



# A Community-Based School Nutrition Intervention Improves Diet Diversity and School Attendance in Palestinian Refugee Schoolchildren in Lebanon

Zeina Jamaluddine,<sup>1</sup> Jowel Choufani,<sup>2</sup> Amelia Reese Masterson,<sup>3</sup> Reem Hoteit,<sup>4</sup> Nadine R Sahyoun,<sup>5</sup> and Hala Ghattas<sup>1</sup>

<sup>1</sup>Center for Research on Population and Health, American University of Beirut, Beirut, Lebanon; <sup>2</sup>The George Washington University, Washington, DC, USA; <sup>3</sup>CitySeed, Inc., New Haven, CT, USA; <sup>4</sup>Department of Family Medicine, American University of Beirut Medical Center, Beirut, Lebanon; and <sup>5</sup>Department of Nutrition and Food Science, University of Maryland, College Park, MD, USA

## ABSTRACT

**Background:** School feeding programs have the potential to supply children with healthy school food, alleviate short-term hunger, and improve children's educational outcomes.

**Objectives:** We linked community kitchens to a subsidized school snack intervention and assessed the impact of this intervention on nutritional (diet diversity, hemoglobin, and anthropometry) and educational (attendance and academic performance) outcomes of Palestinian refugee schoolchildren.

**Methods:** We collected data from 1362 students (aged 5–15 y) and their parents at baseline, and at an 8-mo follow-up in 2 control and 2 intervention schools. We conducted linear, logistic, and negative binomial regression analyses to assess changes in outcomes of children participating in the intervention schools compared with children in control schools (intention-to-treat). We also assessed the impact of the snack intervention in children who participated  $\geq 50\%$  of the time (HP, high-participation) compared with those who participated  $< 50\%$  (LP, low-participation), or who only received nutrition education (control) (per protocol). All the analyses were adjusted for child age and gender, maternal education, household expenditure, and school-level clustering effect.

**Results:** At endline, there were 648 children in the control group, and within the intervention group, 260 children were LP and 454 were HP. There was a significantly greater increase in overall diet diversity score and dairy consumption in the HP group compared with controls. Both LP and HP groups were more likely to consume proteins, and less likely to consume desserts than controls. Furthermore, the HP group had a significant increase in hemoglobin, and both LP and HP groups had a significant decrease in school absenteeism compared with controls.

**Conclusions:** This community-based school nutrition intervention had a positive impact on diet diversity, hemoglobin, and school attendance of children. *Curr Dev Nutr* 2020;4:nzaa164.

**Keywords:** nutrition intervention, school feeding program, double burden of malnutrition, diet diversity, food security

© The Author(s) 2020. Published by Oxford University Press on behalf of the American Society for Nutrition. This is an Open Access article distributed under the terms of the Creative Commons Attribution-NonCommercial License (<http://creativecommons.org/licenses/by-nc/4.0/>), which permits non-commercial re-use, distribution, and reproduction in any medium, provided the original work is properly cited. For commercial re-use, please contact [journals.permissions@oup.com](mailto:journals.permissions@oup.com)

Manuscript received August 10, 2020. Initial review completed October 19, 2020. Revision accepted October 21, 2020. Published online November 24, 2020.

This study was funded by The Nestlé Foundation for the Study of Problems of Nutrition in the World. The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

Author disclosures: The authors report no conflict of interest.

Supplemental Tables 1 and 2 are available from the "Supplementary data" link in the online posting of the article and from the same link in the online table of contents at <https://academic.oup.com/cdn/>.

Address correspondence to HG (e-mail: [hg15@aub.edu.lb](mailto:hg15@aub.edu.lb)).

Abbreviations used: CBO, community-based organization; HKHC, Healthy Kitchens, Healthy Children; HP, high-participation; IRR, Incidence rate ratio; LP, low-participation; SFP, school feeding program; UNRWA, United Nations Relief and Works Agency for Palestine Refugees in the Near East; USD, US dollars.

## Introduction

Palestinian refugees living in Lebanon have experienced  $> 70$  y of marginalization, poverty, precarity, and food insecurity (1, 2). Most Palestinian refugees in Lebanon live in overcrowded urban refugee camps with poor housing and infrastructure (2, 3). Like many urban slum-like settings in low- and middle-income countries, Palestinian camps have crowded food markets, largely operated by small traders with very little regulation around food products sold.

In this context, food insecurity is associated with poor diet quality, decreased consumption of meat and chicken, and fruits and vegetables, and increased consumption of high-sugar, high-fat processed foods (4, 5). There is some evidence of a double burden of malnutrition—the simultaneous manifestation of under- and overnutrition—in this population. The Global School Health Survey found that 63% of Palestinian refugee schoolchildren in Lebanon consume unhealthy food from fast-food retailers at least once a week (6), and that  $\sim 28\%$  are overweight (6). At the same time, 22% of children in this population are anemic

upon entry to elementary school (7). Food insecurity combined with the coexistence of multiple forms of malnutrition can lead to various adverse developmental, behavioral, emotional, and educational outcomes in children (5, 8–10).

Food availability in schools contributes significantly to children's diet quality (11–15). Schools in this setting are operated by the UN Relief and Works Agency for Palestine Refugees (UNRWA) and have a small private food vendor selling packaged food inside the school, largely dominated by products high in fat, sugar, and salt. There is an urgent need for improvement of food quality in schools attended by Palestinian refugees in Lebanon. A recent series of articles published on the double burden of malnutrition identified school feeding programs (SFPs) as a possible opportunity for the direct provision of healthy food to children (16). It is proposed that SFPs can regulate school food environments and increase fruit and vegetable intake, reduce sugar and sugar-sweetened beverage intake, and subsequently stem the increase in multiple forms of malnutrition among children (16). However, this series pointed out that this opportunity has yet to be thoroughly investigated (16). SFPs could act as a social safety net to decrease short-term hunger in children and potentially increase attendance and academic performance (17). By providing food to children, SFPs can contribute to limiting food insecurity experience in households and relieving some of the worry concerning food (18). A systematic review of the impact of SFPs concluded that school meals have a positive impact on diet diversity, weight, height, school attendance, and academic performance in mathematics (19). School meals also appear to have a more significant positive effect when delivered to vulnerable children (20). Although the literature evaluating the impact of SFPs shows positive effects on some nutritional and educational outcomes, in many developing countries, SFPs are highly reliant on external funding and are criticized for their modest effectiveness and lack of sustainability when they are not integrated into national policy.

