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Disparities in SNAP online grocery delivery and implementation: Lessons learned from California during the 2020-21 COVID pandemic

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ABSTRACT

During the COVID-19 pandemic in 2020, the Supplemental Nutrition Assistance Program (SNAP) Online Purchasing Pilot (OPP) was rapidly expanded across the US. This program, enabling direct-to-home grocery delivery, could be a transformative step towards improving fresh-food access. However, lack of information on which areas are serviced by SNAP OPP hinders the identification of potential demographic and regional disparities in access. Lessons from the initial implementation period are critical for understanding continuing inequities and informing the implementation of future programs. In California, SNAP OPP expanded food access for 85.9% of the state's SNAP households in 2020–21. Coverage was significantly greater in urban areas, covering 87.2% of CalFresh households in urban limited food access areas as compared with 29.9% of CalFresh households in rural limited food access areas. County-level COVID-19 rates did not have a meaningful association with SNAP OPP coverage.

1. Introduction

The Supplemental Nutrition Assistance Program (SNAP) provides financial food assistance, formerly known as "food stamps", to over 41 million low-income US households (USDA, 2022a). First implemented in 1939 through small pilot programs, then robustly expanded via the 1964 Food Stamp Program, today's program provides participants with monthly funds added to an Electronic Benefits Transfer (EBT) card (Caswell et al., 2013). All foods and beverages sold at SNAP-accepting retailers, except tobacco, alcoholic beverages, hot foods, and garden plants and seeds, can be purchased with SNAP. In most cases, households must have a gross income below 130% of the federal poverty line and net income below 100% of the federal poverty line in order to be eligible, and, with few exceptions, must meet additional requirements regarding citizenship, residency, and employment (USDA, 2022b). SNAP participation has been linked with reductions in poverty, child food insecurity, poor nutrition, sick days off work, and doctor's visits, improved self-reported health, and boosts in the economy by increasing low-income spending, especially during economic recessions (Gregory and Deb, 2015; CBPP, 2019; Keith-Jennings et al., 2019). The COVID-19 pandemic has exacerbated unemployment, income loss, and food insecurity nationwide, contributing to an 11.7% increase in SNAP participation between fiscal years 2019 and 2020, and an additional 4.1% increase between fiscal years 2020 and 2021 (USDA, 2022a).

The United States Department of Agriculture (USDA)'s recent rollout of the SNAP Online Purchasing Pilot (OPP) aims to modernize the program and increase access. This program, enacted in the 2014 Farm Bill and first implemented in 2019 in New York, allows SNAP participants to use their benefits to purchase groceries online for curbside pickup and delivery (USDA, 2021). Initially piloted in just a few states, the program expanded rapidly during COVID-19 as social distancing and safe purchase options became essential public health measures, with

Abbreviations: SNAP, Supplemental Nutrition Assistance Program; OPP, Online Purchasing Pilot; USDA, United States Department of Agriculture.

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health authorities encouraging online grocery shopping (CDC, 2020). In February 2022, 47 states and the District of Columbia were participating in SNAP OPP (USDA, 2021), and more resources have been allocated to expanding the program. The December 2020 COVID-19 Economic Relief Bill provided $5 million for SNAP OPP expansion (NCSL, 2021) – such as creating an online portal for retailers – and the March 2021 American Rescue Plan allocated an additional $25 million (US Congress, 2021).

Expanding online purchasing for curbside pick-up and delivery has the potential to transform SNAP grocery access not only during emergencies, but also into the future. Focusing on grocery delivery may help address food access gaps in areas with few brick-and-mortar grocery stores, and for individuals with limited mobility and transportation access. It may also increase access to fresh fruits and vegetables in areas where physical stores and vendors may sell predominantly non-perishable items. While shelf-stable canned and frozen fruits and vegetables without added sugar, salt, or fat can be as nutritious as fresh produce (Miller and Knudson, 2014), unhealthy additives are commonly included (Oyebode et al., 2014). Numerous barriers prevent SNAP participants from easily and affordably accessing the program. While 10% of US grocery sales were online in 2020 (Mercatus, 2020), only 3% of SNAP sales were online (Jones, 2021), which may be due to potential barriers related to affordability, availability, accessibility for SNAP participants. Prior research has already begun to illustrate such challenges, which include higher food prices online (Appelhans et al., 2013), shipping and delivery fees (Rogus et al., 2020; Headrick et al., 2021) minimum order requirements, difficulties finding discounts, and the unavailability of certain products and entire services in specific regions (Moran et al., 2021).

