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Supplemental Nutrition Assistance Program Education reductions during COVID-19 may have exacerbated health inequities

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ABSTRACT

Objective: Describe, and assess disparities in, the changes in Supplemental Nutrition Assistance Program Education (SNAP-Ed) that occurred the year before vs. the year when COVID-19 restrictions were implemented.
Design: Observational study comparing reach, intensity, and dose of California Local Health Department (LHD) SNAP-Ed interventions in Federal Fiscal years 2019 and 2020 (FFY19, FFY20).
Analysis: Student t-tests determined significance of differences in the number of Direct Education (DE) programs, Policy, Systems and Environmental change (PSE) sites, people reached, and intervention intensity and dose between FFY19 and FFY20 using data reported online by LHDs. Linear regression assessed associations between census tract-level characteristics (urbanicity; percentages of population with income <185% of federal poverty level, under 18 years of age, and belonging to various racial/ethnic groups; and California Healthy Places Index) and changes in number of DE programs, PSE sites, people reached, and intervention dose between FFY19 and FFY20.
Results: From FFY19 to FFY20, the number of DE programs, PSE sites, people reached, and census tract-level intervention intensity and dose decreased. Higher census tract poverty, higher proportions of Black and Latino residents, and less healthy neighborhood conditions were associated with greater decreases in some intervention characteristics including PSE sites, PSE reach, DE programs, and DE dose.
Conclusions and implications: These reductions in LHD SNAP-Ed interventions indicate reduced access to education and environments that support healthy eating and obesity prevention during a time when this support was especially needed to reduce risk of COVID-19 infection and complications. Disproportionately reduced access, may have worsened health disparities in already-disadvantaged communities. Assuring maintenance of SNAP-Ed interventions, especially in disadvantaged communities, should be a priority during public health emergencies.

1. Introduction

Low-income, Black, and Latino communities experience disproportionately poorer health, including higher rates of type 2 diabetes (Gaskin et al., 2014), more emergency room visits (Leal & Chaix, 2011), higher obesity prevalence (Kirby & Kaneda, 2005), and lower life expectancy (Chang et al., 2021; Suglia et al., 2016) than their higher income and white, non-Latino counterparts. Neighborhood-level disadvantages (Do & Finch, 2008; Leal & Chaix, 2011), including healthcare access (Kirby & Kaneda, 2005) and aspects of social and physical environments (e.g., poverty, social cohesion, crime, safety, food access) (Christian et al., 2011; Fonge et al., 2020; Gebreab et al., 2017; Hilmers et al., 2012; Morris et al., 2019; Singh et al., 2010) contribute to these disparities.

COVID-19 disproportionately impacted certain neighborhoods, exacerbating pre-COVID-19 health disparities (Hatef et al., 2020; Levy et al., 2022; Samuels-Kalow et al., 2021; Tung et al., 2021; Wadhera et al., 2020). COVID-19 morbidity and mortality have been concentrated among communities with higher proportions of Black (Glance et al.,

Abbreviations: CDPH, California Department of Public Health; CFHL, CalFresh Healthy Living; DE, direct education; FFY, Federal Fiscal Year; LHD, local health department; PEARS, Program Evaluation and Reporting System; PSE, policy, systems and environmental change; SNAP-Ed, Supplemental Nutrition Assistance Program Education.

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2021; Saffary et al., 2020), Latino (Strully et al., 2021), and low-income households (Rozenfeld et al., 2020). Pre-existing disparities in chronic illness, such as obesity (Holly et al., 2020) and diabetes (Fang et al., 2020), contributed to higher COVID-19-related morbidity and mortality in these same communities (Arasteh, 2021; CDC, 2021). Because cardiometabolic conditions such as obesity (Holsten, 2009), diabetes (Mezuk et al., 2016), and hypertension (Dubowitz et al., 2012) are also associated with the food environment (Karlsson & Beck, 2010), it is important to maintain or expand interventions through multi-level nutrition and obesity prevention strategies that include both education and policy, systems and environmental (PSE) approaches to address COVID-19-related health inequities.

The United States Department of Agriculture's (USDA) Supplemental Nutrition Assistance Program Education (SNAP-Ed) provides funding to every state to implement interventions that support healthy eating and active living for millions of low-income households (income ≤185% of the federal poverty level) each year (Naja-Riese et al., 2019). California's SNAP-Ed, the largest in the U.S., emphasizes PSE approaches implemented in diverse settings such as schools, food stores, food pantries, parks, and early care and education (ECE), supplemented by education strategies. Studies have demonstrated positive SNAP-Ed outcomes including dietary intake, food security, and physical fitness (Molitor & Doerr, 2021; Rivera et al., 2016; Thompson et al., 2020; Molitor et al., 2015). A recent study demonstrated that SNAP-Ed positively impacted dietary outcomes in California schoolchildren during COVID-19 (Linares et al., 2023). The current study examines SNAP-Ed interventions funded through the California Department of Public Health (CDPH), and implemented by 60 local health departments (LHDs) in 57 of 58 California counties and three cities thereby reaching millions of Californians each year. CDPH coordinates efforts with three other state SNAP-Ed implementing agencies (Catholic Charities, California Department of Aging, and CalFresh Healthy Living, University of California); interventions funded through these agencies were excluded from this study.

In response to COVID-19, California declared a state of emergency on March 4, 2020, followed by statewide shelter-in-place orders on March 19, 2020 (State of California, 2020a; State of California, 2020b). Schools, early care and education programs, and many other institutions closed and residents were directed to stay home when not engaged in essential activities. California's LHDs reported challenges resulting from the pandemic, including diversion of funding, staff, and other resources from programs, including SNAP-Ed, to COVID-19 emergency response (PHA, 2022). Because CDPH's SNAP-Ed is California's largest obesity prevention program for low-income communities, changes in the program due to COVID-19 likely had consequences for community nutrition and obesity risk at a time when healthy weight and nutrition were especially important for reducing COVID-19 morbidity and mortality. Few studies have described how individual SNAP-Ed programs pivoted in response to the pandemic (Elwood, 2020; Sweet et al., 2021; Todaro et al., 2021). No studies have explored larger-scale changes in SNAP-Ed interventions during COVID-19. Understanding how interventions changed in response to the pandemic, including which communities were more likely to experience disruptions, is important to inform how obesity prevention programs prepare for and adapt to future public health emergencies.

