NEIGHBORHOOD COMPOSITION AND COMMUNITY GARDEN LOCATIONS: THE EFFECT OF ETHNICITY, INCOME, AND EDUCATION

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ABSTRACT

Community gardens provide food, health, and sustainability benefits to surrounding communities. Research demonstrates that low-income or ethnic-minority communities develop gardens to resist divestment and provide access to healthy food, whereas white or highly-educated communities develop gardens to address local sustainability concerns. Missing from this discussion is a comprehensive picture of the relationship between neighborhood composition and community garden locations. Using GrowNYC and GreenThumb's 2014 survey of New York City community gardens, this study employs negative binomial and spatial regression methods to examine this relationship. Findings reveal increased numbers of gardens in communities with higher aggregate concentrations of: 1. black and/or Latino residents, 2. lower-income residents, and 3. well-educated residents, regardless of ethnicity or income. In keeping with qualitative research on motivations for garden development, this study provides crucial quantitative metrics suggesting the diversity of neighborhoods with community gardens and supports their inclusion in urban public policy and city planning.

KEYWORDS

Food Systems; Community Gardens; Environmental Sustainability; Race/Ethnicity; Class Inequality

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INTRODUCTION

Urban community gardens, cooperative endeavors that provide resources for people to collectively cultivate food (Lawson 2005:3), can provide food access and health benefits for individuals and communities alike. Community gardens help shape local food environments by providing a supply of fruits and vegetables to garden participants, and, through the sharing of garden produce with families and neighbors, improve community food access (Corrigan 2011; McCormack et al. 2010). Beyond food access, which itself has a modest impact on overall health (Cummins and Macintyre 2002, 2006; Kirkpatrick and Tarasuk 2009; Wang et al. 2007), researchers observe a wide range of health benefits associated with community gardens (Alaimo et al. 2016; Draper and Freedman 2010; Teig et al. 2009; Zoellner et al. 2012). Community gardens funded through California Healthy Cities and Communities increased participants' physical activity (Twiss et al. 2003). In San Francisco, community garden participation is included in rehabilitation programs for those with mental illness or learning disabilities (Ferris, Norman, and Sempik 2001). Community gardeners in Denver, Colorado, reported community-level benefits stemming from social connections, reciprocity, trust, collective decision-making, and civic engagement (Teig et al. 2009). Similarly, collective efficacy contributed to Latino community activism in several predominately Latino neighborhood gardens in New York City (Saldivar-Tanaka and Krasny 2004). Community gardens also improve community visual appeal and walkability, increase open and green space for physical activity, and create opportunities for educational and job-skill training within their communities (Draper and Freedman 2010; Ferris et al. 2001; Voicu and Been 2008; Wakefield et al. 2007).

While the contributions of community gardens to health, food access, and local sustainability efforts are consistently demonstrated (Alaimo et al. 2016; Draper and Freedman 2010; Teig et al. 2009; Zoellner et al. 2012), what remains overlooked is the geographic location of community gardens more generally. This is due in part to the place- and community-based, nature of community garden development, including the heterogeneity of communities involved. As Lindsay Campbell (2017:114), in her recent in-depth qualitative case study of urban forestry and agriculture in New York City, explains, community gardening "is not comprised of a single, narrow constituency, but rather of diverse sets of people interested in managing urban land and changing the food system and their role in it from different vantage points." Because social, political, institutional and organizational factors combine with physical space to shape the emergence and location of gardens differently, the development, growth, and impact of community gardens is difficult to decipher and is further complicated by the dearth of quantitative research on these outcomes (Campbell 2017:3).

In New York City (NYC), qualitative research and citizen science have contributed empirical insights into the impact and location of community gardens (Campbell 2017). Though the number and variety of community garden types and participants is vast, much of this research has focused on and revealed evidence of two distinct trends in NYC: an older body of research has focused on community gardens located in poor and/or minority communities, to resist disinvestment and improve food access and health (Armstrong 2000; Campbell 2017; Martinez 2010; Mundel and Chapman 2010; Reynolds and Cohen 2016; Saldivar-Tanaka and Krasny 2004; White 2017), whereas a newer body of research has focused on the rise of the new urban agriculture movement embraced by predominately white, educated, and middle class communities, aimed at revamping local food systems and addressing sustainability concerns (Aptekar 2015; Campbell 2017; Cohen et al. 2012; Kato, Passidomo, and Harvey 2014; Reynolds 2015; Reynolds and Cohen 2016).

Persistent inequality in the retail food environment has been observed in neighborhoods with higher rates of black/Latino or low-income residents, contributing to adverse health and food access impacts (Leclere, Rogers, and Peters 1998; Miller, Middendorf, and Wood 2015). In NYC, a substantial proportion of low-income black and Latino residents have responded to such geographic inequalities by participating in the community garden movement that began in the 1960s and which continues to this day (Campbell 2017; Cohen et al. 2012; Martinez 2010; Reynolds and Cohen 2016). Their participation is understood as a historically rooted effort to resist privatization of land and disinvestment in public space by collectively growing produce in their own communities (Campbell 2017; Cohen et al. 2012; Martinez 2010; Reynolds and Cohen 2016).

In contrast, renewed attention for community garden development has emerged over the last two decades (Campbell 2017). This recent trend is motivated by a broad interest in transforming the food system by “voting with your dollar” campaigns aimed at producing food closer to home. This movement is associated with white, middle class and highly educated community residents (Campbell 2017; McClintock 2014; Pearsall and Anguelovski 2016; Sbicca and Myers 2017). In NYC, this effort is exemplified by formalized non-profit and entrepreneurial urban agriculture ventures that showcase technologies like roof-top gardens and aquaponics (Campbell 2017; Cohen et al. 2012; Reynolds 2015; Reynolds and Cohen 2016). Research suggests that the demographic makeup of gardeners involved in this movement may shape who "belongs" in the garden or its constitution – for example, white and well-educated newly arrived residents of an ethnically-diverse community may be more likely to participate or take an active role in shaping local community garden development, goals, and outcomes, including political narratives and regulating use of space within gardens (Aptekar 2015; Kato et al. 2014). Within one NYC community garden the "green space vision" supported by this more privileged subgroup consistently dominated those held by ethnic minority gardeners, which included a consideration of the garden as a farm or as a compilation of private gardens. Consequently, individual gardener autonomy and food production was sacrificed to improve the aesthetics of the green garden space (Aptekar 2015).