The SNAP OPP's utility is also dependent on the delivery coverage of participating retailers as well as any structural barriers that might disproportionately impact certain regions. For example, the use of SNAP benefits online may differ by urbanicity, given differences in connectivity, infrastructure, and digital ownership across urban and rural areas. Lack of reliable internet is an important component of access, as 26% of Americans living in rural areas and 32% of those living in Tribal areas do not have high-speed Internet ("broadband") (FCC, 2019). This can be compounded by lower rates of digital ownership and lack of experience navigating online or mobile interfaces. The use of SNAP benefits online may also differ in regions that are predominantly low-income and lack fresh fruit and vegetable availability in physical stores (Testa et al., 2021), since these areas presumably have limited delivery coverage. This is important because living in these "limited food access" (sometimes called "low income, low access" or "food desert") regions is associated with poor diet, increased cardiovascular health risks, and increased obesity (Testa et al., 2021; Larson and Story, 2009). During the COVID-19 pandemic, the ability to buy groceries online provided a safe alternative to in-person shopping, which posed the risk of disease exposure. As such, the SNAP OPP was positioned to offer a valuable, socially-distant shopping option for low-income Americans. It is therefore valuable to understand how SNAP OPP retailer coverage overlapped with areas of high rates of COVID cases during the height of the pandemic to understand the extent to which this program actually enabled safe access for SNAP participants.

Despite SNAP OPP's rapid expansion in 2020 and 2021, there has been limited information on its implementation. The USDA Economic Research Service reported that, nationally, $196.3 million was spent using SNAP OPP in September 2020, nearly 2.4% of total SNAP dollars spent (Jones, 2021). In an earlier report, it was found that while states experienced rapid uptake when the program was first introduced, they soon experienced a participation plateau (Foster et al., 2021). Yet, little data exists at the state-level, and while the USDA described this program as a tool that would enable widespread access to online shopping, particularly needed during the pandemic, (USDA, 2020), there is little information on demographic and regional differences in coverage. Thus, analyzing SNAP OPP coverage during the first year of the pandemic is important for understanding the successes and challenges of program implementation, and its implications for future programs.

The aim of this paper, therefore, is to describe the number of households covered by SNAP OPP delivery of perishable (i.e., fresh) groceries during the first year of program implementation (fall of 2020 and early winter of 2021) in California, a state with approximately 10% of all US SNAP households (3.789 million California participants, where SNAP is known as "CalFresh"), and a population that is 36.3% White-only, 14.6% Asian-only, 5.5% Black-only, and 39.4% Hispanic (CBPP, 2021). The authors also sought to identify inequities in the SNAP OPP roll-out in California by comparing differences in at-home delivery coverage by urbanicity, food access, and COVID rates. This paper only addresses SNAP OPP delivery and excludes curbside or in-store pickup, which still requires that customers travel to a brick-and-mortar store, because for those with mobility or transportation challenges, or are immunocompromised, delivery is a critical component for improving food access.

2. Methods

This research analyzes CalFresh participants' access to SNAP OPP in the fall of 2020 and early winter of 2021, during the initial months of program implementation in April 2020. Chi-squared tests were performed for a descriptive analysis and OLS linear regressions were used to model associations between SNAP OPP coverage and variables of interest, such as COVID case rates and limited food access areas.

In particular, this study evaluates the services and coverage region of three specific grocery stores. While over 90 retailers were approved nationwide for the program as of February 2022, a limited subset of these retailers are active in each state. In California, for example, Amazon and Walmart were the only SNAP OPP providers during April to December 2020, during the height of the pandemic. ALDI was added in late December 2020, followed by FoodMaxx, Lucky Supermarkets, Save Mart Supermarkets in April 2021, and subsequently Cardenas Markets, Food4Less, Rancho San Miguel Markets, Sam's Club Scan and Go, and Safeway later in the year (USDA, 2021). Amazon and Walmart utilize the Amazon platform and the Walmart online web-store, respectively, to accept SNAP OPP payments and fulfill grocery orders. In contrast, ALDI accepts SNAP OPP payments through Instacart, an online grocery delivery and pick-up service that partners with grocery markets who may not have their own online-ordering platform (ALDI, 2021). Given that Amazon, Walmart, and ALDI were initially the only active retailers during the height of the pandemic and the first year of the SNAP OPP, this analysis is focused on their service and accessibility.