This study aims to 1) measure and describe changes in reach, intensity, and dose of California LHD SNAP-Ed interventions in the early months of the COVID-19 pandemic by comparing Federal Fiscal Years 2019 (FFY19) (pre-pandemic) with FFY20 (first year of pandemic) and 2) determine if neighborhood-level socioeconomic factors were associated with the observed intervention changes.

2. Methods

2.1. Study design

This observational study compares characteristics such as reach, intensity, and dose of California LHD's SNAP-Ed interventions in FFY19 (10/1/2018-9/30/2019) prior to COVID-19-related restrictions, and FFY20 (10/1/2019-9/30/2020) during which COVID-19 restrictions began midway and persisted through the rest of the year. Furthermore, it examines the relationship between changes in intervention characteristics and census tract characteristics to identify how equity in intervention delivery changed over this time period.

2.2. Intervention characteristics

Data regarding LHDs' SNAP-Ed Direct Education (DE) and PSE interventions were obtained from the online Program Evaluation and Reporting System (PEARS) (Kansas State University, n.d.). PEARS is used by the majority of U.S. states to report on SNAP-Ed-funded activities, and is required for all LHDs in California. LHDs can enter data throughout the year regardless of when (within the fiscal year) the activity occurred. Dates are reported for DE programs but not for PSEs; for consistency all data was compiled by fiscal year. LHDs are instructed to report on all activities that occur, whether or not they were completed as planned, but not on activities that never started. Data are reported by LHDs following detailed guidance, trainings, and technical assistance (Becker et al., 2022) and are reviewed and cleaned according to detailed protocols. Specifically, all PEARS reports are checked for inconsistent, missing, and implausible data, and when identified, LHDs are contacted for clarification and corrections.

DE is defined by USDA as an intervention delivered in-person or live on-line where a participant is actively engaged in the learning process with an educator and/or interactive media. For this study, a DE program was quantified as a single educational program with one or more sessions offered to the same audience. PSEs, reported at the site-level in PEARS, include changes such as systematically changing the foods offered in schools or stores, changing contracts with suppliers for more healthful foods, or modifying physical activity opportunities.

PEARS data used in this study for each DE program and PSE site include 1) location (address); 2) setting, chosen from the following: "After/Before School Programs", "Early Care & Education", "Faith/Places of Worship", "Farmers Markets", "Food Distribution", "Health Care Services", "Learning Sites (other)", "Mass-media", "Places People Play", "Places to Eat", "Residential Sites", "Schools", "Senior Services", "Stores", "Worksites & Related," and "Other"; 3) reach (number of participants in each DE program, number of people exposed to at least one PSE at each site); 4) PSE changes adopted at each site, selected from 203 options, such as "Healthy check-out areas" and "Increased quantity (minutes) of physical education"; and 5) number of hours of instruction for each DE program. In April 2020, an optional question about COVID-19 impact on interventions was added to the PEARS PSE and DE modules with response options including "New", "Cancelled", "Postponed", or "Modified" (CalFresh Healthy Living, 2021). This question was asked of interventions that had at least started and were therefore reported in PEARS.

For FFY19 and FFY20, PEARS data were used to calculate the following:

- Number of DE programs and PSE sites (total, per census tract, by setting)
- Number of people reached by DE and PSE (total, per census tract, per program or site),
- Intensity and dose of DE and PSE (per census tract, per program or site)

Using previously published methodology, these measures were

calculated as follows (Hewawitharana et al., 2021): DE intensity (number of instructional hours for each program); DE dose (number of participants times the number of instructional hours for each program); PSE intensity (number of categories of PSE changes adopted at each site); and PSE dose (number of PSE categories implemented at a site times the number of people reached by at least one PSE at that site). For PSE calculations. described in more detail by Hewawitharana et al. (2021), the authors grouped similar PSE changes adopted from a total of 203 into 22 broader categories. For example, "Added bike storage/racks" and "Increased access or safety of walking or bicycle paths" were collapsed into the category "Active Transport".

PSEs reported at school district-level were attributed to each school within the district when reported for a school setting (or to each elementary school in the district, if reported for a school-based ECE or after/before-school setting). The proportion reached was assumed to be the same at the sites as was reported for the district. When PSEs were reported at both district and site levels ($n_{FFY19} = 98$; $n_{FFY20} = 41$), to give weight to both, the reach at that school from district-level and site-level reports were summed.

For each census tract, changes in DE and PSE (number of DE programs or PSE sites, number of people reached, intensity, dose) were calculated by subtracting FFY19 values from FFY20 values. Measures of change at the census tract-level included all census tracts that had at least one DE program (for DE measures) or PSE site (for PSE measures) in either year; therefore, zero values for some census tracts were possible if DE programs or PSE sites occurred in only one year. Site-level and program-level averages only include extant DE programs and PSE sites within each year; therefore, zeros were not included. DE programs were excluded when reported reach (>1000 participants) or intensity (>3000 h/program) were implausible (n = 31) or census tract information (n = 68) or reach, intensity, or dose (n = 181) was missing in either year. PSE sites were excluded when missing reach, intensity, or dose in either year (n = 344).

The five settings with the most DE programs and PSE sites are presented graphically (Fig. 1). Data for all other settings were combined as "Other."

To generate examples that exemplify adaptations made as a result of COVID-related restrictions, we reviewed optional open text fields in the FFY20 PEARS PSE and DE modules for comments related to what stopped, started, was postponed, or changed due to COVID and why; and narrative success stories (at least one per LHD required annually).