When considering the contributions of community gardens on geographic food access or local sustainability efforts, the location of community gardens is particularly salient because prior research suggests that community gardens are established in different types of communities for these express purposes (Drake and Lawson 2015; Hinrichs and Lyson 2007). Moreover, community gardens have been identified as a cost-effective, egalitarian strategy to accomplish diverse but community-specific goals, as they are inexpensive to develop, maintain, and join (Lawson 2005; Surls et al. 2001). One representative community garden starting guide recommends charging $32 per year to cover their costs(Surls et al. 2001). Some community gardens can be built for as little as $2,500-$5,000, or even less with support and supplies donated from local businesses (Surls et al. 2001).

The literature, however, presents a somewhat bifurcated understanding of the demographic composition of urban communities with geographic access to community gardens: community gardens are either located in primarily low-income and/or black and Latino communities, to remedy food access and as a form of resistance (Armstrong 2000; Campbell 2017; Martinez 2010; Mundel and Chapman 2010; Reynolds and Cohen 2016; Saldivar-Tanaka and Krasny 2004; White 2017), or predominately non-Hispanic white and/or highly-educated communities, in their efforts to achieve local sustainability through urban agriculture (Aptekar 2015; Campbell 2017; Cohen et al. 2012; Kato et al. 2014; Reynolds 2015; Reynolds and Cohen 2016). Though the research has convincingly demonstrated different motivations for community garden development in these distinct communities, with observed benefits (Aptekar 2015; Campbell 2017; Cohen et al. 2012; Kato et al. 2014; Reynolds 2015; Reynolds and Cohen 2016; Saldivar-Tanaka and Krasny 2004; White 2017), this research often employs qualitative methods to examine such cases, which may include small groups of gardens (Aptekar 2015; Saldivar-Tanaka and Krasny 2004) or communities (Kato et al. 2014; White 2017). Missing from this research is a comprehensive understanding of the extent to which community gardens are systematically located in such communities.

This study examines how the demographic composition of communities in New York City (NYC), as measured by ethnic-minority concentration, income, and education, separately, affects the number, location, and founding year of community gardens. This study offers one of the first systematic analyses of community garden locations to provide a more complete understanding of the relationship between neighborhood composition and garden locations, and to offer preliminary evidence of how two separate trends may jointly shape the landscape of community gardens in New York City. Understanding the relationship between neighborhood composition and community garden locations is important for the future of community garden development and persistence in New York City, as the “lack of quantified metrics about the benefits of urban farming and community gardens” limits their consideration or inclusion in city planning and policy making (Campbell 2017).

THEORIZING COMMUNITY GARDEN LOCATIONS

Community Gardens, Food Access, and Social Inequality

Recent research has underscored the importance of the physical environment of a neighborhood on the overall health of its residents. For example, poor physical food environments disproportionately limit access to fresh fruits and vegetables in ethnic-minority and low-income communities (Gordon et al. 2011; Horowitz et al. 2004; McEntee and Agyeman 2010; Miller et al. 2015; Powell et al. 2007; Widener et al. 2013). Black and Latino households within such communities have less access to large grocery stores and supermarkets than predominantly white or higher-income households in their respective communities do (Chung and Myers 1999; Powell et al. 2007). While smaller grocery stores and bodegas provide some access to fresh food items in black, Latino, and low-income communities (Joassart-Marcelli, Rossiter, and Bosco 2017; Moore and Diez Roux 2006; Short, Guthman, and Raskin 2007), the fruits and vegetables found within tend to be of lower-quality and higher-cost than those found at larger supermarkets (Ball, Timperio, and Crawford 2009; Chung and Myers 1999). For example, a survey of neighborhoods in a city located in East Central New York revealed fewer and smaller retail food outlets in Latino as compared to other neighborhoods, contributing to a higher cost of fruits and vegetables in Latino communities (Lopez-Class and Hosler 2010).

Research has explored the potential role of community gardens in addressing food access in ethnic minority and low-income areas (Alaimo et al. 2008; Corrigan 2011; Saldivar-Tanaka and Krasny 2004). Saldivar-Tanaka and Krasny (2004) conducted a study of Latino community gardens across NYC neighborhoods and found community gardens provided access to high quality fruits and vegetables for participants, who also shared produce with community members. Gardeners reported that one community garden's development in their black, low-income community with a poor food environment in Baltimore, Maryland provided fresh fruit and vegetable access to gardeners and the broader community (Corrigan 2011). In Flint, Michigan, community gardens increased fruit and vegetable intake among both garden participants and their households (Alaimo et al. 2008).

Furthermore, some studies suggest that the development of community gardens in under-resourced areas represents a form of resistance by community members to combat the lack of fresh food in their communities (Campbell 2017; Cohen et al. 2012; Lawson

2007; Reynolds 2015; Reynolds and Cohen 2016; Saldivar-Tanaka and Krasny 2004; Taylor and Ard 2018; White 2017). For example, in South Central Los Angeles, a community garden was established in the early 1990s and maintained by over three-hundred families, most of whom were Mexican and Central American immigrants living in the surrounding community, to provide community members with the opportunity to grow their own food in the absence of retail food outlets (Lawson 2007). Likewise, and after the last major chain grocery store closed in one low-income minority neighborhood in Detroit, neighborhood residents worked together to create a community garden to improve their local food environment (White 2017). In NYC, in the 1960s and 1970s, the move of many white, higher-income residents to segregated suburbs left the city underfunded and spurred a grassroots movement among ethnic-minority and low-income residents unable to leave the city to resist public disinvestment in their communities by developing community gardens (Reynolds and Cohen 2016). These studies suggest that community gardens in poor and minority communities may serve to provide access to fresh food and in this way, function as a survival strategy to combat reduced government services and the decline in community wealth in the post-war era (Reynolds and Cohen 2016; Saldivar-Tanaka and Krasny 2004).

NYC community gardeners are made up of a complex network of actors with diverse sets of interests and reasons for supporting community gardens (Campbell 2017). In fact, Campbell (2017) argues that the complexity of the urban agriculture network in NYC, and it's lack of a main institutionalized central node, made the inclusion of urban agriculture, and community gardens, in the city's sustainability plan happen more slowly.

Instead, an urban forestry agenda dominated the first version of the plan, with the urban forestry network in NYC being less complex and centralized around the NYC Department and Parks and Recreation, a main actor in the development of the sustainability plan (Campbell 2017). Along with the concentration of the urban forestry network around a main institutional actor came its discursive alignment with the growth-oriented and competitive approach of the city's sustainability plan, with planting a million trees becoming a tangible and trackable sustainability goal for the city (Campbell 2017). In contrast, the diversity of interests in the NYC community garden and urban agriculture network has left room for more grass-roots and political resistive uses of community gardens across the city (Campbell 2017).