2.1. Outcome

The primary outcome variable was the percentage of SNAP participants covered by SNAP OPP within a geographic unit (county or census-tract). "SNAP OPP coverage" is defined as the operational area within which a given grocery store delivers. For Walmart, this included a 9-mile radius around Walmart locations that provided grocery deliveries (California Association of Food Banks, 2020). CalFresh participants could also place online orders for curbside or in-store pick-up at all Walmart locations (Walmart, 2021), but these locations were excluded from our analysis since they did not also offer direct delivery. A list of ZIP codes for regions where ALDI provided SNAP OPP delivery was obtained for the month of February 2021 (the most recent month for which data was available at the time of this analysis) with the assistance of Basketful, a grocery e-commerce company (Basketful, 2021). Basketful did not have Amazon Fresh delivery area data, so publicly-available list of Amazon Fresh ZIP codes was obtained from an online presentation hosted by the California Association of Food Banks' (CAFB) in June 2020 (California Association of Food Banks, 2020). Thus, SNAP OPP coverage was assessed using ZIP codes where SNAP OPP delivery was available for ALDI and Amazon Fresh shoppers. Amazon shoppers could also order shelf-stable food items online for delivery almost everywhere in the state

using Amazon Pantry; however, given this paper's focus on fresh groceries, such locations were not included in this paper (Leighton, 2020).

Shapefiles representing the delivery regions of Walmart, ALDI, and Amazon were overlapped to find the combined spatial coverage of the SNAP OPP of all three retailers. Five-year estimates for county-level population count and the number of CalFresh households in California were extracted from the U.S. Census' 2019 American Community Survey (ACS) Application Programming Interface (API) (United States Census Bureau, 2019). Using area-weighted interpolation of the aforementioned geometries and estimates of CalFresh household counts, the approximate total number of CalFresh households covered in each census block group was calculated; it was assumed that CalFresh households were equally distributed across census block groups. The percentage of the census block group covered by the geometry of Walmart's, ALDI's, and Amazon Fresh's delivery region was used to represent the percentage of CalFresh households covered by these retailers' online delivery services. To calculate the percentage of CalFresh households covered per geographic unit (county and census-tract) per retailer, the aggregated number of CalFresh households covered by SNAP OPP per geographic unit was divided by the total number of CalFresh households within that geographic unit.

For descriptive analyses, counties were also grouped based on their level of SNAP OPP coverage. using a two-category approach: 0–50% and 51–100% SNAP OPP coverage. A four-category approach (0–25%, 26–50%, 51–75%, and 76–100%) was initially considered, but few counties were classified as having 26–50% and 51–75% coverage (Appendix Fig. 1). As such, these categories were collapsed into a two-category approach: 0–50% ("less than 50% coverage") and 51–100% ("greater than 50% coverage").

2.2. Exposures

Three main exposure variables were assessed in relation to SNAP OPP coverage, including: 1) urbanicity, 2) limited food access areas, and 3) COVID rates.

2.2.1. Urbanicity

To create a county-level urbanicity variable, the USDA's Rural-Urban Continuum Codes (RUCC) were used. The USDA classifies counties into metro areas, as determined by the population size of their metro area, and nonmetro counties, as determined by their degree of urbanization and adjacency to metro area(s). Counties with a RUCC between 4 and 9, inclusive, are considered nonmetro areas; counties with a RUCC 1–3, inclusive, are classified as metro areas (USDA ERS, 2020). Non-metro and metro classification were used as proxies for rural and urban areas in our analysis.

At the census-tract level, the USDA's Rural-Urban Commuting Area (RUCA) codes were used; these codes characterize U.S. census-tracts based on population density, urbanization, and daily commuting rates. RUCA codes between 1 and 3 are considered metropolitan, while 4–6 are micropolitan, 7–9 are small towns, and 10 are rural areas. For this analysis, census-tracts were considered urban if they had a RUCA code between 1 and 3.

2.2.2. Limited food access areas

Limited food access regions were identified using the USDA's Food Access Research Atlas food access database, which categorizes areas as 'low-income and low-access' (henceforth called 'limited food access' regions), or 'food deserts' in other literature (Rhone et al., 2019).[1] The USDA defines 'low-income' areas as census-tracts where the median family income is less than or equal to 80% of the state's or metropolitan area's median family income level. 'Low-access' areas are defined as census-tracts where at least 500 people or 33% of the population are more than one mile away from the nearest grocery store in an urban census-tract, or 10 miles away in a rural census-tract (Rhone et al., 2019). This information was joined with the census-tract-level CalFresh household count data. The proportion of area overlap between limited food access areas and the service areas of the retailers was also calculated. The proportion of the census-tract covered by SNAP OPP coverage was then multiplied by the total CalFresh households in a census block group to estimate the total CalFresh households in limited food access areas covered by Walmart, ALDI, and/or Amazon Fresh., From this result, the aggregate percentage of CalFresh households covered by SNAP OPP in limited food access regions was also calculated.

