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The impact of SNAP-Ed interventions on California students' diet and physical activity during COVID-19

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Abstract

Objective: School-based CalFresh Healthy Living (CFHL) (California's SNAP-Ed) interventions adapted to new learning environments necessitated by COVID-19. We examined the impact of these interventions on student diet and physical activity (PA) outcomes.

Design: Quasi-experimental, two-group, pre-post.

Setting: California public schools with ≥50 % of students Free and Reduced Price Meal-eligible ($n_{intervention} = 47$; $n_{comparison} = 17$).

Participants: Fourth- and fifth-grade students who completed the online Eating and Activity Tool for Students at pre and post ($n_{intervention} = 1087$; $n_{comparison} = 846$ students).

Results: Intervention students reported a significantly greater increase in consumption frequency of total fruit (by 0·16 times/d; $P = 0·032$), driven primarily by a greater increase in 100 % fruit juice (by 0·11 times/d; $P = 0·007$). Intervention students reported a significantly greater increase in total vegetable consumption frequency (by 0·45 times/d; $P < 0·001$) than comparison students. Specifically, intervention students reported increased, whereas comparison students reported decreased, consumption frequencies for starchy vegetables (0·05 *v.* −0·10 times/d, $P < 0·001$), salad/green vegetables (0·01 *v.* −0·11 times/d, $P = 0·005$) and beans (0·04 *v.* −0·03 times/d, $P = 0·025$). Consumption frequency of other vegetables decreased in both groups (−0·01 *v.* −0·09 times/d) but decreased more among comparison students ($P = 0·048$). No differences in pre-post change in PA outcomes were detected.

Conclusions: Findings suggest that despite COVID-19-related challenges necessitating programme modifications, CFHL interventions played a role in protecting student consumption of fruit and vegetables during the 2020–2021 school year. Therefore, it appears that school-based CFHL interventions can be a viable means of safeguarding student nutrition at a time when access to nutritious food and PA opportunities are hindered.

Keywords
Diet
Physical activity
SNAP-Ed
COVID-19
School-based intervention

In March 2020, schools across the USA halted in-person instruction in an effort to protect students, teachers, and school staff against the then unknown effects of the coronavirus disease 2019 (COVID-19). At the start of the 2020–2021 school year, many schools in California continued to have their student population learn remotely by what has since been termed *distance learning*. By spring 2021, over half of California's public school students remained in full-time distance learning[1].

The disruption in the way children attend school impacted student dietary and physical activity (PA) behaviours[2]. In regard to diet, school closures greatly reduced access to school meals. Over 3·5 million children in California are eligible to receive Free and Reduced Price Meals (FRPM) at school, and many depend on the nutritional safety net these meals provide[3–5]. Studies indicate that school meals effectively contribute to diet quality, and more so among low-income students[6–8]. When schools shuttered, districts were forced to pivot to new and innovative ways to ensure regular access to school meals, such as meal pick-up by car or on foot, grab-and-go options, home delivery in rural areas, partnerships with local food banks and pantries, and provision of

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backpacks of shelf-stable groceries or bulk food items[9–12]. Despite the new flexibility of school meal service during COVID-19, student participation in school meal programmes decreased, potentially jeopardising the nutrition they provide[13,14]. To date, data on child diet quality during COVID-19 remains limited. A review by Mayra *et al.* indicates that, of existing studies, findings related to eating patterns of exclusively US children were mixed. While one (of four) studies indicated there were no significant dietary changes during COVID-19, three others indicated that consumption of all snack foods, both healthy and unhealthy, increased during this period[15]. Using a national and international sample, a systemic review by González-Monroy *et al.* indicated that overall frequency of snacking increased among children, in particular, for ultra-processed foods and sweets, while snacking on fresh foods (e.g. fruits and vegetables) was reduced[16].

In addition to impacts on diet, school closures and modifications affected students' opportunities for PA. Prior to the pandemic, in-person school and afterschool programming provided PA access through structured opportunities, like physical education (PE) and structured play, and unstructured opportunities during recess and other breaks. In states such as California that have elementary PE requirements, it has been found that children are typically more active and less sedentary on days they attend school[17–19]. During COVID-19-related school closures, both parents and teachers reported that they perceived children as less physically active[20,21]. Despite teachers reporting they had the ability to deliver structured PA remotely, for schools operating with both in-person and distance learning, requests for waivers of PE requirements increased during COVID-19[20]. Challenges to PE delivery were identified by all schools, regardless of learning method. While student access to the internet was a challenge for distance learning, social distancing, access to a gym or equipment, and concern for personal health were reported challenges for in-person learning[20].

