School meal access and changes in meal participation during COVID-19 school closures: A stratified random sample of CalFresh Healthy Living Eligible school districts in California

Kaela Plank*, Sridharshi Hewawitharana, Evan Talmage, Suzanne Rauzon, Gail Woodward-Lopez

Nutrition Policy Institute, University of California Division of Agriculture and Natural Resources, 1111 Franklin Street, Oakland, CA 94607, United States

ARTICLE INFO

Keywords:
school meals
National School Lunch Program
COVID-19
school nutrition
food access
school closures

ABSTRACT

The National School Lunch and School Breakfast programs are a nutrition safety net for millions of children in the United States, particularly children in households with lower incomes. During Spring 2020 COVID-19 school closures, schools served school meals through the Summer Meal Programs. Despite efforts to increase access, meal participation declined and food insecurity increased. We aimed to (1) describe meal program features as communicated in low-income California school districts’ on-line resources (2) examine associations between meal program features and change in meal participation between May 2019 and May 2020 and (3) evaluate equity by describing meal site coverage and placement relative to the size of priority populations. Data from district online resources and meal reimbursement claims were collected for a stratified, random sample of 190 CalFresh Healthy Living-eligible districts. Linear regression was used to examine associations between district meal program features and percent change in meal participation. Meal site location and density were examined in relation to the size of priority populations. In May 2020, compared to May 2019, total meals served decreased by a median 46%. There were gaps in the information provided in district online resources and low variation in measured district meal program features. These features explained little of the variation in the percent change in meal participation. A greater proportion of meal sites were placed in areas with larger priority populations, yet the density of sites was not proportionate to the priority populations’ sizes. Findings show actionable areas for improving meal access during school closures.

1. Introduction

In March 2020, U.S. schools closed due to the COVID-19 pandemic, impacting meal access for millions of children dependent on school meals, and requiring districts to switch meal distribution from using the United States Department of Agriculture’s (USDA) National School Lunch Program (NSLP) and the National School Breakfast Program (NSBP) to the Summer Meals Programs (SMP). (Kinsey et al., 2020) The federally funded NSLP and NSBP, started in 1946 and 1966, provide free-or-reduced-price meals (FRPM) to schoolchildren from households with incomes below 185% of the federal poverty level (<185%FPL) or who attend Community Eligibility Provision (CEP) schools that serve free breakfast and lunch to all enrolled students if 40% or more students are eligible to receive free meals. (United States Department of Agriculture Economic Research Service, 2018; United States Department of Agriculture Economic Research Service, 2020a; United States Department of Agriculture Economic Research Service, 2021; United States Department of Agriculture Economic Research Service, 2015; United States Department of Agriculture Food and Nutrition, 2019c) Since 1975 schools have used SMP to offer meals during normal school closures. (United States Department of Agriculture Economic Research Service, 2020b; United States Department of Agriculture Food and Nutrition, 2019b; United States Department of Agriculture, 2013).

Nationwide, over 30 million children participate in the NSLP and 15 million participate in the NSBP daily. (United States Department of Agriculture Economic Research Service, 2021; United States Department of Agriculture Economic Research Service, 2019c) Access to these programs increases food security because it greatly contributes to daily food
intake for children. (Ralston et al., 2017; Huang and Barnidge, 2016; Cullen and Chen, 2017) In California, approximately 824 million school meals were served during the 2018–2019 school year, 85% of which were FRPM. (California Department of Education, 2018–2019).

When schools closed due to COVID-19, districts used SMP (comprised of the Summer Food Service Program (SFSP) and the Seamless Summer Option (SSO)) - programs better suited for meal pick up. (United States Department of Agriculture Economic Research Service, 2020b; United States Department of Agriculture Food and Nutrition, 2019a; United States Department of Agriculture, 2013; United States Department of Agriculture, 2020) SMP participation is consistently lower than NSLP and declined annually between 2016 and 2019. (Food Research & Action Center, 2020; United States Department of Agriculture Food and Nutrition, 2021a) This decline along with program awareness, transportation, and eligibility barriers have led to calls for program reform. (Dunn et al., 2020; Litt et al., 2020; Food Research & Action Center, 2018; Food Research & Action Center, 2020).

To ensure equitable meal access and eliminate operational burdens during COVID-19 school closures, USDA issued 18 SMP waivers starting March 20, 2020. (Kinsey et al., 2020; United States Department of Agriculture Food and Nutrition, 2021) These waivers allowed parents/guardians to pick up multiple, free school meals to take home, without children present; allowed nutrition meal standard flexibilities; and expanded eligibility. (Kinsey et al., 2020; United States Department of Agriculture Food and Nutrition, 2021).

Despite these efforts, by Spring 2020, California FRPM meals served dropped 18% compared to Spring 2019; nationally, the drop was 28%. (Food Research & Action Center, 2020a) In Spring 2020, the U.S. also experienced increased unemployment and increased food insecurity for households with children, particularly among Black and Hispanic families. (Lopez et al., 2020; Parker et al., 2020; Schanzenbach and Pitts, 2020a; 2020b).