“Home-grown” models for school feeding could decrease the reliance on external donors. Such approaches, which source food from local farms, school gardens, or local markets (19, 21, 22), and rely on community kitchens run by local communities to prepare food, have the potential to improve the quality of food in schools while providing economic opportunities for the local community (23).

### The “Healthy Kitchens, Healthy Children” intervention

We designed a “home-grown” model that linked community kitchens to an SFP—the “Healthy Kitchens, Healthy Children” (HKHC) intervention. The details of the intervention have been published elsewhere (19). In brief, we established 2 “Healthy Kitchens” in community-based organizations in urban Palestinian camps in Lebanon. These were then linked to a school food intervention through the daily preparation and delivery of a subsidized nutritious school snack to 2 UNRWA-operated elementary schools. By including a strong community partnership, and involving community kitchens in the sourcing of the food for this program, the design aimed to ensure sustainability (19). This model generated livelihood opportunities for women who participated in the “Healthy Kitchens” and improved their household food security (23).

The main aim of this study was to assess the impact of this community-based school nutrition intervention on nutritional (dietary diversity and nutritional status) and educational (school attendance and

school achievement) outcomes of schoolchildren attending UNRWA schools in Lebanon.

## Methods

### Subjects and study design

This study was designed as a quasi-experimental school-based intervention with a matched-pair design (19). A full listing of UNRWA-run elementary schools in the Beirut and Mount Lebanon region was initially used to generate potential matched pairs of schools; each school in the list was paired to its closest match based on gender distribution (all-girls, all-boys, coeducational), neighborhood, and school size. At the same time, 2 community kitchens were established in 2 urban Palestinian camps in Lebanon as detailed in previously published articles (19, 23). Based on the location of the community kitchens, the nearest matched pairs of schools were selected for the study. This resulted in 1 matched pair of all-girls schools, and 1 matched pair of coeducational schools being selected. Using a simple randomization method (a coin toss conducted by a person independent of the study), 1 school from each pair was randomly assigned to the nutrition intervention arm [receiving a subsidized healthy snack sold at school at a cost of 0.25 US dollars (USD) per snack plus nutrition education] and the other school to the control arm (nutrition education only) (19). All 4 schools selected follow the same educational system, guidelines, and policies (19). All program protocols in the community kitchens and the schools were identical. Recipes were standardized across the 2 kitchens through a series of training and quality control procedures (19).

Prior to the beginning of the study, parents of children in the intervention group attended an information session covering the logistical implications and costs of participating in the SFP (19). Families who were part of the UNRWA social welfare program caseload were exempt from paying the subsidized price of the snacks to ensure that all children who wanted to participate could do so. Written informed consent was obtained from parents, and child assent from children from both control and intervention schools. All protocols were approved by the Institutional Review Boards of the American University of Beirut and the University of Maryland.

The study was designed by the authors; however, the implementation was conducted by the community-based organizations and the schools. For this evaluation, a team of data collectors were hired independently and were blinded to the intervention/control school allocation. At baseline and endline, trained data collectors collected sociodemographic data from parents ( $n = 1005$ ) and nutritional status data (diet diversity, anthropometry, and hemoglobin) from 1433 students (aged 5–15y).

In the control and intervention schools, children whose parents provided consent and who assented to participate in the study began receiving nutrition education or nutrition education plus a subsidized daily school snack in October 2014 or October 2015. For 5 d/wk during recess, the community kitchens sold snacks to children at a subsidized price of 0.25 USD/snack). A 4-wk rotating menu was used and included recipes developed and standardized by the community kitchens [details provided elsewhere (19)]. The snack provided  $\sim 314$  kcal and 13 g protein (37% daily requirement) per day, according to the RDA for children aged 9–13 y (24). The snacks were designed to provide  $\geq 30\%$  of micronutrient requirements. Each daily snack included a combination

of  $\geq 3$  food groups from the following food groups: dairy, complex carbohydrates, meat and chicken, vegetables and fruits. In all the schools (intervention and control) a food vendor continued to operate independently of the study, selling packaged snacks to children—mainly chocolate, biscuits, boxed juice, and Lebanese pies (manouche). A nutrition education program was implemented in both intervention and control schools. This involved a half-hour nutrition and health education session, which was delivered to students every 2 mo. School nutrition education kits developed and evaluated as part of previous projects, were adapted and used. The sessions included topics related to the different food groups, diet diversity, breakfast intake, physical activity, and personal hygiene. Trained nutritionists conducted interactive education sessions tailored to each age group.

The intervention ran for the duration of the school year ( $\sim 8$  mo). At the end of the school year (after 8 mo of implementation), endline data collection, which included the same indicators as baseline, took place in the 4 schools.

### Measurements

Prior to the implementation of the intervention study, a set of baseline data was collected from all participating parents and schoolchildren in both the intervention and control schools in the first month of the school year. At the end of the school year (8-mo time point), the same structured questionnaires were readministered and nutritional status measurements were taken.

#### Household-level indicators.

A structured questionnaire administered to parents included modules on household demographics, employment, education, health of the child, living conditions, detailed household expenditures, and household food security. Crowding index was generated as the total number of persons living in the household divided by the total number of rooms; overcrowding was defined as a crowding index of  $\geq 3$  household members per room. Total expenditure was calculated as total monthly household expenditure per capita in USD. Household food insecurity (as reported by parents of the children) was assessed using the Arab Family Food Security Scale and categorized as food secure (a score of 0–2) and food insecure (a score  $\geq 3$ ) (25).

#### Child-level nutritional outcome indicators.

A structured questionnaire was administered to children at school to assess diet diversity, child food security status, and nutritional knowledge. Anthropometry and hemoglobin concentrations were also measured.

