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The Relation of Grocery Delivery Services to Food Insecure Neighborhoods: A GIS Approach to Californian Food Deserts

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ABSTRACT OF THE THESIS

The Relation of Grocery Delivery Services to Food Insecure Neighborhoods: A GIS Approach to Californian Food Deserts

by

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Abstract Low-income areas with limited access to nutritious foods are referred to as "food deserts" and are commonly found in communities of color. Supermarkets are absent from these neighborhoods, mostly due to the residual effects of redlining which began as early as the 1930s. Alternative food institutions, such as farmers' markets, attempt but fail to adequately address the problems of food deserts. Grocery delivery services (GDS) reflect another attempt to address the problems of food deserts. Companies like Amazon Prime, Instacart, and Walmart Pickup & Delivery are becoming more popular. It is not known whether GDS improves access to nutritious foods. This study uses geographical information systems (GIS) to map the service areas of GDS and their overlap with food deserts in California. The results demonstrate that 6.56% of the state is comprised of areas that are food deserts served by GDS, while 28.21% of the state is comprised of areas that are food deserts and not served by GDS. Analysis of the racial

and ethnic demographics suggests that very few people, regardless of race or ethnicity, are in a food desert that is not served by GDS. Future research can assess the utilization of GDS by low-income households to determine the extent to which access to GDS in a food desert translates to reduced food insecurity.

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Communities across the nation that lack access to nutritious foods are commonly labeled as food deserts. The United States Department of Agriculture (USDA) defines food deserts through two measurements: low-income and low access. Low-income neighborhoods are spatial areas of housing tracts with a poverty rate of 20% or higher or tracts with a median income less than 80% of the median family income when compared to the tracts in the area, according to the US Census. Low-access neighborhoods are housing tracts in which 500 people or 33% or more of the population live farther than one mile from the nearest food market (USDA 2017). While these can include rural areas (defined as 10 miles from a grocery store), research on food deserts has commonly focused on more populated, urban areas. Food deserts are deprived of nutritious foods, and they inflate the health problems of community members. Neighborhood conditions directly affect health disparities, and researchers have also noted that disadvantaged individuals residing within deprived communities are affected psychologically as well. However, in recent years, grocery delivery services (GDS), such as Amazon Prime, Instacart, and Walmart Pickup & Delivery, have become popular as a convenient means for acquiring groceries from supermarkets. To utilize GDS, shoppers place their grocery order on a website or phone app, complete their purchase using a credit card, and the groceries are delivered to the shoppers by the GDS for a fee. By bringing foods directly to their customers, GDS have the potential to mitigate the problem of food access found in food deserts. Thus, this study investigates the penetration of grocery delivery services in low-income, low-access communities in California.

Food insecurities are a direct result of systemic racism. For example, food deserts formed during the 1930s through the 1960s when supermarkets were relocating to the city edges in more affluent areas with larger lots and ample parking (Rothstein 2017; Walker et al. 2010). This was mostly achieved through the practice of redlining, where financiers denied loans and insurance to people living in poor neighborhoods because they were deemed a financial risk. This practice especially targeted Black Americans and Black neighborhoods which, in turn, made the neighborhoods more likely to become food deserts (Rothstein 2017). Even as of 2008, only 50% of all Black neighborhoods in urban areas of the U.S. have a supermarket (Raja, Ma, and Yadav 2008). An example of the growth of racial disparities in food access is found in West Oakland, California, where, from 1960 to 1980, the number of grocery stores decreased from 137 to 22 (McClintok 2008). The Black-white racial disparities found among food retailers are even found within affluent neighborhoods (Helling and Swicki 2003).

Food access has direct consequences related to health. In the absence of supermarkets, independent convenience stores fill the void. They typically charge higher prices and lack fresh and nutritious foods, such as raw, unprocessed vegetables (Beaulac et al. 2009; Stronks et al. 1998). Consequently, relative to other areas, food deserts have higher mortality rates due to a higher incidence of chronic diseases including heart disease, cancer, and diabetes (Hendrickson, Smith and Eikenberry 2006). Food desert-related malnutrition can, in turn, lead to fatigue, absences from work and school, infectious diseases, and problems with concentration (Brown and Jameton 2000). Studies have indicated that access to more nutritious foods decreases obesity, increases vegetable

and fruit consumption, and is associated with better diet quality in low-income households (Beaulac, Kristjansson, and Cummins 2009).

Many interventions have aimed to bring healthy foods to food deserts. Two examples are local farmers' markets and community-supported agriculture (CSA), a subscription service for regular weekly or biweekly delivery of produce from a particular farm or group of farms. These alternative food institutions build community and offer a way for producers and consumers to bring about socio-economic change and challenge the traditional food system (Guthman 2008b). They provide many benefits to communities and farmers alike, forming a direct connection that educates consumers about farming and the environment, securing local agricultural farmlands, and improving community food quality (Ostrom 2007). Customers often find themselves enjoying more fruits and vegetables and experimenting with new recipes to incorporate their produce, resulting in a healthier diet (Ostrom 2007).

Alternative food institutions oftentimes fail disadvantaged communities. Farmers' markets are designed and located to secure the most profitable prices for farmers and are typically situated in more affluent areas and cater to wealthier patrons. They disproportionately serve white and middle- to upper-income populations (Guthman 2008a; Guthman 2008b). Rarely are farmers' markets located in neighborhoods of color, low-income communities, or food deserts. Farmers' markets that do exist in neighborhoods of color tend to be very small (Guthman 2008a). In a study on a farmers' market set within the food desert of West Oakland, Guthman (2008a) observed that the market maintained few returning customers, most of whom "are white and/or middle-

class blacks who are from out of the area and who go there specifically to support black farmers" (432).

Some scholars have criticized alternative food institutions run by whites in communities of color as reminiscent of the colonial period in which white organizations managed black communities (Guthman 2008b; McClintock 2008). For that reason, many organizations, like Food from the Hood in Los Angeles, Mo' Betta Foods and the Peoples' Grocery in Oakland, Community Market in Washington DC, and Just Foods in New York have constructed their charters to engage and appeal to people of color (Guthman 2008a; Reese 2019). Some organizations have opted to facilitate anti-racism training for their staff to manage any concerns about race (Guthman 2008a).

While farmers' markets have failed to eliminate food deserts, grocery delivery services have the potential to reduce food deserts. These new services offer convenience and promise to be fast and affordable. Even though they might be a luxury convenience for the middle and upper classes, they may also provide valuable service to residents of food deserts by giving access to healthy foods. Several questions about these services must be asked. Do grocery services deliver to food deserts? What are the demographic characteristics of the neighborhoods that are most served by grocery delivery services? This study will answer these questions. In so doing, it will examine how grocery delivery services relate to structural inequities in food access.

Today, in 2020 and 2021, access to food is a matter of life or death because every trip to the local market involves the threat of contracting the Coronavirus disease 2019 (COVID-19). Due to the COVID-19 pandemic, grocery delivery services have surged in

popularity (Petrova 2020). Having groceries delivered to one's doorstep mitigates the threats of contracting COVID-19 by leaving the home. Especially critical for health-vulnerable populations (CDC 2020b), such as the elderly, people with autoimmune deficiencies, and people of color (who have greater exposure due to working in essential jobs and have a greater risk of infection severity due to preexisting health conditions), grocery delivery services have the potential to save lives and reduce disparities. Living within a service area of a GDS provides a resource to access and does not necessarily mean the service is utilized. For this study, GDS service means that community members are within GDS delivery spatial areas and does not imply that community members are able to utilize the service based on other barriers. This study addresses the question of whether GDS are equally accessible in terms of spatial areas to all the populations who could benefit from them.