2.3. Census tract characteristics

To examine the relationship between census tract-level characteristics and changes from FFY19 to FFY20 in select DE and PSE characteristics, the following data were obtained from the U.S. Census five-year American Community Survey census tract estimates (2015–2019) (U.S. Census Bureau): percentage of population by race/ethnicity (Hispanic/Latino and non-Hispanic Asian, American Indian or Alaskan Native, Black, Pacific Islander, two or more races, other, and White), percentage under 18 years of age, and percentage with income under 185% of the

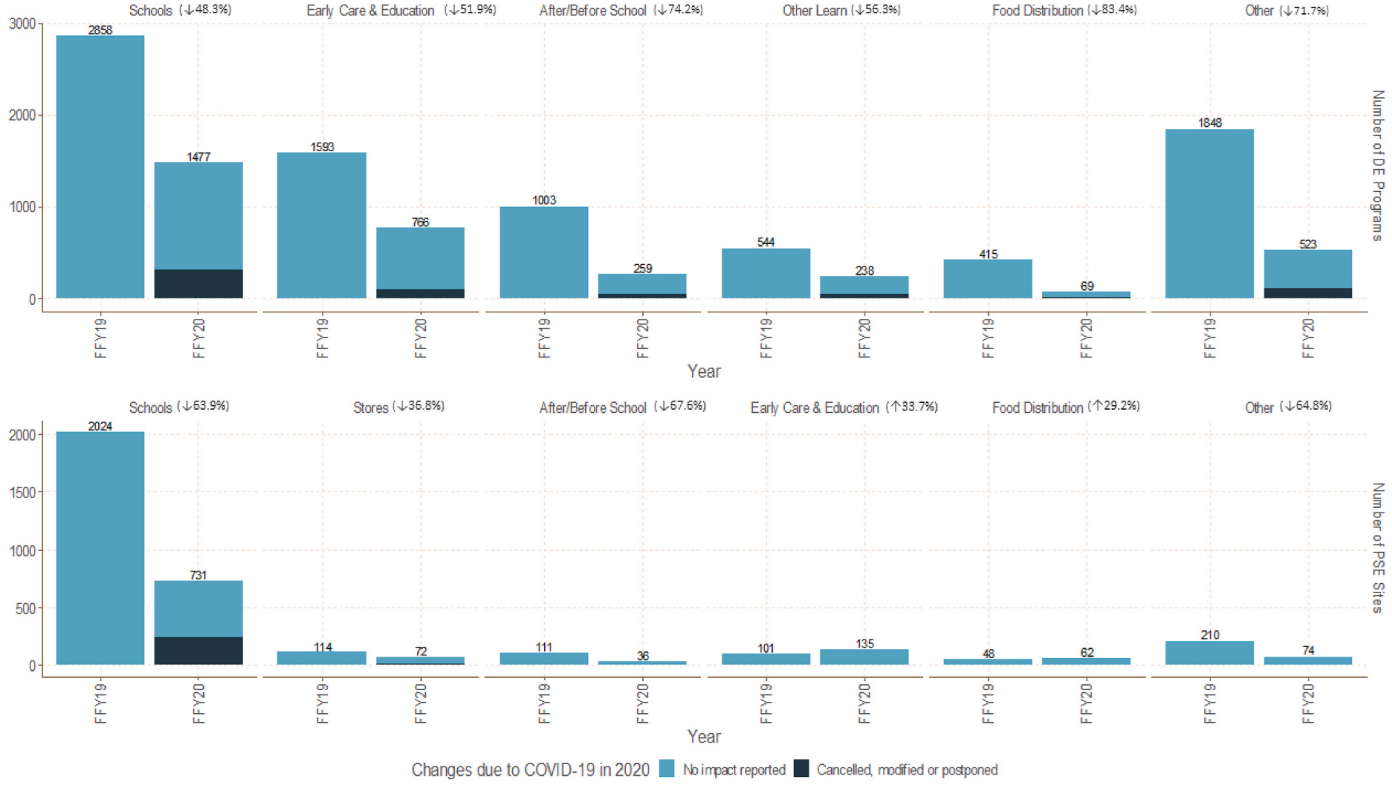

Fig. 1. The number of, and percent change[A] in, California local health department SNAP-Ed[B] direct education (DE) programs and policy systems and environment (PSE) sites in federal fiscal years (FFY) 2019 & 2020 by setting[C,D]. ($n_{DE\ Programs}$ = 8261(FFY19), 3332(FFY20); $n_{PSE\ sites}$ = 2608(FFY19),1110(FFY20)

[A]Percent change in values from FFY19 to FFY20; calculated as ((FFY20 value – FFY19 value)/FFY19 value))(100%). [B]SNAP-Ed, Supplemental Nutrition Assistance Program – Education.

[C] "Other" includes settings other than the five most common in FFY19: (in parentheses: DE programs and PSE sites in FFY19, FFY20) "Mass-media"(DE: 0, 10, PSE: 0, 0), "Places to Eat" (DE: 30, 1, PSE: 2, 8), "Stores" (DE: 64, 44), "Farmer's Market" (DE: 65, 15, PSE: 32, 20), "Other Learn Sites" (PSE: 13, 2), "Faith/Places of Worship" (DE: 168, 20, PSE: 34, 1), "Senior Services" (DE: 144, 36, PSE: 4, 2), "Places People Play" (DE: 250, 94, PSE: 36, 23), "Residential sites" (DE: 312, 102, PSE: 21, 3), "Worksites & Related" (DE: 79, 15, PSE: 28, 0), "Healthcare Services" (DE: 339, 186, PSE: 7, 11) and "Other" (DE: 397, 0, PSE: 33, 4).

[D]For a larger scale version representing number of PSE sites in Stores, After/Before School, Early Care and Education, Food distribution and Other, see Supplementary Fig. 1.

federal poverty level (FPL). Census tract-level urbanicity (urban, rural or suburban) came from 2010 Decennial Census. The Healthy Places Index 3.0 (HPI) served as the census tract-level indicator of community health conditions (Bodenreider et al., 2022). HPI is a composite measure of economic, education, housing, health care access, neighborhood, clean environment, transportation, and social factors.

2.4. Statistical analyses

Student's t-tests assessed significance of differences in intervention characteristics in FFY19 versus FFY20.