The use of community gardens to resist community disinvestment and provide food access suggests their salience and development in low-income and/or ethnic-minority concentrated communities (Campbell 2017; Cohen et al. 2012; Lawson 2007; Reynolds 2015; Reynolds and Cohen 2016; Saldivar-Tanaka and Krasny 2004; Taylor and Ard 2018; White 2017). Qualitative case studies and examples of gardens in black, Latino, and low-income communities support this assumption (Lawson 2007; White 2017). In NYC, community gardeners represent a diverse mix of ethnicities and class backgrounds, despite the systematic exclusion of minorities and poor people from accessing important city and non-profit resources (Cohen et al. 2012; Reynolds 2015; Reynolds and Cohen 2016). Overall, this qualitative research suggests an association between the location and availability of community gardens and the demographic makeup of communities – community gardens provide food access in low-income and black and Latino communities; however, this association has yet to be considered or assessed on a broad geographic scale.

Community Gardens, Sustainability, and the Local Food Movement

Recent trends associated with an increase in community garden development and participation reflect a focus on local food sourcing, sustainability, and environmental concerns. The considered use of community gardens to address local sustainability issues in urban areas is often associated with a particular subset of the population – individuals who are often highly-educated, middle class, and non-Hispanic white -- or what one community garden organizer described as “hipsters” (Campbell 2017:124). Their interest in community gardening is fueled by a broad and growing desire to promote a more sustainable and environmentally friendly alternative to the existing global food system (Campbell 2017; Gould and Lewis 2017, 2018). In fact, locavorism, or “an emphasis on eating locally or regionally” is a main driver of recent interest in community gardening among predominately white and well-educated communities (Campbell 2017:123). In a recent study where more than 70 percent of interview respondents from 28 different gardens across Denver, Colorado, a city that the most recent American Community Survey reports is over 75 percent white (American Community Survey 2017), identified as non-Hispanic white, this sustainable and environmental focus even had positive health impacts on garden participants themselves (Hale et al. 2011).

Education also plays a role in the establishment and maintenance of community gardens. Studies reveal the influence of college-educated Americans’ in shaping garden goals, outcomes, participant demographics, and even locations (Aptekar 2015; Kato et al.

2014). For example, within one community garden in New York City the "green space vision" supported primarily by white, highly-educated gardeners consistently dominated those held by ethnic minority gardeners, including the garden as a farm or as a compilation of private gardens; as a consequence, individual gardener autonomy and food production was sacrificed to improve the aesthetics of the green garden space (Aptekar 2015). Community garden leaders in positions to actively shape the visions and locations of community gardens have also been shown to have higher education rates as compared to non-leader participants (Troy D. Glover, Shinew, and Parry 2005). College-educated white outsiders even impacted the development of community gardens developed in New Orleans after Hurricane Katrina (Kato et al. 2014).

This newer vein of community garden interest played an important role in the insertion of specific urban agriculture goals, including the creation and support of community gardens across the city, in a revised version of the NYC's sustainability plan (Campbell 2017: 11). This represents a substantial advocacy win for urban agriculture and community gardening networks in NYC, and was aided by institutionalized entities outside of city government but within the complex urban agriculture network pressuring City Hall (Campbell 2017: 173). Campbell (2017) further argues that the entrepreneurial undertone of newer interest in community gardening for food system transformation plays a crucial role in gaining government and non-profit support because it is aligned with an institutional focus on growth and attraction of people and businesses to the city. With earlier trends in NYC community gardening focused more on resisting disinvestment and privatization of public space (Armstrong 2000; Campbell 2017;

Martinez 2010; Mundel and Chapman 2010; Reynolds and Cohen 2016; Saldivar-Tanaka and Krasny 2004; White 2017), fresh in the minds of policy-makers in the early 2000s, community gardening was not positioned as well to gain institutional support (Campbell 2017). Community gardens were incorporated into city-wide sustainability plans only after the movement's newer association with white, well-educated gardeners' interest in innovative sustainable farming options like hydroponics or greenhouses (Campbell 2017: 180). This highlights the importance of elite status of actors in the community gardening network for gaining access to public support and resources (Campbell 2017).

Aptekar (2015) demonstrates the transition to this newer understanding of community gardening in a diverse, but gentrifying neighborhood in NYC. The rules of their community garden were influenced by the white well-educated participants in an effort to demonstrate the garden's value to institutional actors with access to resources (Aptekar 2015). The gardeners, much like the surrounding community, represented a variety of ethnicities, income and education levels, and perspectives on what the garden should be; however, it was through the white well-educated gardeners' emphasis on maintaining an orderly green space that the garden gained support from institutions like the Parks Department (Aptekar 2015). Despite resistance to the new rules among non-white gardeners, institutional support helped legitimize this newer understanding of the garden meaning (Aptekar 2015). It follows then, that newer gardens, for example those 129 included as a goal in the revised city sustainability plan (Campbell 2017: 11), are likely to be located in white and well-educated communities where the growth goals of the city may resonate more with residents, and stories of resistance like Aptekar (2015) depicts can be avoided.

The rise in sustainability and environmental concerns and the value placed on these issues more broadly contributes to what Gould and Lewis (2017:35) call the "green growth machine," or green gentrification. According to this framework, while the development and restoration of green spaces, including community gardens, benefits local environments and communities, it also legitimizes increases in the cost of housing. This phenomenon provides an opportunity for investors to profit from reselling property in these communities to newcomers, who are often non-Hispanic white, and who possess the substantial resources necessary to pay higher prices. Such practices often lead to displacing long-time residents of color from these areas (Gould and Lewis 2017). Green gentrification demonstrates the unequal power dynamics that could easily lead to higher rates of community gardens, especially newer gardens, in white or gentrifying communities.