*Diet diversity.* Short-term hunger and diet diversity were measured through an adapted diet recall questionnaire that takes the child through each meal he/she has consumed in the last 24 h, including probes about different types of foods consumed. To facilitate the child's recall, the day was divided into meals and locations (e.g., breakfast, on the way to school, at school, lunch, snacks, and dinner). Dietary data were entered as 8 food groups according to the FAO's guidelines (26): 1) cereals, roots, and tubers; 2) vitamin A-rich fruits and vegetables; 3) other fruit, or other vegetables; 4) legumes and nuts; 5) meat, poultry, and fish; 6) fats and oils; 7) dairy; and 8) eggs. To further validate the child-reported food group, a checklist of food groups was administered to parents, asking about foods that their children consumed. We

constructed a child diet diversity score to reflect diet quality. Diet diversity scores for various age/sex subgroups have been positively correlated with macronutrient and micronutrient adequacy in children and infants (27).

*Food insecurity.* Child-level food insecurity (as reported by children regarding their own experience of food insecurity) was assessed using a recently validated child food security questionnaire consisting of 10 items and categorized as food secure (0–2) and food insecure (3–10) (5).

*Anthropometric measurements.* Weight and height of children were measured by trained field surveyors using standard techniques and calibrated equipment. Children were asked to remove shoes, socks, and any heavy clothing. Weight was measured in duplicate to the nearest 0.1 kg with an electronic digital balance (Seca 874), and height was measured in duplicate to the nearest 0.1 cm with a stadiometer (Shorr Board). Nutritional status indicators ( $z$ -scores for weight-for-height, height-for-age, and BMI-for-age) were generated using the zanthrop command on Stata version 13.0 (StataCorp LLC) based on the WHO Child Growth curves. Subsequently stunting was defined as height-for-age  $z$ -score less than  $-2$ , overweight as BMI-for-age  $z$ -score greater than  $+2$ , and obesity as BMI-for-age  $z$ -score greater than  $+3$ .

*Hemoglobin concentrations.* Hemoglobin assessment was conducted on a finger-prick sample and measured using a portable hematofluorometer (HemoCue Hb 201<sup>+</sup>). HemoCue machines were calibrated on alternate days at the American University of Beirut Medical Center Laboratory against an automated hematology analyzer (Beckman Coulter). Anemia was defined as a hemoglobin value  $< 115$  g/L (28); anemic children were referred to the nearest health center and an invitation letter was sent to their parents to attend an education session on anemia.

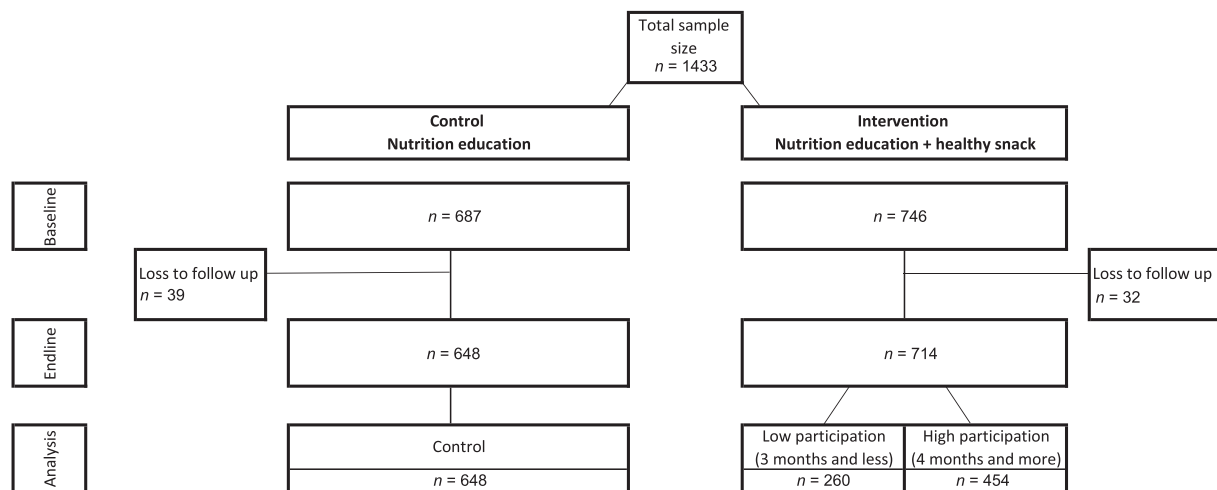
#### Child-level school educational outcomes.

School attendance records were collected daily by teachers and were returned to the study research team at the end of each month of the school year. School absenteeism was defined as the number of days absent per year given the standard length of a school year (180 d).

Educational achievement was assessed using grades in mathematics and language classes (English and Arabic) as proxies. Grades were collected for the average monthly exam, and for the midterm and final exam. Because the school exams were not standardized, the relative median and the top quartile for each section per grade, per school were calculated. A binary variable was generated categorizing children's grades as above or below the class median, and above or below the highest quartile.

### Sample size

To detect a 1-point difference in mean dietary diversity score of children with 80% power (at 95% significance) and 1.2 SD, the sample size required was calculated to be 440 children in each arm (2 control, 2 intervention schools) (accounting for 10% loss to follow-up or nonresponse).



**FIGURE 1** Schematic view of the Healthy Kitchens, Healthy Children study design.

### Statistical analysis

We assessed change between baseline and endline in the nutritional and school performance outcomes of intervention children compared with control children (intention-to-treat). We also assessed the impact of the school food program in children who participated  $\geq 50\%$  of the time (high-participation; HP) compared with those who participated  $< 50\%$  (low-participation, LP), or who only received nutrition education (control) (per protocol).

We conducted multivariable and negative binomial regression analyses to examine associations between program participation and outcomes, controlling for covariates. Covariates included child age and sex, and maternal/main caretaker education level, because research has shown these to be empirically or theoretically associated with the primary nutritional and educational outcomes of interest (29–33). The models were also adjusted for monthly total household expenditure per capita, household food insecurity, and crowding index, because we found some significant differences at baseline between the control and intervention groups for these variables.