Linear regression assessed associations of census tract-level sociodemographic characteristics and HPI quartiles with change in intervention characteristics from FFY19 to FFY20. Regression models with HPI quartiles were adjusted for race/ethnicity and population under 18 years of age, but not urbanicity (because it was not associated with change in any of the intervention characteristics) or income <185% FPL (because a similar measure is part of the HPI). Post-estimation techniques derived adjusted average changes in these intervention characteristics for each HPI quartile. All analyses were conducted using Rv4.1.2, R Core Team, Vienna, Austria.

IRB review was not required for this study because human subjects were not involved, as per US Department of Health and Human Services guidelines (OHRP, 2010).

3. Results

3.1. Sociodemographic characteristics

LHDs reported implementing PSEs in 1,785, and DE in 1,616, census tracts in either or both FFY19 and FFY20 (Table 1). Compared to all census tracts in California, these census tracts had higher proportions of residents below 185% FPL, more Hispanic/Latino residents, fewer White residents, and less healthy community conditions.

3.2. Changes in PSE and DE characteristics

LHDs reported implementing PSEs in 1387 and 460 California census tracts respectively in FFY19 and FFY20 (data not shown). LHDs implemented PSEs in fewer sites (1110 vs. 2608) and these PSEs reached fewer people overall (1,581,214 vs. 2,550,562) in FFY20 compared to FFY19 (Table 2). For PSEs, significant per census tract decreases were observed for number of people reached (1428.6 vs 885.8, $p<0.001$), number of sites (1.5 vs 0.6, $p<0.001$), intensity (1.3 vs 0.6, $p<0.001$) and dose (0.4 vs 0.1, $p<0.001$). Per site, statistically significant increases were observed in number of people reached (986.0 vs 1424.8, $p = 0.030$).

Similar trends were observed for DE (Table 2). In FFY19 and FFY20, LHDs reported offering DE programs in 1445 and 871 California census tracts respectively (data not shown). LHDs reported offering fewer DE programs (3332 vs. 8261) that reached fewer people (146,087 vs. 308,852) in FFY19 versus FFY20. For DE, statistically significant per census tract decreases were observed in number of people reached, (191.1 vs 90.4, $p<0.001$), number of programs (5.0 vs 2.0, $p<0.001$), intensity (740.3 vs 283.8, $p<0.001$]), and dose (3.2 vs 1.1, $p<0.001$). Per DE program, significant differences were observed for reach (37.8 vs 44.2, $p<0.001$) and dose (0.6 vs 0.5, $p = 0.037$).

Declines from FFY19 to FFY20 in the number of reported DE programs were greatest from April–September (84% fewer) compared to October–March (44% fewer) (data not shown).

Schools were by far the most common setting for LHDs' PSE work in both FFYs (Fig. 1). The number of PSE sites in all settings combined dropped by 57% (2608 to 1110). Of 1110 PSE sites in FFY20, 285 had PSEs that were cancelled, modified, or postponed. The largest percentage declines were observed in before/after-school and school settings (68% and 64%, respectively). Increases were observed in the number of PSE sites in ECE (34%) and food distribution (29%) settings.

Table 1
Sociodemographic characteristics of census tracts with California local health department SNAP-Ed[a] interventions in federal fiscal year (FFY) 2019 and/or 2020[b] and all California census tracts.

	All California	Any Policy, Systems and Environment sites in FFY19 and/or FFY20	Any Direct Education in FFY19 and/or FFY20
n census tracts	8057	1785	1616
Census tract characteristics		**Census tracts, n(%)**	
Urbanicity[c]			
Urban	7195(89.3)	1653(92.6)	1347(83.4)
Rural	432(5.4)	46(2.6)	91(5.6)
Suburban	397(4.9)	86(4.8)	178(11.0)
Percent of population		**Mean(median)±SD**	
With income <185% federal poverty level[d]	28.5(24.9) ±17.6	34.7(34.2)±17.3	38.0(37.3)±16.4
Under 18 years[d,e]	22.1(22.4) ±7.1	23.2(23.4)±7.0	24.8(24.9)±6.7
Asian[d,e]	13.6(8.1) ±15.5	11.7(7.4)±13.1	9.2(4.8)±12.4
BlackV	5.6(2.6) ±8.6	7.7(3.4)±11.9	6.2(2.9)±9.0
Latino[d,e]	38.1(30.9) ±26.4	48.6(47.2)±28.2	53.0(52.0)±26.4
White[g,H]	38.7(37.3) ±26.0	28.4(20.7)±24.6	29.2(21.4)±24.1
Two or more races[d,e]	3.0(2.6) ±2.3	2.6(2.1)±2.3	2.4(1.9)±2.1
Other race[d,e,f]	1.0(1.2) ±2.5	1.0(0.4)±1.6	1.1(0.5)±1.9
California Healthy Places Index quartiles[g]		**Census tracts, n(%)**	
Q1(least healthy community conditions)	1948(25.0)	665(37.2)	702(43.5)
Q2	1948(25.0)	511(28.6)	528(32.7)
Q3	1948(25.0)	353(20.0)	274(17.0)
Q4 (healthiest community conditions)	1949(25.0)	256(14.3)	110(6.8)

[a] Supplemental Nutrition Assistance Program – Education.
[b] FFY19 was 10/1/2018 to 9/30/19 and FFY20 was 10/1/2019 to 9/30/2020.
[c] Decennial Census, 2010. Data missing from 34 census tracts in state-wide estimate.
[d] American Community Survey, US census, 2019. Data missing from 46 census tracts in state-wide estimate.
[e] All races listed are non-Latino/Hispanic except "Latino/Hispanic" which can be of any race.
[f] Other includes Native American, Hawaiian, and Alaskan and Pacific Islander.
[g] Public Health Alliance of Southern California, 2015. HPI quartiles missing from 264 census tracts state-wide.

The vast majority of DE programs occurred in learn settings (schools, ECE, after/before school, other learn) in both FFYs (Fig. 1). The number of DE programs in all settings combined dropped by 60% (8261 to 3332) from FFY19 to FFY20. Furthermore, 615 of the 3332 DE programs reported in FFY20 were cancelled, modified, or postponed. The number of DE programs declined in all settings; the largest percentage declines occurred in food distribution (83%) and before/after-school program settings (74%).

