identified in 2011, and the last in 2021. Seven out of the total sixteen selected interventions were in a game format (44%), five were designed as websites (31%), three were in a short-video format (19%), and one was a multicomponent intervention that included a website and a phone

application. The distribution of studies according to the intervention format is presented in figure 2.1. The detailed study characteristics are detailed in Table 2.

Figure 1: PRISMA flow diagram for study selection



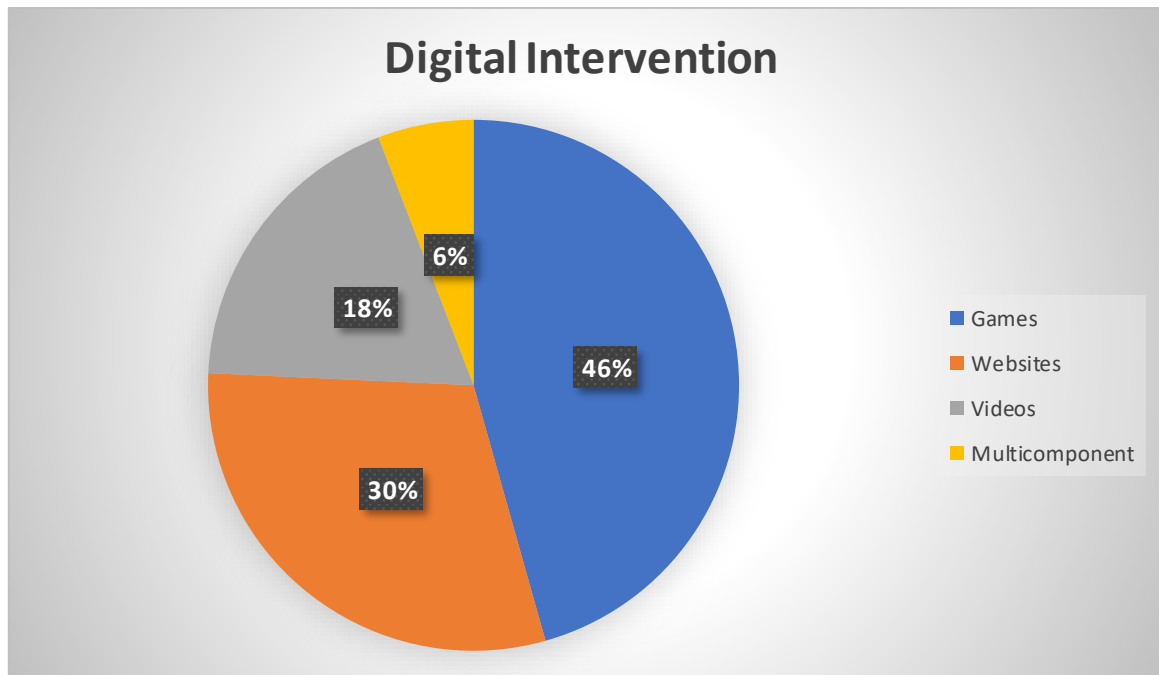


Figure 2: Distribution of studies according to intervention format.

b. By target group characteristics

More than two-thirds of the studies targeted children from both sexes (69%), two studies of the 16 targeted girls only [66, 67], and one study targeted boys only [68]. Additionally, two studies targeted mother-daughter [69] and adult-child dyads [70]. The children who were targeted across all interventions were aged between 5 and 18 years old.

c. By study setting and context

Twelve out of the sixteen interventions recruited children from a school setting, one recruited them from a tertiary care hospital [71], one through participating in a community program [67], and two recruited them via flyers and/or online invitations [69, 70]. From the high-income countries such as the US, Australia and Spain, the recruitment focused on children from low-income settings and communities, such as

minority communities, children living in subsidized housing, and economically disadvantaged neighborhoods. Additionally, there was one intervention that targeted children in eight different countries mixed between high and low income, and were hence included in our review [72].

The interventions in our review were conducted in different countries including the United States (US), China, Mexico, Macedonia, Malaysia, India, Australia, Spain, South Africa, Lithuania, Poland and Indonesia.

#### d. By study design

Half of the included studies were RCTs (n=8) [66, 68, 69, 71, 73-76], seven followed a quasi-experimental design [67, 72, 77-81], while one used a mixed-methods approach, including structured interviews and observations [70].

#### e. By outcomes of interest

Six interventions targeted the knowledge and attitudes of children toward healthy eating habits and physical activity [67, 69, 72, 74, 75, 81]. Another six interventions targeted the eating behaviors of children, in addition to their physical activity levels. Additionally, three interventions aimed to assess the feasibility and acceptability the proposed interventions [66, 70, 71]. Finally, one intervention targeted children's anthropometric measurements (BMI and waist circumference) [68]. Figure 2.2 represents the different outcomes of interest that were targeted.

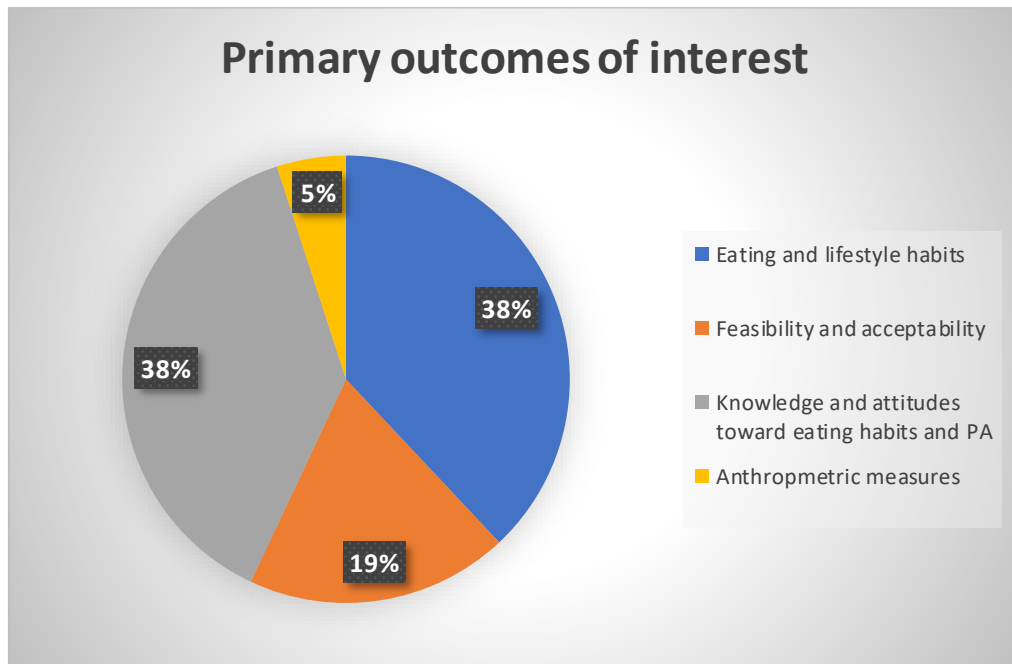


Figure 2.2: Distribution of studies according to primary outcomes of interest.

f. By theory of behavioral change

In ten studies of the total 16 studies included (63%), the interventions were based on one or more behavioral change theories [68, 70, 71, 73-76, 79-81], while the other six didn't mention any. Seven interventions (44%) were based on multiple behavioral change theories, while only one was based only on one theory. The social cognitive theory (SCT) was the most used theory, either alone or in combination with other theories, in eight of the interventions. Other theories included: the transtheoretical model, self-determination theory, persuasion theories, cognitive theory, A.S.E. (attitude, social influence, and self-efficacy) model, and behavioral theory.

## **B. Summary of outcomes**

Table 4 summarizes characteristic of the included interventions and the primary and secondary outcomes of each.

### ***1. Knowledge and attitudes toward healthy eating and physical activity***

Six interventions aimed to improve children's knowledge and attitudes toward healthy eating habits and physical activity. Significant improvements in knowledge and attitude toward healthy eating behaviors were achieved in three of the interventions [69, 75, 76], while increased perception of PA importance and its benefits was achieved in the other three [72, 77, 78]. However, improvements in BMI or children's fitness levels were not significant.

The three interventions that targeted the children's knowledge and attitudes toward healthy eating habits were in a game format [69, 75, 76]. They all had in common an educational component where children are expected to use the given information to make correct choices (i.e. choosing healthier food options) and answering questions regarding healthy/unhealthy eating habits. They played the games in divided sessions over the course of 2 weeks to 45 days, either in the school computer lab or at their homes. The sample sizes in these interventions ranged from 60 to 360 children, both males and females. Two of them followed an RCT design while the other followed a quasi-experimental design. The interventions were implemented in Indonesia, Mexico, and Macedonia.

On the other hand, the three interventions that targeted physical activity knowledge and attitudes were delivered in-class, through short videos [72, 77, 78]. Each video was 3-5 minutes long, and was given twice a week for a period of four months. The videos provided integrated movements to enhance the children's motor and fitness

skills, in addition to an educational component on PA importance. The movements were provided through either a real-life instructor or an animated one that performs the necessary movements for children to follow. This intervention was adopted in ten different countries, reaching 4,075 children in total, and followed a quasi-experimental design.

Two out of the three interventions that targeted knowledge and attitudes toward improving the eating behaviors of school-aged children adopted either the social cognitive theory on its own or a combination of behavioral theory, cognitive theory, and social cognitive theory. On the other hand, the interventions that targeted improvements in knowledge and attitudes of children toward physical activity did not mention adopting any theory of behavioral change.

## ***2. Eating behaviors and lifestyle habits***

Six interventions targeted children's eating and lifestyle behaviors. The interventions in these studies showed significant improvements in fruits and vegetables intake [69, 75, 76], lower consumption of food that is deemed 'unhealthy' (SSBs, packaged snacks, etc.) [66, 81], and decreased cancer risk eating behaviors [74]. However, there were no significant effects on physical activity and water intake in two of these interventions [76, 81], or on the FV intake in another.

Three out of these six intervention were game based [75, 76, 81], which used a character that needed to stay in shape and consume healthy food, mainly fruits and vegetables, and avoid unhealthy ones, namely SSB and processed snacks. The game playing duration ranged from 2 weeks to 3 months.



The other three interventions [66, 69, 74] were designed as websites that included nutrition education component, goal setting, progress tracking, and self-monitoring, and were implemented for 3 weeks, 12 weeks, and 9 months, respectively. The websites included learning sessions given through PowerPoint presentations, animated videos, links to websites that include supplementary material. In addition, they included goal setting features and automatic reminders to increase children's motivation and commitment. The interventions were implemented in Mexico and Spain, economically disadvantaged neighborhoods in Kansas, and publicly subsidized housing setting in different US states. Noteworthy, one intervention targeted mother-daughter dyads only, while others included children of both sexes.

Only one of these six interventions by Schwinn et al. was not grounded by any behavioral change theory [69], while others were guided by social cognitive, self-determination and persuasion theories [76], implicit and inactive learning to promote behavioral change [75], social cognitive and self-determination theories [81], and A.S.E (attitude, social influence and self-efficacy) and transtheoretical models [74]. The sixth intervention was grounded by behavioral weight control principals [66]. All intervention adopted an RCT design, except for one that adapted a quasi-experimental design [81].

### ***3. Feasibility and acceptability of interventions***

The primary goal of three of the included interventions was to assess the feasibility and/or acceptability their implementation. One of them was of qualitative nature, based on structured interviews and observation [70], and the other two followed an RCT design [71] and a quasi-experimental design [67]. Participants from one of

these interventions reported satisfaction with the program and gave positive feedback on the program's design [70]. It was concluded that the second intervention, an internet-based curriculum, is feasible to adapt [71]. Additionally, girls involved in the third intervention reported satisfaction with the program and finding it engaging [67].