2.2.3. COVID-19 case rates

To characterize COVID-19 case prevalence, data were gathered from the New York Times' COVID-19 API, which provides daily COVID-19 cases at the county-level (New York Times, 2021). For each county in California, the number of reported county-level COVID-19 cases per day was summed to the month-level and divided by 1,000 to generate a COVID case prevalence variable. For this analysis, the month of July was used, as it was representative of the 2020 summer COVID-19 peak. July was also a couple of months after SNAP OPP was launched in California, providing time for more people to learn about the program. A state map was generated to show COVID-19 cases (with darker purple representing greater incidence rates), overlaid with SNAP OPP coverage for Amazon Fresh, Walmart, and ALDI (Fig. 1).

2.3. Covariates

To control for potential confounding, several socio-demographic variables were included in our statistical models. Using county- and census-tract level ACS 2019 5-year estimate data, the total percentage of population per race (Black, Asian, White) and ethnicity (Latino) category were calculated. Median household income (per $10,000) and population density (persons/m2) were also included.

2.4. Statistical analysis

In descriptive analyses, chi-squared tests were performed to examine the relationship categorical SNAP OPP coverage (less than 50% versus greater than 50% SNAP OPP coverage) and variables of interest. We used OLS regression to model the associations between our exposure

[1] The authors acknowledge that the term 'food desert' has been frequently used in literature to refer to a region where there is little access to fresh and nutritious food. However, in recent years, there has been increased debate on and push back over this term, with many citing that 'food desert' does not fully capture the racial and discriminatory societal and economic structures that contribute to limited food access. Activists propose that other terms, such as 'food apartheid', should be used to better convey the realities of limited food access and power dynamics that perpetuate this system. As such, the authors decided to not use the term 'food desert' and instead use the phrase 'limited food access' to refer to the USDA-defined 'Low Income, Low Access' regions (UT Austin, 2020; Brones, 2018; UCLA Healthy Campus Initiative, 2021; Sevilla, 2021).

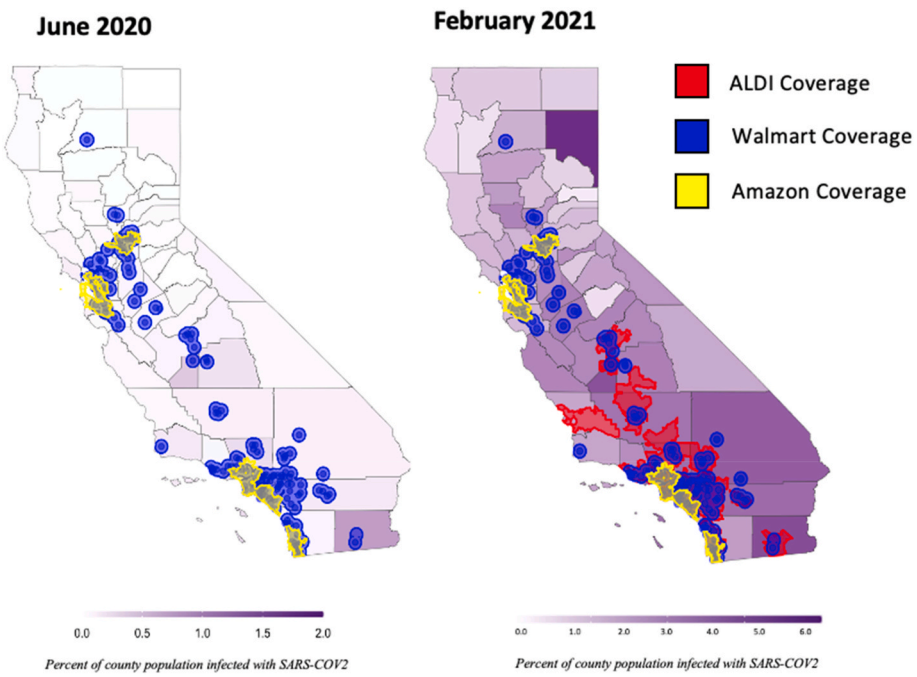

Fig. 1. Supplemental Nutrition Assistance Program (SNAP) Online Purchasing Pilot (OPP) Coverage in COVID-19 Hot Spots: June 2020 and February 2021
Fig. 1 shows the coverage of SNAP Online by different retailors in regions with COVID. Red areas denote ALDI coverage, blue areas denote Walmart coverage, and yellow areas denote Amazon coverage. External data sources used for these calculations include: USDA's Food Access Research Atlas, California Association of Food Banks (CAFB), Walmart Store Locator, U.S. Census 2019 American Community Survey (ACS), Basketful ALDI Data. Note: Scaling for February 2021 is different than June 2020 due different levels of COVID-19 incidence.