Further, as noted in a report of Five Borough Farm, a NYC project of the Design Trust for Public Space, white and well-educated community gardeners have greater access to resources and support that facilitate garden tenure when compared to gardeners in lower-income and ethnic minority communities (Cohen et al. 2012). Specifically, these more privileged gardeners leverage their connections to those in power to take advantage of existing resources more quickly and successfully than their under-resourced counterparts (Cohen et al. 2012). Reynolds and Cohen (2016) argue that increased access to resources is reinforced through mass media's disproportionate attention towards white middle-class gardeners. Media outlets consistently depict urban farming and community gardening as part of this white and well-educated food movement while overlooking the long-standing use of gardens among ethnic-minorities and the working-class to resist inequalities (Reynolds and Cohen 2016). The increased public investment this newer trend has received paints a distorted picture of who participates in community gardening in NYC, with non-white working-class gardeners and their communities being disproportionately ignored (Cohen et al. 2012; Reynolds 2015; Reynolds and Cohen 2016). Given the increased elite positionality and subsequent access to resources of the newer, white, well-educated vein of community gardeners in NYC (Aptekar 2015; Campbell 2017; Cohen et al. 2012; Kato et al. 2014; Reynolds 2015; Reynolds and Cohen 2016), it makes sense that community gardens, especially newer community gardens, would be located in white and well-educated communities.

In sum, existing literature documents the long-standing use of community gardens to resist neighborhood inequalities by providing access to healthy fruits and vegetables in poor and minority communities (Armstrong 2000; Campbell 2017; Martinez 2010; Mundel and Chapman 2010; Reynolds and Cohen 2016; Saldivar-Tanaka and Krasny 2004; White 2017). Research has further documented the emergence of a newer trend in community gardening associated with local sustainability concerns, which appeals to predominately white, well-educated, and well-resourced communities (Aptekar 2015; Campbell 2017; Cohen et al. 2012; Kato et al. 2014; Reynolds 2015; Reynolds and Cohen 2016). When taken as a whole, this prior research suggests community gardens are located in either low-income, ethnic minority neighborhoods or predominately white and educated communities, while meeting the different needs of each; however, because this research overwhelmingly examines small case studies using qualitative methods, the extent to which community gardens are established or located in these communities as implied by these trends remains understudied. A wealth of qualitative research suggests the utility of community gardens to address food access, health, and local sustainability issues; yet, a comprehensive and systematic picture of the number and location of community gardens is missing.

This study provides the first quantitative examination of community garden locations to provide this much needed information. Specifically, this study investigates 1) the relationship between the number and location of community gardens within New York City (NYC) and neighborhood composition by ethnicity, income, and education; and 2) the relationship between garden founding year and neighborhood composition. In keeping with qualitative research on food access and local sustainability, the first analysis reveals the extent to which community gardens are located in either low-income, ethnic minority communities or predominately white, well-educated communities, or both. The second analysis provides evidence of age of the garden in a given location, to capture newer trends associated with local sustainability and the green growth machine framework. Finally, findings may contribute to a better understanding of the degree to which community gardens make up part of the local food and health environment of communities by ethnic concentration, income, and education.

DATA AND METHODS

Setting

New York City (NYC) has a rich and well-documented history of community garden development. Community gardens within NYC have been shown to foster community building and support in disadvantaged areas, and have been used materially and symbolically to resist the privatization of public space that has occurred in NYC since the 1970s (Eizenberg 2012; Hassell 2002; Smith and Kurtz 2003). For example, resistance to the city closing over 100 community gardens for economic development ventures resulted in protections for community gardens, including a special hearing preceding the sale of any garden land (Eizenberg 2013; Hassell 2002; Smith and Kurtz 2003). Community gardens in NYC have served as "participatory landscapes" where community development, open space, and agriculture production intertwine with cultural preservation (Saldivar-Tanaka and Krasny 2004), and have promoted diversity and inclusion while serving as spaces of resistance (Eizenberg 2012), even in rebuilding communities after the major natural disaster of Hurricane Sandy in 2012 (Chan, DuBois, and Tidball 2015).

New York City also provides a prime site for studying the association between neighborhood composition and community garden locations because of the diversity of its population. NYC has substantially higher rates of both black and Latino residents than the U.S. overall (Table 1). Table 1 provides some demographic details of the city and the areas within the city with community gardens. Median household income is lower in NYC ($50,285) than the national average ($51,914). The city also has higher rates of residents with at least a bachelor's degree (33%) than the national average (28%). Table 1 indicates that census tracts within the city that have at least one community garden have higher rates of ethnic minorities (35% black, 38% Latino) than average within NYC (26% black, 29% Latino). Further, census tracts with at least one community garden have lower rates of education (26% have at least a bachelor's degree) and lower median household incomes ($41,525) than the city at large.

Table 1 about here.

Data

This study uses robust data collected by GrowNYC, a non-profit organization focused on improving quality of life throughout NYC, and GreenThumb, part of the city's parks department focused on community gardens (GrowNYC 2014; NYCParks 2017). GrowNYC and the NYC Parks Department maintain a comprehensive database of community gardens within the city to document, support, and sustain them (GrowNYC 2014; NYCParks 2017). This information is publicly available and, because registered gardens receive some tenure protections (Eizenberg 2012; Smith and Kurtz 2003), it provides unusually high-quality data on NYC community gardens, including those not affiliated with formal organizations. This data collection is supported by the Compton Foundation, and researchers and staff from the New York State Department of Agriculture and Markets and from Hunter College. Data used in the present study were last updated in 2014. All demographic and spatial data were sourced from the 2010 US Census.

This study uses NYC community garden and census tract data to model community garden locations and the relationship between a garden's founding year and its neighborhood demographics. I used R and ArcGIS to create a spatial dataset including my outcome, predictor, and control measures along with information on the physical location, size, and shape of each census tract. I excluded census tracts for which the U.S. Census did not have demographic data available (56 out of 2,194 census tracts). I also excluded census tracts which had no neighboring census tracts (5 out of 2,194). As only 2-3 percent of my data was missing for this first analysis, I used list-wise deletion to handle missing data. My final analyses of garden locations included 2,133 census tracts with 547 gardens distributed across them. For my analysis of garden founding year, I also excluded gardens with missing information about their founding year (59 of the 547 gardens). Although this is almost 11 percent of the remaining data, I again used list-wise deletion, because these observations were missing for a main variable of interest. My final sample for this second analysis had a total of 488 gardens.

Measures

Number of Community Gardens. I use the number of community gardens located within each census tract as a measure of community garden location and availability. I created this variable by spatially joining, in ArcGIS, the dataset of community gardens in NYC with census tract data, then using STATA and R to calculate the total number of gardens within each tract. The number of community gardens ranged from 0 to 10, with a mean of .26.