The digital tool used for the first intervention by McGuirt et al. was virtual avatar interactive sessions that were accessed through a website. The sessions focused on understanding eating behaviors and providing guidance through an animated instructor on the importance of healthy eating habits. 15 children (5-10 years old) and their fathers (n=30 in total) were targeted by this intervention that was implemented in an urban area in North Carolina for a duration of 2 months.

Abraham et al. used a website as their digital tool. It was composed of 15-minute interactive sessions, followed by quizzes, games, and reflective questions. 48 clinically obese children aged 12-18 were recruited from a tertiary care hospital in China and were randomized into either the intervention or control groups. The intervention lasted for 12 weeks.

For the third intervention, Nollen et al. adapted a digital computer website for their intervention, where children are registered and receive reminders for fruit and vegetable intake, in addition to an educational online session. This study was limited to 13 girls, and was implemented for 2 weeks in a minority group in the US.

Two of these interventions were based on the social cognitive theory of behavioral change, combined with either the trans-theoretical model [71] or self-determination theory [70]. No behavioral change theory was mentioned in for the third intervention.

#### ***4. Anthropometric measurements***

Three interventions investigated the effect of digital interventions on children's anthropometric measures [68, 69, 71]. The primary objective of one of them, conducted by Smith et al. [68], was to improve children's anthropometric measurements, specifically the BMI and waist circumference [68]. No significant effects were found on both anthropometric measures at the end of the 15-month intervention (BMI = -0.4 kg.m<sup>2</sup>, p=0.15) and waist circumference (-0.5 ± 0.95 cm; p = .57), although they were lower compared to the control group. However, intervention showed significant improvements in reducing screen time and SSB consumption among children who took part in it. Nevertheless, no significant effects were noted for the children's activity levels post the intervention [68]. This intervention followed an RCT design and adopted the self-determination and social cognitive theories of behavioral change. 361 boys were recruited from 14 secondary schools in low-income communities in New South Wales, Australia, and were randomized into either the intervention or control group. It was a multicomponent intervention that lasted for 15 weeks, composed of both a smartphone app and a website used for physical activity monitoring, recording of fitness challenge results, tailored motivational messaging, peer assessment and goal setting for physical activity and screen time.

As for the other two interventions conducted by Abraham et al. [71] and Schwinn et al. [69], no significant improvement in BMI was detected among children. These interventions measured BMI as a secondary outcome, while their primary outcomes were to test feasibility and increase FV intake (described in sections above). It is worth noting that in Abraham et al.'s intervention, the children and teens were obese and recruited from a tertiary care hospital setting.



**Table 2. Characteristics of the included interventions.**

Study reference, year, setting	Study design	Aim	Target population	Intervention design	Comparator	Theoretical framework	Outcomes
Abraham et al.: Lifestyle Intervention Using an Internet-Based Curriculum with Cell Phone Reminders for Obese Chinese Teens: A Randomized Controlled Study (2015) [71]  <b>A tertiary care hospital in China</b>	RCT	(1) Determine the feasibility of using an adapted internet curriculum, an existing nutritional program and cell phone follow up for obese Chinese teens, (2) examine body fat, BMI <sup>1</sup> , physical activity, stress, and dietary knowledge scores	Forty-eight subjects aged 12 to 18 years (16 in CG <sup>2</sup> , 16 in web-based IG <sup>3</sup> and 16 in the live counselling group)	Usual care visits plus a 12-week internet-based curriculum with cell phone calls/texts reminders. The curriculum consisted of twelve 15-minute interactive sessions consisting of reflective questions, wrap-up quizzes, and matching games <b>Type: Website</b> <b>Duration: 12 weeks</b>	The control group received usual care visits with a physician in the obesity clinic every three months	Transtheoretical Model—Stages of Change and the Social cognitive theory	<b>Primary:</b> Results showed that the adapted curriculum is feasible as evidenced by the relatively high recruitment rate, high retention rate, high internet log-in rate, and reasonable compliance with completion of online curriculum sessions and use of cell phone reminders <b>Secondary:</b> Results showed no significant effect of the intervention on physical activity level, dietary intake, stress level, and knowledge related to nutrition/physical activity, as well as weight and blood pressure

<sup>1</sup> BMI: Body Mass Index

<sup>2</sup> CG: Control Group

<sup>3</sup> IG: Intervention Group

<p>Angkasa et al.: 'MAPAGI' video game upgraded breakfast attitude among urban elementary school children in West Jakarta, Indonesia (2020) [79]</p> <p><b>Two urban schools in West Jakarta, Indonesia</b></p>	<p>Quasi-experimental design</p>	<p>Determine the effect of the 'MAPAGI' (Makan Pagi Bergizi) interactive video game on elementary student's breakfast knowledge and attitude</p>	<p>Children aged 9-12 years old (n=228; 114 in CG and 114 in IG)</p>	<p>The game is composed of 10 levels, and each level can be completed by an optimum score. If the player gets a high score, he/she will get a card and can then unlock other levels. The cards contained nutrition and health material</p> <p><b>Type: Game</b> <b>Duration: 2 weeks, 30 min/ session</b></p>	<p>PowerPoint nutrition education material</p>	<p>None mentioned</p>	<p>The mean changes (PT<sup>4</sup>-PT<sub>0</sub> and PT<sub>2</sub>-PT<sub>0</sub>) in knowledge score for IG (4.82±2.53 and 3.25±2.47) significantly differed compared to CG (1.75±2.66 and 1.25±2.69). The mean changes in attitude score for IG (7.16±7.17 and 7.34±7.11) also significantly differed compared to CG (2.83±6.58 and 2.64±6.90). Attitude did not change significantly over seven days of the first post-test.</p>
<p>Baranowski et al.: Video Game Play, Child Diet, and Physical Activity Behaviour Change: A Randomized Clinical Trial (2011) [76]</p>	<p>RCT</p>	<p>Test if Diab and Nano games will increase fruit and vegetable and water intakes and MVPA<sup>5</sup></p>	<p>153 children aged 10-12 years; IG: n=103, CG: n=50</p>	<p>Nine sessions, 40 minutes of game-play per session. Each session contained a mini-game designed to test the knowledge. Goal setting included</p>	<p>Control Group played diet and physical activity knowledge-based games on popular websites.</p>	<p>Social cognitive, self-determination, and persuasion theories</p>	<p>Significant treatment versus control effects at all post-assessments on fruit and vegetable intake. Children playing these video games increased fruit and vegetable consumption by about .67 servings per day (p&lt;0.018).</p>

<sup>4</sup> PT: Post-test

<sup>5</sup> MVPA: Moderate to vigorous physical activity

<p><b>Ethnic-minority communities, low-income urban middle school students, US</b></p>				<p>action and coping implementation intentions, a behavioral inoculation.  <b>Type: Game</b>  <b>Duration: 9 sessions, 40 minutes each</b></p>			<p>There were no significant effects for the other variables (PA<sup>6</sup>, water intake)</p>
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<sup>6</sup> PA: Physical Activity

<p>Espinosa-Curiel et al.: Nutritional Education and Promotion of Healthy Eating Behaviors Among Mexican Children Through Video Games: Design and Pilot Test of FoodRateMaster (2020) [80] <b>Primary school located in Tepic, Nayarit, Mexico</b></p>	<p>Pilot study, Quasi-experimental design</p>	<p>Design and test the serious video game: FoodRateMaster effect on children's knowledge of healthy and unhealthy foods, increase their intake of healthy food, and reduce their intake of processed food</p>	<p>60 Mexican children (29 girls, 33 boys) aged 8-10 years</p>	<p>The players of FoodRateMaster need to perform basic physical movements such as squats, jumps, lateral body movements, and arm movements to avoid obstacles and classify food <b>Type: Game Duration: All game sessions were conducted in 45 days</b></p>	<p>No intervention material was provided</p>	<p>Behavioral theory, cognitive theory, and social cognitive theory</p>	<p>More than half of the participants' parents (&gt;50%) agreed that they perceived improvement in the attitudes of their children toward 6 of the 13 healthy eating behaviors. Participants showed increased food knowledge from pregame (mean 56.9, SD 10.7) to postgame play (mean 67.8, SD 10.7; <math>P&lt;.001</math>). There was a greater self-reported frequency in the consumption of cauliflower and broccoli (<math>P&lt;.001</math>) and corn quesadillas (<math>P&lt;.001</math>). They also indicated a lower self-reported intake of 10 unhealthy foods, including French fries (<math>P=.003</math>), candy and chocolate (<math>P&lt;.001</math>), sweet soft cakes (<math>P=.009</math>), and soft drinks (<math>P=.03</math>).</p>
<p>Gan et al.: Effectiveness of Healthy Foodie Nutrition Game Application as Reinforcement Intervention to Previous Standard Nutrition Education of School-Aged Children: A Randomized Controlled Trial (2019) [73]</p>	<p>RCT</p>	<p>Develop Healthy Foodie nutrition game application and determine its effectiveness</p>	<p>Grade 2 and grade 3 elementary students aged 7-10 years (n=360); IG: n=180; CG: n=180</p>	<p>The game, Healthy Foodie, was composed of two parts: Part 1 discussed the basic food groups and the Filipino food plate, while part 2 tackled the traffic light food groups (red, yellow and green) and the food pyramid.</p>	<p>No intervention material</p>	<p>Social cognitive theory</p>	<p>There was a statistically significant improvement in the post-test knowledge scores of the children who played Healthy Foodie (improved knowledge). There was a statistically higher score (<math>p=0.0001</math>) in the experimental group (<math>10.70\pm0.15</math>) compared to the control (<math>9.07\pm0.15</math>).</p>



<p><b>Two public schools in the Republic of Macedonia</b></p>				<p>The child had to choose one go food, one grow food, and two glow foods (one fruit and one vegetable) and drag these food items to the proper place on the plate.  <b>Type: Game</b>  <b>Duration: 1 session can be completed in 30 minutes</b></p>			
<p>Hajar et al.: The Effects of Brain Breaks on Motives of Participation in Physical Activity among Primary School Children in Malaysia (2019) [78]  <b>Two schools in Kelantan, Malaysia</b></p>	<p>Quasi-experimental design</p>	<p>Measure the effects of brain breaks on motives of participation in PA among primary school children in Malaysia</p>	<p>159 male and 176 female students aged 10 to 11 years old; IG = 183, CG = 152</p>	<p>Each Brain Breaks video provided movement-integrated teaching with motor and fitness skills presented by animated and real-life instructors. Also, a video incorporated health and nutrition education  <b>Type: Videos</b></p>	<p>No intervention material was provided</p>	<p>None mentioned</p>	<p>Mixed factorial ANOVA showed significant changes in enjoyment, p-value = 0.001; competitiveness, p-value = 0.014; appearance, p-value = 0.004; and psychological condition, p-value = 0.013.  No significant effect on mastery, affiliation, and enjoyment.</p>