Commonly mentioned new interventions described in the open text fields of the PEARS PSE and DE modules included PSE's that increased access to and/or established new food distribution sites or methods, and DE delivered remotely. Several LHDs mentioned that community support and partnerships were critical to their ability to pivot their interventions to include new or modified activities. For example, success story narratives indicated that when pandemic safety measures prevented LHD staff from traveling to sites, one LHD partnered with their

Table 2
Characteristics of California local health department (LHD) SNAP-Ed[a] in census tracts with any LHD SNAP-Ed policy, systems, and environmental change (PSE) or Direct Education (DE) in federal fiscal years (FFY) 2019 and/or 2020[b].

	Census tracts with any PSE sites in FFY19 and/or FFY20 (n = 1785[c])				Census tracts with any DE programs in FFY19 and/or FFY20 (n = 1616[c])			
	FFY2019 *mean* ± *SD*	FFY2020 *mean* ± *SD*	Change *Difference (Percent Change)*	p[d]	FFY2019 *mean* ± *SD*	FFY2020 *mean* ± *SD*	Change *Difference (Percent Change)*	p[D]
Number of PSE sites or DE programs								
Total	2608	1110	−1498(−57.4%)	–	8261	3332	−4929(−59.7%)	–
Per census tract	1.5 ± 1.1	0.6 ± 1.0	−0.9(−60.0%)	<0.001	5.0 ± 10.1	2.0 ± 4.3	−3.0(−60.0%)	<0.001
Number of people reached[e]								
Total	2,550,562	1,581,214	969,348(−38.0%)	–	308,852	146,087	162,765(52.7%)	–
Per census tract,	1428.6 ± 6303.2	885.8 ± 5886.0	−542.8(−38.0%)	<0.001	191.1 ± 356.9	90.4 ± 267.7	−100.6(−52.6%)	<0.001
Per Site (PSE) or Program (DE)[c]	986.0 ± 5016.4	1424.8 ± 6904.6	438.8(44.5%)	0.030	37.8 ± 76.5	44.2 ± 81.1	6.4(17.0%)	<0.001
Intensity	Number of PSE change categories implemented				DE Program hours			
Per census tract	1.3 ± 2.9	0.6 ± 1.6	−0.7(−53.8%)	<0.001	740.3 ± 1149.8	283.8 ± 652.0	−456.5(−61.7%)	<0.001
Per Site (PSE) or Program (DE)	0.9 ± 1.1	0.9 ± 1.7	0.0(0.0%)	0.830	146.5 ± 202.6	140.0 ± 163.0	−6.5(−4.4%)	0.088
Dose[f]								
Per census tract	0.4 ± 3.5	0.1 ± 1.0	−0.3(−75.0%)	<0.001	3.2 ± 7.3	1.1 ± 3.0	−2.1(−66.0%)	<0.001
Per Site (PSE) or per Program (DE)	0.3 ± 2.9	0.2 ± 1.2	−0.1(−33.3%)[f]	0.463	0.6 ± 2.8	0.5 ± 1.7	−0.1(−17.0%)	0.037

[D]P-values from Students' t-tests.
[a] SNAP-Ed, Supplemental Nutrition Assistance Program.
[b] FFY19 was 10/1/2018 to 9/30/19 and FFY20 was 10/1/2019 to 9/30/2020.
[c] Census tract means included census tracts that had PSE sites (for PSE values) or DE programs (for DE values) in either year, allowing for zero values if the census tract had a site/program in one year but not the other. Per site/program means include existing sites and programs in each year.
[d] P-values from Students' t-tests.
[e] PSE reach is the sum of the number of people exposed to any PSE change at each site; DE reach is the sum of the number of participants in each DE program.
[f] PSE dose is the sum of the number of PSE change categories times reach for each site; DE dose is the sum of instructional hours times reach for each program.

county education agency to create and distribute "Lunch to Grow" kits that included a pot, soil, seeds, instructions and recipes so families could continue to garden and use the produce at home. When a food pantry switched to drive-through food distribution and in-person nutrition education was no longer possible, one county switched to virtual nutrition education with demonstrations to help clients use the pre-boxed foods they may not have chosen for themselves under the grocery store model.

3.3. Associations between neighborhood characteristics and changes in PSE and DE

Census tract characteristics explained little of the variation in changes in PSE and DE interventions from FFY19 to FFY20 (R-squared range:0.01–0.03; Table 3). Nevertheless, significant associations were observed as follows: For each percent increase in population with income <185% FPL there was an associated decrease in the number of DE programs (β[95%CI]: -0.07[-0.10,-0.03]). For each percent increase in the population under 18 years of age there was an associated increase in the number of PSE sites (β[95%CI]:0.03[0.01,0.04]). For each percent increase in non-Hispanic Asian residents there was an associated increase in PSE reach (β[95%CI]:43.25[9.45,77.06]) and an associated decrease in DE reach (β[95%CI]: -1.48[-2.94,-0.02]). For each percent increase in non-Hispanic Black residents there was an associated decrease in the number of PSE sites (β[95%CI]: -0.01[-0.02,-0.004]). For each percent increase in Hispanic/Latino residents there was an associated decrease in the number of PSE sites (β[95%CI]: -0.01[-0.01,-0.005]) and PSE reach (β[95%CI]: -28.04[-54.68,-1.40]). For each percent increase in non-Hispanic residents of two or more races there was an associated decrease in PSE reach (β[95%CI]: -222.00[-433.24,-10.76]) and an associated increase in the number of DE programs (β[95%CI]:0.33[0.06,0.60]).

The HPI explained little of the variation in changes in PSE and DE (R-squared range:0.01–0.04; Table 4). Nevertheless, compared to census tracts with the healthiest neighborhood conditions (HPI quartile 4): census tracts in HPI quartiles 1, 2, and 3 were each associated with decreased PSE reach (β[95%CI]: -2093.93[-3806.82,-381.04],-2008.87 [-3470.55,-547.20],-1711.18[-3069.74,-352.61], respectively); census tracts in HPI quartile 1 (least healthy neighborhood conditions) were associated with decreased PSE dose (β[95%CI]: -0.76[-1.52,-0.005]); census tracts in quartiles 1, 2, and 3 were each associated with decreased DE dose (β[95%CI]: -2.78[-4.46,-1.09]), -1.77[-3.32,-0.22], -1.82 [-3.38,-0.26], respectively); and census tracts in HPI quartile 1 were associated with a decreased number of DE programs (β[95%CI]: -2.28 [-4.56,-0.004]) (Fig. 2).