While school districts aimed to address food needs, concerns were raised over equitable distribution. Potential gaps were found in meal access for students living in food deserts, necessitating investigation into meal site placement. (McLoughlin et al., 2020) The expansion of meal distribution during COVID-19 school closures, coupled with rising food insecurity, renewed calls for universal school meals which are positively associated with increased meal participation, diet quality, food security and academic performance. (Cohen et al., 2021) California sought to remove access barriers by enacting the first statewide universal school meals legislation - School Meals For All Act of 2021. (California Legislature, 2021) Beginning in the 2022–2023 school year, public districts will offer two nutritionally adequate free school meals to all students. (California Legislature, 2021) Given the shift towards universal school meals, this is an opportune time to gather valuable information on coverage gaps and best practices for reaching students when operating a universal school meals program during school closures.

The COVID-19 pandemic disproportionately impacted low-income and Black, Indigenous, and People of Color (BIPOC) households. CalFresh Healthy Living (CFHL)—the Supplemental Nutrition Assistance Program Education (SNAP-Ed) in California—offered support. (Lopez

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Fig. 1. Diagram of sampling strategy and composition of final sample. Footnotes: 1 List generated from California Department of Education enrollment data. Accessed April 2020. 2 Districts met one of the following CalFresh Healthy Living eligibility criteria: (1) 50% or more of the district’s student population were eligible for Free and Reduced Priced Meals (FRPM) or (2) 50% or more of the schools in the district were eligible for FRPM or (3) the district was eligible for the Community Eligibility Provision (CEP). Caption: Shows a consort diagram of how CalFresh Healthy Living eligible public schools were identified and steps taken to create final sample of 190 school districts.
Table 1
District characteristics and meal program features (n = 175 districts).

| District characteristics and meal program features | n (%) |
|---------------------------------------------------|-------|
| **District sociodemographics** (n = 175) |       |
| Urbanicity (n = 175) |       |
| Rural | 17 (9.71%) |
| Suburban/Town | 105 (60.00%) |
| Urban | 53 (30.29%) |
| **Grade span served (n = 175)** |       |
| Full grade span (PreK/K-12) | 118 (67.43%) |
| Partial grade span starting in elementary school | 41 (23.43%) |
| Partial grade span starting in middle/high school | 16 (9.14%) |
| **Racial/Ethnic distribution of enrolled students (%)** (n = 175) | (25th, 75th percentiles) |
| American Indian/Alaskan Native | 0.35 (0.20, 0.64) |
| Asian | 2.16 (0.94, 5.69) |
| Black | 2.55 (0.97, 7.57) |
| Filipino | 0.92 (0.39, 2.04) |
| Hispanic | 64.88 (46.03, 78.82) |
| Multiracial | 2.15 (0.94, 3.90) |
| Pacific Islander | 0.27 (0.12, 0.61) |
| White | 15.43 (5.97, 29.21) |
| Not reported | 0.26 (0.02, 0.92) |
| **Student enrollment (n = 175)** |       |
| Median | 13,695.00 |
| % of students eligible for free or reduced priced meals (n = 175) | (4121.00, 22376.00) |
| Proportion of schools per district using Community Eligibility Provision in 2019 (n = 175) | 0.19 (0.00, 0.71) |
| **District catchment area characteristics (n = 168)** |       |
| Median |       |
| Square mileage | 72.24 (30.73, 199.09) |
| Total population | 1,011,645.50 (2,964,60.0, 17,476,52.50) |
| Proportion of population with income < 185% Federal Poverty Level | 0.35 (0.27, 0.42) |
| Proportion of total population that are children living in households with income < 185%FPL | 0.11 (0.08, 0.15) |
| District meal program features (as described on website in May 2020) (n = 174) | n (%) |
| **Meal distribution mode (n = 174)** |       |
| Onsite pickup, not further specified, only | 82 (47.13%) |
| Onsite drive-thru only | 23 (13.22%) |
| Onsite drive-thru and walk up | 33 (18.97%) |
| Onsite pickup and delivery | 31 (17.82%) |
| Other | 5 (2.87%) |
| **Pickup site service hours (n = 171)** |       |
| Only times between 9am and 4 pm | 150 (87.72%) |
| Times between 9am and 4 pm, along with times before 9am or after 4 pm | 17 (9.94%) |
| Other | 4 (2.34%) |
| **Meal eligibility (n = 174)** |       |
| Children - not required to be students | 129 (74.14%) |
| Students | 31 (17.82%) |
| Other | 9 (5.17%) |
| Information not specified | 5 (2.87%) |
| **Number of service days per week (n = 174)** |       |
| 1-2 days/week for all offered distribution methods | 52 (29.89%) |
| 3-4 days/week for all offered distribution methods | 24 (13.79%) |
| 5 days/week for all offered distribution methods | 75 (43.10%) |
| Other | 23 (13.22%) |
| **Menu posted on website (n = 174)** |       |
| Yes | 16 (9.20%) |
| No | 158 (90.80%) |
| **Child presence required (n = 165)** |       |
| Yes | 51 (30.91%) |
| No | 28 (16.97%) |
| Information not provided on website | 86 (52.12%) |
| **Number of meals offered per week:** |       |
| Breakfast (n = 120) | 5.00 (5.00, 5.00) |
| Lunch (n = 125) | 5.00 (5.00, 5.00) |
| Total meals (n = 127) | 10.00 (10.00, 10.00) |
| **Change in district meal participation May 2019 vs May 2020** | Median |
| Percent change in breakfast meals served (n = 171) | -18.25 (-51.33, 17.37) |
| Percent change in lunch meals served (n = 172) | -58.73 (-71.95, -41.63) |
| Percent change in total meals served (n = 172) | -46.21 (-63.08, -29.86) |
et al., 2020; Parker et al., 2020; Siddiqi et al., 2021) Collaborating with under-resourced communities to improve food security and diet quality are focuses of CFHL, which promotes healthy food consumption and access through nutrition education and policy, systems and environmental changes in schools with high FRPM eligibility. (United States Department of Agriculture, 2016) Because so many students rely on school meals, when schools pivoted to pick-up meal distribution, CFHL-eligible schools and their families were heavily impacted. To inform local health departments’ school-based CFHL work and best practices for universal school meal programs during school closures, we aimed to (1) describe meal program features as communicated on CFHL-eligible public school districts’ on-line resources, (2) examine associations between these meal program features and change in meal participation between May 2019 and May 2020 and (3) evaluate equity by describing geographic coverage and placement of meal sites in each district relative to the size of priority populations.