				<b>Duration: 4 months</b>			
<p>Kato-Lin et al.: Impact of Pediatric Mobile Game Play on Healthy Eating Behavior: Randomized Controlled Trial (2020) [75]</p> <p><b>Three schools in Chennai, India</b></p>	RCT	Examine the immediate impact of a paediatric dietary mobile game with implicit learning on children's actual food choices and understand how they associate gameplay patterns with players' actual food choices	104 participants aged 10 to 11 years; IG: n=52, CG: n=52	<p>Players present themselves as avatars in Fooya!, a game that consists of 80 levels that progress with increasing difficulty. At each level, the players' main goals are to maintain a good body shape for the avatar and earn enough coins to win the level and unlock the next level.</p> <p><b>Type: Game</b></p>	The control group played a board game (Uno), which does not deliver any knowledge about healthy eating.	Implicit learning, enactive learning to promote behavioral change	Children from the treatment group chose 1.38 more good foods than the control group. The number of healthy foods correctly identified by the treatment group in the post-test survey question was also significantly higher (treatment 2.48, control 1.10; P<.001) and identified (treatment 7.3, control 6.94; P=.048)

				<b>Duration: 2 sessions, 40 minutes each, played 1 week apart</b>			
<p>Lana et al.: Impact of a web-based intervention supplemented with text messages to improve cancer prevention behaviors among adolescents: Results from a randomized controlled trial (2013) [74]</p> <p><b>Schools in Spain and Mexico</b></p>	RCT	<p>Assess the impact of a web-based intervention supplemented with text messages to reduce cancer</p> <p>Risks including smoking, unhealthy diet, alcohol consumption, obesity, sedentary lifestyle, and sun exposure</p>	<p>2001 adolescents (12-16 years old), CG: n=987, IG: n=1014</p>	<p>The website included several sections to learn how to prevent and treat main cancer risk behaviors. It also provided dietetic advice after analyzing common homemade recipes and 24-hour food recalls, peer-starred educational videos, forums and chat lines to discuss cancer-</p>	No intervention material	<p>A.S.E. model (acronym of Attitude, Social influence and self-Efficacy) and the Transtheoretical model</p>	<p>The prevalence of being overweight decreased significantly (about 20%) in the intervention group that received text messages and not in the other groups. Total cancer behavioural risk (TCBR) significantly decreased intervention groups. the prevalence of students who did not eat fruits reduced significantly in all groups: experimental group 1 (-62.6%), experimental group 2 (-71.5%), but even the control group (-66.8%). Total cancer behavioural risk score, which ranged from 0 to 100 points (highest risk), was significantly reduced in the experimental group 1 (-3.5 points) and in the experimental group 2 (-5.3 points).</p>

				related topics, documents and web links with selected information and online educational games. <b>Type: Website</b> <b>Duration: 9 months</b>			
Majumdar et al.: “Creature-101”: A Serious Game to Promote Energy Balance-Related Behaviors Among Middle School Adolescents (2013) [81]  <b>New York City low-income public middle schools</b>	Quasi-experimental design	Evaluate the efficacy of “Creature-101.” on FV <sup>7</sup> and water intake, increase PA, decrease intake of processed snacks (e.g., chips, candy) and SB, and reduce recreational screen time	Sixth and seventh grade students (11-13 years old) IG: n= 359 students CG: n=171 students	Participants in the intervention group played "Creature-101" game, where a teen named Murphy seeks the help of nutritionists and food scientists and recruits the students to save 'creatures' from high SB and PS intake and high screen time and	The participants in the control group played "Whyville", a set of general science/health minigames excluding any nutrition related games	Social cognitive and self-determination theories	<b>Primary:</b> Students who played “Creature-101” reported significant decreases in frequency (P = 0.011) and amount (P = 0.007) of SB and frequency (P < 0.0001) and amount (P = 0.040) of PS <sup>8</sup> intake. <b>Secondary:</b> No improvement was detected in FV intake, water intake, and physical activity levels.

<sup>7</sup> FV: Fruit and vegetable

<sup>8</sup> PS: Packaged snacks

				help them adopt a healthier lifestyle <b>Type: Game</b> <b>Duration: 1 month</b>			
McGuirt et al.: Virtual Avatar Coaching With Community Context for Adult-Child Dyads with Low Income (2020) [70]  <b>Urban area, North Carolina, recruitment via flyers</b>	Qualitative study, structured observation and in-depth interviews	Examine the acceptability of an evidence-based, contextually tailored, virtual avatar coaching approach for nutrition education among adult-child dyads with low income	15 adult-child dyads (n = 30 total participants, children aged 5-10 years old)	Age-appropriate child-focused section for child and avatar interaction, and the child and adult completed it together (with the child leading the interaction). Children were asked about typical snacking behaviors, including fruits, vegetables, sugar-sweetened beverages, and	N/a	Social Cognitive Theory and self-Determination Theory	Children responded positively to the tailored communication from the avatar, especially when the avatar responded positively to the healthy snack the child had created. Children and adults reported that they liked the program because of the interaction, educational content, child focus, pictures/graphics, tailored advice, and relatability of the avatar. Both children and adults reported enjoyment interacting with the avatar, including the ability to dialogue back and forth and discuss dietary habits. Children and adults reported increased knowledge on healthful eating/snacking. intake increased.

				salty snack consumption <b>Type: Website</b> <b>Duration: 2 months</b>			
Mok et al.: Brain Breaks® Physical Activity Solutions in the Classroom and on Attitudes toward Physical Activity: A Randomized Controlled Trial among Primary Students from Eight Countries (2020) [72]  <b>Schools in Croatia, Lithuania, Macedonia,</b>	Quasi-experimental design	Evaluate the effectiveness of the Brain Breaks® Physical Activity Solutions in changing children's attitudes toward PA	Students (N = 3036) aged 8–11 years; CG: n=1122, IG: n= 1914	Students in the experimental group performed a series of 3-to-5-minute group activity exercise videos within the classroom during a school day. In addition to PA, the content of the video incorporated health and nutrition education. <b>Type: Videos</b>	No intervention material	None mentioned	Repeated measures of ANOVA identified a significant interaction effect for the following APAS <sup>9</sup> variables: self-efficacy with a large effect size; learning with a medium effect size; and benefits, importance, personal best, and fun with a small effect size. No significant improvement in fitness levels.

<sup>9</sup> APAS: Attitudes toward Physical Activity Scale

<p><b>Poland, Romania, Serbia, South Africa, and Turkey</b></p>				<p><b>Duration: 4 months</b></p>			
<p>Nolen et al.: Mobile Technology for Obesity Prevention A Randomized Pilot Study in Racial- and Ethnic-Minority Girls (2014) [66]</p> <p><b>Economically disadvantaged neighborhoods, Kansas, USA (schools)</b></p>	<p>RCT, pilot study</p>	<p>To test a 12-week mobile technology intervention on participant's eating habits and screen time</p>	<p>Fifty-one low-income, racial/ethnic-minority girls aged 9-14 years (n=51; 26 in CG and 25 in IG)</p>	<p>The intervention included goal-setting and planning that required girls to set two daily goals and an accompanying plan for improving the behavior addressed in each module, cues to action, and self-monitoring that prompted girls to self-monitor progress toward their goals at five preselected times throughout the</p>	<p>Controls received the same content in a written manual</p>	<p>The intervention was grounded in behavioral weight control principles</p>	<p>A significant association was found between MT<sup>10</sup> use and SSB. Mobile technology girls used the program on 63% of days and exhibited trends toward increased FVs (p&lt;0.08) and decreased SSBs (p&lt;0.09). No statistically significant differences were observed for screen time.</p>

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<sup>10</sup> MT: Mobile technology

				day and feedback and reinforcement on goal attainment. <b>Type: Website</b> <b>Duration: 12 weeks</b>			
Nollen et. al: Development and functionality of a handheld computer program to improve fruit and vegetable intake among low-income youth (2012) [67]  <b>Predominately low-income, racial/ethnic minorities participating in a community program, US</b>	Quasi-experimental design	The primary objective of this phase was to assess program use, acceptability, and satisfaction. A secondary objective was to evaluate the impact of the program on FV intake and behavior change skills	13 girls (9-13 years old)	The program sent an audible alarm that reminded girls of their two daily goals and the pre-selected plan related to fruit and vegetable intake, in addition to a health education component <b>Type: Website</b> <b>Duration: 2 weeks</b>	N/a	None mentioned	<b>Primary:</b> Girls were satisfied with the program and found it helpful and engaging. <b>Secondary:</b> Girls increased their FV consumption from 4.0 (2.3) daily servings at baseline to 5.6 (2.8) daily servings at Week 2 (P<0.05). They used an average of 8.4 (4.3) behavioral skills to remind them to eat FV at baseline and 10.7 (4.2) behavioral skills at Week 2 (<0.05).
Schwinn et al.: A web-based, health promotion program for adolescent girls and their mothers who reside in	RCT – Pilot study	Test the effect of a brief, health promotion program for low-income girls and their mothers on the following parameters: improving	Mother–daughter dyads (each n=67) Daughters aged 10-12 years; IG:	Intervention-arm dyads completed the 3-session health promotion program through a secure website.	Control-arm dyads received no intervention material	None mentioned	<b>Primary:</b> Intervention-arm girls demonstrated greater mother–daughter communication (p < .05), closeness (p < .05), increased fruit consumption (p b .05), reduced psychosocial stress



<p>public housing (2013) [69]</p> <p><b>27 U.S. states, publicly subsidized housing, online recruitment</b></p>		<p>dietary intake, increasing physical activity</p>	<p>n=36, CG: n=31</p>	<p>The integrated, 3-session program focused on developing and maintaining girls' and mothers' healthy relationships, bodies, and minds. <b>Type: Website</b> <b>Duration: One session/week for three weeks</b></p>			<p>(<math>p &lt; .05</math>), relative to control-arm girls. There was no improvement in physical activity levels. <b>Secondary:</b> No significant improvement in BMI</p>
<p>Smith et al.: Smart-Phone Obesity Prevention Trial for Adolescent Boys in Low-Income Communities: The ATLAS RCT (2014) [68]</p> <p><b>14 secondary schools in low-income communities in New South Wales, Australia</b></p>	<p>RCT</p>	<p>Evaluate the impact of the Active Teen Leaders Avoiding Screen-time (ATLAS) intervention for adolescent boys, an obesity prevention intervention using smartphone technology</p>	<p>361 adolescent boys (aged 12–14 years) considered at risk of obesity, IG: n=181, CG: n=180</p>	<p>Active Teen Leaders Avoiding Screen-time (ATLAS) is a multicomponent intervention designed to prevent unhealthy weight gain by increasing physical activity, reducing screen-time, and lowering SSB consumption among adolescent boys attending schools in low-income</p>	<p>No intervention material</p>	<p>Self-determination theory and social cognitive theory</p>	<p><b>Primary:</b> No intervention effects were found for the primary outcomes of BMI (<math>-0.4 \text{ kg.m}^2</math>, <math>p=0.15</math>) and waist circumference (<math>-0.5 \pm 0.95 \text{ cm}</math>; <math>p = .57</math>) <b>Secondary:</b> Intervention boys reported less screen-time (mean:2306 10.08 min/d; <math>P = .03</math>) and SSB consumption (mean:20.660.26 glass/d; <math>P = .01</math>) than control boys at follow-up. No significant differences were observed for overall activity (mean counts per minute) or moderate to vigorous physical activity.</p>

				<p>areas. The smartphone app and Web site are used for physical activity monitoring, recording of fitness challenge results, tailored motivational messaging, peer assessment, and goal setting for physical activity and screen-time.</p> <p><b>Type: Multicomponent</b> <b>Duration: 15 weeks</b></p>			
<p>Zhou et al.: Implementation of Brain Breaks® in the Classroom and Its Effects on Attitudes towards Physical Activity in a Chinese School Setting (2021) [77]</p> <p><b>School in Henan province, China</b></p>	<p>Quasi-experimental design</p>	<p>Examine the effects of three-months of classroom-based Brain Breaks Physical Activity Solution (Brain Breaks) on attitudes toward physical activity levels of primary school children in Henan Province, China</p>	<p>704 primary school children (370 boys and 334 girls) from 3rd to 5th grade (7-11 years old); IG: n= 353, CG = 334</p>	<p>Each Brain Breaks video provided movement-integrated teaching with motor and fitness skills presented by animated and real-life instructors. In addition to PA, the content of the video</p>	<p>No intervention material</p>	<p>None mentioned</p>	<p>The main time effect (before and after the intervention) was significant (<math>p &lt; 0.001</math>) for all APAS scales. Significant main effects of Group for Learning (<math>p = 0.009</math>), Fun (<math>p = 0.007</math>), Fitness (<math>p &lt; 0.001</math>), and Personal Best (<math>p &lt; 0.001</math>) scales.</p>

				incorporated health and nutrition education. <b>Type: Videos</b> <b>Duration: 3</b> <b>months</b>			
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\*APAS: Attitudes toward Physical Activity Scale, BMI: Body mass index, BP: Blood Pressure, CG: Control Group, FV: Fruit and vegetable, IG: Intervention Group, MPVA: moderate-to-vigorous physical activity, MT: Mobile technology, PA: Physical activity, PT: Post-test, RCT: Randomized controlled trial, SSB: sugar-sweetened beverages.