variables and SNAP OPP coverage (continuous, 0–100%) in R (version 4.0.2). Due to the difference in geographic units used to calculate limited food access regions (census-tract level) and COVID-19 case rates (county-level), two separate OLS regressions were run. Both regression models included urbanicity and both included as controls the demographic variables (race, ethnicity, median income, and population density). Given that each geographic unit (county or census-tract) only appeared once in each respective dataset, there was no clustering per geographic unit. In both regressions, associations with $p < 0.10$, $p < 0.05$, and $p < 0.01$ values were noted, and those with a $p < 0.05$ value were considered statistically significant. All analyses were performed in R version 4.0.2.

3. Results

3.1. SNAP OPP coverage, overall

The areal-weighted interpolation analysis shows that 1,116,829 CalFresh Households were covered by SNAP OPP fresh grocery delivery, about 85.9% of the total CalFresh Households in California (Appendix Table 1). Walmart had the greatest fresh grocery coverage out of the SNAP OPP retailers, covering 1.04 million CalFresh households, as compared with Amazon Fresh (0.59 million CalFresh Households) and ALDI (0.74 million CalFresh households) (Fig. 2). Just 31.6% of CalFresh Households were covered by all three retailers.

3.2. SNAP OPP coverage, urbanicity

There was greater SNAP OPP coverage in urban versus rural areas. Of the 37 urban counties, 27 had over 50% of their CalFresh population covered by SNAP OPP (73.0%), compared with zero of the 21 rural counties. Therefore, 100% of the counties with over 50% SNAP OPP coverage were urban. Approximately 67.7% of the 31 counties with less than or equal to 50% SNAP OPP coverage were rural (Table 1). Results from the OLS regressions suggest that SNAP OPP coverage was 39.6% higher in urban counties compared to rural counties ($p < 0.01$) (Table 2). Similarly, SNAP OPP coverage was 33.1% higher in urban (versus rural) census-tracts ($p < 0.01$).

Table 1
County and census-tract stratification analysis for SNAP OPP coverage by urbanicity and limited food access status

	≤50% SNAP OPP Coverage	>50% SNAP OPP Coverage	p-value
# CalFresh Recipients/County Population (mean (SD))	0.11 (0.04)	0.12 (0.06)	0.34
# Counties per Urbanicity Category			<0.001***
Urban	10 (27.0%)	27 (73.0%)	
Rural	21 (100.0%)	0 (0.0%)	
# of Census Tracts in Rural and Urban Limited Food Access Areas			<0.001***
Urban, Limited Food Access Area (n (%))	17 (0.9%)	1896 (99.1%)	
Rural, Limited Food Access Area (n (%))	17 (45.9%)	20 (54.1%)	

Footnote: Table 1 shows chi-squared results from the stratification analysis, comparing counties and census-tracts by SNAP OPP coverage (less than or equal to 50% SNAP population covered by SNAP OPP, or greater than 50% SNAP population covered by SNAP OPP). The symbol * indicates $p \leq 0.05$, ** means $p \leq 0.01$ and *** corresponds to $p \leq 0.001$. External data sources used to support this analysis include: California Association of Food Banks' (CAFB), Walmart Store Locator, California Association of Food Banks' (CAFB), U.S. Census' 2019 American Community Survey (ACS), Basketful ALDI Data, Rural-Urban Continuum Codes (RUCC) from USDA. 'Limited Food Access' areas refers to the USDA's Low Income, Low Access regions, called 'food deserts' in other literatures, and is at the census tract rather than county-level.