2. Methods

2.1. Study design and sample

This is an observational, cross-sectional study of a stratified, random sample of CFHL-eligible public school districts in California.

Of the 1035 public school districts in California open during the 2019–2020 school year. (California Department of Education, 2019-2020) 708 met criteria for CFHL eligibility: 50% or more of the district’s student population (or the schools in the district) were eligible for FRPM or the district was eligible for CEP. (California Department of Education Nutrition Services, 2019a; 2019b; California Department of Education, 2020) These 708 districts were divided into four strata by 2019–2020 FRPM enrollment: 10,000 or more students (Stratum A); 5,000–9,999 students (Stratum A); 1,000–4,999 students (Stratum C); and 0–999 students (Stratum D). The final sample (n = 190 districts) included all districts in Stratum A (n = 86) and approximately equal numbers of randomly selected districts from strata B through D (n = 34–35). (Fig. 1).

2.2. Meal program features and district characteristics

To describe districts’ meal program features, data collectors took screenshots of district online resources (websites and social media posts) over a three-day period at the end of May 2020. They collected days and hours of operation; meal delivery and/or onsite pickup options; number and location of meal distribution sites; number and types of meals served; meal eligibility (children only, students only, or open to community); if child presence was required; and if menus were shown.

USDA waivers during COVID-19 school closures allowed schools to provide meals to any child 18 years of age or younger (children). (United States Department of Agriculture Food and Nutrition, 2021) Accordingly, we classified meal eligibility information from district online resources as meeting, more liberal than, more restrictive than USDA waiver requirements, or eligibility not specified (if no information was provided).

To describe district characteristics, we used District Catchment Area (DCA) boundaries provided by National Center for Education Statistics (NCES). (National Center for Education Statistics, 2019) DCAs are used as residence-based criteria for attending schools in the district and are used by the Census to describe demographics of residents served by the district. (National Center for Education Statistics, 2019) DCA characteristics including square mileage, total population, proportion of population with incomes < 185%FPL, and proportion of population < 18 years old living in households with incomes < 185%FPL, were calculated using 2018 American Community Survey (ACS) estimates. (United States Census Bureau, 2018).

District student racial/ethnic distribution, student enrollment, percent of students qualifying for FRPM, and grade range served were obtained from the publicly available California Department of Education (CDE) 2018–2019 enrollment data. (California Department of Education, 2019-2020; California Department of Education, 2020). Meal sites were classified as either school or non-school locations. In order to compare the number of meal sites operating in May 2020 (during COVID-19 closures) to those operating prior to COVID closures (May 2019), meal site data for the 2018–19 school year were obtained from 2018 to 2019 CDE SMP administrative data. (California Department of Education Nutrition Services, 2019a; 2019b).

2.3. Change in meal participation

To calculate change in meal participation, we used CDE school district meal reimbursement claims for the months of May 2019 and May 2020. Claims data, a proxy for meal participation, were summed across all district meal distribution sites participating in NSLP, NSBP, SSO, and/or SFSP. Percent change in the number of breakfasts, lunches, and total meals (includes breakfast, lunch, snack, and supper meals) in May 2019 (served through NSLP and NSBP because schools were open) compared to May 2020 (served through SSO or SFSP because schools were closed) was calculated.

2.4. Meal site coverage and placement relative to the size of priority populations

To describe geographic meal site coverage and placement, meal locations were obtained from district websites and geocoded using ArcGIS Pro 2.8. The number of schools serving meals on-site through NSLP and NSBP, prior to school closures, was obtained from 2019 to 2020 CDE enrollment data. (California Department of Education, 2019-2020).

The 2019 NCES DCA boundary files were overlaid onto meal site location data to determine total number of sites and number of sites per 100 square miles located within each DCA. (National Center for Education Statistics, 2019) We calculated total number of sites in DCA per 1000 children and children < 185%FPL using 2018 ACS estimates and total number of sites per 1000 students eligible for FRPM in district using 2019–2020 CDE FRPM enrollment data. (California Department of Education, 2020).