### C. Quality appraisal

According to the JBI critical appraisal tool for RCTs, seven out of the eight RCTs were of moderate quality, one was of high quality while the other was of low quality. As for the quasi-experimental designs, five out of six studies were of high quality, and one was of moderate quality. The only qualitative study included was of moderate quality. The detailed scores of each design are presented in tables 3.1, 3.2 and 3.3.

Table 3. Quality score of RCTs based on JBI critical appraisal tool for RCTs

\*Note: Rating score is from 1 (lowest) to 13 (highest); Y= Yes; N=No; U= Unclear.

Quality score were categorized into three groups: Low: 1-5, Moderate: 5-9, and High: 10-13

A- Author (Year)	1	2	3	4	5	6	7	8	9	10	11	12	13	Score	Quality
Majumdar et al. (2013)	N	N	Y	N	N	U	Y	Y	N	Y	Y	Y	Y	6	Low
Gan et al. (2019)	Y	N	Y	N	N	U	Y	Y	U	Y	Y	Y	N	7	Moderate
Shwinn et al. (2014)	Y	U	N	N	N	U	Y	Y	Y	Y	Y	Y	U	7	Moderate
Lana et al. (2014)	Y	N	Y	N	N	N	Y	Y	N	Y	Y	Y	U	7	Moderate
Lin et al. (2020)	Y	N	Y	N	N	U	Y	Y	U	Y	Y	Y	Y	8	Moderate
Abraham et al. (2015)	Y	N	Y	N	N	Y	Y	Y	U	Y	Y	Y	Y	9	Moderate
Smith et al. (2014)	Y	U	Y	N	Y	Y	Y	Y	U	Y	Y	Y	Y	10	High
Baranowski et al. (2011)	Y	N	Y	N	N	U	Y	Y	N	Y	Y	Y	Y	8	Moderate
Nollen et al. (2014)	Y	N	Y	N	N	N	Y	Y	N	Y	Y	Y	Y	8	Moderate

Table 4. Quality score of quasi-experimental designs based on JBI critical appraisal tool for quasi-experimental designs

Author (Year)	1	2	3	4	5	6	7	8	9	Score	Quality
Hajar et al. (2019)*	Y	U	Y	N	Y	Y	Y	Y	Y	7	Moderate
Nollen et al. (2012)	Y	Y	Y	N	Y	Y	Y	Y	Y	8	High
Agnaska et al. (2020)	Y	Y	Y	Y	Y	Y	Y	Y	Y	9	High
Curriel et al. (2020)	Y	U	N	N	Y	Y	Y	Y	Y	6	Moderate

Note: Rating score is from 1 (lowest) to 9 (highest); Y= Yes; N=No; U= Unclear.

Quality score were categorized into three groups: Low: 1-4, Moderate: 5-7, and High: 8,9

\*Two additional studies used the same protocol as Hajar et al. but in different setting, so we mentioned the earliest publication.

Table 5. Quality score of qualitative study designs based on JBI critical appraisal tool for quasi-experimental designs

Author (Year)	1	2	3	4	5	6	7	8	9	10	Score	Quality
McGuirt et al. (2021)	Y	Y	Y	Y	Y	U	N	Y	Y	U	7	Moderate

Note: Rating score is from 1 (lowest) to 9 (highest); Y= Yes; N=No; U= Unclear.

Quality score were categorized into three groups: Low: 1-4, Moderate: 5-7, and High: 8-10

## D. Qualitative Study Findings

### 1. Nature of the educational interventions done during the pandemic

A total number of 6 interviews were conducted with key informants, 5 representing the Lebanese private schools and one representing the Lebanese public schools.

During the pandemic interruptions along with the other political disturbances taking place in the country. This necessitated the school closures to protect from COVID-19 spread, and also to ensure the safety of children amid the road closures and repeated strikes chaos. The interviewed teachers reported using Zoom as the main online platform during online learning, in addition to Whatsapp as a means of communicating with students the homework and supplementary material and the necessary links for them to follow.

## ***2. Themes and subthemes emerging from the interviews***

A total of four themes and thirteen subthemes emerged from out interviews with the key informants. A summary is presented in Table 6.

Table 6. Summary of themes/subthemes emerging from interviews with key informants

Themes	Sub-themes	Supportive quotes
Perceptions of key informants on the role of NE in schools and parental involvement in promoting healthful behaviours	NE sessions are needed to improve children’s eating habits	<p><i>“..two nutrition sessions per week for children are necessary to educate them” (KI.PR1)</i></p> <p><i>“..what we give as science teachers is not enough, children need more extensive nutrition sessions” (KI.PR2)</i></p> <p><i>“..every school should have a nutrition educator that gives regular session” (KI.PR4)</i></p> <p><i>“..children need guidance on what is healthy and what is not” (KI.PR5)</i></p>
	Healthy food environment in schools	<p><i>“..unhealthy food should not be sold at school kiosks” (KI.PR1)</i></p> <p><i>“..children should not be allowed to bring unhealthy stuff” (KI.PR3)</i></p>

		<p><i>"..fruits should be available at the kiosk" (KI.PR4)</i></p> <p><i>"..the kiosk is a big problem, makes it convenient for kids to buy unhealthy stuff" (KI.PR5)</i></p>
	<p>Parental and teachers' involvement</p>	<p><i>"..teachers as well as children need to attend these sessions" (KI.PR1)</i></p> <p><i>"..parents should be educated, not only children" (KI.PR3)</i></p> <p><i>"..parents should attend the workshops too" (KI.PR4)</i></p> <p><i>"..parents should also learn what to send with their children" (KI.PR5)</i></p>
<p>Perceptions of key informants towards the use of digital learning as compared to traditional learning</p>	<p>Online tools can be interactive, fun, and engaging</p>	<p><i>"..when we explained something related to food, like the food pyramid, we had breakfast online" (KI.PR1)</i></p> <p><i>"..the teacher can split students to breakout groups and make them play a game" (KI.PR2)</i></p> <p><i>"Children enjoy media in learning" (KI.PR2)</i></p> <p><i>"..children in virtual classes were highly interactive as if they were in the class" (KI.PR3)</i></p> <p><i>"..we used to practice and dance online" (KI.PR3)</i></p> <p><i>"..children enjoy quizzes in a game form" (KI.PR2)</i></p> <p><i>"..students liked the animated presentations and videos" (KI.PR4)</i></p>

	<p>Digital interventions promote time flexibility</p>	<p><i>“..If we didn ’t find time for them to be given in the classroom, the health educator will give them online, and this will be helpful” (KI.PU)</i></p> <p><i>“..they can watch the video anytime” (KI.PR1)</i></p> <p><i>“..children can go over the material again” (KI.PR2)</i></p> <p><i>“..it does not interfere with the school curriculum” (KI.PR4)</i></p>
	<p>Limited social interaction and communication with teachers and peers</p>	<p><i>“..there was no socialization or acquaintance” (KI.PR1)</i></p> <p><i>”..we cannot give everything online and disregard the actual class atmosphere and social interaction and the interaction between students and their teachers” (KI.PR2)</i></p> <p><i>“..children need to experience learning in a school setting with friends” (KI.PR4)</i></p>
<p>Barriers faced during the online learning process</p>	<p>Country-level challenges</p> <p>Technical challenges (electricity outage and internet shortage)</p>	<p><i>“..for it had myriad disadvantages such as internet and electricity shortages” (KI.PR1)</i></p> <p><i>“..we were facing a problem with internet and electricity shortages” (KI.PR2)</i></p> <p><i>“..we weren't able to keep their cameras on the whole session due to Internet issues” (KI.PR3)</i></p> <p><i>“..there were many challenges to the online process, like wifi and electricity issues” (KI.PR4)</i></p>



	Economic crisis, political disturbances and strikes	<p><i>“..communication was hard because we cannot turn cameras on..” (KI.PR5)</i></p> <p><i>“..internet and electricity shortages were a main obstacle” (KI.PU)</i></p> <p><i>“..but also the economic problems, especially state employees whose pensions are on the 1500 L.L. rate, and the increase in food and fuel prices, it all lead to educators going on strikes and not giving the online sessions”( KI.PU)</i></p> <p><i>“..the political situation and repeated strikes lead to less online sessions delivered” (KI.PU)</i></p>
	<p>Student-level challenges: Low attendance and limited attention/laziness</p> <p>Weak discipline</p>	<p><i>“..there was a problem in communicating ideas because some children were not attending the sessions”(KI.PR5)</i></p> <p><i>“..children were not attending the sessions” (KI.PR2)</i></p> <p><i>“..some students were lazy” (KI.PR3)</i></p> <p><i>“others did not attend just because they are lazy or not willing to” (KI.PR4)</i></p> <p><i>“..students lost focus and attention in zoom classes” (KI.PR5)</i></p> <p><i>“..we scroll on Facebook through a phone and get disturbed, so how would it be for children to look into PowerPoints, read, write, and copy” (KI.PR2)</i></p> <p><i>“..the discipline or behaviour of a student sitting in front of a computer, telephone, tablet screen won't be the same if he</i></p>

	Limited availability of devices	<p>were in the classroom”;  “Discipline is absent in online learning” (KI.PR3)</p> <p>“I had students whose parents sat next to them and helped them” (KI.PR5)</p> <p>“..another obstacle.. also if the students own a phone, tablet or computer, or they share them with other siblings (KI.PU)</p> <p>“..siblings from the same home faced problems as their classes were at the same time and they share the tablet” (KI.PR3)</p>
	<p>School-level challenges</p> <p>Limited training of school-teachers on the use of digital tools</p> <p>Limited availability of digital resources</p>	<p>“..teachers were not equipped for online delivery” (KI.PR1)</p> <p>: “..teachers faced difficulties with new technology” (KI.PR3)</p> <p>“..this could have had a positive effect if we have professors and health counselors who are familiar with the technology, but it takes time for you to do training” (KI.PU)</p> <p>“..The material was not designed in a digital format” (KI.PR2)</p> <p>“..it was hard to cope with new online tools and deal with an edited curriculum in order to cover everything” (KI.PR3)</p> <p>“..The teachers also faced problems with the material and making it online-friendly” (KI.PR4)</p>
Recommendations for digital NE interventions in Lebanese schools	Designing interactive, fun, and engaging videos and games	“..when we explained something related to food, like the food pyramid, we had breakfast online” (KI.PR1)