3.3. SNAP OPP coverage, limited food access areas

Using the USDA's Food Access Research Atlas, it was found that 46.8% of CalFresh households were located in limited food access areas. Of the CalFresh households located in limited food access areas, nearly 91,037 (15.0%) were not covered by SNAP OPP fresh grocery delivery. The OLS regression model results suggest that, when controlling for demographic factors and urbanicity, SNAP OPP coverage was approximately 1.2% higher in limited food access census-tracts compared to non-limited food access census-tracts ($p < 0.01$) (Table 2). The majority of limited food access areas (1,893 census-tracts, 97.5%) were classified

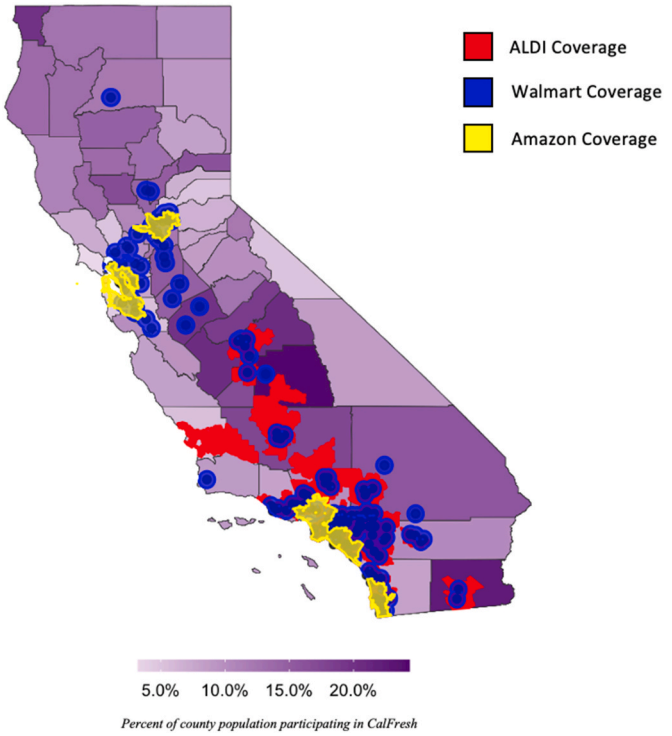

Fig. 2. Supplemental Nutrition Assistance Program (SNAP) Online Purchasing Pilot (OPP) Coverage and Percent of CalFresh Households

Fig. 2 shows the coverage region of each retailer overlaid with the concentration of CalFresh households per county. Red areas denote ALDI coverage, blue areas denote Walmart coverage, and yellow areas denote Amazon coverage. External data sources used for these calculations include: USDA's Food Access Research Atlas, California Association of Food Banks (CAFB), Walmart Store Locator, U.S. Census 2019 American Community Survey (ACS), Basketful ALDI Data.

Table 2
Associations between urbanicity, COVID case rates, and limited food access areas with SNAP OPP coverage

	% of CalFresh population covered by SNAP OPP
Urban census-tract[a] (β)	33.061*** (95% CI: 30.93, 35.19)
Limited food access area[b] (β)	1.177*** (95% CI: 0.48, 1.88ss)
Urban county[a] (β)	39.595*** (95% CI: 20.44, 58.75)
COVID cases[c] (β)	0.006 (95% CI: 0.005, 0.016)

NOTE: *$P < 0.05$; **$P < 0.01$; ***$P < 0.001$; SNAP means the USDA's Supplemental Nutrition Assistance Program; OPP means the Online Purchasing Pilot, a new SNAP program that allows for online grocery ordering & delivery; COVID represents SARS-CoV2 case rates.
Estimates were modeled using Ordinary Least Squares regression, controlling for the percentage of population that is White, percentage of population that is Black, percentage of population that is Asian, percentage of population that is Latino, median household income, and population density (persons/m^2).

[a] Urban area at the county-level are defined using the USDA's Rural-Urban Continuum codes (RUCC) #1–3. Urban census-tracts are defined using the USDA's Rural-Urban Commuting Area (RUCA) codes # 1–3.

[b] Limited food access area defined by the USDA as census-tracts that are 'low-income' (median family income is less than or equal to 80% of the state's or metropolitan area's median family income) and 'low-access' (census tracts where at least 500 people or 33% of the population are more than one mile away from the nearest grocery store in an urban census tract, or 10 miles away in a rural census tract).

[c] COVID case rate defined per 1,000 cases per county, for the month of July 2020. Data gathered from the New York Times' COVID-19 API.

as urban, and represented 27.9% of all urban census-tracts; and a disproportionately larger percentage of rural areas were classified as limited food access areas (40.8% of all rural census-tracts) (Appendix Fig. 2). Of all the CalFresh households in urban limited food access areas, 87.2% were covered by SNAP OPP, whereas just 29.9% of rural households in limited food access were covered by the SNAP OPP (Table 3).