With families staying home and students learning at home more often, an increase in screen time and sedentary behaviour was also of concern. In addition to an increase in school-related online screen time, children spent more time watching television, gaming and using the internet for recreation during the pandemic[22]. One study indicates that child leisure screen time increased approximately 30 h/week on average during COVID-19, and nearly a quarter of children engaged in leisure screen time lasting over 2 h at a time[23]. Semi-structured interviews of parents revealed reasons for increased sedentary behaviour included children being bored, stuck indoors and having more time for screen use because of less structured school schedules and halted extracurricular activities[24].

Schools with higher percentages of low-income learners were more likely to remain in distance learning longer than schools with lower percentages[1], potentially contributing to widening disparities in PA and dietary intake. As both diet and physical activity/inactivity have been associated with poorer outcomes as a result of COVID-19[25–28], continuance of public health programmes that support healthful eating and active living practices in low-income schools, such as the California Department of Public Health's CalFresh Healthy Living (CFHL) programme, were essential to combat the potential negative health effects and widening disparities due to school closures. CalFresh Heathy Living – the Supplemental Nutrition Assistance Program-Education (SNAP-Ed) in California – is led by the California Department of Social Services, and the California Department of Public Health is one of four agencies implementing the programme[29]. The California Department of Public Health directly funds local health departments to carry out healthy eating, active living interventions in settings such as schools and school-based afterschool programmes with a student population at or above 50 % eligible for FRPM. These interventions utilise direct education (e.g. series-based nutrition lessons), promotional materials, and policy, system, and environmental approaches (e.g. nutrition standards for school foods, strengthened wellness policies, etc.). The nutrition interventions aim to increase fruit, vegetable, and water consumption and decrease consumption of sugar-sweetened beverages (SSB). PA interventions aim to increase students' achievement of daily, high-quality PA through increased opportunities to be active in school and afterschool settings.

In order to continue CFHL interventions during COVID-19, local health departments had to modify their approaches and/or delay their delivery. Nutrition education was adapted for delivery via distance learning in school and afterschool sites when traditional face-to-face education was not feasible due to school closure or prohibition of outside educators. Curricula adaptations relied on delivering live content through online platforms like Zoom or Google Classroom or pre-recorded content through websites like YouTube. Understandably, using pre-recorded content proved less interactive than face-to-face, but the same was often true with live online content, as supplemental activities like taste tests could no longer be incorporated into education delivery. Where applicable, face-to-face PA education was adapted to abide by masking and social distancing requirements, along with limiting use of any shared equipment. While it was possible to continue or shift to policy, system and environmental approaches not dependent on in-person interaction, it was more difficult to initiate and/or maintain approaches dependent on student and family interaction at sites that were engaged exclusively in distance learning. This study aimed to examine the impact of COVID-modified, school-based CFHL programming on student dietary and PA outcomes during the 2020–2021 school year.

Methods

Sampling and data collection

A quasi-experimental, two-group, pre-post design was used to examine the impact of CFHL school and afterschool

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programme-based interventions on students' dietary and PA behaviours. Schools and afterschool sites (hereby referred to as *sites*) in California serving fourth and fifth grades that were CFHL-eligible (had at least 50 % of students eligible for FRPM) were eligible to participate in this evaluation. CFHL eligibility was determined using FRPM data from 2017 to 2018, the latest data available when site recruitment began. Intervention sites were invited to participate by local health departments if they were partnering on delivery of CFHL intervention during the 2020–2021 school year that included direct education and policy, system, and environmental approaches with fourth and fifth grades and were agreeable to conducting the required elements for evaluation. Comparison sites were eligible for CFHL but had not received any CFHL intervention. Comparison sites were selected, to the extent possible, to have similar socio-demographic characteristics, including student race/ethnicity, FRPM, urbanicity and enrolment to the local health department's corresponding intervention site(s). A convenience sample of forty-seven intervention sites and seventeen comparison sites consented to participate in this study. Comparison sites were given a $500 stipend, to use as desired, as compensation for participation in this evaluation.

At each participating site, a sample of approximately sixty fourth- and/or fifth-grade students from at least three classrooms were invited to participate in a pre-post survey. Passive parental consent was obtained by distributing an opt-out form 2 weeks prior to survey administration, and students were given the opportunity to opt out of the evaluation on the day of survey administration. Students were excluded from the analyses if they did not complete both a pre-test and a post-test survey or if they had incomplete demographic information. Pre- and post-test surveys were matched using unique study ID numbers assigned and maintained by the survey administrator (local health department staff or classroom teacher). Only matched student pre- and post-tests were used in the analyses.