4. Discussion

By comparing the year before (FFY19) to the year during (FFY20) which COVID-19 restrictions began, this study reveals widespread reductions in SNAP-Ed interventions implemented by California LHDs. Furthermore, these reductions were not equitably distributed. The potential impact of these reductions is great, because CDPH's SNAP-Ed is the largest source of ongoing funding for nutrition education and obesity prevention efforts in the state, reaching nearly every county and millions of Californians with low incomes with interventions that support behavior changes to prevent cardio-metabolic disease (Sallis et al., 2012; Sun et al., 2017).

This study found that decreases from FFY19 to FFY20 in total people and number of sites reached, programs offered, and intervention intensity and dose for PSE and DE ranged from 38% to 75%, indicating that fewer people benefited from these interventions during a time when nutrition-related diseases increased COVID-19 morbidity and mortality (Hacker et al., 2021). The vast majority of observed intervention reductions occurred in schools and other "learn" settings (i.e., ECE, after/before-school, other learn), disproportionately affecting children and their families. Although the observational design of this study precludes causal inferences, COVID-19-related closures and social distancing measures during FFY20 presented challenges for SNAP-Ed implementation (PHA, 2022). PSEs addressing institutional practices, if they could be implemented at all, had to pivot to be feasible at closed sites. Sites that remained open had new safety and social distancing protocols that may have reduced staff interest in or ability to partner with LHDs to implement SNAP-Ed. SNAP-Ed DE, which had been

Table 3
Associations of census tract characteristics and change in California local health department SNAP-Ed[a] policy, systems and environment change (PSE) and direct education (DE) from federal fiscal year 2019–2020[b].

Census tract characteristics	PSE			DE		
	Change in number of people reached[f]	Change in number of sites	Change in Dose[g]	Change in number of people reached[h]	Change in number of programs	Change in dose[i]
	β (95% Confidence Interval)[c] n = 1785 census tracts[d]			β (95% Confidence Interval)[c] n = 1616 census tracts[e]		
Urbanicity (ref. urban)						
Rural	188.94 (−2361.30, 2739.17)	0.24 (−0.18, 0.65)	0.21 (−0.92, 1.33)	−17.38 (−94.24, 59.49)	0.69 (−1.53, 2.91)	−0.85 (−2.50, 0.80)
Suburban	−907.88 (−2758.43, 942.68)	0.03 (−0.27, 0.33)	−0.38 (−1.19, 0.44)	−8.71 (−63.84, 46.42)	−0.09 (−1.68, 1.50)	−0.61 (−1.79, 0.58)
Percentage income <185% federal poverty level	−23.66 (−54.39, 7.08)	−0.00 (−0.01, 0.00)	−0.01 (−0.02, 0.00)	−0.94 (−2.16, 0.29)	−0.07*** (−0.10, −0.03)	−0.02 (−0.05, 0.00)
Percentage under 18 years of age	68.14 (−4.20, 140.47)	0.03*** (0.01, 0.04)	0.02 (−0.01, 0.05)	−1.20 (−4.43, 2.02)	−0.04 (−0.13, 0.05)	−0.01 (−0.08, 0.06)
Percentage Asian (not Latino/a)	43.25* (9.45, 77.06)	0.00 (−0.01, 0.00)	0.01 (−0.00, 0.03)	−1.48* (−2.94, −0.02)	0.01 (−0.03, 0.06)	0.01 (−0.02, 0.04)
Percentage Black (not Latino/a)	1.71 (−33.52, 36.95)	−0.01*** (−0.02, −0.00)	0.01 (−0.01, 0.02)	−0.53 (−2.46, 1.40)	0.04 (−0.02, 0.09)	0.02 (−0.02, 0.06)
Percentage Latino/a	−28.04* (−54.68, −1.40)	−0.01*** (−0.01, −0.00)	−0.01 (−0.02, 0.00)	−0.52 (−1.60, 0.56)	0.03 (−0.01, 0.06)	0.01 (−0.01, 0.03)
Percentage two or more (not Latino/a)	−222.00* (−433.24, −10.76)	0.03 (−0.00, 0.06)	−0.05 (−0.15, 0.04)	3.72 (−5.51, 12.94)	0.33* (0.06, 0.60)	0.19 (−0.01, 0.38)
Percentage other race (not Latino/a)	11.47 (−238.13, 261.08)	−0.03 (−0.07, 0.01)	0.01 (−0.10, 0.12)	1.53 (−7.22, 10.28)	0.09 (−0.16, 0.35)	0.02 (−0.16, 0.21)
R squared	0.02	0.03	0.01	0.01[i]	0.02	0.01
Overall model F-test p-value[g]	**<0.001**	**<0.001**	0.052	**0.036**	**<0.001**	0.136

[a] SNAP-Ed, Supplemental Nutrition Assistance Program–Education.
[b] FFY19 was 10/1/2018 to 9/30/19 and FFY20 was 10/1/2019 to 9/30/2020.
[c] *$p<0.05$ **$p<0.01$ ***$p<0.00$. Coefficients (β) and confidence intervals derived from linear regressions.
[d] Census tracts with any LHD SNAP-Ed PSE sites in FFY19 and/or FFY20.
[e] Census tracts with any LHD SNAP-Ed DE programs in FFY19 and/or FFY20.
[f] PSE reach is the sum (within a census tract) of the number of people exposed to any PSE change at each site.
[g] PSE dose is the sum (within a census tract) of the number of PSE change categories times reach for each site.
[h] DE reach is the sum (within a census tract) of the number of participants in each DE program.
[i] DE dose is the sum (within a census tract) of instructional hours times reach for each DE program.

delivered primarily in-person, switched to online formats which often required revising curricula, upgrading technology, and coordinating with staff and teachers who had limited availability. COVID-19 also resulted in rapid scale-ups of public health department functions, such as COVID-19 testing and contact tracing. LHD staff were reassigned to these COVID-19-related efforts, leaving SNAP-Ed programs understaffed. Other factors may have accounted for some year-to-year variation but were much less disruptive and therefore less likely to account for such dramatic reductions in SNAP-Ed. SNAP-Ed funding awarded to LHDs from FFY19 to FFY20 did not change (personal communication,

Table 4
Associations of census tract California Healthy Places Index[a] quartiles and change in California local health department (LHD) SNAP-Ed[b], policy, systems and environment change (PSE) and direct education (DE) from federal fiscal years (FFY) 2019–2020.