THEORETICAL FRAMEWORK

This study aims to address the longstanding structural inequities in food access tied to race, power, and privilege. Food access is directly related to health outcomes. Thus, this study is informed by several theoretical frameworks: critical race theory (CRT), race and technology, and social determinants of health.

In America, racism is always operating. This includes within food systems, as well as on the internet and within technology mediums (Daniels 2012). Critical race theory seeks to expose the persistent failures of institutions in which racial inequities and racism are normalized in common, everyday occurrences (Delgado and Stefancic 2012). It aims to uncover how race and racism operate to shape outcomes. CRT frames race as

ideological and as a material means of capital accumulation for white Americans, as the dominant racial group, though it is rarely acknowledged in many institutions across the country (Richter 2017). CRT is helpful to this study in understanding that racism is commonplace in all institutions including the food systems within communities of color. For example, while the US food system currently produces enough food to feed all households two times over, Black and Latinx communities remain food insecure disproportionately than white communities (Garth and Reese 2020). Because racism is always operating, addressing the food system through a critical race theoretical lens provides an opportunity to examine these systematic failures. This study examines whether there are racial differences in access to GDS.

Scholars have argued that racism continues within the internet and technology (Coleman 2009; Daniels 2012; Benjamin 2019; Hui Kyong Chun 2009; Umoja Nobel 2018; Reese 2019). For example, Benjamin (2019) argues that technology "often hides, speeds up, or even deepens discrimination, while appearing to be neutral or benevolent when compared to the racism of a previous era" (8). She highlights how structural inequalities are amplified through engineering and coding that are rooted in racism, classism, and sexism. Likewise, Umoja Nobel (2018) documents racism within search engines that reinforces racial stereotypes. She calls for greater regulations and public policies about technology. In her book, *Black Food Geographies*, Reese (2019) explores the ways that unequal food access is socially reproduced, including how racial segregation can shape the food landscape. By centering the voices of Black community members, Reese shows the consequences found within the racialized structure of the food

system. Race and technology are directly connected and are recreating our food systems. As more companies, such as GDS, adopt technology to reach customers, we must consider the ways that technology reinforces and reproduces inequities.

Many studies on race and technology have focused on the digital divide – that is, inequities in access to the internet and related technology. People from lower socio-economic backgrounds have less access to technology (Hargittai and Hinnant 2008; Cohron 2015; Umoja Nobel 2018). Early studies focused on whether populations had access to technology, however, today, most people now have access to some technology. And while the elderly and the less-educated population tend to have less access to the internet, most people across the nation own computers and smartphones (Cohron 2015). Current studies focus on the quality of the access (e.g., slow versus fast internet access) and additional factors (e.g., internet skills) that affect the ability to take advantage of the access to technology and use it to improve life outcomes (Hargittai and Hinnant 2008; Cohron 2015). For example, Hargittai and Hinnant (2008) found that children from higher socioeconomic backgrounds were more likely to watch educational programs, which ultimately propels their already advantaged backgrounds. They argue that the question of the digital divide is no longer regarding the *haves* versus the *have-nots*, but rather regarding whether and how technology utilization relates to improved outcomes, given that different demographic groups experience technology, including the internet, differently (Hargittai and Hinnant 2008). The present GDS study connects to these existing studies by documenting access to the new technology. It assesses whether access to GDS is equitably distributed by race, ethnicity, and urban/rural status.

GDS were born during the dot com boom of the late 1990s (Ervin 1998). Despite their early arrival to the internet, GDS didn't gain in popularity until the late 2010s alongside the rise of online shopping and the growing gig economy. GDS are a technological innovation, but their accessibility is nevertheless tied to income, geographical location, age, and education (Cohron 2015). Utilizing GDS requires access and knowledge on four points, (1) being geographically situated where a GDS provides service and a person can acquire internet access, (2) being able to afford to purchase internet services and the extra costs of GDS, (3) knowing that GDS exist as an available service, and (4) knowing how to use GDS website and software applications.

As a technology, GDS is a resource that may reduce insecure food access. As such, it may improve health by addressing a social determinant of health: living in a food desert. In the context of COVID-19, it may also improve health by reducing exposure to the virus, even in non-food deserts, by enabling people to stay home instead of going to the grocery store. In other words, it provides safer (from COVID-19) food access as a community resource. Social determinants of health are "nonmedical factors influencing health, including health-related knowledge, attitudes, beliefs, or behaviors" (Braveman et al. 2011:383). This study examines whether GDS operates in these ways by improving food access and providing access equitably across social groups.

RESEARCH DESIGN AND METHODS

This study uses cross-sectional, primary and secondary data to determine the overlap of GDS service areas and food deserts in California. Two datasets were analyzed through geographic information systems (GIS): a dataset of food deserts obtained from

the United States Department of Agriculture (USDA) and a dataset of GDS service areas created for this study by collecting data from five companies: Amazon, Kroger, Albertsons, Instacart, and Walmart.

The study focuses on California. The state of California is a good sample because of its large population and demographic diversity. In a recent study using 2019 census data, California was ranked first of fifty for cultural diversity and third for socioeconomic diversity (McCann 2020). California also maintains the largest population of any state, with 39.5 million as of 2019, followed by Texas at 28.9 million (US Census Bureau 2019). Having a large and diverse sample increases the validity of the results (Creswell and Creswell 2018) and will provide a good proxy for the rest of the United States.

Measures

GDS Service Areas. To identify the GDS service areas, a list of the 2,587 Californian zip codes was obtained from the United States Postal Service (http://tools.usps.com/) in July 2020. Five GDS were analyzed: Amazon Prime, Kroger, Albertsons, Instacart, and Walmart Pick-up & Delivery. These providers have the largest grocery delivery services in California (de Looper 2020). Data collection included looking up each zip code on each of the five GDS websites, where each zip code was coded as "1" if the GDS served that zip code or "0" if the GDS did not serve that zip code. This process produced five variables, one for each of the five GDS. Then, a sixth variable was created in which each zip code was coded as "1" if any of the five GDS served that zip code or "0" if none of the five GDS served that zip code.

Amazon Prime delivers exclusively from Whole Foods Market grocery stores, and the Amazon Prime website (amazon.com) was used to collect the data. Kroger delivers from three grocery chains: Ralphs, Food 4 Less, and Food Co. These chains were checked individually on their respective websites (ralphs.com, food4less.com, and foodco.com). The Kroger variable represents whether a zip code has at least one of the three stores delivering to it.