For nutritional outcomes, mean changes in children's diet diversity, hemoglobin concentrations, BMI-for-age  $z$ -score, and height-for-age  $z$ -score were assessed using multivariable regression adjusting for covariates. Using negative binomial regression models, we assessed the association between school absenteeism and participation in the program. All the models were adjusted for school as a cluster effect. Significance threshold was set at  $P < 0.05$ . Data analysis was conducted using Stata 13.0 (StataCorp LLC).

### Results

At the beginning of the school year (baseline) we collected nutritional status and sociodemographic data from 1433 students and their parents, respectively. A total of 71 students were lost to follow-up during the school year (39 in control schools and 32 in intervention schools) as children changed schools or families of the children migrated outside the country (Figure 1). At the 8-mo time point (endline), data were

therefore collected from 1362 children from the 4 study schools. Students had the option to opt in or opt out of the snack program throughout the school year, and the mean participation rate was 4.69 mo. In any given month,  $\sim 66\%$  of children participated in the subsidized school meal program. Due to this fluctuation in participation, we present analyses taking into account duration of exposure (per protocol) as well as using intention-to-treat.

At endline, data were available for 648 children from control schools (receiving only nutrition education), and 714 children from intervention schools (receiving school snacks plus education). Of these, 260 children participated in the program for  $< 50\%$  of total school days (and were therefore classified as LP 3 mo), whereas 454 children participated for  $> 50\%$  of school days (and were classified as HP  $\geq 4$  mo).

### Sociodemographic characteristics of children participating in the HKHC program

At baseline, the mean age of study children was 8.92 y (range: 5–15 y). The majority of participating children were female because 1 pair of the matched control and intervention schools consisted of single-sex girls' schools (Table 1). There were some significant differences between the intervention and control groups at baseline. Compared with the intervention group, the control group had higher maternal education levels (52.98% in the control compared with 39.71% in the intervention having intermediate education;  $P < 0.001$ ) and higher mean household monthly expenditure per capita (203.84 USD  $\pm$  4.68 USD compared with 179.78 USD  $\pm$  4.02 USD;  $P < 0.001$ ). Moreover, crowding and food insecurity were significantly higher in the intervention group compared with the control group (19.11% in the control compared with 26.90% in the intervention,  $P < 0.001$ ; and 44.71% in the control compared with 52.41% in the intervention,  $P < 0.001$ ). All models were adjusted for these variables.

### Impact of the HKHC program on children's nutritional outcomes

Unadjusted results are presented in Supplemental Table 1. After adjusting for covariates, there was a significantly greater increase in child

**TABLE 1** Baseline socioeconomic and nutritional characteristics of children enrolled in the study ( $n = 1362$ )<sup>1</sup>

	n	Control	Intervention (intention-to-treat): low- and high-participation	Intervention (per protocol)	
				Low-participation	High-participation
Children's characteristics					
Age, y, mean $\pm$ SE	1307	9.08 $\pm$ 0.08	8.78 $\pm$ 0.07	8.94 $\pm$ 0.13	8.69 $\pm$ 0.09
Gender, % (n)	1362				
Male		30.25 (196)	34.73 (248)	38.46 (100)	32.60 (148)
Female		69.75 (452)	65.27 (466)	61.54 (160)	67.40 (306)
Child food insecure, % (n)	1217	16.44 (95)	25.20 (161)	28.88 (67)	23.10 (94)
Children's household characteristics					
Mother/caretaker education attainment, % (n)	1294				
Illiterate/completed primary		47.02 (284)	60.29 (416)	61.51 (155)	59.59 (261)
Above primary level (including middle, high-school, and college)		52.98 (320)	39.71 (274)	38.49 (97)	40.41 (177)
Average monthly expenditure per capita (US dollars), mean $\pm$ SE	1310	203.84 $\pm$ 4.69	179.79 $\pm$ 4.03	169.40 $\pm$ 7.10	185.83 $\pm$ 4.83
Receiving financial assistance, % (n)	1308	11.49 (70)	19.31 (135)	22.35 (57)	17.57 (78)
Food-related assets, mean $\pm$ SE	1310	3.15 $\pm$ 0.03	2.96 $\pm$ 0.03	2.79 $\pm$ 0.06	3.05 $\pm$ 0.4
Food security, % (n)	1262				
Food secure		55.29 (319)	47.59 (326)	43.78 (109)	49.77 (217)
Moderately food insecure		23.22 (134)	27.74 (190)	30.12 (75)	26.38 (115)
Severely food insecure		21.49 (124)	24.67 (169)	26.10 (65)	23.85 (104)
Crowded household ( $\geq 3$ household members per room), % (n)	1306	19.11 (116)	26.90 (188)	34.51 (88)	22.52 (100)
Diet diversity					
Child diet diversity score, mean $\pm$ SE	1307	4.35 $\pm$ 0.05	4.17 $\pm$ 0.05	4.14 $\pm$ 0.08	4.19 $\pm$ 0.06
Household diet diversity score, mean $\pm$ SE	1275	6.50 $\pm$ 0.07	6.38 $\pm$ 0.06	6.23 $\pm$ 0.10	6.47 $\pm$ 0.08
Nutritional status of children					
Hemoglobin concentration, g/L mean + SE	1214	127.91 $\pm$ 0.42	124.58 $\pm$ 0.38	124.35 $\pm$ 0.67	124.72 $\pm$ 0.46
Anemia, % (n)	1214	9.95 (58)	12.36 (78)	14.35 (34)	11.17 (44)
BAZ, mean $\pm$ SE	1286	0.54 $\pm$ 0.05	0.28 $\pm$ 0.05	0.24 $\pm$ 0.08	0.29 $\pm$ 0.05
BAZ, % (n)	1286				
Thinness		1.17 (7)	1.74 (12)	1.98 (5)	1.61 (7)
Overweight ( $>1$ SD and $<2$ SD BMI for age)		19.17 (115)	15.45 (106)	15.48 (39)	15.44 (67)
Obese ( $\geq 2$ SD BMI for age)		15.17 (91)	10.05 (69)	9.92 (25)	10.14 (44)
HAZ, mean $\pm$ SE	1301	-0.28 $\pm$ 0.04	-0.29 $\pm$ 0.04	-0.24 $\pm$ 0.06	-0.30 $\pm$ 0.04
Stunted, % (n)	1301	5.95 (36)	5.17 (36)	5.51 (14)	4.92 (22)

<sup>1</sup>BAZ, BMI-for-age z-score; HAZ, height-for-age z-score; Food-related assets: A score consisting of the number of the following assets owned by the household: fridge, freezer, gas/electric oven and microwave.

diet diversity score in the overall intervention group compared with the control ( $P = 0.028$ ) and specifically in the HP group ( $P = 0.009$ ), but not in the LP group (Table 2). Mean change in overall diet diversity score between baseline and endline was +0.33 units in children in the high-participation group compared with the control group ( $\beta = +0.33$ ; 95% CI: 0.16, 0.51;  $P = 0.009$ ). Interestingly, we note that boys had a greater change in diet diversity (+0.52 units) than girls (+0.25 units) (data not shown).