		<p><i>“..the teacher can split students to breakout groups and make them play a game” (KI.PR2)</i></p> <p><i>“..students need to interact with a character or with their peers in a game”(KI.PR4)</i></p>
	Supportive to in-class learning	<p><i>“..sending videos a day ahead can facilitate the learning process” (KI.PR1)</i></p> <p><i>“..I support the idea of sending a task to the student a day ahead” (KI.PR2)</i></p> <p><i>“..it might be a video or collecting some information with his parents including some discussions with them” (KI.PR3)</i></p> <p><i>“..videos and animated PowerPoints can aid the learning process” (KI.PR5)</i></p>
	Collaborations with educational institutions and ministries to facilitate the implementation of digital NE in schools	<p><i>“..it happens with all the parties that operate, such as AUB” (KI.PU)</i></p> <p><i>“..it will be implemented with the assistance of several responsible bodies, for example, the internet is with the Ministry of Communications, and there are many private meetings with them..” (KI.PU)</i></p>

When it came to the topic of nutrition education in schools, all our key informants stressed on the need for such programs to improve the children’s health and wellbeing. They reported different challenges that were faced during the online learning process, in addition to advantages of using online platforms for education. Recommendations for digital NE programs were provided. Table 4 summarizes the

main themes and subthemes extracted from the interviews with our key informants. Four main themes were identified: the perceptions of teachers on the need for promoting healthy eating habits in schools, the perceptions of teachers towards the use of digital learning vs classroom, barriers faced during the online learning process, and recommendations for digital NE interventions in Lebanese schools. Thirteen sub-themes were later identified from these major themes.

- *Theme 1: Perceptions of key informants on the role of NE in schools and parental involvement in promoting healthful behaviors*

According to our 5 interviewed teachers from the private sector, their schools have no stable nutrition education component, but rather few workshops done throughout the year. The children, according to them, do get influenced by these workshops and ask their parents to prepare healthy food for them. The need for nutrition education for children was highlighted by all the interviewed teachers, as they stressed on the importance of dedicating fixed sessions for NE, as two of them elaborate: “..what we give as science teachers is not enough, children need more extensive nutrition sessions” (KI.PR2); “..every school should have a nutrition educator that gives regular sessions” (KI.PR4).

The teachers do believe that securing a healthy eating environment through the offerings at the school kiosk, as one teacher mentions, “..the kiosk is a big problem, makes it convenient for kids to buy unhealthy stuff” (KI.PR5) “... Additionally, four out of the five interviewed teachers emphasized that teachers and parents should be involved in the NE sessions, since they have a great influence on children’s diet:

*“..teachers as well as children need to attend these sessions” (KI.PR2); “..parents should be educated, not only children” (KI.PR3).*

- *Theme 2: Perceptions of key informants towards the use of digital learning as compared to the traditional classroom learning*

Our key informants had both positive and negative perceptions toward the use of digital tools as compared to traditional classroom learning. First, they identified digital tools as being fun, engaging, and interactive, which made children more enthusiastic to learn: *“..the teacher can split students to breakout groups and make them play a game” (KI.PR1), “Children enjoy media in learning” (KI.PR1), “..children in virtual classes were highly interactive as if they were in the class” (KI.PR2).* Also, time flexibility was a major positive aspect of the online learning process, as children were able to access and save the material and watch it at their convenience: *“..If we didn’t find time for them to be given in the classroom, the health educator will give them online, and this will be helpful” (KI.PU); they can watch the video anytime” (KI.PR3).*

As for the negative perceptions, our key informants identified limited social interaction with peers and teachers as a major setback related to online learning. As one teacher mentions, children need to be present in a classroom setting to first interact with other children and with their teachers, *“..we cannot give everything online and disregard the actual class atmosphere and social interaction and the interaction between students and their teachers” (KI.PR4).*

- *Theme 3: Barriers faced during the online learning process*

All our key informants mentioned electricity and internet shortages as the main challenges facing them and their students during the closure of the schools due to the COVID-19 pandemic and the shift to online education. They stated that these are country-level challenges that affected both the teachers' and students' performance, and as one of the teachers mentioned, "*..we were facing a problem with internet and electricity shortages*" (KI.PU), and another added, "*..we weren't able to keep their cameras on the whole session due to Internet issues*"(KI.PR2).

Other challenges faced during online learning were student-related, and those included low attendance, limited attention during the sessions, and the limited availability to electronic devices. Teachers stated that low attendance in online classes affected the student's interaction and involvement in the learning process, and one teacher emphasized how the communication was affected, "*..there was a problem in delivering information because some children were not attending the sessions*" (KI.PR3). Weak student discipline was an additional challenge faced during online learning, as teachers believed that the class setting is imperative for building discipline. In their opinion, children are disciplined through the classroom rules and the teachers' presence: "*..the discipline or behaviour of a student sitting in front of a computer, telephone, tablet screen won't be the same if he were in the classroom*" (KI.PR 2); "*children can be eating and playing during online class without the teacher knowing*" (KI.PR 3).

The teachers, from their end, also faced challenges related to their readiness to the use of digital tools and material, and mentioned that as an additional factor that altered the effectiveness of online learning, "*..it was hard to cope with new online tools*

*and deal with an edited curriculum in order to cover everything” (KI.PR4); “The teachers also faced problems with the material and making it online-friendly” (KI.PR5).*

Unique barriers to the public schools setting were presented by our key informant. She stated that the economic situation in the country, including the currency devaluation and increase in the food and fuel prices, while teachers’ salaries being fixed at the old Lira rate, has led to increased strikes. This further hindered the online learning process, amidst the existing technical challenges.

- *Theme 4: Recommendations for digital NE interventions in Lebanese schools*

The teachers agreed that in-school education is irreplaceable, but using digital tools can be helpful and support the in-class learning process. They suggested that video and/or game format for NE delivery can support in-class practical and sensual applications. A video, according to them, is more practical given the internet and electricity shortages, as children can watch it at their own pace, instead of a fixed online hour that all students are obliged to commit to regardless of their circumstances. Our key informant representing public schools stressed on the necessity of collaborations with educational institutions, as well as the ministry of communications, to facilitate the access of schools to internet supply that students can use for NE sessions.

## CHAPTER IV

### DISCUSSION

In this section, results of the scoping review, and findings from the qualitative study were first discussed separately. Integrated findings were also presented and explored in light of the scientific literature.

#### **A. Discussion of scoping review results**

The online (digital) interventions in the scoping review conducted as part of this study can be grouped into three categories: interventions that focused on improving children's knowledge, attitudes, and perceptions towards healthful eating and physical activity, digital interventions that targeted changes in eating behaviors and lifestyle habits, and interventions that aimed to improve children's body weight and anthropometric measures in an attempt to prevent overweight and obesity.

#### *Changes in children's knowledge, attitudes, and practices toward eating and PA:*

Three interventions targeted children's knowledge and attitudes toward healthful eating habits [58, 64, 65], and showed a consistent increase in children's attitudes and knowledge scores. All these interventions utilized a game format, where the child is required to choose healthful food options (for example, FVs, beans, corn), in addition to avoiding unhealthy ones (such as SSBs, chips, fast food), in order to advance in the game levels. Sahota et al. (2010) presented similar improvements in attitudes and knowledge were observed in response to traditional school-based NE interventions, where NE sessions were given to children in-class, and then their choices were



evaluated according to the knowledge given [42]. Increasing knowledge is highly dependent on the mentor's ability to deliver the information, in addition to proper reception by children. In the case of digital interventions included in our review, a virtual instructor and/or NE videos took the place of the teacher or nutrition educator, while still proving that these digital tools are successful at delivering the NE messages to children, as evidenced by increased knowledge scores.

Regarding physical activity, three of the included interventions aimed to increase knowledge and perception of the importance of PA, in addition to increasing the children's PA levels. According to Mok et al. [72], BrainBreaks was a video-based intervention that was implemented in ten different European, Asian, and African countries, and aimed to improve the attitudes of children toward physical activity [72, 77]. The intervention was delivered in-class, through videos that encouraged physical activity and were given twice per week for a duration of three to four months (varied by country of implementation). Overall, the intervention was shown to significantly improve the exercise self-efficacy, enjoyment, learning, perceived benefits, and personal best components of 8-11-year-old children, albeit differences in the magnitude of these changes across countries. In addition, the study showed positive effects for school-aged children from both sexes. On the other hand, BrainBreaks did not lead to significant improvements in the children's confidence in their fitness capabilities that reflect strength and endurance, such as their belief that they can move heavy objects or going on long walks. These effects could be attributed to the intervention duration that lasted over four months, which was found to be sufficient to change perceptions and attitudes toward physical activity, but was not long-enough to make children more confident about their fitness level. Previous studies have shown that increased fitness

levels require a more frequent, in-person engagement in a physical activity routine for at least 60 minutes per day as a part of a sustained active lifestyle is needed for significant improvements to be noted [82, 83].

*Changes in children's eating practices:*

Several eating habits were targeted as part of the interventions and studies included in this scoping review. These eating habits included the increase in FV, increasing water as a main source of hydration for children, and the reduction in intake of SSB and processed foods. Overall studies that explored these habits showed improvement in the children's eating behaviors. The targeted eating habits amongst studies included in this scoping review included increasing fruits and vegetable intake, promoting water intake, and reducing the intake of SSB and processed foods. All the six studies that targeted these behaviors reported improvement [66, 69, 74-76, 81]. Similar findings were reported by Murimi et al. [84], a systematic review of online NE programs that targeted adults, adolescents, as well as children in high-income countries. The positive effect on children's eating behaviors is also in line with other school-based nutrition education interventions that focused on improving children's eating habits [85-88]. Increase in FV consumption was another common finding with school-based interventions. According to Howerton et al. [89], school-based interventions relied on classroom weekly or monthly sessions, family engagement, and food service to promote the increase in FVs [89]. In our review, Nollen et al. [67] used a computer-based website to promote increased FVs. Their program used an audible alarm system that sends automatic reminders for the children to consume FVs throughout the day. This might have played an important role in the significant increase in their FV consumption, especially that Majumdar et al., another included digital intervention that used a game

format did not achieve significant improvements in FV consumption among the participants [81]. This might also be explained by the fact that the game design focused on the character avoiding SSBs and ultra-processed snacks, and the FVs promotion was not the main theme of the game.

According to a systematic review conducted by Gonzalesz-Suarez and colleagues [90], the school-based interventions that showed reduction in SSB intake were delivered in the traditional school setting and were mainly behavioral and educational. The approach they followed was through explaining the negative health consequences associated with SSB consumption. Two of our included interventions [66, 68] achieved similar reductions in SSB intake to Gonzalesz-Suarez et al., but differed in the method of delivery. Both Smith et al. [68] and Nollen et al. [66] used a web-based program to deliver modules that explain SSB health consequences and encouraged the reduction in SSB intake through reminders sent daily through the programs. While online modules can deliver similar educational messages with the lessons given in class, the reminders feature was thought to be key for children's dedication and compliance in these interventions, which was unique to their digital design.