California Healthy Places Index Quartiles (ref. Quartile 4: most healthy community conditions)	PSE			DE		
	Change in number of people reached[f]	Change in number of sites[f]	Change in dose[g]	Change in number of people reached[h]	Change in number of programs	Change in dose[i]
	β(95% Confidence Interval)[c] (n = 1785 census tracts[d])			β(95% Confidence Interval)[c] (n = 1614 census tracts[e])		
Quartile 1 (least healthy community conditions)	−2093.93* (−3806.82, −381.04)	−0.07 (−0.35, 0.20)	−0.76* (−1.52, −0.00)	−56.71 (−135.34, 21.93)	−2.28* (−4.56, −0.00)	−2.78** (−4.46, −1.09)
Quartile 2	−2008.87** (−3470.55, −547.20)	0.18 (−0.06, 0.42)	−0.50 (−1.15, 0.14)	−33.03 (−105.36, 39.29)	−1.13 (−3.22, 0.97)	−1.77* (−3.32, −0.22)
Quartile 3	−1711.18* (−3069.74, −352.61)	−0.05 (−0.28, 0.17)	−0.26 (−0.86, 0.34)	12.26 (−60.35, 84.86)	0.08 (−2.03, 2.18)	−1.82* (−3.38, −0.26)
R^2	0.02	0.04	0.01	0.01	0.02	0.01
Overall model F-test p-value[g]	**<0.001**	**<0.001**	**0.042**	**0.011**	**0.001**	**0.016**

[a] California Healthy Places Index, Public Health Alliance of Southern California, 2021
[b] SNAP-Ed, Supplemental Nutrition Assistance Program – Education.
[c] *$p<0.05$ **$p<0.01$ ***$p<0.001$. Coefficients (β) and confidence intervals derived from linear regressions adjusted for census tract-level percent of population by race/ethnicity and population under 18 years of age.
[d] Census tracts with any LHD SNAP-Ed PSE sites in FFY19 and/or FFY20.
[e] Census tracts with any LHD SNAP-Ed DE programs in FFY19 and/or FFY20.
[f] PSE reach is the sum (within a census tract) of the number of people exposed to any PSE change at each site.
[g] PSE dose is the sum (within a census tract) of the number of PSE change categories times reach for each site.
[h] DE reach is the sum (within a census tract) of the number of participants in each DE program.
[i] DE dose is the sum (within a census tract) of instructional hours times reach for each DE program.

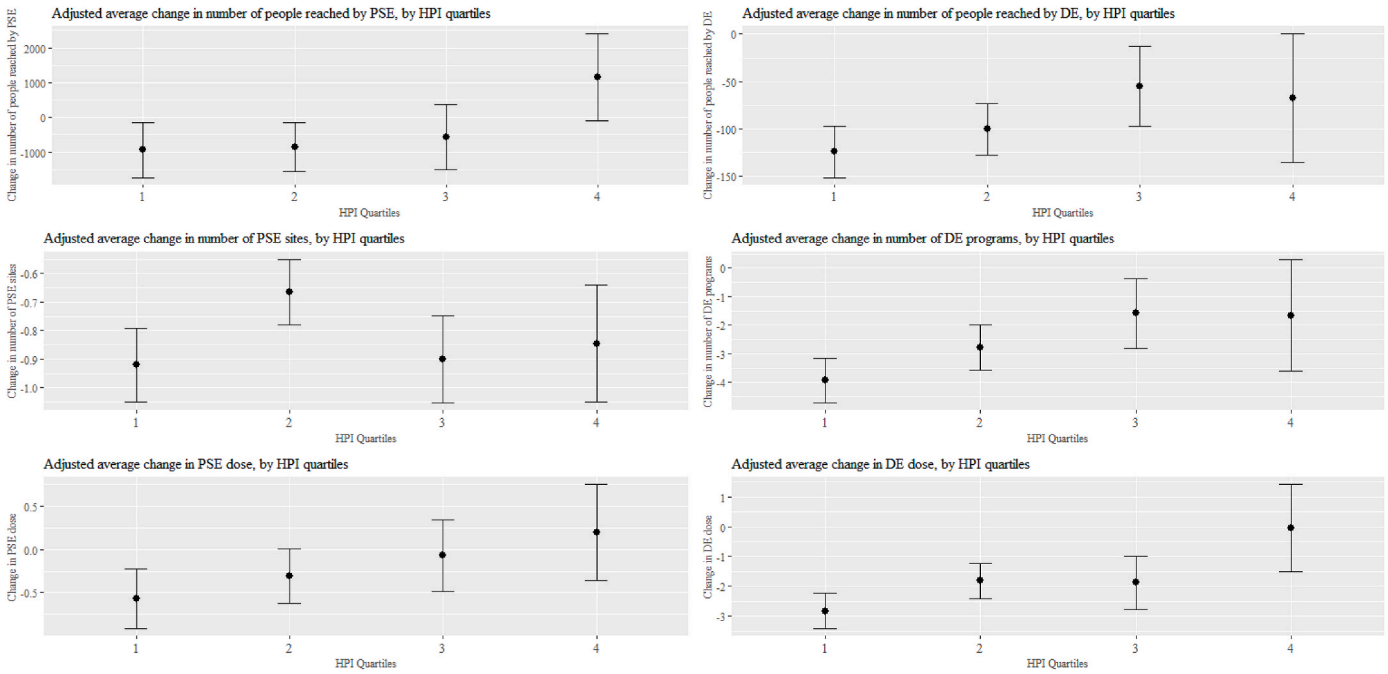

Fig. 2. Adjusted census tract-level average change[A] from Federal Fiscal Year 2019–2020 in California local health department SNAP-Ed policy systems and environment (PSE) and direct education (DE) characteristics, and 95% confidence intervals (CI), by Healthy Places Index (HPI)[B] quartiles.
[A]Adjusted averages and 95% CIs derived from linear regression models adjusted for census tract-level percent of population by race/ethnicity and population under 18 years of age.
[B]Public Health Alliance of Southern California, 2020

CDPH). Likewise, programmatic guidance changes between FFY19 and FFY20 were minor. Specifically, the FFY20 guidance (CDPH, 2018) provided more concrete menus of intervention options and required LHDs to implement interventions in schools and/or ECE, which were already among the most common settings in FFY19 (Fig. 1).