To evaluate meal program equitable geographic access, we first defined DCA block groups according to the size of three priority populations: number < 185%FPL, number of children, and percent BIPOC. We then calculated the proportion of total meal sites located in DCA block groups, ranked into quartiles, separately for the three priority populations, ranging from smallest priority population (Quartile 1/Q1) to largest priority population (Quartile 4/Q4). The number of meals sites per 1000 people < 185%FPL was also calculated for the DCA and for...
| Covariate-only model (n = 171–172) | District characteristics | Urbanicity | n | Beta (95% CI) | p-value | R-squared | n | Beta (95% CI) | p-value | R-squared | n | Beta (95% CI) | p-value | R-squared |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Rural | | | 16 | 17.74 | 0.37 | | 16 | 19.67 | 0.06 | | 16 | 21.19 | 0.09 | |
| Suburban/Town | | | 104 | 6.67 | 0.53 | | 105 | –0.60 | 0.90 | | 105 | 0.64 | 0.91 | |
| Urban | Ref. | | 51 | –14.36 | 27.69 | | 51 | –9.53 | 8.35 | | 51 | –10.22 | 11.51 | |
| Racial/Ethnic Distribution | Majority White | | 21 | –17.22 | 0.28 | | 21 | –3.26 | 0.63 | | 21 | –4.12 | 0.66 | |
| Other racial distribution | | | 28 | 19.53 | 0.18 | | 28 | 1.44 | 0.79 | | 28 | 7.22 | 0.30 | |
| | Ref. | | 122 | –9.31 | 48.37 | | 123 | –9.26 | 12.14 | | 123 | –6.40 | 20.85 | |
| Student Enrollment scaled to 1000 | | | 171 | –0.07 | 0.02 | | 172 | –0.01 | 0.64 | | 172 | –0.03 | 0.16 | |
| Percent of students eligible for Free or Reduced-Price Meals | | | 171 | –0.45 | 0.29 | | 172 | –0.05 | 0.76 | | 172 | –0.05 | 0.80 | |
| Grade span served | Partial grade span starting in elementary school | | 39 | 7.72 | 0.54 | | 40 | –1.18 | 0.81 | | 40 | 0.42 | 0.95 | |
| | Partial grade span starting in middle/high school | | 14 | –1.77 | 0.85 | | 14 | 13.41 | 0.04 | | 14 | 11.64 | 0.09 | |
| | Full grade span (PreK/K-12) | | 118 | –20.73 | 17.20 | | 118 | 8.83 | 25.99 | | 118 | –1.79 | 25.07 | |

Models with individual predictors of interest

| Meal Program Features | Meal distribution mode (n = 170–171) | Onsite drive thru only | 22 | –23.25 | 0.09 | 22 | –3.76 | 0.59 | 22 | –8.65 | 0.27 | |
| | | Onsite drive thru and walk up | 33 | –12.70 | 0.22 | 33 | –4.89 | 0.28 | 33 | –6.40 | 0.28 | |
| | | Onsite pickup (drive thru, walk up, and/or not further specified) and delivery | 30 | 7.92 | 0.53 | 30 | 6.95 | 0.19 | 30 | 7.77 | 0.25 | |
| | | Other | 5 | –17.63 | 0.59 | 5 | –5.90 | 0.69 | 5 | –9.95 | 0.56 | |
| | | Onsite pickup (not further specified) only | 80 | Ref. | – | 81 | Ref. | – | 81 | Ref. | – | |

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Table 2 (continued)