Albertsons's service involves grocery chains: Albertsons, Vons, Safeway, and Pavilions. Unlike Kroger, the company operates its grocery deliveries out of "hubs," where only one of the four grocery stores in the area will provide delivery service. For example, if a neighborhood has both a Vons and an Albertsons, only one of the two would provide delivery service to a customer. Looking up a zip code at the Albertsons website (albertsons.com) would kick the shopper over to its sister store's website, to the designated store that is deemed the hub for that service area. Thus, for any given zip code, the Albertsons company would have only one of its four stores deliver to it. Lucky stores are part of Albertsons but are never used as a hub and therefore, they make no deliveries. For this reason, the Lucky store was removed from the dataset. The Albertsons variable represents whether one of the four Albertson's stores deliver to the zip code.

Instacart is not affiliated with any grocery chain; it is exclusively a grocery delivery service. At the time of data collection, it operated in approximately 84 grocery stores across the state. This meant that for each zip code, multiple stores were scored. Each zip code was observed on the Instacart website (instacart.com). Instacart also provides delivery from multiple retail and convenience stores that are not considered

grocery stores, like Sephora, Bevmo, and Texaco gas stations. Research assistants were instructed to determine whether each retail store was a "grocery store" by asking the following two questions: Does it have a meat counter? Does it have over 20 employees? Stores that did not fit the criteria were not included in this study.

Walmart operates its grocery delivery through Walmart Pick-up & Delivery (walmart.com/grocery/) as a separate website from the Walmart retail stores. To determine if it provides service to an area, Walmart Pick-up & Delivery required a full and real address in addition to a zip code. This created an additional step. First, each zip code was searched in Google Maps to capture a real address within the zip code. Research assistants were instructed to approximate the geographic center of the zip code whenever possible, drop a pin on a building, and copy the address provided by Google Maps. Then, the full address was entered on the Walmart website to determine if that address, and therefore zip code, was served by Walmart.

The GDS data were cleaned and double-checked for errors. Zipcodes are geographic spatial areas that do not necessarily contain residents; they are a tool for postal services to organize mail distribution. For this reason, many zip codes were considered "invalid" because they do not exist as spatial areas in the state of California. These invalid zip codes were removed from the dataset.

Food Deserts. The USDA has compiled the nationwide Food Access Research Atlas (ERS 2020). It identifies census tracts that are food deserts defined as low-income and low access. For the present analyses, the variable employed had defined food deserts as low access to food within one mile for urban areas and ten miles for rural areas. The

variable also accounts for income levels in that the tract's poverty rate is 20 percent or greater or the tract's median family income is less than or equal to 80 percent of the statewide median family income (ERS 2020).

Population Demographics. Variables capturing the socio-economic demographics of census tracts characterized the total count of race and ethnicity of the population within the census tract: Black population, Asian population, Native Hawaiian or Other Pacific Islander, American Indian and Alaskan Native population (henceforth called Indigenous), multiple-race or "other," and of white population. For each area, the total population count of each racial group was divided by the total population count of the area to create a percentage. Each area was then defined by the plurality as the racial group with the greatest percentage.

In addition to the race demographics, each area was defined as being the majority (50% or greater of the total population) Latinx or not.

Urbanicity. The USDA dataset also provides the urban variable which indicates whether the census tract is in an urban area. A census tract is urban if the geographic centroid of the tract (reported at block level) is in an area with more than 2,500 people. All other tracts are not urban (ERS 2020).

ANALYSIS

The data were analyzed with Geographic Information System Mapping through ArcGIS Desktop 10.8 (hereafter ArcGIS). First, the GDS zip code spatial areas and the USDA census tract spatial areas were joined (combined) within ArcGIS to create over 20,000 polygons, the unique geographic areas where they overlapped. The polygons

hereafter termed "areas," are measured in square footage and are the primary unit of analysis.

General Analyses #1-4

Geographic information system analysis of the areas reveals the following: analysis #1 highlighted the extent of California areas served by GDS and analysis #2 the extent of California areas characterized as a food desert. Analysis #3 becomes a central analysis that is duplicated in several variations throughout the research. It looked at the extent of California spatial areas falling into each of four types: (1) served by GDS but were not food deserts, (2) served by GDS and were food deserts, (3) not served by GDS but were food deserts, and (4) not served by GDS and were not food deserts. Later, this analysis will be duplicated using racial plurality, total population count, and more. Analysis #4 examined the percentage of food deserts served by GDS, using the subsample of areas that were food deserts.

Race and Ethnicity Analyses #5-10

Six analyses focus on the data related to race and ethnicity. Analyses #5 is a replication of analysis #3, specifically looking at the percentage of areas with a plurality of a given race in each of the four area types. None of the areas were defined as having a plurality of Native Hawaiian or Other Pacific Islander; thus, the Native Hawaiian or Other Pacific Islander group was not included. Analyses of the areas revealed the percentage of areas with a Black plurality, the percentage of areas with an Asian plurality, the percentage of areas with an Indigenous plurality, the percentage of areas with the plurality of multi-racial people, and the percentage of areas with a white

plurality. Analysis #6 focused on the racial demographics within the food deserts, as done in analysis #4, using food deserts as the subsample.

Analysis #7 reproduced Analysis #3, focusing on the percentage of majority Latinx areas in each of the four area types. Analysis #8 looked at the percentage of majority Latinx areas using food deserts as the subsample, like in analysis #4.

Analysis #9 investigated the percentage of each racial population group in each of the four GDS-food desert area types. To this, analysis #9 is duplicating analysis #3 but with the total population of each racial demographic rather than the spatial area. Likewise, analysis #10 investigated the percentage of the Latinx population in each GDS-food desert area type.

Urban and Rural Analyses #11-14

Finally, several analyses were conducted to understand the impact of urbanism on grocery service deliveries. These analyses duplicated analysis #3 and analysis #4 with the urban variable. Thus, analysis #11 reproduced analysis #3, replacing the percentage of the state with the percentage of urban areas in each of the four area types. Likewise, analysis #12 reproduced analysis #4 using urban food deserts as the subsample. While analyses #11 and #12 investigated the urban spatial areas, analyses #13 and #14 focused on the total population living in these areas. Thus, analysis #13 parsed out the total population of individuals living in urban areas. Similarly, analysis #14 examined the total population of residents of rural areas. These two analyses investigated the percentage of urban population and percentage of the rural population in each GDS-food desert area type as created in analysis #3.

FINDINGS

General Analyses #1-4 Findings

Analysis #1 examined the areas of California that are served by GDS. Figure 1 maps these areas and reports the percentage. Across California, GDS serve 35.74% of the state. Table 1 shows the descriptive statistics, breaking down the coverage by each GDS. This table reports that Instacart has the largest service area, covering 28.39% of the state, followed by Albertsons at 18.03%. Kroger and Walmart have similar coverage at 16.00% and 16.07% respectively. Amazon has the smallest service area, covering only 7.02%. GDS service areas have high overlap with each other, thus the total percentage of coverage of the state is not much greater than the coverage of individual GDS.