Ethnicity. I examined non-Hispanic black and Hispanic/Latino ethnic minority groups, as these ethnic categories are often discussed in the literature on the food system, local food programs, and community gardens (Alkon and Norgaard 2009; Guthman 2008; Slocum 2006, 2007). Though mostly not reported[1], I also considered non- Hispanic white as an additional racial/ethnic category. Each of these three variables represents the percent of residents in each census tract identified in the U.S. census as 1) non-Hispanic black (herein black), 2) Hispanic (herein Latino), and 3) non- Hispanic white (herein white). Rates of black residents ranged from 0 to 100, with a mean of 24.87; rates of Latino residents ranged from 0 to 100, with a mean of 26.08; rates of white residents ranged from 0 to 100 with a mean of 34.12.

Income was measured as median household income of each census tract, consistent with previous research on food deserts and alternate food outlets (Chung and Myers 1999; Miller et al. 2015; Powell et al. 2007). This variable is reported in $1,000 increments; it ranged from $8,694 to $232,768, with a mean of $55,031.

Education. Previous work suggests that "food deserts" overlap with "education deserts" in addition to low-income areas (Brown and Brewster 2015; Morton and Blanchard 2007). Further, community garden participants may usually be more educated, suggesting education may be an important driver of garden locations on a broader scale. Answering Brown and Brewster's (2015) call for more complex understandings of the food environment in food access research, I consider education in these analyses. This variable represents the percent of residents of each census tract that have a bachelor's degree or more education. Education rates ranged from 0 to 100, with a mean of 30.61.

Garden Founding Year is measured by the founding year of the gardens, as reported in the GrowNYC community garden dataset. The founding years of the gardens ranged from 1970 to 2014 (garden ages 44 to 0 years), with an average of 1991 (garden age of 23 years). Over half of the gardens were founded between 1978 and 1997, making their ages between 36 and 17 years, and about 15% were founded between 2000 and 2014, making their ages between 14 and 0 years.

Total Population of the census tracts may affect the number of gardens located there and garden tenure. It follows logically that there may be more gardens, and that those gardens may persist for longer, in census tracts with more people to organize and participate in them. This measure represents the total number of people residing in each census tract. Total census tract population was measured in 1,000 increments, and ranged from 26 to 25,199, with a mean of 3,831.

Analysis

For my first set of analyses predicting the number of community gardens in a zip code, I used two different statistical techniques[2]: negative binomial logistic regression (Table 2) and spatial regression (Table 3). For both techniques, my predictor variables were black, Latino, income, and education, and I controlled for total population. I also tested interactions of each ethnicity variable and income, and of each ethnicity variable and education, as well as the interaction of education and income (Tables 2 & 3). Only interactions of education and income, income and percent black, and education and percent black were significant, and only in the negative binomial models.

Negative binomial logistic regression fits the non-normal distribution of my outcome variable (number of community gardens) which is a count variable with a lower mean (.26) than variance (.68).[3] However, spatial regression accounts for the spatial autocorrelation of NYC community gardens for which the negative binomial model was unable to fully control. The spatial autocorrelation of gardens refers to the likelihood of gardens being clustered across space (as seen in Figures 1.1-1.4). Community gardens may be clustered due to reasons outside the scope of the present study, including soil quality, zoning, or land-use regulations.[4] But gardens could also be clustered simply due to exposure, given that ideas can spread spatially (Goodchild et al. 2000). While the starting of a new garden comes with challenges, including access to resources and social capital (Cohen et al. 2012; Reynolds 2015; Reynolds and Cohen 2016), simply knowing a community nearby has a garden may inspire someone to start another. A spatial error model, which uses a matrix of information from neighboring census tracts to control for geographic clustering, accounts for potential biases due to these factors (Ward and Gleditsch 2008).

Figures 1.1 through 1.4 about here

A Moran's test, which measures spatial autocorrelation (Ward and Gleditsch 2008), run on the residuals from the full negative binomial regression model produced a highly significant Moran’s I of .045. The Moran’s I for negative binomial models including interactions ranged from .034 to .085 with consistent significance at the .01 level. These indicate that there was spatial autocorrelation in the dataset not explained using negative binomial regression.

I used fully standardized ordinary least squares spatial error model, to control for this spatial autocorrelation and examine the relationships between my outcome and predictor variables more accurately. Moran's tests on the residuals from the spatial error models yielded Moran's Is that were close to zero and no longer significant, indicating that the spatial autocorrelation was adequately controlled for.[5] However, the log-likelihood measures were larger and the AIC measures were smaller for the negative binomial models, suggesting their superior overall fit for these data.[6]

For the analysis of the relationship between garden founding year and neighborhood demographics, I constructed five separate models, each using the main predictor variable of the founding year of the garden. The first three models, reported in Table 4, predicted 1) percent black, 2) percent Latino, and 3) percent white. For these models, I used negative binomial models, as this technique best fits the non-normal distribution of these outcome variables. Each has a mean ($Mean_{black}$ = 24.87; $Mean_{Latino}$ = 26.08; $Mean_{white}$ = 34.12) substantially lower than its variance ($Variance_{black}$ = 932.65; $Variance_{Latino}$ = 530.67; $Variance_{white}$ = 1002.20). For these models I controlled for income, education, and total population. The last two models, reported in Table 5, predicted 4) income and 5) education rates. For these models, the outcome variables were close to normally distributed, allowing me to use ordinary least squares regression. For these analyses, I controlled for black, Latino, income (for the model predicting education), education (for the model predicting income), and total population.

RESULTS

Ethnic Minority Concentration and Community Garden Locations

Table 2 shows the odds ratios from the negative binomial regression model predicting the number of community gardens in each census tract in NYC. Overall these results show that communities with higher concentrations of ethnic minority residents have more gardens. A one-point increase in the percent of non-Hispanic black residents in a census tract is expected to yield an increase in the number of community gardens located there by a factor of 1.034 or 3.42 percent ($P < .001$), controlling for Latino residents, income, education, and total population. Similarly, a one-point increase in the percentage of Latino residents is expected to yield an increase in the number of gardens by a factor of 1.034 or 3.45 percent ($P < .001$), holding all else constant. For example, census tracts with 80 percent of the population identifying as non-Hispanic black are expected to have, on average, approximately 1 more garden than census tracts with a 20 percent black population, holding Latino, income, education, and total population at their means. Similarly, census tracts with 80 percent of the population identifying as Latino are expected to have, on average, approximately 1 more community garden as compared to census tracts with a 20 percent Latino population, holding all other variables at their means.

Table 2 about here

The spatial error models also show a positive relationship between a community's ethnic-minority concentration and the number of community gardens located in a given census tract (Table 3). A one standard deviation (31 point) increase in the percentage of non-Hispanic black residents in a census tract is associated with a .16 standard deviation (.13 garden) increase in the number of community gardens in a census tract in NYC ($P < .001$), controlling for Latino residents, income, education, and population size. A one standard deviation (23 point) increase in the percentage of Latino residents in a census tract is associated with a .12 standard deviation (.10 garden) increase in the number of community gardens in a census tract ($P = .002$), net of other variables.