At endline, both LP and HP groups had higher odds of consuming meat or chicken (OR: 1.72; 95% CI: 1.34, 2.21;  $P < 0.001$ ; and OR: 1.88; 95% CI: 1.17, 3.00;  $P = 0.008$ ), and lower odds of consuming desserts (OR: 0.55; 95% CI: 0.41, 0.76;  $P < 0.001$ ; OR: 0.59; 95% CI: 0.38, 0.92;  $P = 0.020$ ) compared with the control, respectively. The HP group also had higher odds of consuming dairy (OR: 1.22; 95% CI: 1.14, 1.31;  $P < 0.001$ ) and lower odds of consuming sweetened beverages (OR: 0.76; 95% CI: 0.59, 0.99;  $P = 0.046$ ) compared with control

(results by food group are included in Supplemental Table 2). Similar results were reported when examining food group consumption of children as reported by parents (data not shown). The increase in diet diversity in the overall intervention group and specifically for HP (and not LP) was paralleled with a significantly greater change in hemoglobin ( $\beta = +3.44$  g/L; 95% CI: 0.03, 6.85;  $P = 0.049$ ) compared with the control group. Although we note an improvement in hemoglobin concentrations, the intervention had no significant change in odds of anemia. Moreover, it is interesting to note that in the overall intervention group we found a marginally significant decrease in household food insecurity score compared with the control group (-0.33 score point) (Table 3). However, the intervention had no significant impact on food insecurity status as reported by children or parents when data were disaggregated into HP or LP groups. As for anthropometric measurements, there were no significant differences in mean BMI-for-age z-score, height-for-age z-score, or odds of overweight, obesity, or stunting.

**TABLE 2** Change in nutritional indicators from baseline to endline in children attending intervention schools compared with control schools<sup>1</sup>

	n	Intervention (intention-to-treat)		Intervention (per protocol)		P value	
		All	P value	Low-participation	High-participation		
Mean change in diet diversity of children	1242	0.33 (0.07, 0.60)	0.028	0.33(-0.10, 0.76)	0.093	0.33 (0.16, 0.51)	0.009
Mean change in hemoglobin	1126	3.26 (0.99, 5.54)	0.020	2.95 (-0.19, 6.08)	0.058	3.44 (0.03, 6.85)	0.049
Odds of anemia <sup>2</sup>	1126	0.88 (0.76, 1.01)	0.073	0.74 (0.62, 1.20)	0.100	0.97 (0.79, 1.18)	0.727
Mean change in BAZ	1231	0.04 (-0.14, 0.19)	0.435	0.03 (-0.02, 0.08)	0.167	0.05 (-0.16, 0.25)	0.520
Mean change in HAZ	1243	-0.01 (-0.10, 0.08)	0.714	-0.01 (-0.08, 0.05)	0.578	-0.01 (-0.12, 0.10)	0.784
Odds of overweight <sup>2</sup>	1226	0.98 (0.65, 1.49)	0.923	0.83 (0.36, 1.95)	0.673	1.07 (0.72, 1.59)	0.753
Odds of obesity <sup>2</sup>	1226	1.06 (0.48, 2.30)	0.891	0.92 (0.32, 2.61)	0.871	1.13 (0.32, 2.61)	0.766
Odds of stunting <sup>2</sup>	1240	1.47 (0.73, 2.97)	0.278	1.83 (0.63, 5.36)	0.267	1.29 (0.76, 2.21)	0.347

<sup>1</sup>Multivariable models adjusted for child age, sex, maternal education level, monthly expenditure per capita, crowding index, household food insecurity, and school clustering effect. , -for-age z-score; HAZ, height-for-age z-score.

<sup>2</sup>Adjusted for baseline measurement.

<sup>3</sup>Linear regression.

<sup>4</sup>Logistic regression.

## Impact of the HKHC program on children's educational outcomes

In both LP and HP groups, risk of school absenteeism significantly decreased compared with the control group [Incidence rate ratio (IRR): 0.76; 95% CI: 0.58, 0.99;  $P < 0.001$ , and IRR: 0.76; 95% CI: 0.59, 0.98;  $P = 0.032$ , respectively]. In the control group, mean absenteeism was 5.7 d over the school year, whereas in both the LP and HP groups, absenteeism was 4.3 d. After adjustment for covariates in the model (Table 4), there was no significant association between participation in the school snack program and odds of having a score above the median in any of the school subjects assessed. However, HP children in the school snack program had significantly higher odds of achieving an Arabic language score in the top quartile.

## Discussion

This study evaluated the impact of a community-based school food intervention on diet diversity, nutritional status, and educational outcomes of urban protracted refugee schoolchildren. We found that the provision of a healthy school snack through the HKHC model provided an opportunity for participating children to improve their diet diversity and reduce school absenteeism compared with schools where only the nutrition education component of the program was implemented.

In this urban refugee population where stunting and thinness were at low levels, anemia was at 11.2%, and overweight and obesity were high at baseline, this intervention was able to improve diet diversity and fill a diet quality gap (by increasing animal source protein) while reducing dessert and sugar-sweetened beverage consumption (and therefore empty calories). It also was associated with a modest increase in mean hemoglobin concentration without increasing overweight and obesity. In fact, evidence from the literature shows that including animal source foods in school-based interventions can be effective at improving micronutrient status and health outcomes of children (34–36). This adds to the evidence that over and above nutrition education in school, the provision of healthy food at school can reinforce good dietary practices of schoolchildren (37, 38).