| Any drive-thru meal distribution mode specified | Percent change in breakfast meals served | Percent change in lunch meals served | Percent change in total meals served |
|------------------------------------------------|----------------------------------------|-----------------------------------|-----------------------------------|
| (n = 170–171)                                   |                                        |                                   |                                   |
| Yes                                            | 67                                     | 0.04                              | 67                                | 0.09                              | 67                                | 0.05                              |
|                                                | (−35.77, −0.88)                        | 0.07                              | (−14.62, 1.15)                    | 0.09                              | (−19.27, 0.15)                    | 0.08                              |
| No                                             | 103                                    | Ref.                              | 104                               | Ref.                              | 104                               | Ref.                              |
| Child presence required (n = 162)               |                                        |                                   |                                   |                                   |                                   |                                   |
| Yes                                            | 49                                     | −0.06                             | 49                                | −0.08                             | 49                                | −0.05                             |
|                                                | (−0.60, 1.82)                          |                                   | (−0.26, 1.30)                     |                                   | (−0.33, 0.13)                     |                                   |
| Information not provided on website            | 85                                     | 0.08                              | 85                                | 0.11                              | 85                                | 0.10                              |
|                                                | (−0.43, 15.41)                         |                                   | (−19.28, 8.37)                    |                                   | (−24.86, 9.76)                    |                                   |
| No                                             | 28                                     | Ref.                              | 28                                | Ref.                              | 28                                | Ref.                              |
| Service hours for meal pickup (n = 167–168)    |                                        |                                   |                                   |                                   |                                   |                                   |
| Times between 9am and 4 pm, along with times either before 9am or after 4 pm | 17                                     | 0.82                              | 17                                | 0.82                              | 17                                | 0.96                              |
|                                                | (−0.23, 29.40)                         |                                   | (−0.14, 11.44)                    |                                   | (−0.17, 16.31)                    |                                   |
| Other                                          | 3                                      | 0.05                              | 3                                 | 0.07                              | 3                                 | 0.05                              |
|                                                | (−0.70, 78.00)                         |                                   | (−0.31, 50.63)                    |                                   | (−0.42, 61.25)                    |                                   |
| Only times between 9am and 4 pm                | 147                                    | Ref.                              | 148                               | Ref.                              | 148                               | Ref.                              |
| Menu posted (n = 170–171)                      |                                        |                                   |                                   |                                   |                                   |                                   |
| Yes                                            | 16                                     | 0.72                              | 16                                | 0.07                              | 16                                | 0.06                              |
|                                                | (−0.27, 40.03)                         |                                   | (−0.12, 15.06)                    |                                   | (−0.15, 21.02)                    |                                   |
| No                                             | 154                                    | Ref.                              | 155                               | Ref.                              | 155                               | Ref.                              |
| Meal Eligibility (n = 170–171)                 |                                        |                                   |                                   |                                   |                                   |                                   |
| Students                                       | 31                                     | 0.09                              | 31                                | 0.07                              | 31                                | 0.05                              |
|                                                | (−0.30, 55.73)                         |                                   | (−0.84, 21.44)                    |                                   | (−0.26, 28.37)                    |                                   |
| Other                                          | 8                                      | 0.74                              | 9                                 | 0.32                              | 9                                 | 0.60                              |
|                                                | (−0.38, 54.54)                         |                                   | (−0.92, 27.95)                    |                                   | (−0.15, 26.18)                    |                                   |
| Information not specified                      | 5                                      | 0.52                              | 5                                 | 0.24                              | 5                                 | 0.28                              |
|                                                | (−0.30, 59.53)                         |                                   | (−1.11, 43.78)                    |                                   | (−1.45, 50.13)                    |                                   |
| Children – not required to be students         | 126                                    | Ref.                              | 126                               | Ref.                              | 126                               | Ref.                              |

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Table 2 (continued)

### Consistency with open site waiver standards

| Component | Percent change in breakfast meals served | Percent change in lunch meals served | Percent change in total meals served |
|-----------|-----------------------------------------|------------------------------------|-------------------------------------|
| Consistency with open site waiver standards (n = 170–171) | | | |
| More restrictive | 34 | 25.19 | 0.07 | 34 | 10.73 | 0.05 | 34 | 14.16 | 0.04 |
| | | (−2.17, 52.55) | | | (−0.12, 21.59) | | | (0.68, 27.63) | |
| More liberal | 6 | 10.87 | 0.73 | 7 | 7.60 | 0.42 | 7 | 4.42 | 0.71 |
| | | (−50.53, 72.26) | | | (−10.94, 26.14) | | | (−18.90, 27.74) | |
| Not further specified | 5 | 14.93 | 0.51 | 5 | 16.40 | 0.24 | 5 | 17.92 | 0.27 |
| | | (−29.93, 59.78) | | | (−10.97, 43.76) | | | (−14.31, 50.16) | |
| Meets waiver (any child under 18 is eligible for meals) | 125 | Ref. | – | 125 | Ref. | – | 125 | Ref. | – |

### Meal site coverage

| Component | Percent change in breakfast meals served | Percent change in lunch meals served | Percent change in total meals served |
|-----------|-----------------------------------------|------------------------------------|-------------------------------------|
| Number of meal site locations in the district catchment area | 164 | 1.07 | 0.21 | 0.06 | 165 | 0.30 | 0.36 | 0.08 | 165 | 0.54 | 0.22 | 0.07 |
| | | (−0.62, 2.76) | | | (−0.34, 0.94) | | | (−0.32, 1.39) | |
| Number of meal sites per 100 sq mi in district catchment area | 157 | 0.03 | 0.63 | 0.06 | 157 | 0.07 | 0.20 | 0.07 | 157 | 0.06 | 0.18 | 0.05 |
| | | (−0.09, 0.14) | | | (−0.04, 0.17) | | | (−0.03, 0.15) | |