All interventions included in the scoping review that targeted children's eating behaviors were based on more or more theories of behavioral change. Significant improvements in increased FV intake and decreased SSB and processed snacks consumption were observed in these interventions showed. This effect was mediated by the theories' effect on specific aspects of children's behaviors. For instance, the SCT is known to improve skills and self-efficacy. This was manifested in the games that children played through the system of unlocking levels that requires constant improvement in the characters' eating behavior, in addition to handing the child

responsibility for picking healthy choices amid the obstacles set in the game design. In addition, the self-determination theory, which was integrated in three of the included intervention [79, 81], is thought to play a role in improving children's eating habits through increasing their competence. This was an important aspect of the games designed for children, as their experience of mastery was profound through accomplishing the character's goals. Other reviews highlighted the important role of behavioral change theories in health interventions and the need to adapt them to achieve preset objectives [91, 92]. The reason behind the importance of behavioral change theories lies in their consideration of the different factors that affect individuals' behavior. Those include societal, individual, social, and contextual factors that cannot be viewed separately from the individuals' behaviors. In our context, children's eating behavior and lifestyle habits are affected by parental lifestyle, peer influence, school environment, in addition to their knowledge and experiences. Thus, the integration of all these components is imperative when designing interventions aimed at improving their knowledge and attitudes toward healthy eating and lifestyle habits, and at a later phase, their eating and lifestyle behaviors.

*Changes in children's anthropometric measures:*

Only three studies included in our scoping review explored the effects of online NE interventions on BMI and anthropometric measures. No significant decrease was observed in BMI and waist circumference was observed among children after a 15-week multi-component digital intervention among boys at high-risk of obesity from low-income Australian communities [68]. Another intervention showed a decrease in BMI among obese children who received Abraham et al. [71] web-based curriculum however, the changes were not found to be statistically significant (mean difference:

0.4,  $p = 0.15$ ). This can be attributed to the short duration of both interventions that ranged between 12 to 15 weeks. Authors highlighted that their broad inclusion criteria, which included boys at risk of becoming obese based on their PA and screen time, decreased the ability of observing significant improvements in anthropometric measures. Another reason mentioned was the 15-month duration of the interventions, as authors expected that if the observed improved eating behaviors can be sustained, changes in anthropometric measurements will consequently be observed. The duration is an important factor when aiming at a significant decrease in BMI, especially following a sustained plan that encourages building healthier eating and lifestyle habits over time as opposed to restrictive dieting. It was reported in several studies that explored school-based NE interventions that longer duration, at least 1-2 years, are required for significant changes in BMI to occur among school-aged children [93, 94]. Similarly, a meta-analysis conducted by Gonzalez-Suarez et al. [90] showed that school-based interventions conducted on school-aged children in both low- and high-income countries did not lead to significant BMI reduction (mean difference:  $-0.62 \text{ kg.m}^2$ ), and authors suggested that more a 2- year intervention period would be needed along is needed to observe significant changes in body composition [90]. Another possible reason for the lack of a significant effect of the digital NE interventions included in our review on weight status could also be attributed to the absence of parental and environmental engagement. According to Mclean et al, parental involvement have been highlighted as a main mediator of children's healthy lifestyle habits adaptation. This was explained by the parents being perceived as role models by their children, and mimicking their eating and lifestyle habits is not an exception. Additionally, the school environment has shown to play a major role in inducing long-

term changes in children's behavior and consequently anthropometric measurements [95-97]. This includes the school kiosks offering healthy breakfasts and snacking options, combined with restricting SSB and packaged snacks. It is important to note, however, that only one digital intervention was identified in our scoping review that targeted anthropometric changes as a primary outcome, which leaves little room for understanding what could be the factors that contributed to the non-observed effects on those measures.

*Feasibility and acceptability of digital interventions by children and their parents:*

The primary goal of three of the 16 interventions included in our review was to assess the feasibility and acceptability of the proposed interventions, and they found to have positive outcomes. Abraham et al. [71], an intervention that recruited obese children and teens from a tertiary hospital setting, concluded that their internet-based curriculum targeted toward 12-18 year old obese Chinese adolescents coupled with cell phone reminder is feasible to adapt, based on high recruitment rate, high login rate, and completion of the online sessions [71]. More thorough feedback was given by participants in the study conducted by McGuirt et al. [70], where children aged 5-10 years old and their parents reported liking the web-based virtual avatar intervention, especially the interaction, educational content, pictures/graphics, and the tailored advice. Both children and their parents reported enjoyment interacting with the avatar, including the ability to engage in dialogues back and forth with it and discuss their dietary habits. Interacting with a virtual professional was a unique approach to this digital intervention and is an important factor to build on when designing remote interventions. Evidence supports the importance of the interaction component, as Poole

stresses on the importance of the engagement of human-computer interaction specialists for designing successful mobile health interventions to increase participant understanding, motivation, and dedication [98].

In these three feasibility studies, challenges to implementing the recommended change were faced. These challenges were related to the low-income and poor-resourced setting of implementation. In McGuirt et al.'s [70] virtual avatar, a section was dedicated to suggesting nearby stores based on the participants' addresses where healthful food options are available. Not all dyads were able, however, to purchase the recommended options, and some were able to purchase a few of them only, accordingly with their purchase power. Another challenge related to the low-income setting was the lack of built-in environment. In Nollen et al.'s intervention [67], girls were not being able to engage in the recommended physical activities due to the lack of space in their neighborhoods. Instead, they reported resorting to the mobile and computer devices in their free time. The challenges that are unique to poor-resourced settings should be addressed from as early as the design phase of the interventions, to make necessary adjustments to ensure that the recommended eating and physical activity habits are feasible to adapt by the target population.

The interventions included in this review were implemented either in LMICs, or poor-resourced communities in high-income ones. It is important to note that we did not capture any digital NE intervention that was implemented in countries of the MENA region, which presents a major gap in this area. The interventions that were included varied in designs, methodologies, and target groups, which makes it difficult to generate

a clear recommendation of what is the best approach when it comes to digital NE in low-income settings. Thus, more interventions are needed, and those should focus on the elements of interaction and fun, as these were the ones most reported as contributors to interventions acceptability among children and adolescents. Games have shown to be successful at engaging children in the behavior change process, and more game-based NE interventions are required to reach particularly the most vulnerable populations of the MENA region. Incorporating interactive videos with real-life or virtual instructors has also been shown to be effective among children and adolescents, so these elements are recommended for future digital NE designs. Lastly, more interventions that include personalized reminders are needed, as only few interventions included this feature but reported a positive feedback from participants and/or their parents. Overall, although the interventions included in our review have shown to be successful at improving children's knowledge, attitudes and behaviours on healthful eating and lifestyle habits, each group of digital NE interventions adopted a unique approach, lasted for a different duration and measured different outcomes, and more insight on each of them is needed to come up with reliable inferences, taking into account the practical implications associated with poor-resourced settings.

## **B. Discussion of qualitative study findings**

The results of the scoping review guided the interviews conducted with the key informants in terms of highlighting the main digital tools used in the reviewed interventions. Also, the challenges to implementing digital NE interventions associated with LMICs and resource-poor settings, as discussed in the reviewed interventions, were discussed with our key informants.



A total of four themes and twelve subthemes emerged from our interviews with key informants. The themes revolved around the key informants' perceptions of the need for NE in schools, their perception with digital tools as means for education, the challenges faced with online learning, and finally their recommendations for digital NE in Lebanese schools.

Regarding the perceptions of key informants of the importance of NE in schools, they believe that NE sessions addressed to children are needed to improve their eating and lifestyle habits. In addition, they stress on the need to secure a healthy eating environment at school and involving teachers and parents in the NE given. The teachers' role in specific was highlighted by Kupolati et al. [99], where teachers from South Africa expressed the need to strengthen teachers' capacities to enable them to model positive eating behaviors among primary school children. In addition, children's exposure to specific types of food has been shown to greatly affect their consumption patterns [100]. This is where parents', as well as the school eating environment involvement is important to control the availability aspect of food to the child.

Regarding the advantages of online learning, key informants, most commonly, reported time flexibility and great room for creativity as a plus. This is in line with finding from India, where teachers referred to online learning as 'flexible' and 'convenient', and 'time saving' [101], and from Egypt and Saudi Arabia supports flexibility, engagement, and creativity as advantages to online tools [102]. The online tools used in these settings included PowerPoints for delivering the education sessions, in addition to online quizzes for evaluation and interactive videos as supplementary material. These tools were used in response to the COVID-19 pandemic-related

confinement that necessitated the shift to online education. However, we did not find a health promotion or NE intervention that was implemented in similar MENA setting.

As for the digital tools used, the most frequent tool reported by teachers in our study was using videos. Other teachers in Greece reported the use of more advanced tools, namely project management software and wiki tools to interact with children [103]. In the latter study, authors highlighted that those teachers participating in their study had different levels of literacy on technological advances in education, and that affected the type of the digital tools they used. The use of videos reported in our study can be due to the availability of videos on numerous topics, but also could be attributed to the simplicity of preparing a slideshow with the needed information and adding the educator's recordings to it in a voice-over format. Other digital tools are more sophisticated and untrained teachers can find them more challenging.

The main challenges to online learning presented by our key informants were country-level challenges related to poor connection and electricity shortages, which disrupted the learning process and created additional obstacles to communication and interaction with students. These technical and logistical challenges have been also reported earlier in similar LMIC settings including Indonesia [104] and India [101] were "poor internet connection and/or electricity" affected the online learning process. A common finding on a student-level was related to poor discipline. Some of our teachers reported a lack of discipline when students are at home with their cameras off, and their siblings or parents disrupting the learning environment, and this was also a common challenge with Indonesian teachers who reported 'interference from younger siblings' as a challenge [104]. This is mainly due to the absence of continuous monitoring and observation by teachers and school principals as in the school setting. A

greater load was placed on already busy and overwhelmed parents to make sure their children are following up with classes. Similar findings were also reported from Egypt and Saudi Arabia, with greater focus ‘family interruptions’ as a common challenge to students during online classes [102].

Using digital tools for nutrition education can be helpful, but only in addition to in-class follow-up and practical application, as our key informants concluded. Certain aspects of in-class learning, such as social interaction and teachers’ eye contact cannot be mimicked in virtual settings, as they mentioned. However, teachers agree that digital tools are enjoyable, beneficial, and well-accepted by children, and their introduction to the learning process is advantageous.

### **C. Integration of findings from the scoping review and qualitative exploratory study**

Results from the scoping review conducted as part of this study highlighted promising findings regarding the effectiveness of online NE in improving children’s knowledge and attitudes toward healthy eating and lifestyle habits. According to these results, using digital tools in NE can lead to positive changes in children’s eating behavior and knowledge of healthy eating and lifestyle habits. A common digital tool reported in the included studies was using interactive and instructional videos, in addition to incorporating fun games into the learning process. These methods are in line with our key informants’ suggestions on methods for delivering NE programs in Lebanese schools. Specifically, the teachers that recommended the use of videos justified their choice by the flexibility of watching them at the students’ convenience, given the challenges with electricity and internet shortages. The advantages of using digital tools, as rationalized in the interventions included in the scoping review,

included the elements of fun, creativity, and interaction. Our key informants agree that digital tools offering a unique range of ideas and applications for education delivery, but this is acknowledged by them only when coupled with in-person activities and application, as the sensual and sociological school experience is vital for the learning process, according to them. Governmental support and interventions remain imperative to facilitate the implementation of digital NE, especially to overcome technical barriers related to internet shortages and electricity outages.