Pre-test surveys were always conducted prior to the start of any CFHL intervention at a given site. Due to delays (that varied by site) caused by COVID-19 in the initiation of interventions, pre-tests were administered between October 2020 and May 2021. Post-test data were collected within the last 2 months of the school year (April–June 2021), after interventions were implemented at the sites. Though intended to capture a full school year intervention, due to the delays previously mentioned, the total intervention period ranged from 1 month to 7 months, with most beginning intervention before the December holiday break, and concluding in May or June. To ensure that all students recalled school day dietary behaviours, survey administrators were directed to survey students on a weekday that was not a Monday or the day after a weekday school holiday or break. However, given the enormous burden on sites navigating distance learning, some schools were only able to schedule surveying on days that would reflect weekend or holiday eating behaviours. Sensitivity analyses were conducted to determine if day relative to the weekend or holiday of survey administration was associated with dietary outcomes of interests. Analyses indicated that inclusion of survey administration date reduced model fit and did not significantly impact our conclusions (data not shown). Therefore, to maintain sample size, these surveys (*n* 219) were included in analyses.

Student dietary and physical activity behaviours

Students' self-reported dietary and PA behaviours were assessed using the Eating and Activity Tool for Students (EATS), administered online by trained local health department nutrition educators and/or classroom teachers. The EATS survey, utilised by CFHL state implementing agencies to evaluate the effectiveness of CFHL interventions delivered to youth, was modified in July 2020 to account for the effects of COVID-19[30].

Dietary behaviours assessed included if and where (i.e. home or school) students consumed school breakfast and school lunch on the previous day as well as consumption frequencies of fruits, vegetables, and beverages in the past day assessed via sixteen questions adapted (minor wording and/or formatting changes) from the validated School Physical Activity and Nutrition (SPAN) survey. These questions asked about frequency of consumption of vegetables (starchy vegetables (corn, potatoes and peas), orange vegetables, salad and green vegetables, other vegetables, beans), fruit (fruit, 100 % fruit juice), French fries and chips, diet soda, SSB (fruit drinks, sports drinks, regular soda, energy drinks, sweetened coffee and tea, flavoured milk), and water[31,32]. With the exception of the fruit question, response options ranged from '*No, I didn't eat/drink ___ yesterday*' to '*Yes, I ate/drank ____ 3 or more times yesterday*'. Response options for fruit ranged from '*No, I didn't eat fruit yesterday*' to '*Yes, I ate fruit 5 or more times yesterday*'. Responses to individual fruit, vegetable and SSB questions were summed to derive total fruit, total vegetable and total SSB intakes, respectively.

Three PA behaviours were assessed on the EATS survey: (1) the number of days students were active for at least 60 min daily, to measure student attainment of the moderate/vigorous PA recommendation[33]; (2) the number of days students had a structured PE class; and (3) the relative proportion of time they were active in PE class. Two additional PA behaviours: (1) the frequency with which students had recess on the days they were at school and (2) the proportion of time they were physically active during recess were also assessed among students attending school in person. The question assessing the number of days students were active at least 60 min daily was used in its original, validated form[31,32], and the remaining PA questions were developed by the authors to assess specific programmatic priorities. For further information regarding survey questions

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and response categories, refer to EATS (see online Supplemental Material).

Student-level and site-level demographics

EATS also included questions regarding student demographics: race/ethnicity, sex, age and grade as well as type of school attendance (in-person, distance learning and combination) in the past day and week.

Site-level demographic data, including racial/ethnic distribution, student enrolment, percent of students qualifying for FRPM and grade range served at intervention and comparison sites, were downloaded from the California Department of Education[34–36]. Urbanicity of sites was determined using 2019 National Center for Education Statistics (NCES) Public School Locale data[37].

Statistical analyses

Descriptive statistics were calculated for measured socio-demographic characteristics. *T*-tests and chi-square tests, adjusted for clustering by sites, were used to assess bivariate differences in socio-demographic characteristics between intervention and comparison groups. ANCOVA adjusting for student pre-test scores, age, sex, and race/ethnicity and for clustering by site was used to examine the intervention impact on change scores of continuous outcomes (all dietary intake outcomes, days achieving 60 min or more of moderate or vigorous PA, and days of PE class). Generalised estimating equations, adjusting for student age, sex, and race/ethnicity, and for clustering by site, were used to assess the impact of intervention on time spent active in PE class. All analyses were performed in SAS v.9.4. (SAS Institute Inc.). *P*-values of <0·05 were considered statistically significant.