Table 1 also highlights the differences between each GDS according to the total population they each serve. Instacart serves the greatest percent of Californians at 91% whereas Amazon Prime only delivers to 61%. When looking at only the residents of food deserts, Instacart again serves the most at 80% of residents within food deserts. Amazon Prime is reaching only a quarter of all residents living within food deserts. These numbers are vastly different and can speak to a company's desire to promote food equities or customer acquisition. For instance, Amazon delivers from Whole Foods Market stores and maintains a reputation of situating itself in highly affluent regions across the nation. Because food deserts, by definition, are low-income areas, it may be unlikely that Amazon Prime would reach these areas. Reflected in these descriptive statistics are the inequalities found between GDS companies (for the information on all five GDS companies, see Table 1). While these descriptive statistics do not answer the

research question, there is a potential to answer future research questions that investigate the differences between the companies. More research could dive into other avenues of inequalities found between GDS companies. Analysis #2 becomes a point of comparison for the GDS delivery areas. This analysis utilized the USDA data and displays the areas of California that are food deserts, as defined by the USDA (see Figure 2). Just over a third of the state (34.77%), is a food desert.

Analysis #3 defines the four main area types which are duplicated throughout the research. This analysis examines the overlap between GDS service areas and food deserts statewide. As presented in Table 2, 6.56% of the state is comprised of areas that are served by GDS and are food deserts, 28.21% of the state is comprised of areas that are not served by GDS but are food deserts. 29.18% of the state is comprised of areas that are served by GDS but are not food deserts, and 36.05% of the state is comprised of areas that are neither served by GDS nor are food deserts. Figure 3 maps these four types of areas. Analysis #4 (result not shown in tables) examined the subset of the state that is characterized as a food desert. It showed that 18.87% of areas characterized as food deserts are served by GDS. Likewise, of the food deserts, 81% are not served by GDS. While this percent is incredibly high, it is important to articulate this analysis in terms of population. For the most part, 81% of food deserts not being reached by GDS may be found in rural areas with limited residents. This will be parsed out further in analyses #11 through #13.

Race and Ethnicity Analyses #5-10 Findings

Analyses #5 through #8 investigated the spatial areas related to race and ethnicity, whereas analyses #9 and #10 examined the racial and ethnic demographics by the total population. First, analysis #5 examined the percentage of each area racial composition type that falls into each of the four GDS-food desert area types (see Table 3). Focusing on the top row of the table, we see that areas with an Indigenous plurality have the smallest percentage (0%) of areas that are served by GDS and are a food desert. They are followed by areas with an Asian plurality (0.76%), areas with a white plurality (6.13%), areas with a Black plurality (14.69%), and areas with a plurality of multi-racial people (21.77%). These differences are likely explained by differences in the racial composition of food deserts. Thus, analysis #6 (results not shown in tables) examined only areas that are food deserts. It showed that 100% of food deserts with a Black plurality and 100% of food deserts with an Asian plurality are served by GDS, 88.14% of food deserts with a multi-racial plurality are served by GDS, and 17.37% of food deserts with a white plurality are served by GDS.

Analyses #7 and #8 highlighted Latinx as an ethnicity-addition to the racial demographics above. First, analysis #7 (results not shown in tables) investigated the percentage of majority Latinx areas that fall into each GDS-food desert area type. The findings show that 12.19% of majority Latinx areas are served by GDS and are food deserts, 36.54% of the areas are served by GDS but are not food deserts, 10.46% of the

areas are not served by GDS but are food deserts, and 40.82% are not food deserts and are not served by GDS. Analysis #8 (result not shown in tables) demonstrated that 53.83% of food deserts with a Latinx majority are served by GDS.

The prior analyses investigated racial and ethnic demographics by spatial areas (as a way to understand the data by neighborhood), however, articulating the data in terms of population is also essential. Thus, analyses #9 and #10 parse out the total population counts for race and ethnicity. First, analysis #9 (see Table 4) investigated the percentage of each racial group in each GDS and food area type created in analysis #3. Of total population of individuals who identify as Black in California, 8% are served by GDS and reside within food deserts, 90% are served by GDS but do not reside in food deserts, less than one half a percent is not served by GDS but reside in food deserts, and 1.2% do not reside in food deserts and are not served by GDS. Of Asian individuals in California, 3% are served by GDS and reside within food deserts, 96.25% are served by GDS but do not reside in food deserts, one-tenth of one percent are not served by GDS but reside in food deserts, and less than one percent, at 0.6% do not reside in food deserts and are not served by GDS. Of indigenous people in California, 8.8% are served by GDS and reside within food deserts, 80.2% are served by GDS but do not reside in food deserts, 2.75% are not served by GDS but reside in food deserts, and 8.1% do not reside in food deserts and are not served by GDS. Of multi-racial people in California, 8.1% are served by GDS and reside within food deserts, 88.5% are served by GDS but do not reside in food deserts, 1% are not served by GDS but reside in food deserts, and 2.49% do not reside in food deserts and are not served by GDS. Of whites in California, 6.2%

are served by GDS and reside within food deserts, 89.3% are served by GDS but do not reside in food deserts, 1% are not served by GDS but reside in food deserts, and 3.5% do not reside in food deserts and are not served by GDS. For this analysis, the data finds the great disparities of GDS access within the Indigenous populations.

An even greater understanding of the racial demographics can be gained by articulating how Latinx individual identify their race. This will be parsed out further in the discussion section. However, for analysis #10, it investigated the percentage of Latinxs in each GDS and food desert area type. For Latinx demographics across the state of California, 8.1% are served by GDS and reside within food deserts, 88.65% are served by GDS but do not reside in food deserts, only 0.8% are not served by GDS but reside in food deserts, and 2.4% do not reside in food deserts and are not served by GDS. This analysis provides insight into how Latinx populations fair, though, understanding the population's connection to race will give a better sense of the ways racial and ethnic demographics are distributed relating to GDS and food access across California.

Urban and Rural Analyses #11-14 Findings

The first analysis demonstrated that GDS serve only 35.74% of the state's area, however, much of California is unpopulated. For this reason, analyses #11 through #13 investigated only those regions defined as urban, according to the US Census. Analysis #11 (results not shown in tables) investigated the extent to which urban spatial areas have overlap between GDS and food deserts. The findings demonstrate that 15.03% of the urban areas are served by GDS and are food deserts, 59.58% of urban areas are served by GDS but are not food deserts, 14.01% of the areas are not served by GDS but are food

deserts, and 11.39% of the areas are not served by GDS and are not food deserts. Of the areas considered to be urban food deserts, analysis #12 parses out that 51.75% of those areas are served by GDS.

Analysis #13 investigated the percentage of the total population living in urban areas in each GDS-food desert area type. Of the urban population in California, 6.15% are served by GDS and reside within food deserts, 85% are served by GDS but do not reside in food deserts, only one half of a percent is not served by GDS but reside in food deserts, and less than one percent (0.9%) do not reside in food deserts and are not served by GDS.

Analysis #14 repeats the previous analysis; however, it is focused on the total population residing within rural areas instead of urban areas. Of the total population living within rural areas in California, 2.5% are served by GDS and reside within food deserts, 68% are served by GDS but do not reside in food deserts, 4.6% are not served by GDS but reside in food deserts, and 24.8% do not reside in food deserts and are not served by GDS. Table 6 summarizes these results.