Table 3 about here

Median Household Income and Community Garden Locations

Table 2 shows that lower-income census tracts have more gardens. After controlling for black and Latino residential rates, education, and total population, a $1,000 decrease in the median household income of a census tract is expected to yield an increase in the number of gardens by a factor of 1.04 or 4.00 percent ($P < .001$). Census tracts with median household incomes of $10,000 are expected, on average, to have almost 1 more community garden compared to census tracts with a median household income of $90,000 or more. The spatial error models also show a negative relationship between household income and number of community gardens (Table 3); however, this relationship is only marginally significant ($P=.053$). A one standard deviation ($26,244) decrease in the median household income in a census tract is marginally associated with a .066 standard deviation (.054 garden) increase in the number of community gardens in a census tract.

Education Rates and Community Garden Locations

Table 2 also shows that communities with higher rates of residents with at least a bachelor's degree have more gardens. A one-point increase in the percentage of the population with a bachelor's degree or more education is expected to yield an increase in the number of gardens by a factor of 1.064 or 6.39 percent ($P < .001$), net of other factors. Census tracts where 80 percent of the population has at least a bachelor's degree are expected to have, on average, about 3 more gardens than census tracts where 10 percent of the population has at least a bachelor's degree. In the models controlling for spatial clustering (Table 3), the relationship between education rates and community gardens is also positive but did not reach statistical significance.

Interaction Effects on Community Garden Locations

Table 2 shows the negative binomial models with all statistically significant interaction terms included, each in a separate model. The interactions between income and percent Latino as well as between education and percent Latino were not significant and therefore not included. The effect of the interaction of income and education was positive and statistically significant (Table 2; $P = .009$). As demonstrated in Figure 2, there are exponentially more gardens in census tracts with lower median household income, but this is a stronger relationship when the percent of the residents with a bachelor's degree or more education is higher. In census tracts where only 4 percent of the population has at least a bachelor's degree, those with a median household income of $15,000 are expected to have, on average, about one more community garden than those with a median household income of $90,000 or more (Figure 2). In contrast, among census tracts where education rates are 40 percent, tracts with a median household income of $15,000 are expected to have, on average, about 3.5 more gardens than those with a median household income of $90,000 or greater (Figure 2)

The effect of the interaction between income and percent black was negative and statistically significant (Table 2; $P < .001$). Figure 2 shows that there are exponentially more gardens in census tracts with higher percentages of black residents, but more so in those tracts that also have lower median household incomes. In census tracts with a median household income of $15,000, tracts with 80 percent black residents were expected to have more than 20 more gardens than those with 20 percent or lower black residents (Figure 2). In contrast, among census tracts with a median household income of $69,000, tracts with 80 percent black residents were expected to have about 5 more gardens than those with 20 percent or lower black residents (Figure 2).

The effect of the interaction between education and percent black was also negative and statistically significant (Table 2; $P < .001$). Figure 2 shows that there are exponentially more gardens in census tracts with higher rates of black residents, but more so when those also have higher rates of residents with at least a bachelor's degree. Among census tracts where 4 percent of the residents have at least a bachelor's degree, those with 80 percent black residents were expected to have about 1 more community garden than those with 20 percent black residents (Figure 2). However, in tracts where 40 percent of residents had at least a bachelor's degree, those with 80 percent black residents were expected to have about 20 more gardens than those with 20 percent or lower black residents (Figure 2).

However, as shown in Table 3, once the spatial clustering of the community gardens is controlled for, there are no statistically significant (at the .05 level) impacts of these iterations on the number of community gardens located in a census tract. The interaction of income and percent black does show a marginally significant ($P = .088$) negative effect, similar to the corresponding negative binomial model.

In sum, we should expect to see more community gardens in communities with higher rates of non-Hispanic black and/or Latino residents, lower median household incomes, and possibly with higher rates of residents with at least a bachelor's degree (the significance of the impact of education was inconsistent). The interaction terms in the negative binomial regression models suggest that we should see more gardens in low income communities that also have higher education rates, in black communities that are also lower-income, and in black communities that also have higher education rates. However, these interactions did not reach statistical significance once the spatial clustering of the gardens was controlled for.

Community Garden Founding Year

There is a positive and statistically significant relationship between garden founding year and the percent of residents being white (Table 4). A garden being one year newer or younger (ie a one-year increase in the founding year of the garden) is expected to yield an increase in the rates of white residents by a factor of 1.012 or 1.25%, net of other variables (Table 4; $P = .004$). There was no statistically significant relationship between the founding year and the rates of black or Latino residents. While the founding year of the garden had no statistically significant impact on the median household income of a garden's census tract, there was a negative relationship between the founding year of the garden and the education rates in the corresponding census tract (Table 5). A garden being one year newer or younger (a one-year increase in the founding year) was associated with a .14 point decrease in the rates of residents with a bachelor's degree or more education (Table 5; $P < .001$), holding constant the rates of black and Latino residents, the median household income of the tract, and it's population size. In other words, newer/younger gardens were associated with higher rates of white residents while older gardens were associated with higher education rates.

DISCUSSION

The analysis indicates that community gardens are located and more prevalent in areas of higher ethnic-minority concentration and lower-income, in keeping with literature highlighting the use of community gardens among this population to resist community disinvestment (Campbell 2017; Reynolds 2015; Reynolds and Cohen 2016; Saldivar-Tanaka and Krasny 2004; White 2017). Both the negative binomial model and the spatial error model indicate that communities with higher concentrations of ethnic minorities, measured as the percentage of the population identifying as non-Hispanic black or Latino, were associated with increased numbers of community gardens. The interaction terms in the negative binomial models further suggest that the increased number of gardens expected in black communities is even more dramatic for lower-income and higher-education areas. The negative binomial models also indicated that a community having a lower median household income was associated with an increased number of community gardens being located there, particularly if the community also had higher concentrations of black residents or higher educational attainment (Table 2).

My findings also provide some support for there being more community gardens located in communities with a higher proportion of college-educated residents. This outcome is consistent with examples from the literature of community gardens catering to the local food and sustainability preferences of college-educated participants (Aptekar 2015; T D Glover, Parry, and Shinew 2005; Kato et al. 2014). Notably, the negative binomial regression model demonstrates an association between community garden locations and areas with higher concentrations of college-educated residents, particularly if that community had a lower median household income or higher rates of black residents (Table 2). Older gardens were also associated with higher education rates, which may highlight the importance of education for the tenure of community gardens.