Results

Study sample

The final sample included 1087 fourth- and fifth-grade students with matching pre-/post-surveys in forty-seven CFHL-eligible sites receiving CFHL intervention administered by local health departments. The comparison group included 846 fourth- and fifth-grade students with matching pre-/post-surveys in seventeen CFHL-eligible sites not receiving CFHL or other, similar interventions. Initially, at pre-test, 98 % (2305 of 2355) of students invited to participate at the intervention site and 99 % (1432 of 1449) of students invited to participate at comparison sites completed surveys. At post-test, 97 % (1965 of 2036) of intervention students and 99 % (1440 of 1451) of comparison students invited completed surveys. Of these, surveys from 1087 students at intervention sites and 846 students at comparison sites completed surveys that could be matched at pre- and post-test time points and, thus, were included in the final sample. Unmatched surveys were due primarily to low and inconsistent class attendance and remote survey administration challenges (e.g. unique ID assignment and internet connectivity).

Intervention and comparison students were, on average, 9·8 years old. A greater proportion of intervention group students identified as female, as compared with the comparison group ($P < 0·001$). There were no statistically significant differences between intervention and comparison groups in regard to student race and ethnicity. There were also no statistically significant differences between intervention and comparison site urbanicity, percent of students eligible for FRPM, enrolment, or school type. Intervention and comparison sites differed slightly in racial/ethnic distribution, with intervention sites tending to have a lower percent of White students than comparison sites ($P = 0·018$), Table 1.

Intervention

The CFHL interventions at all forty-seven intervention sites included nutrition and PA education curricula. In the majority (85 %, forty sites) of intervention sites, education was delivered exclusively online; only a small proportion of sites delivered curricula either exclusively in person (9 %, four sites) or a mix of online and in person (6 %, three sites). Mode of nutrition/PA education delivery typically corresponded to mode of general education delivery (i.e. school was in distance learning, in-person or hybrid). The Dairy Council's Let's Eat Healthy curriculum was used most commonly by sites (45 %, twenty-one sites)[38]. Less than half of all intervention sites implemented policy, system and environmental approaches. Of the twenty-one sites that implemented these approaches, twelve (57 %) focused on school gardens. Improved PA quality was the most common type of PA policy, system, and environmental approach, and food distribution was the most common healthy food access strategy with each adopted by seven sites (33 %), as shown in Table 2.

Dietary outcomes

Intervention students reported a 0·16 times/d greater increase in total fruit intake frequency ($P = 0·032$) than comparison students, as shown in Table 3. This was driven largely by 100 % fruit juice consumption, which increased 0·11 times/d more among intervention than comparison participants ($P = 0·007$). There was also a favourable intervention effect on frequency of total vegetable consumption, with intervention students reporting an increased consumption frequency, on average, by 0·09 times/d, compared with an average decrease of 0·36 times/d among the comparison group ($P < 0·001$). In regard to individual vegetable components, comparison students reported decreases in consumption frequencies of starchy vegetables (−0·10 times/d), salad/green vegetables (−0·11 times/d) and beans (−0·03 times/d), while intervention students reported increases in consumption frequencies of

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Table 1 Socio-demographic characteristics of sampled students and sites*, by intervention status, 2020–2021 school year

	Intervention group (*n* 1087)		Comparison group (*n* 846)		
Student characteristics	Mean	SE	Mean	SE	*P*-value†
Age	9·8	0·1	9·8	0·1	0·622
	n	%	*n*	%	
Sex					
Female	602	55·4	415	49·1	**<0·001**
Male	485	44·6	431	50·9	
Race/ethnicity					
American Indian/Alaska Native	5	0·5	7	0·8	0·306
Asian	53	4·9	18	2·1	
Black	62	5·7	63	7·4	
Latino	586	53·9	411	48·6	
Native Hawaiian/Pacific Islander	8	0·7	5	0·6	
White	94	8·6	99	11·7	
Multiracial	276	25·4	242	28·6	
Other	3	0·3	1	0·1	
Site characteristics	*n* 47		*n* 17		*P*-value
	n	%‡	*n*	%‡	
Urbanicity					
City	18	38·3	2	11·8	0·090
Suburban	27	57·5	14	82·4	
Rural	2	4·3	1	5·9	
	Mean	SE	Mean	SE	
Percent of students eligible for FRPM	83·1	1·6	78·2	3·9	0·364
Enrolment	540	27·2	543	36·3	0·608
	n	%§	*n*	%§	
School type					
Elementary only	39	83·0	16	94·1	0·420
Elementary and secondary	8	17·0	1	5·9	
	Mean	SE	Mean	SE	
Percent of students belonging to racial/ethnic groups					
Hispanic	73·5	3·4	69·7	4·3	0·279
African American	6·5	1·4	8·3	2·4	0·289
American Indian/Alaska Native	0·2	0·0	0·5	0·1	0·144
Asian	3·9	1·1	3·0	1·5	0·381
Filipino	1·8	0·3	1·5	0·6	0·542
Pacific Islander	0·5	0·1	0·6	0·3	0·993
White	10·3	2·5	13·1	3·2	**0·018**
Multiracial	2·5	0·4	3·0	0·5	0·355