### Number of meal sites in May 2020 for every 1000...

| Component | Percent change in breakfast meals served | Percent change in lunch meals served | Percent change in total meals served |
|-----------|-----------------------------------------|------------------------------------|-------------------------------------|
| Children in district catchment area | 157 | 9.84 | 0.01 | 0.09 | 157 | 6.02 | 0.01 | 0.14 | 157 | 7.83 | 0.01 | 0.13 |
| | | (1.98, 17.70) | | | (1.28, 10.76) | | | (1.69, 13.97) | |
| People in households with incomes at or below 185% Federal Poverty Limit (FPL) in district catchment area | 157 | 9.77 | 0.47 | 0.07 | 157 | 4.03 | 0.56 | 0.07 | 157 | 5.70 | 0.53 | 0.06 |
| | | (−16.75, 36.29) | | | (−9.55, 17.62) | | | (−12.21, 23.62) | |
| Children belonging to households below 185% FPL | 157 | 0.55 | 0.75 | 0.06 | 157 | 0.30 | 0.75 | 0.06 | 157 | 0.42 | 0.74 | 0.05 |
| | | (−2.78, 3.87) | | | (−1.57, 2.17) | | | (−2.04, 2.87) | |
| Students eligible for Free and Reduced Priced Meals in district in 2019–2020 school year | 164 | 4.83 | 0.40 | 0.06 | 165 | 1.63 | 0.44 | 0.06 | 165 | 2.08 | 0.46 | 0.05 |
| | | (−6.53, 16.19) | | | (−2.56, 5.82) | | | (−3.52, 7.68) | |
| Students enrolled in district in 2019–2020 school year | 164 | 6.52 | 0.42 | 0.06 | 165 | 2.34 | 0.43 | 0.06 | 165 | 2.91 | 0.47 | 0.05 |
| | | (−9.54, 22.59) | | | (−3.55, 8.22) | | | (−4.99, 10.82) | |
| Proportion of schools in district using CEP, Baseline Year 2019 | 171 | 27.32 | 0.07 | 0.07 | 172 | 2.26 | 0.75 | 0.07 | 172 | 7.24 | 0.40 | 0.06 |
| | | (−2.05, 56.68) | | | (−11.46, 15.99) | | | (−9.71, 24.19) | |

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1. Meal program characteristics as reported in district online resources in May 2020.
2. All models adjusted for district urbanicity, racial/ethnic distribution, student enrollment, percent of students eligible for free or reduced-price meals, and grade span served unless indicated elsewhere.
3. Children defined as less than 18 years old.
4. Adjusted for district urbanicity, racial/ethnic distribution, student enrollment, and grade span served.
5. Adjusted for district urbanicity, racial/ethnic distribution, percent of students eligible for free or reduced-price meals, and grade span.
6. Community Eligibility Provision (CEP).
each DCA quartile. District meal sites located within a 2010 U.S. Census block group outside the district’s DCA boundaries were excluded (n = 11 meal sites), ensuring that all meal sites were serving a specified DCA’s population.

### 2.5. Statistical analysis

To describe school district meal program features communicated on district online resources during COVID-19 closures, descriptive statistics were calculated for the measured characteristics. To examine associations between district characteristics or meal program features and percent change in number of breakfasts, lunches, and total meals served between May 2019 and May 2020, linear regression models, adjusting for district urbanicity, racial/ethnic distribution, student enrollment, percent of students eligible for FRPM, grade span served, and accounting for the stratified sampling design, were used.

P-values of < 0.05 were considered statistically significant. Descriptive and statistical analyses were performed in SAS®9.4. Spatial analyses used ArcGIS Pro 2.8.

### 3. Results

#### 3.1. District characteristics, meal program features and change in meal participation

A total of 172 of 190 districts provided meal operations information in their online resources and had reported meal claims data to CDE and were included in the regression analyses. A total of 168 of 175 districts provided meal site addresses and were included in the spatial analyses. A total of 9 of 168 districts included meal sites outside their DCA and were excluded from coverage analyses.

Most districts were in suburban/town (60%) or urban areas (30%) and served prekindergarten/kindergarten-12 grades. (Table 1) Enrolled students were largely Hispanic (median 65%), followed by White (15%). A median of 70% of enrolled students in a district were FRPM-eligible.

Districts’ DCAs with meal site addresses covered a median of 72.2 square miles and had a 0.11 median proportion of children living in households < 185%FPL out of the total population.

There was little variation in measured district meal program features. On-site pickup was the main meal distribution mode, 97% offered on-site pickup; only 18% also offered meal delivery. (Table 1) Most districts (88%) operated meal sites within a 9am-4 pm time frame. Districts usually offered five breakfasts and lunches per week and 74% offered meals to all children whether they were enrolled students or not. Meal distribution sites were open one to five days per week; 43% were open five days per week.

Many districts’ online resources did not include some key information about the meals. The majority (91%) did not post menus. Over half (52%) did not provide information on whether children needed to be present to receive meals.

Most meal sites (93%) operated at school locations. Over one-third (37%) of meal sites offered summer meals in 2019. (Data not shown).

Between May 2019 and May 2020 there was a 46% median decrease in total school meals served. Median lunch participation was greater than median breakfast participation at both time points (data not shown). The decrease in total meal participation was much greater for lunch than for breakfast (−59% versus −18%; Table 1).

#### 3.2. Associations between meal program features, district characteristics or meal site coverage and change in meal participation

Measured district meal program features explained little of the variation in the percent change in breakfast, lunch, and total meals served (R-squared range: 0.05–0.13; Table 2). Percent change in breakfast, lunch and total meals served decreased at all sampled districts. However, the decrease in total breakfast meals served was larger among districts that offered any drive-thru meal distribution, compared to districts offering other forms of meal distribution (p = 0.04). Districts with eligibility requirements that were more restrictive than the USDA eligibility waiver, experienced less of a decrease in the percent change of total meals served, compared to districts that met the waiver requirements (p = 0.04), but not for total breakfast or lunch meals served. There were no other statistically significant associations between meal program features and change in meal participation.