Whether changes in dietary practices manifest as changes in anthropometric outcomes depends on meal composition and size, modality of distribution, duration of the study, and baseline nutritional status of the population (39). For instance, in a context where stunting rates are high, a large-scale school meal intervention in Ghana found improvements in height-for-age (40). However, in a similar context to ours, a government-led school lunch program (covering 33% of energy requirements of children) implemented in Turkey had no impact on body weight, height, or BMI of participants compared with nonparticipant students aged 9–14 y (41). In contrast, a school meal and breakfast program implemented in South Africa, which provided a larger proportion of nutritional requirements than both the Turkish program and our intervention, had a positive effect on the double burden of malnutrition; children receiving the 2 meals had a lower prevalence of obesity or overweight when compared with the control group and children receiving the standard school lunch program, and stunting was lower in children receiving the 2 meals compared with those

**TABLE 3** Change in food insecurity indicators in children attending intervention schools compared with control schools<sup>1</sup>

	n	Intervention (intention-to-treat)		Intervention (per protocol)			
		All	P value	Low-participation	P value	High-participation	P value
		Adjusted $\beta$ (95% CI) <sup>2</sup>		Adjusted $\beta$ (95% CI) <sup>2</sup>		Adjusted $\beta$ (95% CI) <sup>2</sup>	
Change in household food insecurity	919	-0.33 (-0.65, -0.00)	0.049	-0.37 (-0.92, 0.17)	0.115	-0.31 (-0.97, 0.36)	0.238
Change in child food insecurity	1116	-0.20 (-0.67, 0.27)	0.273	-0.31 (-0.83, 0.21)	0.157	-0.14 (-0.62, 0.35)	0.443

<sup>1</sup>Multivariable models adjusted for child age, sex, maternal education level, monthly expenditure per capita, crowding index, and school clustering effect.

<sup>2</sup>Linear regression.

receiving the standard school lunch program over a period of 6–10 mo (42, 43).

Evidence regarding the most effective way to tackle the double burden of malnutrition remains fragmented, but the present analysis adds to the mounting evidence regarding the potential of SFPs as entry points to provide healthy diets to children (16).

An improvement in diet quality and nutritional status can also improve the learning capacity and academic performance of children (36, 44, 45). It is hypothesized that the additional energy source provided during school alleviates short-term hunger and could contribute to more effective cognitive performance and produce sustained gains in test scores (46). However, there is little evidence of this impact of SFPs (47). Some studies find an improvement in math and English language scores in students receiving school food (48) whereas others detect no impact (49). In this study we only found a small association between the intervention and Arabic language achievement. However, our study could be limited by the fact that no one standardized test was used to assess school performance, and variations could exist across teachers in how test scores are allocated.

The literature additionally highlights that SFPs decrease school absenteeism because they act as an incentive to send children to school. Results from this study showed that school absenteeism significantly decreased in children attending schools that received the subsidized school snack intervention; however, although the effect size was sufficiently large, the impact was small due to low levels of absenteeism overall in the study. Similar to our study some experimental studies have revealed a small effect on school attendance in developing countries (20, 47, 50).

Although we do find some positive effects on diet diversity and school attendance, this study is limited by the fact that it was only implemented for 1 academic year. Participation in the school snack program also fluctuated, with children opting in and out of the program; we attempted to address this limitation by conducting both intention-to-treat and per protocol analyses, which did show a higher impact in the HP group. The effect could also have been diluted by the fact that participation in the program was assessed through the receipt of the snack rather than actual consumption, which was not monitored on an individual basis. The results of this study are only generalizable to Palestinian refugee children living in Beirut camps, and further research will be needed to test this model in other contexts.

It is also possible that some of the statistically significant results in the study could have occurred by chance as a result of multiplicity of outcome testing, and these should therefore be interpreted with caution. However, considering the debate in the literature on the need for this adjustment (51), and in alignment with the majority of the literature on SFP evaluation (33, 40, 46), we did not adjust *P* values for multiple hypothesis testing and maintained the threshold for statistical significance at 0.05.

In conclusion, the HKHC home-grown model implemented in an urban protracted refugee setting showed a modest but significant effect on diet diversity and school attendance. Considering that this intervention was also associated with improvements in economic, food security, and social support outcomes for women who provide food through the community kitchens (23), scaling up such an approach can contribute to human capital gains of 2 generations of protracted refugees. More research is required to determine whether the sustained

**TABLE 4** Odds/incidence of school educational outcomes in children attending intervention schools compared with control<sup>1</sup>

	n	Intervention (intention-to-treat)		Intervention (per protocol)		P value
		All	P value	Low-participation	High-participation	
School absenteeism	1245	0.76 (0.59, 0.98)	0.037	0.76 (0.58, 0.99)	0.046	0.032
Endline top quartile in class for Arabic <sup>2</sup>	1245	1.16 (0.97, 1.38)	0.092	1.14 (0.88, 1.47)	0.305	0.024
Endline top quartile in class for math <sup>2</sup>	1245	1.00 (0.72, 1.39)	0.982	0.77 (0.52, 1.14)	0.195	0.414
Endline top quartile in class for foreign language <sup>2</sup>	1245	0.95 (0.72, 1.26)	0.763	0.59 (0.34, 1.04)	0.066	0.184
Endline top half in class for Arabic <sup>2</sup>	1245	1.04 (0.81, 1.33)	0.771	0.93 (0.73, 1.20)	0.579	0.501
Endline top half in class for math <sup>2</sup>	1245	1.06 (0.82, 1.36)	0.674	1.01 (0.61, 1.67)	0.972	0.258
Endline top half in class for foreign language <sup>2</sup>	1245	1.04 (0.79, 1.37)	0.772	0.93 (0.67, 1.30)	0.685	0.479

<sup>1</sup>Multivariable models adjusted for child age, sex, maternal education level, monthly expenditure per capita, crowding index, household food insecurity, and school clustering effect. IRR; Incidence Rate Ratio.

<sup>2</sup>Adjusted for baseline school performance.