DISCUSSION

This study investigated grocery delivery services across California by total area and total population, finding mixed evidence on the availability of GDS in the state. By area, roughly thirty percent of the entire state are areas defined as food deserts and not served by GDS.[1] When zeroing in on those food deserts, over eighty percent of them are

[1] Analysis #3, table 2

not served by GDS.[2] Eighty percent appears disparaging, however, much of the regions across the state are sparsely populated, that is, small numbers of people are affected. This is explained by analyzing the total population of Californians. Analysis #1 (Table 1) refers to the total number of Californians served by GDS, which is 96.3%. This means that there is close to four percent of residents, 140 thousand people, that do not have access to a grocery delivery service across California. 11.8% of those living within a food desert, do not have access to a GDS.[3] The numbers reflect, of the nearly 2.67 million residents of Californian food deserts, 250 thousand of them do not receive service from any grocery store. These are 250 thousand individuals that do not have healthy foods within their proximity and are unable to have them delivered. While this number is small compared to the 37 million Californians, it remains an injustice that any Californian should not have access to healthy foods. These issues are compounded by critical gaps in internet access for rural residents and link to broader social concepts which affect health (Lee et al. 2020; van Deursen 2020).

Over 86% of the state of California is defined as rural. Rural areas are served less commonly by GDS. As well, most Californians, ninety-six percent, live in urban areas (ERS 2020), and these areas are nearly saturated by GDS. Given that GDS operate in approximation to grocery stores which are centrally located where humans live, this result suggests that GDS determine their service areas based on where the most people reside, perhaps to capitalize on their revenues. Although they may constitute small numbers, residents in rural food deserts have less access to GDS. Future research could

[2] Analysis #4. (not shown in table)
[3] Analysis #1, table 1

examine motivational factors that might encourage GDS to expand service in rural areas, especially those that are food deserts.

This study also investigated service areas and populations as it relates to race and ethnicity. As discussed above, very few people are both in a food desert and not served by a grocery delivery service. The findings reflect this regardless of race and demonstrate that GDS provide services to areas with people of color, including Latinxs, even in food deserts. Nevertheless, there are nuances regarding race and ethnicity that can be scrutinized.

Much of the difference between racial groups can be explained by urbanicity and ruralism. For example, Black and Asian demographics mostly live within areas defined as urban. To this, there are not many areas with a Black or Asian plurality that are not being served by GDS. This is similar when looking at the total population counts for those demographics. Less than half a percent of Black individuals across the state are living in a food desert and not served by GDS. That number is a tenth of a percent for Asian populations in California. Counter to this would be the racial demographics living within rural areas. The data explains that there are no areas defined as Indigenous plurality that are (1) food deserts, (2) served by GDS, or (3) in urban areas. And yet, as a total population count, Indigenous People are almost three times more likely to not be served when living in a food desert compared to all other demographics.[4] This may be explained by the fact that higher numbers of Indigenous individuals throughout California reside in

[4] Analysis #9, table 4

areas defined as rural, compared to other demographics.[5] The data have the potential to expose inequalities found within tribal lands. Future research should investigate how grocery delivery companies are neglecting California's tribal lands to shed light on the food injustices which Indigenous People are experiencing at disproportionate rates.

By areas of plurality, white demographics are less likely to be served by GDS when living within a food desert, followed by the multiple-race group.[6] Thus, the data articulates that by racial group, communities of color are served by GDS in greater numbers than white communities. This was not expected; however greater insight can be articulated by looking at the analyses about ethnicity. Analysis #8 shows that almost half of all Latinx areas within a food desert are not served by GDS. This might be because individuals identifying their ethnicity as Latinx may also report their race as white or multiracial. According to the *2010 Census Brief*, 53% of individuals identifying as Latinx also identify as white and 36.7% identify as multi-racial (Ennis et al. 2011). These numbers relate to the numbers of rural, food desert demographics that are not served by GDS. A limitation of the study was that it could not assess the extent to which racial subgroups of Latinxs, particularly white or multiracial Latinxs, have access to GDS, because the data did not allow it. For this reason, an investigation into California's rural-Latinx communities would provide a more complete picture. Especially vulnerable are the unincorporated and underinvested regions, for example, those found throughout California's Central Valley. The data have the potential to analyze these communities in greater focus and depth in future projects.

[5] Analysis #5, table 3
[6] Analysis #5, table 3

This study drew from critical race theory to further explain how institutional racism contributes to food injustices. The contributing factors of food insecurities found within communities of color are oftentimes tied to institutional racism, are longstanding, historically, and culturally embedded in the nation's structures. The unequal power relations and distributions of resources generate greater deprivation and social exclusion for these communities. They are plagued with a lack of wealth, power, and privilege (Allen 2010; Bedore 2010). Yet, the current analyses do not go far enough, and more research is needed to understand how racism may operate within GDS and populations. This study does not demonstrate the key principles of the CRT in action; however, racism is always in operation within our institutions. Further, study is required to identify how it is operating.

This study engages with the race and technology discourse relating to the accessibility of grocery delivery services, specifically defined as community members residing within GDS spatial delivery areas. The data suggest that people of color reside within service areas at the same rates as white residents, however, the data cannot answer if all groups are utilizing the services at the same rates. In defining service, access and utilization mean different things. This is because not all race and ethnic demographics can access technology in the same manner. This speaks directly to the race and technology discourse, in that GDS is a technological component that can be an incubator for inequalities for BIPOC. Mainly, residing within a GDS service area is only one type of accessibility for grocery deliveries of which there are at least four access barriers. First, as clarified, residents must be geographically situated where a GDS provides

service, but, in addition to this, they must be geographically situated to access the internet. Second, accessibility also means being able to afford to purchase internet services and the extra costs of GDS. While this study cannot speculate on results related to additional costs of GDS services as it relates to food securities, there have been many tangential studies connecting service costs as a barrier resulting in unfavorable health outcomes. For example, Tate et al. (2009) provide a meta-study of the cost-benefit analysis of internet access related to health outcomes, among many of which discuss internet fees concerning health care costs. Within their study, the authors report how internet access fees and other access barriers that were monetized could mitigate the costs of health care through preventive measures (Tate et al. 2009).

The remaining two access barriers relate to knowledge and further bolster the discourse related to race and technology. First, community members must have the knowledge that GDS exist as an available service. And finally, community members must have knowledge in how to use GDS websites and software applications, including the navigation of any language barriers. Parallel studies have highlighted this as a principal mechanism for utilizing services. Villagra et al. (2019) investigated health insurance plans and identify how terminology, "use rules," or billing can often create access barriers due to their difficulty in navigating health plans. Their study cites how accessibility issues were conflated for low-income, racial and ethnic minoritized populations possibly due to language barriers and fear of additional financial burdens (Villagra et al. 2019). Like these studies, GDS depends not only on geographical access but knowledge in the existence, usage, and trust of the software platforms.