FRPM, Free and Reduced Price Meals.
*Sites included sampled school and afterschool programme sites.
†*T*-tests, adjusted for clustering by site for student characteristics, were used for continuous outcomes. Chi-square and Fisher's exact tests, adjusted for clustering by site for student characteristics, were used for categorical outcomes. *P*-values of <0·05 were considered statistically significant and appear in bold.
‡Site urbanicity was defined using the 2019 National Center for Education Statistics (NCES) Public School Locale classifications (city, suburban, town and rural)[37].
§Elementary only defined as K-5 or K-6 schools. Elementary and secondary defined as K-7, K-8 and K-10 schools.

these vegetable components (0·05 times/d, 0·01 times/d and 0·04 times/d, respectively). Although, the reported consumption frequency of 'other vegetables' decreased in both intervention and comparison groups (−0·01 *v.* −0·09 times/d), a larger, statistically significant decrease was observed among the comparison group ($P = 0·048$). The difference in change in these consumption frequencies between the intervention and comparison groups was statistically significant, indicating an intervention effect in the direction of increasing the consumption of these vegetable components.

While intervention student change in reported total SSB intake frequency was not significantly different from comparison students, intervention students did report an increase in the frequency of consumption of regular soda compared with a decrease among comparison students (0·06 times/d *v.* −0·01 times/d, $P = 0·041$).

At pre-test, 18 % and 15 % of students in intervention and comparison groups, respectively, reported consuming school breakfast either at school or at home on the previous day. At post-test, this increased to 19 % of intervention students and 20 % of comparison students. At pre-test, 23 % and 20 % of students in intervention and comparison groups, respectively, reported consuming school lunch either at school or at home on the previous day. At post-test, this increased to 26 % of intervention students and 28 % of comparison students. No differences were detected between groups (data not shown).

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Table 2 Nutrition and physical activity curricula and policy, systems, and environmental change strategies adopted by intervention sites*, 2020–2021 school year

Nutrition and physical activity curricula† (*n* 47)‡	Number of sites adopting	%
Let's Eat Healthy (Dairy Council)	21	45
Serving Up MyPlate: A Yummy Curriculum (USDA)	10	21
Coordinated Approach to Child Health (CATCH)	8	17
Teams with Intergenerational Support (TWIGs)§	3	6
Food Smarts for Kids (Leah's Pantry)	3	6
Power Play! Community Youth Organization (CYO) Kit	2	4
Policy, systems and environmental change strategies‖ (*n* 21)¶		
Gardens	12	57
Physical activity		
Improved quality	7	33
Environmental improvements	6	29
Increased access	5	24
Healthy food access		
Food distribution	7	33
Food procurement	2	10
Healthy choice promotion	2	10
Policy development	6	29
Healthy defaults	5	24
Capacity building	2	10

*Sites included sampled school and afterschool programme sites.
†All curricula are approved by the US Department of Agriculture and are reported by local health departments on internal planning worksheets[51].
‡Sample includes the forty-seven intervention sites (full sample) that received nutrition education.
§Teams with Intergenerational Support (TWIGS) does not include a physical activity component.
‖Data obtained from the Program Evaluation and Reporting System (PEARS)[52].
¶Sample includes the twenty-one intervention sites that adopted one or more policy, system, and environmental changes.

Physical activity outcomes

There were no significant differences between intervention and comparison students in terms of change in the number of days students reported achieving 60 or more minutes of moderate or vigorous PA per week, the number of days students had a PE class each week nor the proportion of time students reported being physically active during PE class, as shown in Tables 4 and 5.