Finally, these findings indicate that gardens in communities with higher percentages of white residents were associated with a newer founding year, consistent with existing literature arguing that newer trends in community gardening serve the interests of a majority white movement driven by an interest in local food and sustainability (Campbell 2017; Cohen et al. 2012; Reynolds 2015; Reynolds and Cohen 2016).

CONCLUSION

This study examines neighborhood compositional trends in the geographic availability of community gardens on a broad scale, and furthers our understanding of who is spatially situated to benefit from community gardens, by ethnicity/race, income and education.[7] Previous research highlights two distinct trends in community gardening: an older trend suggests that low-income and ethnic minority communities have more gardens to address food access inequality and as a strategy of resistance in the face of public and private disinvestment (Campbell 2017; Cohen et al. 2012; Lawson 2007; Reynolds 2015; Reynolds and Cohen 2016; Saldivar-Tanaka and Krasny 2004; Taylor and Ard 2018; White 2017). A newer trend suggests that white and highly-educated communities have more gardens given their interest in the local food and sustainability movement, and their ability to mobilize necessary resources to accomplish these goals (Aptekar 2015; Campbell 2017; Cohen et al. 2012; Kato et al. 2014; Reynolds 2015;

Reynolds and Cohen 2016). The present study teases apart the individual impacts of ethnicity/race, income, and education and considers further, older and newer gardens, typically associated with challenging inequality or localizing food systems, respectively (Angotti 2018; Campbell 2017; Gould and Lewis 2017, 2018). Consistent with Campbell's (2017: 37) depiction of the complexity of the urban agriculture network in NYC, my findings demonstrate a diversity of community garden locations across the city.

Based on robust data collected in NYC, my findings illustrate how two major community gardening trends interlock to create a more complex landscape of community garden locations than either would independently. Overall, community gardens are more prevalent in ethnic minority concentrated and lower-income communities. However, my results further suggest that income and education may operate differently from one another. In fact, I find limited evidence that, especially among black communities, those with lower income but higher educational attainment are likely to have more community gardens than those with lower income and lower educational attainment. This finding contradicts a descriptive examination of the mapped locations of NYC community gardens (Figure 1.2) and the raw comparison of education rates in census tracts with gardens to the city-wide average (Table 1). The statistical models presented here suggest that community gardens are likely more prevalent in lower-income communities, with education rates actually having the opposite effect; that is community gardens are likely more prevalent in more educated communities (see Table 2; Figure 2).

The inconsistency between the effect of income and education likely reflect specific differences in these two social class-related measures within local food environments. Education may be an especially important resource that otherwise disadvantaged communities are utilizing to understand the value of and to help maintain their community gardens. Interviews with NYC community gardeners and activists suggest that white upper-class garden advocates use their social and cultural capital to gain access to the resources available from political and non-profit actors throughout the city (Cohen et al. 2012). It may therefore be the case that gardens in low-income and black communities with higher rates of education are leveraging education-related social and cultural capital to gain similar access to resources necessary for garden tenure, ultimately shaping which disadvantaged communities have community gardens.

Education may also drive an interest in sustainable and local food, with highly-educated residents seeing a broader variety of benefits associated with community gardens, regardless of their ethnicity or income level. In contrast, income may independently shape the accessibility and utilization of more costly food outlets. For example, even among the highly-educated, those with more income may seek out less time-consuming but more expensive means for getting fresh food, like shopping at high-end supermarkets or frequenting other forms of local food outlets, like community supported agriculture programs.

My findings yield conflicting evidence on who is more likely to be served by newer community gardens. I find that the communities surrounding newer gardens are likely to have higher rates of white residents, likely resulting from newer trends in community garden participation associated with the white, upper-class local food movement (Campbell 2017; Gould and Lewis 2017, 2018). However, I also find that communities with newer gardens are more likely to have lower educational attainment, which may demonstrate the contribution of this new trend to green gentrification.

At the same time, this finding shows that older gardens are likely to be located in communities with more educational attainment. Education may, therefore, play a critical role in maintaining important resources for community gardens. This is consistent with the growth and unequal distribution of government resources and support for NYC community gardens, where upper-class and white gardeners receive a disproportionate level of recent support and recognition (Campbell 2017; Cohen et al. 2012; Reynolds 2015; Reynolds and Cohen 2016). For example, elite connections, institutional actors, and entrepreneurial framings of urban agriculture associated with newer white gardeners contributed to the inclusion of community gardens in recent revisions of NYC's sustainability plan (Campbell 2017).

Further, my findings that newer gardens were associated with higher rates of white residents while older gardens were associated with more education attainment may reveal the role of both newer and older gardens in the gentrification process. This would be consistent with previous literature implicating both the restoration of existing environmental amenities and the building of new ones in the gentrification process (Angotti 2018; Aptekar 2015; Gould and Lewis 2017, 2018). For example, Gould and Lewis (2017) argue that the elaborate restoration of Prospect Park in Brooklyn, NY, from its previous state of neglect to a space attracting urban gentrifiers and ultimately contributing to the displacement of black and poor residents and increase in local housing costs. Aptekar (2015) also demonstrates how gaining institutional support in an existing community garden in a gentrifying NYC neighborhood coincided with a shift toward garden meanings associated with newer, white and well-educated residents. However, the transformation of Gowanus Canal into a new environmental amenity came with community shifts, including disproportionate increases in rates white and higher-class residents and housing costs (Gould and Lewis 2017). Future work should consider further the connections between community gardens and green gentrification, with a particular eye towards educational changes in communities (Gould and Lewis 2017, 2018). While a full consideration of connections between community garden locations and gentrification is outside of the scope of this study, the increased presence of gardens within more educated communities may signal gentrification.

These findings also demonstrate that more work is needed in considering the accessibility, both in terms of geographic barriers and utilization barriers, of community gardens among ethnic minorities, low-income individuals, and individuals with little education. First, communities with lower educational attainment lack access to traditional food outlets (Morton and Blanchard 2007), and the present findings indicate they may also lack availability of community gardens. This suggests that education may pose a double barrier to food access, with both traditional and alternate food outlets being limited in less educated communities.