In addition, narrative synthesis showed that children who participated in a variety of digital nutrition education interventions had positive changes in their eating and physical activity behaviors. The effectiveness of these NE interventions can be attributed to multitude of factors including the use of interactive videos, fun activities and avatar characters that attracted children and helped improve their efficacy, competence, mastery and confidence in adopting healthier eating habits and performing physical activity. These results were also in line with the favorable attitude of key informants from the qualitative interviews towards online NE. They highlighted that such interventions can be fun, interactive, and be a valuable addition that complements the in-class learning and supports it. However, teachers also cautioned from the distractions that may come along with the use of digital devices and that may lead to lack of concentration during sessions. This is where the parents' role is imperative in maintaining home learning environment that facilitates their children's receptiveness to the digital tools. Another challenge mentioned by the teachers was the weak student discipline in virtual settings. This might not be an issue when using videos for children

to watch before class, as teachers recommended, or when sending evaluation games or quizzes.

Moreover, key informants highlighted challenges and barriers to the use of online educational approaches including digital interventions for NE and promoting behavioral change. Some of these challenges were school-relevant and included limited teacher training on the use of digital tools, and the limited availability of these tools. On the other hand, key informants highlighted country-level barriers including poor electrical coverage and a rather unreliable WIFI infrastructure that can further render these online and digital interventions harder to achieve, especially at a large scale. In addition, teachers agreed that the school administration collaboration in this regard is essential for the implementation of such interventions and incorporating them into the school curriculum.

It is worth noting that not every digital approach can be feasible to adapt, given the unique challenges of the context. The key informants' perception of a certain digital tool effectiveness took into consideration the different more than did it consider the digital tool and its design and effectiveness independently from the barriers faced during their experience with online education tools.

#### **D. Strengths and limitations of the study**

The present study combined two methodologies, a scoping review that was complemented with an exploratory qualitative study, To our knowledge, this is the first scoping review that explored online NE interventions targeting school-aged children and adolescents from low- to middle-income settings and/or resource poor settings. A rigorous search strategy was followed in this scoping review and it was guided by the

PICOS criteria. The search was done on three different databases that enabled us to capture as much relevant studies as possible, with different study designs. The database search included a wide range of terminologies that were developed with the expertise of a medical librarian to ensure all the inclusion criteria are covered by the search. Also, the JBI quality appraisal tools were used to assess the quality of different study designs and interventions included in the scoping review (RCTs, quasi-experimental, and qualitative), which helps improve transparency and trustworthiness when reporting results. Nevertheless, the scoping review should be interpreted while considering few limitations. First, articles that did not follow a randomized, controlled design, were included, as the evidence on online NE programs is scarce, especially in LMIC settings, and our aim was to capture as many digital interventions and methodologies as possible. Another limitation is the diversity in methodologies of different studies included in this review, which makes it difficult to discern which specific types of digital interventions or theoretical frameworks underpinning these educational interventions may be most effective in changing eating habits and lifestyle behaviors of school-aged children.

As for the exploratory qualitative phase of the study. There were also several strengths and weaknesses that are worth considering. To date, and based on the results of the scoping review, there have been limited studies that explore the use, acceptance, and feasibility of online NE interventions among children from LMICs and particularly from the MENA region. The present study aimed to address this gap in the literature by exploring the perceptions and experiences of teachers' and representatives of educational departments with respect to the use of digital tools in resource-challenged settings. Another strength of the study is exploring the use of online interventions during the era of the COVID-19 pandemic that have forced schools globally to

transition to online teaching approaches, yet limited studies have been exploring the challenges faced with online teaching during the pandemic. However, our findings should be interpreted in the light of several limitations. First, our sample size was small and included few teachers from private schools in Beirut, and one representative from the public-school system. Future studies are needed to further explore the themes that emerged from this exploratory study and help identify the types of digital interventions that may be feasible and acceptable for teachers, children, parents and school administrators in Lebanese schools. In addition, the present study did not consider potential differences in the modes of interventions and resources that may be effective, and results from this exploratory qualitative study to establish recommendations on what is feasible and might work in terms of digital NE in Lebanese schools. A greater sample of key informants from both private and public Lebanese schools is needed to construct a clearer picture on the feasibility and acceptability of digital NE in schools. In addition, we did not interview children to understand their experiences with and perceptions of digital tools. This would also be of additional benefit and would strengthen any set of recommendations concerning what digital tools are acceptable and enjoyable from the children's point of view. Another limitation is limiting the interviews to teachers of private schools, which can be considered as selection bias. We did interview a key informant that is representative of Lebanese public schools, but relaying the voices of public-school teachers that had their own unique challenges (i.e. going on strikes, minimal technological advances, etc.) would have been an valuable addition to our study and synthesis of findings. Additionally, we conducted our interviews through phone calls, and one through Microsoft Teams. This might stand in the way of understanding and reporting non-verbal gestures, such as body language.





## CHAPTER V

### CONCLUSION AND RECOMMENDATIONS

Study findings suggest that digital interventions can improve children's knowledge and attitudes toward healthy eating and lifestyle habits, in addition to positively affecting their eating and physical activity behaviors. However, limited evidence exists as to the impact of such digital interventions on changes in body weight and other measures of nutritional status of school-aged children at risk of overweight and/or obesity, particularly those living in resource-poor settings. The scoping review highlights the scarce data on the use of digital interventions to promote improvements in dietary knowledge, attitudes and practices of school-aged children in countries within the MENA region. The latter region is witnessing overlapping economic, political, and health crises that place children among other vulnerable groups at a greater risk of inadequate dietary intakes and increased risks of overweight and obesity. The COVID-19 pandemic has further exacerbated the situation, through placing greater burden on the health care systems and causing a global economic fallout. Combined, these factors have increased the vulnerability of a high proportion of children to be at risk of food insecurity and inadequate dietary intake, thus further increasing the risk for obesity and other non-communicable diseases, which necessitates NE and health promotion interventions. Digital NE interventions adopting multi-component approaches are needed in MENA region settings to test their effectiveness on inducing positive behavior change among school-aged children and adolescents, and thus enable researchers and public health professionals to identify what is effective and works in such complex, multi-level challenged settings.

Addressing region-specific challenges is key when developing digital NE interventions to promote healthful eating and lifestyle habits. To ensure that designed interventions will reach the most vulnerable, and that the recommendations given are applicable and feasible to adapt in a poor-resourced settings, specific considerations should be given to the technical aspects of any digital intervention and the feasibility of using games, videos or other online sources that can require minimal bandwidth. Government-level collaborations are needed to facilitate the schools' adaptation of digital NE interventions, particularly when it comes to securing internet and electricity supply. Additional considerations shall be given to the built-in environment and healthful food availability in such settings, as securing spaces for physical activity and ensuring children's access to healthful food is essential for the applicability of the given information. The school administration plays a crucial role here in facilitating the adaptation of digital interventions, and also in securing health food school environment. In addition, students' opinions, perceptions, experiences, and preferences are critical to ensure the acceptability of digital educational interventions and NE programs, and may help identify new strategies to increase the adoption of such novel interventions among children and youth. Moreover, parents' experiences and challenges with following-up with their children's digital education experience, and the parents' own digital literacy, are important to understand to ensure their engagement and support. Thus, the perceptions and buy-in of parents along with the school staff and administrators are also key for the design and implementation of any future digital interventions that aim at improving the dietary intake and lifestyle behaviors of children and youth. Last, but not least, studies that help explore the effectiveness of novel methods and strategies in nutrition education and promotion, through using digital platforms or hybrid forms of teaching, are much

needed and will be key to inform evidence-based policies and programs that aim at preventing and managing pediatric overweight and obesity among the school-aged children population in Lebanon and similar settings.

## APPENDIX A:

### JBI CRITICAL APPRAISAL CHECKLIST FOR RANDOMIZED CONTROLLED TRIALS

	Yes	No	Unclear	NA
1. Was true randomization used for assignment of participants to treatment groups?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. Was allocation to treatment groups concealed?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. Were treatment groups similar at the baseline?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. Were participants blind to treatment assignment?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. Were those delivering treatment blind to treatment assignment?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. Were outcomes assessors blind to treatment assignment?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. Were treatment groups treated identically other than the intervention of interest?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8. Was follow up complete and if not, were differences between groups in terms of their follow up adequately described and	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9. Were participants analyzed in the groups to which they were randomized?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10. Were outcomes measured in the same way for treatment groups?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
11. Were outcomes measured in a reliable way?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
12. Was appropriate statistical analysis used?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
13. Was the trial design appropriate, and any deviations from the standard RCT design (individual randomization, parallel groups) accounted for in the conduct and analysis of the trial?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

## APPENDIX B:

### JBI CRITICAL APPRAISAL CHECKLIST FOR QUASI- EXPERIMENTAL STUDIES

	Yes	No	Unclear	Not applicable
1. Is it clear in the study what is the ‘cause’ and what is the ‘effect’ (i.e. there is no confusion about which variable comes first)?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. Were the participants included in any comparisons similar?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. Were the participants included in any comparisons receiving similar treatment/care, other than the exposure or intervention of interest?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. Was there a control group?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. Were there multiple measurements of the outcome both pre and post the intervention/exposure?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. Was follow up complete and if not, were differences between groups in terms of their follow up adequately described and analyzed?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. Were the outcomes of participants included in any comparisons measured in the same way?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8. Were outcomes measured in a reliable way?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9. Was appropriate statistical analysis used?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

## APPENDIX C:

### JBI CRITICAL APPRAISAL CHECKLIST FOR QUALITATIVE RESEARCH

	Yes	No	Unclear	Not applicable
1. Is there congruity between the stated philosophical perspective and the research methodology?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. Is there congruity between the research methodology and the research question or objectives?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. Is there congruity between the research methodology and the methods used to collect data?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. Is there congruity between the research methodology and the representation and analysis of data?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. Is there congruity between the research methodology and the interpretation of results?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. Is there a statement locating the researcher culturally or theoretically?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. Is the influence of the researcher on the research, and vice-versa, addressed?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8. Are participants, and their voices, adequately represented?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9. Is the research ethical according to current criteria or, for recent studies, and is there evidence of ethical approval by an appropriate body?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10. Do the conclusions drawn in the research report flow from the analysis, or interpretation, of the data?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

## APPENDIX D:

### SEARCH STRATEGIES ACROSS EMBASE, MEDLINE OVID, AND EMBASE

Database: **Ovid MEDLINE**(R) and Epub Ahead of Print, In-Process, In-Data-Review  
& Other Non-Indexed Citations and Daily <1946 to October 18, 2021>

#### Search Strategy:

- 
- 1 (nutrition\* education or health education or health promotion).mp. (182941)
  - 2 (diet or lifestyle or physical activity or behavior?r\* change or lifestyle change or behavior?r\* modification or lifestyle modification).mp. (696860)
  - 3 (knowlegde or perception\* or attitude\*).mp. (860404)
  - 4 (online education or online learning or distanc\* learning or virtual learning or virtual education or virtual\* or internet or web?based or web or game\* or gaming or application\* or app or social media or facebook or youtube or instagram).mp. (1797262)
  - 5 (child or child behavior?r or children).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (2472488)
  - 6 (adolescent\* or adolescent behavior?r or adolescence).mp. (2211474)
  - 7 (youth or teen\* or school-aged or teenager).mp. (120714)
  - 8 (developing countries or developing country or low-income country or low-income or middle-income country or middle income or LMIC? or underdeveloped or third world or poor).mp. (817156)
  - 9 1 or 2 or 3 (1640840)
  - 10 5 or 6 or 7 (3643337)
  - 11 4 and 8 and 9 and 10 (1677)
  - 12 limit 11 to yr="2010 - 2021" (1231)