The avenues of accessibility to GDS service areas are related to social determinants of health. The most predominant factor is that food deserts are a product of neighborhood effects that directly affect social determinants of health. Yet, accessibility to GDS have several additional aspects that require addressing and, in many cases, are related to payments and fees. As of the *2018 Farm Bill*, GDS are required to take SNAP and WIC, commonly referred to as food stamps (Meyersohn 2020); however, this has been slow to roll out. Amazon currently accepts food stamps for all their delivery service areas nationwide, however, the annual cost for an Amazon Prime membership is $119. With an Amazon Prime membership, customers have access to grocery delivery at Whole Foods Market for an additional $9.99 for a $35 minimum order. As well, the costs for staple items like milk and poultry cost relatively more when compared to local chain supermarkets. These fees can quickly add up. A similar subscription model has been adopted by Walmart for $12.95 per month, or $98 annually. Called Walmart+, their company delivers groceries exclusively through their department store. Likewise, many local grocery chains offer delivery services with a $35 minimum grocery order and a $9.99 fee per delivery, examples within California include Kroger and Albertsons. Instacart, a same-day, on-demand GDS, partner with hundreds of local markets and has multiple fees. Potential policies could be created to subsidize or waive delivery fees for all GDS, including membership fees, to provide low-income households access to GDS at no additional cost. As well, grocery delivery services do not currently accept cash. They require a credit card, which oftentimes requires a social security card. Especially important for undocumented immigrants or individuals that lack “proper” credit ratings

who oftentimes cannot acquire a credit card, the lack of accepting cash is another barrier for marginalized populations to make use of GDS. Policies should be created to implement a cash-based system to pay for groceries. Future studies can explore these options and their effectiveness in promoting the use of available GDS.

The COVID-19 pandemic has created additional public health and economic crises around the globe and the virus continues to threaten lives. The most vulnerable individuals are seniors, people of color, and those with a high risk of chronic diseases (CDC 2020a). As well, the pandemic has exposed considerable cracks in our nation's food system with 1 in 7 Americans now facing food insecurities (Feeding America 2020). GDS have the potential to mitigate health-related impacts from COVID-19. The absence of healthy and affordable food has disastrous effects on health and impact human capital and the economy (Stronks et. al. 1998; Hendrickson, Smith, and Eikenberry 2006; Beaulac, Kristjansson, and Cummins 2009). Utilizing GDS mitigates one's exposure to the COVID-19 virus because community members are not physically entering public spaces where they may be in contact with the virus. Current research has extrapolated that low-income, people of color are more at risk of severe illness and death connected to the virus (CDC 2020), thus, exposure must be minimized. For this reason, subsidies for membership fees, service fees, and cash payments might allow grocery delivery services to become an available avenue for all demographics to increase their overall well-being as it pertains to their health. Additional marketing strategies to promote GDS aimed at community members within food deserts might implemented to encourage service utilization.

LIMITATIONS

This research aims to expose the barriers which low-income and people of color have in utilizing grocery delivery services by understanding the barriers in utilizing grocery delivery services. However, this study is limited to only showcasing the service areas and total populations served by GDS. Additional research is required to understand if low-income and communities of color are currently utilizing GDS. This includes learning if community members can acquire internet access, afford internet services, afford the extra costs of GDS, have knowledge that GDS exist as an available service, and can use GDS websites and software applications. History has proven that inequalities tend to reproduce themselves. GDS has the potential to create equal access to healthy food among all community members, but further research is needed to uncover that pathway.

In addition to the research design limitations, this study has several issues with the data. For one, this study draws from United States census data which has several limitations regarding race and ethnicity. As an example, the Asian demographic is considered one race, rather than providing options to fully classify the multiple ethnicities represented under the Asian umbrella. Also, Latinx is an ethnicity on the US census (called Hispanic or Latino) that is not mutually exclusive to racial demographics. The census does not explain how Latinx individuals self-identify their race. Future studies should consider using a data source that articulates race and ethnicity with more nuanced detail.

As well, the USDA variable for urban areas could be more discretely defined. Urban areas, defined by census blocks, can be highly segregated and, as a limitation, we cannot know some information with certainty beyond the block data. As an example, most neighborhoods throughout the US are highly segregated by race. A census block may be segregated and when defined within the data, cannot discretely point out the accurate racial demographics when creating the polygons for analysis.

Additionally, defining the areas into racial categories based on plurality meant excluding large populations within an area. Oftentimes, as an example, an area would have a high total count of an underrepresented racial group but would be less than the total count of the white demographic. As a result, the white racial group received a larger total count of the overall areas within the sample. This would undervalue other underrepresented racial groups. A solution for this would be to repeat this study several times, with differing definitions for defining the racial demographics of the areas to add further context.

The GDS data for this study were collected in August and September 2020. This period is a major limitation of this study. With the development of the Coronavirus-19, there has been an ever-increasing surge in the popularity of using GDS. This is causing a shift in the landscape of grocery delivery service areas, as the GDS aims to reach more customers. This study could have been improved with data collected pre-pandemic to establish a baseline. A longitudinal design with data points before and during the Covid-19 pandemic would highlight how the pandemic has changed the service areas of GDS.

Another limitation within the GDS variable is related to the Amazon data. This study collected the zip codes for the delivery areas of Amazon Prime (serviced by Whole Foods Market) neglecting to identify the delivery services for Amazon Fresh. As an oversight, the research team learned that Amazon Fresh and Amazon Prime are two different entities serving communities throughout the state of California months after the data collection phase of this study. Future research should include Amazon Fresh in addition to Amazon Prime to provide a more accurate depiction of the company and its service areas.

Finally, multiple analyses are missing from this study. Mainly, all demographics by total population count with food deserts as the subset are not included within this study. This was an oversight that was identified at the end of the research process. Further research is required to complete the study and create a consistent analysis of the data. This also includes the rural variable by area for each area-type and the rural variable for each area-type with food deserts as the subset. The next draft of this study will primarily focus on the total population counts of individuals throughout California that are served by GDS, live within food deserts, and explicate the racial and ethnic demographics, and urban versus rural nuances, while simultaneously minimizing the results regarding spatial areas. New research questions will be formulated for the next draft of this study so that the true nature of this study's purpose will be fulfilled. Additionally, special attention will be given to the most vulnerable areas throughout California, such as trial lands and unincorporated areas.

CONCLUSION

This paper highlights the impact of grocery delivery services across communities of California. By examining the characteristics of underserved spatial areas, this research contributes to the discourse surrounding food insecurities. Grocery delivery services are changing the landscape of food deserts, providing a valuable community resource: access to healthy and nutritious foods. However, specific demographics are underserved, primarily rural areas. History has also demonstrated the ways technology creates inequalities for people of color. While this study has exposed how neighborhoods defined as food deserts by the USDA are now being served by grocery stores, further research is required to understand the extent to which food insecure populations are using these services and are provided access to these services. Thus, accessibility to GDS is understood through four points. One, community members need to be geographically situated where a GDS provides service in addition to having internet access. Second, community members must be able to afford internet services and the extra fees related to GDS. Third, individuals must know that GDS exist as an available service. And finally, individuals must have working knowledge in using GDS websites and software applications. Policies are required to address these barriers to using grocery delivery services to provide more equitable health outcomes for all racial and ethnic demographics. Residing within a GDS service area may only partially determine health, and accessibility to GDS must be explored through additional avenues.