Larger districts experienced a larger decrease in total breakfasts served (p = 0.02). Districts that served a partial grade span that included only middle and/or high schools experienced a smaller decrease in lunches served compared to districts that served the full grade span (PreK-K-12) (p = 0.04). There were no other significant associations between district characteristics and change in meal participation.

As the number of meal sites in May 2020 per 1000 children in the DCA increased, districts experienced a smaller decrease in breakfasts (p = 0.015), lunches (p = 0.013), and total meals served (p = 0.013). There were no other significant associations between meal site coverage measures and change in meal participation.

#### 3.3. Meal site coverage and placement relative to the size of priority populations

The median number of meal sites in the DCA after school closures in May 2020 was three times lower than the median number of school sites operating in 2019 (6.0 versus 19.0; Table 3). Median number of meal sites in DCA per 100 square miles dropped from 23.2 in 2019 to 8.9 meal sites in May 2020. Similar decreases were seen between 2019 and May 2020, for median number of meal sites per 1000 children < 185%FPL in the DCA (2.3 vs 0.7) and per 1000 students eligible for FRPM in the district (2.3 vs 0.8).

On average, a greater proportion of meal sites were placed in block groups with the largest priority populations (Q4 DCA). The median proportion of meal sites increased from 0.1 (Q1) to 0.3 (Q4) among DCA

### Table 3

| Meal site coverage measures among sampled school districts (n = 168)1 |
|--------------------|---------|---------|
| Number of meal sites within district catchment area (DCA)2 | Fall 2019 (Prior to school closures) | May 2020 (Post school closures) |
| n | Median (25th, 75th percentile) | n | Median (25th, 75th percentile) |
|---|------------------|---|------------------|
| Total | 159 | 19 | (9.00, 31.00) | 159 | 6.0 | (3.00, 10.00) |
| Per 100 square miles3 | 159 | 23.2 | (5.45, 68.05) | 159 | 8.9 | (2.11, 21.90) |
| Number of meal sites in DCA for every 1000... | | | | |
| Children1,3 | 159 | 1.0 | (0.77, 1.28) | 159 | 0.3 | (0.18, 0.53) |
| Children belonging to households below 185% Federal Poverty Limit 2,4 | 159 | 2.3 | (1.57, 3.21) | 159 | 0.7 | (0.38, 1.24) |
| Students eligible for Free and Reduced Priced Meals3 | 168 | 2.3 | (1.74, 3.14) | 168 | 0.8 | (0.51, 1.32) |

1 22 sampled districts were excluded from this analysis due to missing meal site location data in district online resources (n = 21) or having all sites outside district catchment areas (n = 1).

2 Districts with meal sites located outside the district catchment area were excluded from analysis (n = 9).

3 Data derived from the American Community Survey 2014–2018 5 year-estimate data: table B17024.

4 Children defined as <18 years old.

5 Data derived from 2019 to 2020 California Department of Education Free or Reduced-Price Meal (Student Poverty) Dataset. (California Department of Education, 2020).
block groups ranked by population < 185% FPL and by child population (Fig. 2). While this trend was not as linear for percent BIPOC, greater proportions of meal sites were in Q3 and Q4 versus Q1 and Q2 block groups (median proportion 0.3 and 0.3 versus 0.1 and 0.2).

Fig. 3 shows a California district exemplifying these trends. Of the 55 schools in the district, 17 schools and two non-school sites served school meals in May 2020. Eleven of these 19 meal sites were in DCA block groups with greater percent BIPOC populations (Q3 and Q4). However, when looking at density of sites per 1000 people < 185% FPL, the median number of meal sites per 1000 people < 185% FPL within each quartile decreased as the population < 185% FPL increased (Fig. 4). Of DCA block groups ranked by population < 185% FPL, those in Q4 had a median of 0.1 meal sites per 1000 people < 185% FPL versus a median of 0.2 among those in Q1. For example, when block groups in one district were ranked into quartiles by population < 185% FPL, we saw an upward trend with Q1 having the smallest proportion of meal sites (0.13) and Q4 having the largest (0.38). However, when looking at the density of sites per 1000 people < 185% FPL in that same district, there was a median of 0.54 meal sites per 1000 people < 185% FPL versus a median of 0.16 meal sites per 1000 people < 185% FPL in Q4 (Data not shown).

4. Discussion

Despite an expected increase in need during COVID-19 school closures, meals served dropped precipitously in California. A similar trend was seen nationwide. (Food Research & Action Center, 2020a) Students have immediate meal access during a regular school year, but during school closures, logistical hurdles (e.g., transportation, scheduling conflicts) reduce access to school meals. USDA waivers addressed some barriers, yet participation still decreased. (Food Research & Action Center, 2020; United States Department of Agriculture Food and Nutrition, 2021a) Strategies to increase meal accessibility are needed. We sought to understand how differences in school meal program features affected meal participation.