\*\*\*\*\*

#### Embase

##### Session Results

No.	Query Results	Results	Date
#26.	#22 AND #23 AND #24 AND #25	4,603	20 Oct 2021
#25.	#20 OR #21	2,690,882	20 Oct 2021
#24.	('developing country':ti,ab,kw OR developing:ti,ab,kw OR countries:ti,ab,kw OR 'low income country':ti,ab,kw OR 'middle income country':ti,ab,kw OR 'low middle income country':ti,ab,kw) AND [2010-2021]/py	793,741	20 Oct 2021
#23.	(('child':ti,ab,kw OR 'child behavior':ti,ab,kw) AND 'school child':ti,ab,kw OR school:ti,ab,kw OR children:ti,ab,kw OR 'school age':ti,ab,kw OR	1,123,583	20 Oct 2021

- 'adolescent':ti,ab,kw OR 'adolescence':ti,ab,kw  
OR 'adolescent behavior':ti,ab,kw OR  
teen\*:ti,ab,kw OR teenager:ti,ab,kw OR  
'juvenile':ti,ab,kw OR youth:ti,ab,kw) AND  
[2010-2021]/py
- #22. ('e-learning':ti,ab,kw OR 'distance  
learning':ti,ab,kw OR  
distan\*:ti,ab,kw OR learning:ti,ab,kw OR 'virtual  
reality':ti,ab,kw OR 'artificial  
intelligence':ti,ab,kw OR 'internet':ti,ab,kw OR  
virtual\*:ti,ab,kw OR 'social media':ti,ab,kw OR  
facebook:ti,ab,kw OR youtube:ti,ab,kw OR  
video\*:ti,ab,kw OR web:ti,ab,kw) AND  
[2010-2021]/py 1,088,591 20 Oct 2021
- #21. ('diet':ti,ab,kw OR 'dietary intake':ti,ab,kw OR  
'lifestyle':ti,ab,kw OR 'lifestyle  
modification':ti,ab,kw OR behavio?r\*:ti,ab,kw OR  
change:ti,ab,kw OR 'behavior':ti,ab,kw OR  
'physical activity':ti,ab,kw OR  
'knowledge':ti,ab,kw OR 'attitude':ti,ab,kw OR  
'perception':ti,ab,kw) AND [2010-2021]/py 2,666,187 20 Oct 2021
- #20. ('nutrition\* education':ti,ab,kw OR 'health  
education':ti,ab,kw OR 'health  
promotion':ti,ab,kw) AND [2010-2021]/py 54,814 20 Oct 2021
- .....

## Scopus

14

( TITLE-ABS-  
KEY ( "child" OR "adolescent" OR "youth" OR "juvenile" OR "teen" OR "teenager" ) )  
AND ( TITLE-ABS-KEY ( "online" OR "online method" OR "virtual" OR "virtual  
method" OR "web  
based" OR "internet" OR "computer" OR "game" OR "application" OR "facebook" OR  
"video" OR "youtube" OR "distant" OR "distance learning" OR "online  
education" ) ) AND ( TITLE-ABS-KEY ( "developing country" OR "low income  
country" OR "middle income country" OR "Imic" OR "underdeveloped  
country" OR "low income" OR "middle income" OR "poor" ) ) AND ( ( TITLE-ABS-  
KEY ( "nutrition education" OR "health education" OR "health  
promotion" ) ) OR ( TITLE-ABS-KEY ( "diet" OR "dietary change" OR "physical  
activity" OR "behavior  
change" OR "behavior" OR "perception" OR "attitude" OR "knowledge" OR "lifestyle  
change" OR "lifestyle modification" ) ) )



## APPENDIX E:

### INTERVIEWS AND SCRIPTS/GUIDELINES

- Can you please reflect on your experience with online learning for the past two years?
- Have you ever taken part in any nutrition education program for school-aged children? (developing, teaching, coordinating)
- If yes, describe your experience and was the program effective? do you think that the program outcomes can be achieved through online programs?
- What, in your opinion, what additional advantages do face-to-face school interventions offer compared to online nutrition education (NE) programs?
- Do you think there is enough time for online NE given the children's current curriculum? Do you think that children might be overwhelmed if online NE was incorporated into the curriculum?
- Approximately, how many hours per week do you think a NE program should be given to maximize efficiency?
- Do you think children can learn well nutritional information or concepts through online programs?
- As teacher, do you think you can deliver well nutritional information or concepts through online programs?
- What, in your opinion, are the barriers to implementing online NE in schools? (situation of the country, message delivery, time, evaluation standards, internet/electricity shortages..)
- And what about the facilitators? (Previous program experiences, time/cost efficiency, children's engagement..)
- What do you think are the school-related barriers to implementing online NE programs? (time, logistics, technical support, availability of teachers?etc.)

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*27 DEC 2021*

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## APPENDIX F:

### TEACHERS/HEALTH COORDINATORS CONSENT FORM



**Study Title: “Exploring Innovative Methods for Online Nutrition Education: A Qualitative Study to Promote Behavioral Change among School aged Children in Beirut, Lebanon”.**

**Principal Investigator: Dr. Lamis Jomaa, American University of Beirut**  
**Graduate Student: Rabab Swaidan** **Research Staff: Marwa Diab El-Harakeh,**  
**Research Assistant**

You are invited to participate in a research study, conducted by the Department of Nutrition and Food Sciences at the American University of Beirut. It is important that you read the information below carefully before agreeing that you and your child participate in the study and to understand the purpose, actions, benefits and risks related to you and your child’s participation in this project. Please feel free to ask any questions if you need any clarification about what is stated in this form or if you need any additional information. You will be provided with this consent form, which includes the project information as well as contact information of those carrying out the study for your future reference.

Your participation is voluntary. If you decide to participate, you will be asked to provide your oral consent and will receive a scanned copy of the form.

#### **Purpose:**

Lebanon is experiencing an increase in obesity prevalence, particularly among children and adolescents. Due to the shift to distant learning as a result of COVID-19 lockdowns, and considering that online tools are time and cost effective, the present study will evaluate the perceptions and experiences of school-aged children (aged 10 to 12 years) towards online nutrition education and digital material to facilitate their readiness and motivation for positive eating and lifestyle behavioral changes and examine the barriers and facilitators to administering innovative online nutrition education tools and resources as part of the curriculum in Lebanese schools.

Results from this study can help in setting standards for online NE programs that are accepted by school-aged children (10-12 years old), and considered feasible and applicable in Lebanon.

#### **Eligibility criteria include:**

Lebanese teachers and health coordinators at schools in Beirut, Lebanon.

### **Project Procedures and Duration**

We will ask you to participate in an in-depth interview at a convenient setting. It might be conducted in person or through a phone call for about 15 minutes.

We would like to tape record your interview to make sure that we remember accurately all the information that will be provided. Only the aggregated data from the interviews (which will have no identifiers) will be shared. You may still participate in the interview if you do not want to be taped.

Below is a description of what will happen if you decide to participate in the study:

We will ask you to participate in an individual interview and will ask you some questions about your opinion on online nutrition education and using digital tools to induce behavioral change in school-aged children. We will also ask about what you think are the facilitators and barriers for implementing an online NE program in Lebanese schools. We assure you that this information will be kept strictly confidential. You will be interviewed at a convenient date and time that we will predetermine. The interview will take place on the school premises unless any logistic inconvenience necessitated a virtual setting, and will require around 15-20 minutes of your time.

### **Risks, Benefits**

There are no risks resulting from your participation in this study. You can choose not to answer any question if you wish.

At the end of your participation in the study, you will receive nutrition tips and information on healthy eating and living. Upon the completion of the interview, the findings of the study can help us identify some barriers and facilitators to implementing online nutrition education in Lebanon and develop a set of recommendations to assist in designing online nutrition education interventions that target school-aged children and are feasible and applicable in Lebanese schools.

### **Confidentiality**

You may leave the study at any time. If you decide to stop your participation in the study, there will be no penalty to you, and you will not lose any benefits to which you are otherwise entitled.

Your decision will have no impact on future relationships with the school or with AUB or AUB Medical Center in any possible way.

The interview tapes will be kept in a locked file drawer in the university. They will only be used by the research team. You may still participate in the interviews if you do not want to be taped. In this case, the recorder will be paused whenever you express your opinions.

All data will be represented as aggregate data and will have no identifiers that could be linked to your personal responses. Phone numbers will be destroyed upon the completion of data collection. Opinions shared during the discussions will be kept confidential and used only as collective information. Findings from this study will be used for research purposes only.

All the documentation of the interviews will be stored in a locked cabinet in the principal investigator's office at AUB. Electronic versions of the data will also be secured and locked by a password. Records will be monitored and may be audited by the IRB, however, measures will be taken to make sure confidentiality is not being violated.

### **Incentives**

As a thank you for participating in the interview, you will be provided with age- and culturally- appropriate nutrition tips and information on healthy eating upon completion of the study.

The Social & Behavioral Institutional Review Board responsible for human subjects research at AUB has reviewed this research project and found it to be acceptable, according to applicable Lebanese and U.S. federal regulations and AUB policies designed to protect the rights and welfare of participants in research.

*Please note that we will make sure that your interview will take place at a convenient time for you. The interviews will be audio-taped to make sure that the research team remember accurately all the information you provide. We might be quoting you in the texts, reports and articles we produce without attaching any name or other identifiers and all your quotations will be kept anonymous. Records will be monitored and may be audited by the IRB without violating confidentiality.*

We would like to obtain your agreement in:  
(Kindly check all the options below you give consent for)

- Participating*
- Audiotaping*
- Quoting*

You will be given **one week** to provide us with your consent in case you are willing to participate in the study.

A scanned copy of this consent form will be left with you and if you have any questions or concerns about the research, you may contact:

**Contacts and Questions:** For questions, concerns, or complaints about the study you may contact

Dr. Lamis Jomaa, Faculty of Agricultural & Food Sciences – AUB

**Tel:** 961-1-350000 (Ext 4544) **E-mail:** [lj18@aub.edu.lb](mailto:lj18@aub.edu.lb)

Rabab Swaidan, Nutrition, MSc – AUB

Tel: 961-3046475 E-mail: [ras96@mail.aub.edu](mailto:ras96@mail.aub.edu)

For questions about your child's rights as a participant in this study or to discuss other study-related concerns or complaints with someone who is not part of the research team, you may contact

AUB Social & Behavioral Science Institutional Review Board – AUB  
Tel: 961 -1-350000 (Ext 5445) E-mail: [irb@aub.edu.lb](mailto:irb@aub.edu.lb)

**Kindly check next to the items you want to give permission for you:**

➤ *For teacher/health coordinator*

I have read and understood the above information. I voluntarily agree to participate in the study. I give you permission to:

**Participate in one in-depth interview**

I am not giving up any legal rights by signing this form. I will be given my oral consent and a scanned copy of this form.

\_\_\_\_\_

\_\_\_\_\_  
**Participant Name**  
**Phone Number**

\_\_\_\_\_  
**Participant Signature**

*Note: If you consented on participating in the interview, the research team will follow-up with you through a phone call to provide you with additional details regarding the potential dates of your interview.*

**Investigator/Research Staff**

I have explained the research to the participants before requesting the signature(s) above. There are no blanks in this document. A scanned copy of this form will be given to the parent/legal guardian of the child participant/subject.

\_\_\_\_\_  
**Printed name of person obtaining permission**

\_\_\_\_\_  
**Signature of person obtaining permission**

\_\_\_\_\_ AM/PM  
**Date and Time**

*Institutional Review Board  
American University of Beirut*

*27 DEC 2021*

**APPROVED**

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