3.4. SNAP OPP coverage, COVID-19 case rates

SNAP OPP coverage was clustered in urban areas, which initially had a greater prevalence of COVID cases, as shown in the June 2020 map (Fig. 1). However, as the pandemic progressed, the case rate increased in rural counties, which had lower SNAP OPP coverage. The addition of ALDI, shown in the February 2021 map, helped provide additional coverage in some areas with greater COVID case rates. The results of the OLS regression model show no statistically significant relationship between the COVID case rate and the percentage of the county's SNAP population covered by the SNAP OPP (Table 2).

4. Discussion

This study assessed the SNAP OPP's fresh grocery delivery coverage during 2020 and the beginning of 2021, as it was first being implemented in California. Importantly, this research also sought to identify areas in the state that were underserved by the program. The results showed that, overall, a large percentage of the CalFresh population (85.9%) was covered by the SNAP OPP. This is a promising finding, because as the COVID-19 pandemic grew and public health authorities encouraged online grocery shopping (CDC, 2020), the SNAP OPP was positioned as an important tool to enable safe, socially distant grocery shopping.

Yet this analysis shows that access to the SNAP OPP was still not available for many participants, depending on where they lived. Those in rural areas – which were hard-hit during the second wave of the pandemic, after the initial surge in urban areas (Miller et al., 2020) – had disproportionately less coverage than urban areas. Indeed, regression results indicate that SNAP OPP coverage was 33.1% and 39.6% higher in urban counties or census-tracts, respectively, compared to rural areas. These disparities based on urbanicity are concerning because individuals living in rural areas face unique challenges, such as lower access to key services, including health resources, and have a higher burden of chronic diseases (Cuadros et al., 2021; Miller et al., 2020).

The results of this study also show that SNAP OPP coverage was slightly higher (1.2%) in limited food access areas. The findings further show that 87.2% of CalFresh households (and 99.1% of census-tracts) in limited food access areas in urban geographies were covered by SNAP OPP, while only 29.9% of CalFresh households (and 54.1% of census-tracts) in limited food access areas in rural geographies were covered. These findings corroborate work by Brandt, E.J et al., which provided evidence of similar disparities in SNAP OPP coverage in the eight states that participated in the initial roll-out of the program (not including California) (Brandt et al., 2019). Brandt E.J. et al. found that 93.0% of urban limited food access areas (referred to as 'food deserts' in their research) in these states were fully deliverable (meaning all ZIP codes in the county were covered) through SNAP OPP and only 5.9% were not deliverable at all (meaning no ZIP codes were covered) (Brandt et al., 2019). In comparison, no rural limited food access areas were fully serviced, 30.5% were partially deliverable, and 69.5% were not deliverable at all (Brandt et al., 2019). Overall, increasing access to online shopping in limited food access areas may mitigate the purported harms of living in such areas, which is typically associated with worse health outcomes (Richardson et al., 2017).

In contrast, the results of this study suggests there was relationship between COVID case rates and the percentage of the CalFresh population covered by the SNAP OPP. Despite the lack of an association

Table 3
Supplemental nutrition assistance program (SNAP) online availability in limited food access areas

	Count of CalFresh Households	% of total CalFresh Households in Limited Food Access Areas	% of total CalFresh Households in Urban Limited Food Access Areas	% of total CalFresh Households in Rural Limited Food Access Area Census Tracts	% of total CalFresh Households in CA
Covered by SNAP OPP in Limited Food Access Areas	516,739	85.0%	87.2%	29.9%	39.8%
Not Covered by SNAP OPP in Limited Food Access Areas	91,037	15.0%	12.8%	70.1%	7.0%

Footnote: External data sources used for these calculations include: USDA's Food Access Research Atlas, California Association of Food Banks' (CAFB), Walmart Store Locator, California Association of Food Banks' (CAFB), U.S. Census' 2019 American Community Survey (ACS), Basketful ALDI Data.
'Covered' means that Households were able to access and order from at least one SNAP Online retailer where they lived. 'Limited Food Access' areas refers to the USDA's Low Income, Low Access regions, called 'food deserts' in other literatures.

between COVID-19 case rates and SNAP OPP coverage, future programs launched during other health crises should consider the availability of their services in areas most impacted by crises or natural disaster, given how equitable access to online grocery delivery services may help reduce the risk of disease transmission among at-risk populations. Expanding the appeal, equity, and utility of programs like the SNAP OPP during emergencies involves ensuring online shopping prices are as, or more, affordable than in-store prices; that discounts and coupons are available and easily useable for those shopping with SNAP benefits; that the experience is convenient and time-saving, that the experience is accessible to less digitally-literate users; and that consumer data privacy is protected (Cohen et al., 2020).