<sup>3</sup>Negative binomial regression.

<sup>4</sup>Logistic regression.

implementation of this subsidized program could further improve children's nutritional and educational outcomes in the longer term and whether these findings can be replicated in other contexts with other vulnerable subpopulations.

## Acknowledgments

We acknowledge the community-based organization (CBO) directors, Mariam Al Shaar and Manal Hamad, for welcoming the study into their CBOs; UNRWA's Relief and Social Services and Education teams, including Leila Kaissi, Darine El Khatib, Hadia Chanaa, and Dr Hanin Fuddah, for their support and logistical assistance, and UNRWA school directors for welcoming us in the schools; Ali Basma for designing the kitchens; Dominique Anid, Marwa Soubra, and Dr Salwa Tawk for the entrepreneurship and food safety program training; Samia el Joueidi, Rachel Bteich, Eman Sharara, Aline Semaan, Joanne Khabsa, Carmen Uwaydah, and the data collection team for supporting data collection, cleaning, transcription, and translation.

The authors' responsibilities were as follows—HG and NRS: designed research (project conception, development of overall research plan, and study oversight); ZJ, JC, and ARM: led the field research; ZJ: analyzed data and performed statistical analysis; ZJ and HG: wrote the paper; HG: had primary responsibility for the final content; and all authors: read and approved the final manuscript.

## References

1. Chaaban J, Ghattas H, Habib R, Hanafi S, Sahyoun N, Salti N, Seyfert K, Naamani N. Socio-economic survey of Palestinian refugees in Lebanon. Beirut: American University of Beirut; 2010.
2. Chaaban J, Salti N, Ghattas H, Irani A, Ismail T, Batlouni L. Survey on the socioeconomic status of Palestine refugees in Lebanon 2015. American University of Beirut (AUB) and the United Nations Relief and Works Agency for Palestine Refugees in the Near East (UNRWA); 2016.
3. Knudsen A, Hanafi S. Palestinian refugees: identity, space and place in the Levant. Routledge; 2010.
4. Ghattas H, Sassine AJ, Seyfert K, Nord M, Sahyoun NR. Prevalence and correlates of food insecurity among Palestinian refugees in Lebanon: data from a household survey. *PLoS One*. 2015;10:e0130724.
5. Jamaludine Z, Sahyoun NR, Choufani J, Sassine AJ, Ghattas H. Child-reported food insecurity is negatively associated with household food security, socioeconomic status, diet diversity, and school performance among children attending UN Relief and Works Agency for Palestine Refugees schools in Lebanon. *J Nutr* 2019;149:2228–35.
6. World Health Organization. Global school-based student health survey. World Health Organization; 2010 [Internet]. Available from: <http://www.emro.who.int/health-education/global-student-health-survey/unrwa.html>.
7. United Nations Relief and Works Agency for Palestine Refugees in the Near East (UNRWA). Health department: annual report 2018. UNRWA Amman; 2019.
8. Alaimo K, Olson CM, Frongillo EA. Food insufficiency and American school-aged children's cognitive, academic, and psychosocial development. *Pediatrics* 2001;108:44–53.
9. Pelletier DL, Olson CM, Frongillo EA. Food insecurity, hunger, and undernutrition. In: Bailey LB, Moyers S, Gregory JF, Bowman B, Russell R. Present knowledge in nutrition. Washington, DC: International Life Sciences Institute; 2001;701–13.
10. Shankar P, Chung R, Frank DA. Association of food insecurity with children's behavioral, emotional, and academic outcomes: a systematic review. *J Dev Behav Pediatr* 2017;38:135–50.
11. Briefel RR, Crepinsek MK, Cabili C, Wilson A, Gleason PM. School food environments and practices affect dietary behaviors of US public school children. *J Am Diet Assoc* 2009;109:S91–S107.