Although the number of people reached overall and per census tract decreased from FFY19 to FFY20, the PSE per-site and DE per-program reach increased. The increase in per-site PSE reach may be due to an increased focus on policy work that reaches the total site population, such as improving school wellness policies, and may be more feasible during site closures. Policy work also serves to build or maintain strong site partnerships that facilitate SNAP-Ed implementation once sites reopen. The switch to online formats for DE may have accommodated larger audiences and increased accessibility for some participants, thereby providing some long-term benefit. The observation that per-site PSE intensity and dose did not decrease, and DE intensity and dose only decreased modestly, suggests that LHDs were able to maintain similarly intense, and therefore potentially similarly effective, interventions at the site and program levels. Qualitative data from PEARS reports indicate that strong community partnerships helped LHDs make creative adaptations in order to continue delivering services under COVID-related constraints. Therefore, it appears that changes between FFY19 and FFY20 primarily affected how many sites and people LHDs reached rather than intervention quality. However, dose and intensity only measure limited aspects of intervention quality; other, unmeasured aspects of quality may have changed.

Although the number of PSE sites declined in most settings, the number of PSE sites in food distribution settings increased. This suggests that LHDs adapted to the increased need for charitable food by focusing on food distribution sites to reach populations at high risk for food insecurity, poor nutrition, and increased susceptibility to COVID-19 (Escobar et al., 2021; Niles et al., 2021; Wolfson & Leung, 2020). However, DE programs in food distribution settings declined, possibly due to the challenge of offering either on-site or virtual education in this setting.

This study found that census tracts with higher poverty rates, lower percentages of residents under 18, larger percentages of residents identifying as Black or Hispanic/Latino, and less healthy neighborhood conditions experienced greater reductions in some aspects of SNAP-Ed interventions (i.e., fewer DE programs, fewer PSE sites, lower PSE reach, and lower PSE and DE dose). Communities with these characteristics were also at greater risk for COVID-19 infection and complications (Cantor et al., 2020; CDC, 2022; Fitzpatrick et al., 2018; Hacker et al., 2021; Riley et al., 2021). Therefore, in the early months of the pandemic, pre-existing health inequities may have been exacerbated by unequal interruptions in SNAP-Ed interventions that improve dietary intake and are associated with improved food security and fitness (Linares et al., 2023; Molitor & Doerr, 2021; Rivera et al., 2016; Thompson et al., 2020). The low R-square values suggest that the measured census-tract characteristics account for a small portion of the observed variation in intervention characteristic changes. While other, unmeasured factors such as local variations in COVID-19 restrictions and site ability or interest to engage in SNAP-Ed interventions may explain more variation, it is nonetheless important to address the observed statistically significant associations to prevent future intervention inequities.

There are several limitations worth noting. Because this is an observational, cross-sectional study, causality cannot be established. Data regarding intervention characteristics were self-reported by LHDs and therefore may be subject to recall error, under-reporting, and bias including social desirability bias. Although guidance was provided for estimating PSE reach, obtaining accurate reach estimates for some settings (e.g., stores) is much more challenging than in settings for which there was access to objective enrollment information (e.g., schools, ECE).

5. Conclusions

These findings indicate that there were large reductions in California LHDs' SNAP-Ed interventions the year COVID-19 closures began

compared to the prior year. These reductions disproportionately affected communities at higher risk for poor nutrition-related health outcomes (Chang et al., 2021; Gaskin et al., 2014; Kirby & Kaneda, 2005; Leal & Chaix, 2011; Suglia et al., 2016), including COVID-19 infection and complications. To ameliorate health disparities exacerbated during the pandemic (Hatef et al., 2020; Levy et al., 2022) and prevent widening disparities during future public health emergencies, policies and programs such as SNAP-Ed, that have been shown to be effective at improving dietary intakes, fitness, and food security, should be strengthened and supported, especially in communities with greater health disparities to ensure that they do not fall further behind in health outcomes. Measures to ensure program maintenance and ability to adapt during public health emergencies could include increased funding for evidence-based programs, built-in program flexibilities and diversification, flexible hiring practices and diversification of staff skills, adequate staff infrastructure, technical assistance and training, strong community support and engagement, and monitoring and rapid reporting of changes in program delivery. Intervention diversification increases the ability to pivot nimbly when some options are blocked. Reaching the same participants in multiple ways and in multiple settings is recommended by USDA SNAP-Ed (Naja-Riese, 2019) and may enhance program effectiveness whether or not there is a health emergency. Strong community engagement and an emphasis on PSE can strengthen program sustainability and resilience. For this to happen, recognition of the importance of supporting healthy eating and active living to prevent widening of health disparities is needed, particularly during public health emergencies.

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Author contributions

Gail Woodward-Lopez: funding acquisition, conceptualization, investigation, methodology, project administration, supervision, writing - original draft. Erin Esaryk: methodology, data curation, formal analysis, visualization, writing - original draft. Sridharshi C. Hewawitharana: methodology, data curation, formal analysis, visualization, writing - review & editing. Janice Kao: methodology, investigation, data curation, writing - review & editing. Evan Talmage: investigation, data curation, writing - review & editing. Carolyn D. Rider: conceptualization, investigation, project administration, methodology, data curation, writing - original draft, writing – review. All authors approved the version to be published.

Declaration of competing interest

None.

Data availability

Data will be made available on request.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ssmph.2023.101471.

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