While much is still unknown about how the digital food environment impacts health outcomes, the nutritional profile of grocery retailers may be improving over time (Taillie et al, 2016), and the greater convenience of online shopping experience may increase healthy food purchasing (Granheim et al., 2022). At the same time, online supermarkets employ targeted marketing strategies that often promote unhealthy, ultra-processed food products (Chester et al., 2020), and some customers may also be less willing to order fresh produce online, given the inability to interact with food items (Jilcott Pitts et al., 2018.). In order for the SNAP OPP to improve food security and diet quality, especially in limited food access regions, government agencies should further oversee and regulate marketing tactics that promote unhealthy items, and encourage those that incentivize healthy ones (Headrick et al., 2021; Chester et al., 2020). In addition, policymakers may promote SNAP OPP's effective and equitable implementation by supporting innovative delivery models including community drop-off hubs, bridging internet and device access gaps and increasing digital literacy, and forming multi-stakeholder coalitions on advancing health equity through the SNAP OPP. Retailers can offer delivery or other service discounts for SNAP participants, promote nutritious options, and avoid engaging in targeted marketing of unhealthy options (Moran et al., 2021; Headrick et al., 2021).

4.1. Limitations

Several assumptions were made to conduct this analysis. To calculate SNAP OPP coverage, the most readily accessible data on fresh grocery delivery by store was used. While more recent data from Walmart and ALDI (February 2021) was accessible, the most recent available data for Amazon Fresh ZIP code coverage information came from a public webinar in June 2020. Additionally, this analysis was completed prior to the inclusion of FoodMaxx, Lucky Supermarkets, Save Mart Supermarkets, and other smaller retailers in the SNAP OPP (Save Mart, 2021a). Like ALDI, these stores participate in the SNAP OPP as Instacart partners, and offer delivery in select ZIP codes near brick-and-mortar stores, primarily located in the same densely-populated regions as Amazon Fresh, Walmart, and ALDI (Lucky Supermarkets, 2021; FoodMaxx, 2021; Save Mart, 2021b). Nonetheless, this analysis specifically focused on SNAP OPP access during its initial roll out during the pandemic, as the aim was to identify insights to improve the launch and implementation of other pilot and emergency programs, and it is unlikely that their participation meaningfully increased SNAP OPP coverage. More importantly, the analysis for Amazon Fresh, Walmart, and ALDI revealed significant differences based on area-level characteristics, highlighting inequities in the expansion of the SNAP OPP, which was the key objective of this study. Data granularity and consistency were also a challenge, as COVID-19 case rate data as only available at the county-level, as compared to the census-tract level data for other variables of interest. Additionally, due to data privacy and data sharing limitations from the California Department of Social Services, the authors were unable to obtain information on the types of food purchased with SNAP benefits online. This information would be useful for providing a more in-depth understanding of SNAP online shopping behaviors and purchases.

4.2. Public health implications

The SNAP OPP program in California has the potential to expand safe and equitable access to fresh foods for CalFresh shoppers. During its first year of implementation, participating retailers' delivery networks covered a large percentage of the state's urban limited food access areas, providing opportunities to offer fresh food access to populations without nearby brick-and-mortar grocery stores. However, many regions, especially rural areas, lacked access to fresh grocery delivery through the program. Such lack of access may contribute to, rather than mitigate, the geographic and income-based health disparities that the SNAP OPP program aims to address. These insights should be taken into account when implementing future programs and pilots to ensure that such disparities do not persist, particularly when deploying a new program during a health-related emergency. Federal and state-level data analyses of program coverage should be integrated into the implementation process, to assess which populations are and are not covered in real-time. This would ensure that policy-makers and operators better understand program accessibility and disparities that might be further exacerbated rather than remediated.

Human participation protection

This research was conducted using publicly available data sources and was deemed exempt through Stanford's Institutional Review Board (IRB) as it did not involve human subjects.

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Statement of authors' contributions

Together, the authors devised the analysis plan, and reviewed and edited the paper. All authors approved the final version. I. S. Foster led the writing and editing of the article, data analysis, and creation of the table and figures. S. Y. Liu led the geospatial data analysis, performed data analysis, and contributed to the drafting of the paper and figures. C. T Hoffs contributed to the analysis plan and the drafting and editing of the paper. C. LeBoa assisted with table and figure preparation, provided revisions, and advised on statistical methods. A. S. Chen helped with data collection and advised on statistical analysis and methods. P.E. Rummo oversaw the study, and contributed to the design, edits, and drafting of the manuscript.

Declaration of competing interest

The authors do not have any conflicts of interest to report.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.healthplace.2022.102811.

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