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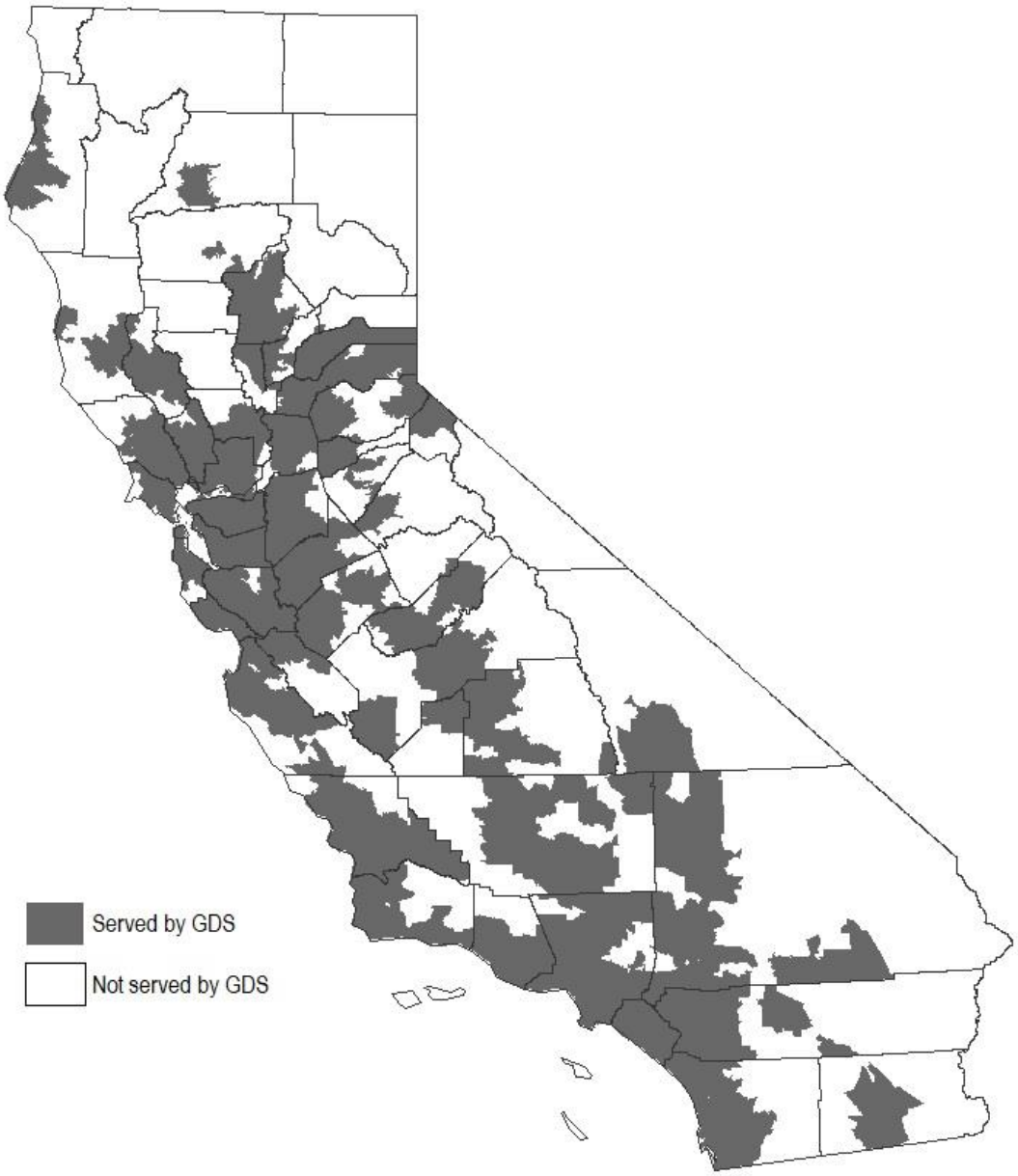