We examined meal program features during school closures and found that districts did a commendable job providing meals and information about how to access meals. Most provided program eligibility information, instruction on where and when to get meals, and offered at least five breakfasts and lunches per week. (Food Research & Action Center, 2020; United States Department of Agriculture Food and Nutrition, 2021a) Strategies to increase meal accessibility are needed. We sought to understand how differences in school meal program features affected meal participation.

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sites were largely open daily within a 9am-4pm timeframe. These hours pose a barrier to families without transportation, who work during this timeframe (common with low-wage work), or that care for children learning online from home. (UC Berkeley Labor Center, 2021; Carrillo et al., 2017) Most students living in households with lower incomes are reliant on school buses for transportation to school, suggesting personal vehicles may not be available to pick up meals. (U.S. Department of Transportation, 2021).

We evaluated changes in meal participation and found sampled districts had a 46% median reduction in meal participation when comparing May 2019 to May 2020 and a 32% median reduction in number of meal sites. Although directionality cannot be established, we found that a greater number of meal sites per 1000 children in the DCA was significantly associated with a smaller decrease in percent change of breakfast, lunch and total meals served, suggesting that geographic access may affect meal participation.

We found limited associations between the meal program features (e.g., meal distribution method, hours, eligibility, etc.) and percent change in meals served. Of the four statistically significant findings, two were counterintuitive: offering drive-thru pickup was associated with a larger decrease in breakfast participation, and incorrectly stating that only students were eligible for meals was associated with a smaller decrease in total meal participation. Covariance with other unmeasured factors may explain these findings which are otherwise difficult to interpret. District size was negatively associated with change in breakfast participation, and districts with secondary schools only experienced smaller declines in lunch participation, suggesting that schools with typically higher baseline meal participation (i.e., elementary schools and larger schools) may have experienced greater declines. (Moore and Lara Ponza, 2009; Schirm, 2010) The relative increase in meals served at secondary schools may be due to their central location in most communities; and why they are chosen as SMP sites. (Turner et al., 2019) Generally, the R-squares for our regression models were low, suggesting that measured features explained only a small portion of the observed variation in the change in meals served; other unmeasured factors may explain more variation. Although the low variability in many of the meal features and access measures limited our ability to test their influence on meal participation, the large decreases in meal participation and limits on access (hours, posted menus, site proximity) suggest that improvements in access could increase meal participation.

We assessed equity in the placement of meal sites and found that despite fewer meal sites during COVID-19, it appears districts

Fig. 3. COVID-19 meal sites in a Northern California, suburban school district catchment area block groups characterized by quartiles of percent Black, Indigenous, and People of Color (BIPOC) population (n = 19 meal sites) Footnotes: ¹ BIPOC defined as percent of non-white population in block group based on ACS 2019 5-year estimates Table B03002 ² Block group percent BIPOC quartile cutoffs are as follows: Q1/first quartile - <40%; Q2/second quartile - between 40% and 52%; Q3/third quartile - between 52% and 72%; Q4/fourth quartile - greater than 72%³ District quartile cutoffs were based on 25th, 50th and 75th percentiles Block group percent BIPOC population was derived using American Community Survey 2014–2018 5 year-estimate data. The total meal site count within each quartile category for percent BIPOC are as follows: Q1 – 4 sites, Q2 = 4 sites, Q3 – 6 sites Q4 – 5 sites. Caption: Provides an example of meal site locations within a district catchment area overlayed onto district catchment area block groups that have been ranked in quartiles by percent BIPOC.
While our study could not account for meal site distribution capacity, we found an inverse trend between block group population concentration in areas where expected demand for meals is greatest and number of sites per 1000 people. This may have reduced our data accuracy and comprehensiveness. Nevertheless, online resources (websites) provide valuable information on how to provide equitable access to food through schools is essential.

6. Conclusions

To our knowledge, this study is the first to quantitatively examine the association of CFHL-eligible school district characteristics, meal program features and meal site coverage with change in school meal participation during school closures. Our findings suggest that online resources about meal access could be improved and identify specific areas for improvement. We found that a greater number of meal sites per 1000 children was positively associated with meal participation and that the density of meal sites during the closures was not proportional to the size of the population < 185%FPL; suggesting that meal site placement in relation to the density of priority populations should be considered when choosing meal sites. As communities cope with earthquakes, floods and fires related to climate change, school closures are likely to occur, and understanding how to provide equitable access to food through schools is essential.

Funding statement

This study was conducted as part of a contract with the California Department of Public Health with funding from USDA SNAP-Ed. These institutions are equal opportunity providers and employers. The views expressed are those of the authors and not necessarily those of the funders.

CRediT authorship contribution statement

Kaela Plank: Investigation, Project administration, Data curation, Software, Formal analysis, Visualization, Writing – original draft. Sridharshi Hewawitharana: Software, Formal analysis, Data curation, Visualization, Writing – original draft, Writing – review & editing. Evan Talmage: Data curation, Formal analysis, Visualization, Writing – original draft, Writing – review & editing. Suzanne Rauzon: Supervision, Project administration, Writing – review & editing. Gail Woodward-Lopez: Conceptualization, Methodology, Supervision, Writing – review & editing, Funding acquisition.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

The authors would like to thank Anna Martin, Hallie Randel-