Discussion

We examined the effectiveness of school and afterschool-based CFHL programming modified during the 2020–2021 school year due to COVID-19. Compared with comparison students, those receiving intervention reported a significantly greater frequency of fruit and vegetable intake. Though the observed increase in fruit and vegetable intake may appear modest at just under one-third of a time per d total increase, it is important to note that, in regard to vegetable consumption, CFHL appeared to protect students from decreasing vegetable intake. Positive fruit and vegetable results were expected, because fruit and vegetable consumption is a core focus of all nutrition education curricula used and is in alignment with CFHL's behavioural goals and objectives[39]. Murimi *et al.* found that in addition to identification of specific behaviours to be modified, successful nutrition education interventions targeting elementary school children employed four key components: (1) face-to-face parent engagement; (2) education fidelity through teacher training or use of trained experts to deliver education; (3) intervention duration of at least 6 months and (4) use of age-appropriate activities[40]. The interventions examined in this study actively employ most of these key elements. Though we evaluated collective and non-homogeneous CFHL interventions, all curricula were delivered with fidelity by trained educators or content experts and have been previously tested and approved by USDA as age-appropriate. The study design was intended to test a robust, full school year intervention, and despite the impact of COVID-19 on execution, many sites were still able to achieve this. Accomplishing face-to-face engagement with parents was the less feasible intervention component during a period of school closures and subsequent distance learning, thus highlighting the need for creative engagement approaches. Given school meal distribution may have been the only opportunity for face-to-face parent engagement, implementers should look to this key interaction to employ policy, system, and environmental approaches and distribution of other educational materials to families.

Our findings indicate that students reported consuming fruit (excluding 100 % juice) about 1·5 times/d and vegetables just over 3 times/d. Per the Dietary Guidelines for Americans (DGA) 2015–2020, it is recommended children aged 9 to 13 years, depending on caloric needs, consume between 1·5 to 2 cups of fruit and 1·5 and 3·5 cups of vegetables daily[41]. Nationally, data show that average daily intake falls short of the recommendation with intake of about one cup for both fruits and vegetables[41]. As such, we acknowledge that equating cups/d to times/d is likely not straightforward and infer the student population in the present study had some room for improvement in this regard. Encouragingly, the reported pre- to post-increase in vegetable intake among intervention students was driven by a wide array of vegetables; however, the increase in total fruit was primarily driven by an increase in 100 % fruit juice intake. This finding is less than ideal given that whole fruit is nutritionally superior to fruit juice[42]. This finding may be explained in part by the inclusion of material addressing how and why to select 100 % fruit juice in the CFHL nutrition curricula. Additionally, though juice intake among intervention students increased more, both intervention and comparison students reported increases in juice intake, which may have been due to the convenience of providing juice as part of school meals distributed via grab-and-go. Unlike milk, 100 % juice is typically shelf-stable and may have been selected more often if meals were not going to be consumed immediately or were

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Table 3 Adjusted change in dietary intake frequencies among sampled students, by intervention status, 2020–2021 school year

	Intervention group				Comparison group						
Dietary intake*, times/d	*n*	Adjusted† mean change	Adjusted† mean, pre	Adjusted† mean, post	*n*	Adjusted† mean change	Adjusted† mean, pre	Adjusted† mean, post	Adjusted† mean difference in change, intervention and comparison	95 % CI	*P*-value‡
Fruit, w/ 100 % juice	1072	0·20	2·39	2·59	841	0·04	2·39	2·43	0·16	0·01, 0·31	**0·032**
Fruit, no 100 % juice	1074	0·02	1·48	1·50	843	−0·04	1·48	1·44	0·06	−0·07, 0·20	0·374
100 % fruit juice	1072	0·18	0·91	1·09	841	0·07	0·91	0·98	0·11	0·03, 0·19	**0·007**
Vegetables	1063	0·09	3·18	3·27	839	−0·36	3·18	2·82	0·45	0·25, 0·65	**<0·001**
Starchy vegetables	1072	0·05	0·69	0·74	841	−0·10	0·69	0·59	0·15	0·08, 0·23	**<0·001**
Orange vegetables	1074	−0·01	0·56	0·54	843	−0·05	0·56	0·51	0·04	−0·03, 0·10	0·243
Salad/green vegetables	1071	0·01	0·77	0·78	843	−0·11	0·77	0·66	0·12	0·04, 0·20	**0·005**
Other vegetables	1070	−0·01	0·78	0·77	842	−0·09	0·78	0·69	0·08	0·00, 0·15	**0·048**
Beans	1070	0·04	0·38	0·43	842	−0·03	0·38	0·35	0·07	0·01, 0·14	**0·025**
Water	1065	0·12	2·30	2·42	837	0·17	2·30	2·47	−0·05	−0·12, 0·02	0·189
Sugar-sweetened beverages	1059	0·13	2·15	2·29	835	0·08	2·15	2·24	0·05	−0·23, 0·33	0·719
Fruit drinks	1063	−0·01	0·62	0·60	837	−0·05	0·62	0·57	0·04	−0·05, 0·13	0·395
Sports drinks	1063	0·10	0·29	0·40	836	0·10	0·29	0·40	0·00	−0·07, 0·07	0·991
Regular soda	1065	0·06	0·38	0·44	837	−0·01	0·38	0·37	0·07	0·00, 0·14	**0·041**
Energy drinks	1064	0·00	0·07	0·07	837	0·01	0·07	0·07	−0·01	−0·04, 0·03	0·701
Sweetened coffee/tea	1063	0·02	0·25	0·27	837	0·00	0·25	0·25	0·02	−0·02, 0·06	0·331
Flavoured milk	1064	0·00	0·54	0·54	836	0·05	0·54	0·59	−0·05	−0·16, 0·06	0·358