12. Condon EM, Crepinsek MK, Fox MK. School meals: types of foods offered to and consumed by children at lunch and breakfast. *J Am Diet Assoc* 2009;109:S67–78.
13. Larson N, Story M. Are 'competitive foods' sold at school making our children fat? *Health Aff* 2010;29:430–5.
14. Kubik MY, Lytle LA, Hannan PJ, Perry CL, Story M. The association of the school food environment with dietary behaviors of young adolescents. *Am J Public Health* 2003;93:1168–73.
15. Neumark-Sztainer D, French SA, Hannan PJ, Story M, Fulkerson JA. School lunch and snacking patterns among high school students: associations with school food environment and policies. *Int J Behav Nutr Phys Act* 2005;2:14.
16. Hawkes C, Ruel MT, Salm L, Sinclair B, Branca F. Double-duty actions: seizing programme and policy opportunities to address malnutrition in all its forms. *Lancet* 2020;395:142–55.
17. Bundy D, Burbano C, Grosh ME, Gelli A, Juke M, Lesley D. Rethinking school feeding: social safety nets, child development, and the education sector. World Bank; 2009.
18. Bartfeld JS, Ahn H-M. The School Breakfast Program strengthens household food security among low-income households with elementary school children. *J Nutr* 2011;141:470–5.
19. Ghattas H, Choufani J, Jamaluddine Z, Masterson AR, Sahyoun NR. Linking women-led community kitchens to school food programmes: lessons learned from the Healthy Kitchens, Healthy Children intervention in Palestinian refugees in Lebanon. *Public Health Nutr* 2020;23:914–23.
20. Galloway R, Kristjansson E, Gelli A, Meir U, Espejo F, Bundy D. School feeding: outcomes and costs. *Food Nutr Bull* 2009;30:171–82.
21. Shrestha RM, Schreinemachers P, Nyangmi MG, Sah M, Phuong J, Manandhar S, Yang RY. Home-grown school feeding: assessment of a pilot program in Nepal. *BMC Public Health* 2020;20:28.
22. Masset E, Gelli A. Improving community development by linking agriculture, nutrition and education: design of a randomised trial of "home-grown" school feeding in Mali. *Trials* 2013;14:55.
23. Sahyoun NR, Jamaluddine Z, Choufani J, Mesmar S, Reese-Masterson A, Ghattas H. A mixed-methods evaluation of community-based healthy kitchens as social enterprises for refugee women. *BMC Public Health [Internet]* 2019;19:1590.
24. US Department of Health and Human Services, US Department of Agriculture. 2015–2020 dietary guidelines for Americans. Washington (DC): US Department of Health and Human Services; 2015.
25. Sahyoun NR, Nord M, Sassine AJ, Seyfert K, Hwalla N, Ghattas H. Development and validation of an Arab family food security scale. *J Nutr* 2014;144:751–7.
26. Kennedy G, Ballard T, Dop M. FAO guidelines for measuring household and individual dietary diversity. Rome (Italy): Food and Agriculture Organization of the United Nations; 2013.
27. Steyn NP, Nel JH, Nantel G, Kennedy G, Labadarios D. Food variety and dietary diversity scores in children: are they good indicators of dietary adequacy? *Public Health Nutr* 2006;9:644–50.
28. World Health Organization. Haemoglobin concentrations for the diagnosis of anaemia and assessment of severity. Vitamin and Mineral Nutrition Information System. Geneva: World Health Organization; 2011.
29. Motbainor A, Worku A, Kumie A. Stunting is associated with food diversity while wasting with food insecurity among underfive children in East and West Gojjam zones of Amhara region, Ethiopia. *PLoS One* 2015;10:e0133542.
30. Asfaw M, Wondaferash M, Taha M, Dube L. Prevalence of undernutrition and associated factors among children aged between six to fifty nine months in Bule Hora district, South Ethiopia. *BMC Public Health* 2015;15:41.
31. Aurino E, Tranchant J-P, Sekou Diallo A, Gelli A. School feeding or general food distribution? Quasi-experimental evidence on the educational impacts of emergency food assistance during conflict in Mali. *J Dev Stud* 2019;55:7–28.
32. Fekadu Y, Mesfin A, Haile D, Stoecker BJ. Factors associated with nutritional status of infants and young children in Somali region, Ethiopia: a cross-sectional study. *BMC Public Health*. 2015;15:846.
33. Zenebe M, Gebremedhin S, Henry CJ, Regassa N. School feeding program has resulted in improved dietary diversity, nutritional status and class attendance of school children. *Ital J Pediatr* 2018;44:16.
34. Arsenault JE, Mora-Plazas M, Forero Y, López-Arana S, Marín C, Baylin A, Villamor E. Provision of a school snack is associated with vitamin B-12 status, linear growth, and morbidity in children from Bogota, Colombia. *J Nutr* 2009;139:1744–50.
35. Neervoort F, von Rosenstiel I, Bongers K, Demetriades M, Shacola M, Wolffers I. Effect of a school feeding programme on nutritional status and anaemia in an urban slum: a preliminary evaluation in Kenya. *J Trop Pediatr* 2013;59:165–74.
36. Miller del Rosso J. School feeding programs: improving effectiveness and increasing the benefit to education—a guide for program managers. Washington (DC): The World Bank; 1999.
37. Izumi BT, Rostant OS, Moss MJ, Hamm MW. Results from the 2004 Michigan Farm-to-School survey. *J School Health* 2006;76:169–74.
38. Grantham-McGregor SM, Chang S, Walker SP. Evaluation of school feeding programs: some Jamaican examples. *Am J Clin Nutr*. 1998;67:785S–95S.
39. FAO. Nutrition guidelines and standards for school meals: a report from 33 low and middle-income countries. Rome: FAO; 2019.
40. Gelli A, Aurino E, Folsom G, Arhinful D, Adamba C, Osei-Akoto I, Masset E, Watkins K, Fernandes M, Drake L. A school meals program implemented at scale in Ghana increases height-for-age during midchildhood in girls and in children from poor households: a cluster randomized trial. *J Nutr* 2019;149:1434–42.
41. Ongan D, Inanc N, Cicek B. Comparing school lunch and canteen foods consumption of children in Kayseri, Turkey. *Pak J Med Sci* 2014;30:549–53.
42. Graham L, Hochfeld T, Stuart L. Double trouble: addressing stunting and obesity via school nutrition. *SAJCH* 2018;12:90–4.
43. Hochfeld T, Graham L, Patel L, Moodley J, Ross E. Does school breakfast make a difference? An evaluation of an in-school breakfast programme in South Africa. *Int J Educ Dev* 2016;51:1–9.
44. Acham H, Kikafunda J, Malde M, Oldewage-Theron W, Egal A. Breakfast, midday meals and academic achievement in rural primary schools in Uganda: implications for education and school health policy. *Food Nutr Res* 2012;56:11217.
45. Jacoby ER, Cueto S, Pollitt E. When science and politics listen to each other: good prospects from a new school breakfast program in Peru. *Am J Clin Nutr* 1998;67:795S–7S.
46. McEwan PJ. The impact of Chile's school feeding program on education outcomes. *Econ Educ Rev* 2013;32:122–39.
47. Kristjansson EA, Robinson V, Petticrew M, MacDonald B, Krasevec J, Janzen L, Greenhalgh T, Wells G, MacGowan J, Farmer A, et al. School feeding for improving the physical and psychosocial health of disadvantaged students. *Cochrane Database Syst Rev* 2007; CD004676.
48. WFP. State of school feeding worldwide 2013. Rome: World Food Programme; 2013.
49. Sorensen LB, Damsgaard CT, Dalskov S-M, Petersen RA, Egelund N, Dyssegaard CB, Stark KD, Andersen R, Tetens I, Astrup A, et al. Diet-induced changes in iron and n-3 fatty acid status and associations with cognitive performance in 8–11-year-old Danish children: secondary analyses of the Optimal Well-Being, Development and Health for Danish Children through a Healthy New Nordic Diet School Meal Study. *Br J Nutr* 2015;114:1623–37.
50. Bundy D, Burbano C, Gelli A, Risley C, Neeser K. On the transition to sustainability: an analysis of the costs of school feeding compared with the costs of primary education. *Food Nutr Bull* 2011;32:201–5.
51. Streiner DL. Best (but oft-forgotten) practices: the multiple problems of multiplicity—whether and how to correct for many statistical tests. *Am J Clin Nutr* 2015;102:721–8.