Figure 4. *Areas of the state that are served by GDS and not served by GDS*

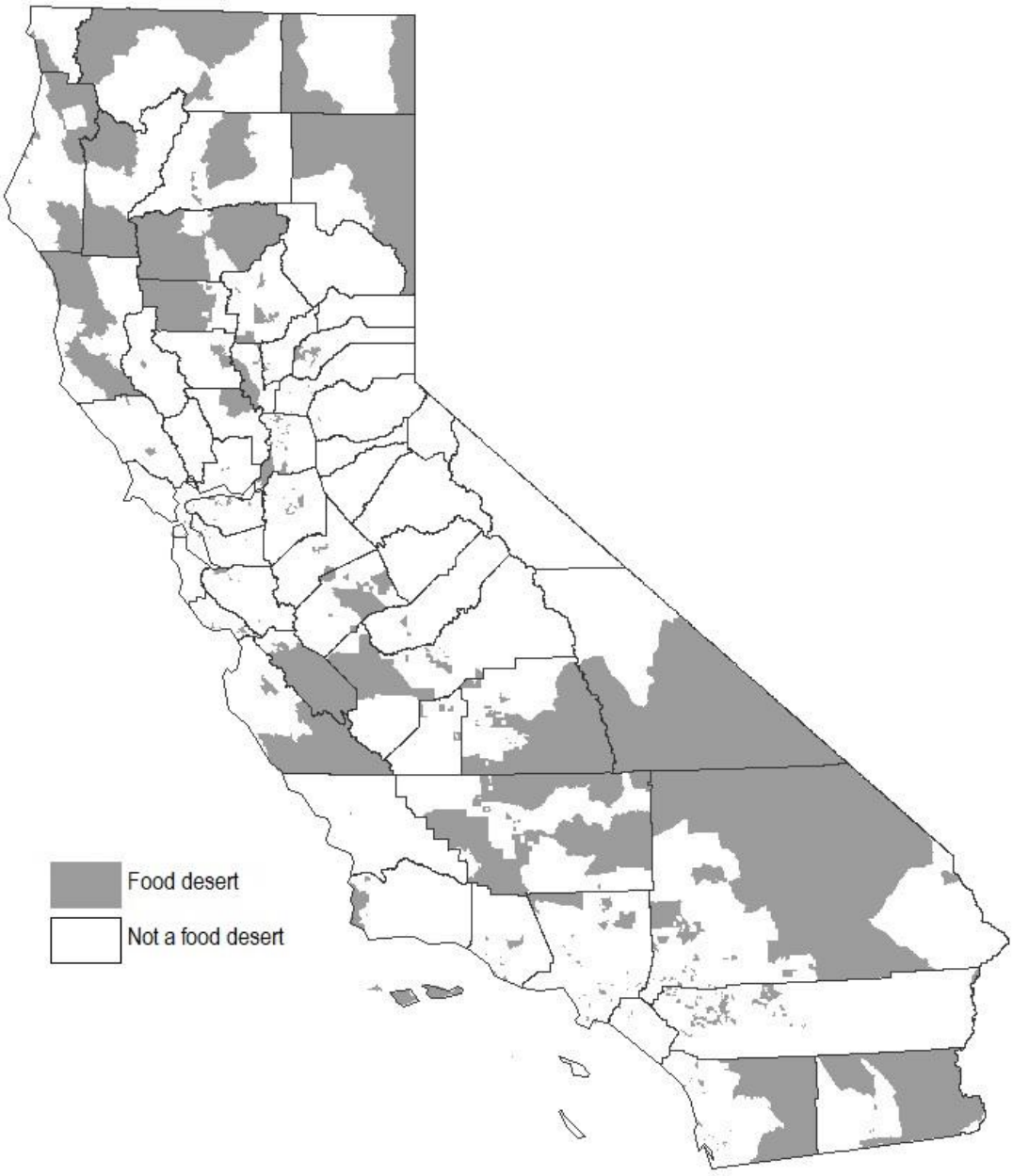

Figure 5. *Areas of the state that are food deserts and not food deserts*

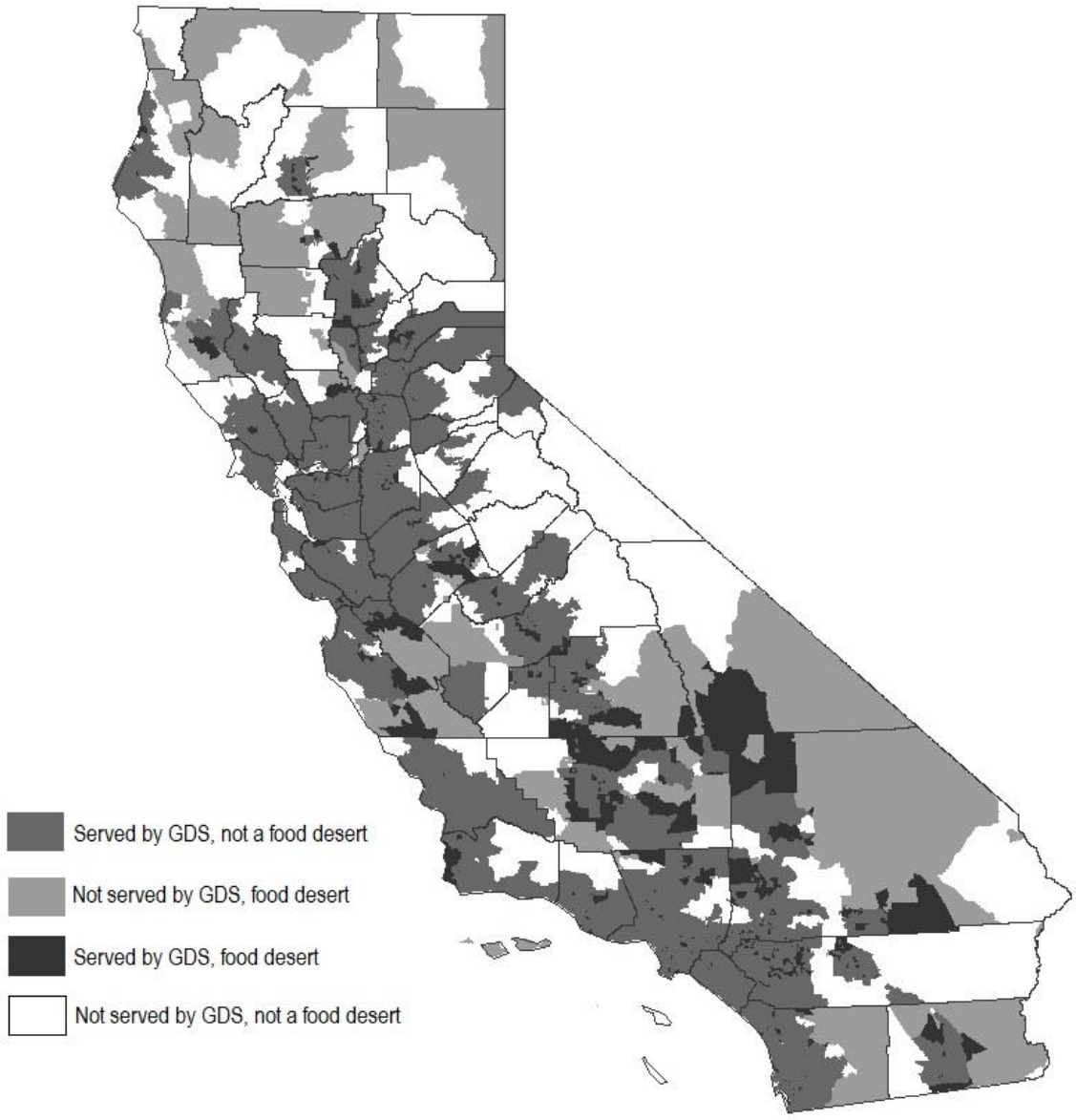

Figure 6. *Areas of the state by area type: Overlap between GDS and food deserts*

GDS Company	State-wide Coverage by Area	Total Population Served	Food Desert Residents Served
Instacart	28.39%	91.1%	80.8%
Albertsons	18.03%	87.6%	55.2%
Walmart	16.07%	75.1%	70.9%
Kroger	16.00%	78.4%	57.1%
Amazon Prime	7.02%	61.8%	25.9%
TOTAL	**35.73%**	**96.3%**	**88.2%**

Table 1. Descriptive statistics by GDS company*: The left column is state-wide coverage by area. It highlights the spatial areas served by GDS across the state. The two columns on the right are according to population. The middle column displays the percent of Californians served regardless of where they reside. The right-most column displays the percent of Californians served who reside within food deserts.*

	Food Desert	Not Food Desert	Total
Served by GDS	6.56%	29.18%	35.74%
Not Served by GDS	28.21%	36.05%	64.26%
	34.77%	65.23%	100%

Table 2. *By Spatial Area: Percentage of the state by area type: GDS and food deserts*

	Black plurality	Asian plurality	Indigenous plurality	Multiple-Race plurality	White plurality
Served by GDS and Food Desert	14.69%	0.76%	0.00%	21.77%	6.13%
Served by GDS and Not Food Desert	85.31%	99.24%	0.00%	24.29%	28.98%
Not Served by GDS and Food Desert	0.00%	0.00%	0.00%	2.93%	29.16%
Not Served by GDS and Not Food Desert	0.00%	0.00%	100.00%	51.01%	35.72%

Table 3. By Spatial Areas: Percentage of each area racial composition type in each GDS-food area type. *This table displays the percentage of spatial areas for each racial demographic. The areas are defined according to the plurality of the racial group. For example, 100% of the areas where residents identify as Indigenous demographic more than any other demographic are reported as not living in a food desert or served by GDS.*

	Black	Asian	Indigenous	Multiple-Race	White
Served by GDS and Food Desert	8.05%	3.04%	8.88%	8.14%	6.16%
Served by GDS and Not Food Desert	90.34%	96.25%	80.25%	88.55%	89.34%
Not Served by GDS and Food Desert	0.43%	0.11%	2.75%	0.83%	1.03%
Not Served by GDS and Not Food Desert	1.18%	0.61%	8.12%	2.49%	3.47%

Table 4. By Population: Percentage of each racial sub-population in each GDS-food area type. *For example, of the total individuals across the state of California that identify as Black, 8.05% are served by GDS and reside within a food desert.*

	Latinx
Served by GDS and Food Desert	8.18%
Served by GDS and Not Food Desert	88.65%
Not Served by GDS and Food Desert	0.80%
Not Served by GDS and Not Food Desert	2.37%

Table 5. *By Population: Percentage of Latinxs in each GDS-food desert area type*

	Urban	Rural
Served by GDS and Food Desert	6.15%	2.48%
Served by GDS and Not Food Desert	84.99%	68.01%
Not Served by GDS and Food Desert	0.49%	4.66%
Not Served by GDS and Not Food Desert	0.93%	24.84%

Table 6. *By Population: Percentage of urban versus rural population in each GDS-food desert area type*