*For all beverage (including 100 % juice) and vegetable questions, response options ranged from *No, I didn't eat/drink ___ yesterday* to *Yes, I ate/drank ____ 3 or more times yesterday*. Response options for fruit ranged from *No, I didn't eat fruit yesterday* to *Yes, I ate fruit 5 or more times yesterday*.
†Estimates derived from ANCOVA, adjusted for student self-reported age, sex, and race/ethnicity, pre-test scores, and for clustering by site.
‡*P*-values of <0·05 were considered statistically significant and appear in bold.

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Table 4 Adjusted change in physical activity outcomes among sampled students, by intervention status, 2020–2021 school year

	Intervention group				Comparison group						
Physical activity outcome*, d/week	*n*	Adjusted† mean change	Adjusted† mean, pre	Adjusted† mean, post	*n*	Adjusted† mean change	Adjusted† mean, pre	Adjusted† mean, post	Adjusted† mean difference in change, intervention and comparison	95 % CI	*P*-value‡
60+ min moderate/vigorous physical activity	1057	0·44	2·49	2·93	831	0·40	2·49	2·88	0·04	−0·29, 0·38	0·802
Physical activity class like PE	1049	0·17	1·22	1·39	826	0·03	1·22	1·25	0·15	−0·31, 0·61	0·530

*For frequency of 60+ min of moderate or vigorous physical activity, students selected the days per week (Mon–Sun), they were active for at least 60 min. For frequency of a physical activity class like PE, students selected the days per school week (Mon–Fri), they engaged in a PE class.
†Estimates derived from ANCOVA, adjusted for student self-reported age, sex, and race/ethnicity, pre-test scores, and for clustering by site.
‡*P*-values of <0·05 were considered statistically significant.

picked up in bulk. Furthermore, our data indicate that reported school meal consumption for intervention and comparison increased from pre to post, and we speculate due to more students returning to school campuses in at least some capacity. Further research is needed on how individual food items and nutritional content of school meals may have changed from pre-COVID to adoption of grab-and-go. As grab-and-go models of serving food continue to be offered as necessitated throughout the school year, school meal quality may be a priority area of focus for CFHL policy, system and environmental interventions.

Our data indicate a reported baseline SSB consumption of just over two times/d among the study population, compared with an average of roughly one SSB, or 143 calories/d, for children aged 2 to 19 years in the USA[43]. Two SSB (with 286 calories from sugar total) per d would likely contribute to sugar intake in excess of the maximum recommended intake of 10 % of total calories given that the daily allowance for total calories for children aged 9 to 13 years is 1400–2600[41]. Despite the need to reduce the excessive intake of SSB among the study population, there was no difference in reported change in frequency of total SSB intake from pre to post between intervention and comparison. As with increasing consumption of fruits and vegetables, decreasing consumption of SSB and increasing consumption of water are specific objectives of CFHL[39]. While evidence suggests consumption of SSB can be effectively reduced in children[44], this may be difficult to achieve if the nutrition education component of the intervention does not provide sufficient focus on healthy beverage selection. Additionally, research shows that reducing unhealthy behaviours can be more challenging than initiating healthy ones[45,46], which suggests that moving the needle on SSB intake may prove more difficult than increasing healthy eating behaviours, like fruit and vegetable intake. Another important consideration during this time period were the unknowns of the food environment at home. During the initial spring 2020 school closures, elementary children experienced an overall increase in dietary intake, encompassing both healthy and unhealthy foods[2]. Key reasons for increased SSB and snack intake during the pandemic included having unlimited access to food, eating/drinking out of boredom, and less parental oversight over child food and beverage choices[47]. It is reasonable that this shift in dietary pattern persisted until students returned to school in-person, with a more regulated food environment. Strengthening the focus of CFHL curricula to better address SSB consumption and employing policy, system, and environmental efforts to support healthy beverage environments at home may help address the observed increases in SSB consumption among fourth- and fifth-grade students.

At baseline, students reported being physically active for at least 60 min/d for two and a half days per week. This is four and a half days short of the aerobic recommendation

Table 5 Adjusted change in proportion of PE time being physically active among sampled students, by intervention status, 2020–2021 school year

Physical activity outcome*	Group	*n*	Baseline (%)	Follow-up (%)	Change (%)	*P*-value†
Spent half or more of PE class being physically active	Intervention	474	67·93	62·66	−7·76	0·677
	Comparison	398	79·90	80·15	0·31	

*Question responses were recoded as spent half or more of PE class being physically active *(About half of the class time and most or all of the class time)* and did not spend half or more of PE class being physically active (*Less than half of class time*).
†*P*-values derived from generalised estimating equations, adjusted for age, sex, and race/ethnicity, and for clustering by site. *P*-values of <0·05 were considered statistically significant.

for their age group[33]. Additionally, our findings indicate that students reported receiving PE just under one and a quarter days per week. California Education Code indicates elementary students should not receive less than 200 min of PE instruction every 10 d[48]. Estimating a typical elementary PE class is 45 min long, during COVID, students missed out on almost half of the required PE minutes. Though another study showed that schools receiving CFHL PA intervention in years prior to COVID closures had better fitness and slightly lower BMI *Z*-scores[49], neither attainment of the 60 min moderate–vigorous recommendation nor reported amount of or activity level during PE were impacted by the interventions in this study that were modified due to COVID-19. Two-thirds of intervention sites utilised Let's Eat Healthy or Serving Up My Plate: A Yummy Curriculum. While both address aspects of PA, their primary focus is on teaching healthy eating behaviours. Only 38 % of all intervention sites supplemented education with a PA-focused policy, system, and environmental strategy, and of those, a third worked toward environmental changes, potentially not benefiting students until they returned to campus. Considering the challenges associated with delivery of PE during COVID-19[20], it is likely that CFHL programming focused less on PA if it was more difficult to deliver virtually or the PA programming that was delivered was less effective when offered virtually. Although improving nutrition alone is good, incorporating PA into robust, multicomponent nutrition interventions has added benefits[50]. Furthermore, PA has been shown to reduce risk of severe COVID-19 outcomes[26,28]. Given the increase in physical inactivity among children during COVID-19[22,23], further research should focus on improving delivery of virtual PA interventions to ensure that the positive impacts achieved with in-person delivery of CFHL PA interventions can be equally effective in a distance learning environment.

Due to the complex nature of the CFHL grant process, the intensive resources needed to deliver programming, and the challenges associated with conducting research in the school setting, we were unable to randomise and instead were limited to recruitment of a convenience sample of intervention and comparison sites. This may have resulted in selection bias within our sample. Though validated questions were used to measure dietary behaviour measures, intake was self-reported and therefore subject to recall error and bias. Furthermore, in order to capture intake on a typical weekday and reduce recall error, students recalled these behaviours for the prior day. That day may not be representative of their usual intake. Despite these limitations, the inclusion of a comparison group strengthens these findings, which provide valuable information regarding the effectiveness of CFHL interventions that were modified during a public health emergency; a time when maintaining a healthy diet and physically active lifestyle were particularly important in protecting youth from potentially severe consequences of COVID-19[25–28].

Conclusion

Whether faced with another global pandemic, a natural disaster, or other health and/or safety concerns, schools in California will continue to face the possibility of temporary closure with a shift to online learning to protect student and staff wellbeing. Additionally, over the last 2 years, many districts have developed more comprehensive online learning and independent study programmes for students that are unable or do not prefer to return to in-person schooling. As a result, schools should be at the ready to provide education, including nutrition and PE, in an online format. Though some common policy, system and environmental approaches are less feasible when students are not on campus, many, such as implementing staff professional development, strengthening wellness policies and addressing meal quality, can benefit students both on and off campus. There is still much work to be done improving students' diet and PA behaviours through increasing fruit and vegetable intake, decreasing SSB intake, and attaining the recommended activity level, and for this reason, CFHL must continue to innovate and adapt interventions. This study's findings indicate that at the sampled schools, CFHL had a positive impact on student diet, and, thus, can serve as an example of how to modify delivery of nutrition and PA interventions to reach students when away from campus.

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Supplementary material

For supplementary material accompanying this paper visit https://doi.org/10.1017/S1368980023000137

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