Additionally, non-spatial barriers may prevent disadvantaged individuals from accessing community gardens, even when they are nearby. For example, participation in community gardens requires consistent dedication of time and energy, and may provide inconsistent results in terms of food production. Previous work also documents the use of problematic framings within local food programs resulting in participants being primarily white, higher-income, and well-educated individuals (Guthman 2011; Kato 2013; Mcentee 2011; Slocum 2006, 2007). Community gardens may also be using language or goals that resonate more with white, higher-income, or well-educated individuals. Gardens may therefore not be reaching those at greater risk of food insecurity and health issues, even within disadvantaged communities. Future work should examine the framings and goals articulated by community garden organizations and leaders more closely to investigate this further.

Limitations

The present study was limited by the availability of data on the locations of community gardens across the U.S. and on garden participant demographics. This study did not include a nationally representative sample, which would allow for more generalizable results than focusing on NYC. Because this city is especially densely-populated and has much higher rates of black and Latino residents as compared to the national average (Table 1), generalizing to other areas of the United States – for example, rural areas or areas with few non-white residents – should be done with caution. Future research should strive to collect and utilize a more nationally representative dataset. Future work should then consider these relationships on a larger geographic scale and investigate variation by population density and larger scale ethnic-minority concentration.

This study shows that community gardens are more likely to be located in ethnic-minority concentrated and, potentially, in low-income census tracts. Although the community-level benefits of these gardens are likely reaching low-resource populations

(Draper and Freedman 2010), disadvantaged individuals residing in these census tracts may not be the ones benefiting from them on an individual level. As demonstrated by one organic grocery store located in a historically disadvantaged community in Portland, Oregon (Sullivan 2014), the garden participants may be primarily white and high-income neighborhood residents, rather than black, Latino, or low-income. Similarly, as Kato (2013) documents in a local food market on the edge of a predominately black community, the actual participants in community gardens may be traveling from nearby areas with fewer ethnic minority residents and more affluence. Future research should strive to address this question by examining the demographics of community garden participants as compared to the surrounding community demographics.

Future work should continue to consider spatial clustering in examinations of local food environments. Here, the spatial regression model, which controlled for the spatial clustering of the community gardens, only showed statistical significance of rates of black and Latino residents on the number of community gardens located in a census tract. This may suggest that the significance of income and education are driven by potentially unrelated spatial clustering. However, results of income and education were reported here because the negative binomial model, in which income and education are consistently significant, seems to be a better fir for the data overall.

Lastly, the results presented here may be specific to the type of spatial measure used (census tracts). Literature quantifying geographic food environments and their effects on food access and health has produced inconsistent results depending on how spatial availability is measured (McEntee and Agyeman 2010; Thomas 2010; Widener et al. 2013). The use of census tracts in this study may be masking a more nuanced process through which people access community gardens and benefit from them. Future analysis should explore the relationships examined here using different spatial measurements, including driving or walking distance to gardens.

Implications

My findings suggest that residents of less educated communities may disproportionately face spatial barriers to accessing community gardens, and therefore the wide range of dietary, mental, and physical health benefits associated with them. However, I also find community gardens have a sizeable presence in communities that have historically experienced limited food access in the American food system, implicating their ability to substantially improve overall access to fresh fruits and vegetables. This study strengthens our understanding of community gardens as health and food resources by suggesting who may most easily, at least geographically, utilize them: residents of ethnic-minority concentration, low-income, and highly-educated communities.

Future academic research on food access should consider the extent of the impact of community gardens on local food and health environments, investigate strategies for improving and broadening the food security and health impacts of existing gardens, and explore variations in community garden benefits. Specifically, literature on alternate food outlets should more directly incorporate non-retail, low-cost, or fresh food outlets like community gardens that also provide broader health benefits. Research on the impact that well-educated individuals have on the goals and outcomes of community gardens should also consider the impact of these individuals in shaping where gardens are located.

Organizations and policymakers should do more to ensure equal access to gardens and their health benefits by supporting a more equitable distribution of resources, support, and recognition within the community garden movement. While community gardens face constraints that likely limit their ability to address food access inequalities on a larger scale, they are also low-cost in comparison to other efforts on the part of local governments to address food access, for example the NYC Food Retail Expansion to Support Health (FRESH) has cost the city $100 million as of 2019 (New York City Economic Development Corporation 2019). FRESH provides a variety of financial incentives to supermarkets for opening locations in marginalized communities, including a 25-year land tax abatement ranging annually from $500 to the value of the land itself (New York City Economic Development Corporation n.d.). Given their well-documented improvements to food access and health at both the participant and community level (Alaimo et al. 2016; Draper and Freedman 2010; Teig et al. 2009; Zoellner et al. 2012), local governments should incorporate support for community gardens, especially those already established in marginalized communities, into broader-scale food environment plans.

Specific to NYC, the local government has already taken some important actions to support community gardens within the city through organizations like GreenThumb and entities like the NYC Parks Department (NYCParks 2017). However, organizers of community gardens serving marginalized populations within the city have articulated a lack of support from these entities and have noted some important and tangible actions needed address this, including "increase access to information about available resources," "support capacity building," and "facilitate participation in policymaking" (Cohen et al. 2012:10). The present study suggests the wide-spread impact that these actions on the part of the city could make, given the existing locations of community gardens in NYC.

ENDNOTES

1. These analyses were also run using the percent of residents who identify as non-Hispanic white as the main predictor variable for ethnicity/race. Outcomes were substantively similar, but these models tended to have higher AICs as compared to the models including percent black and percent Latino residents, suggesting that their model fit was not as good. I chose to exclude percent white from my analyses for this reason, and because the inclusion of both black and Latino provided a more nuanced analysis.

2. The data I use for the analyses of garden locations are particularly challenging to model because my outcome variable, the number of community gardens in each census tract, is not normally distributed and shows signs of geographic clustering. Due to a lack of consistent statistical method for applying a spatial regression technique to a negative binomial model, I am not able to account for both of these challenges in the same type of model. I therefore use two separate statistical techniques: a negative binomial model to account for the non-normal distribution of my data, and a fully standardized spatial error model to account for the spatial clustering.

3. A likelihood ratio test for the alpha measuring overdispersion is also statistically significant at the .001 level, indicating that the alpha of 1.32 is not equal to 0 and that there is overdispersion in my outcome variable. This suggests that the a negative binomial regression model is a better fit for my data than a Poisson regression model.

4. The clustering of community gardens, in and of itself, is an interesting topic of discussion, and an analysis of the historical, social, and political processes leading to this clustering should be more thoroughly investigated in future research.

5. In addition, the Lambda for the full spatial error model, an estimated parameter measuring spatial autocorrelation, is statistically significant at the .001 level, further indicating that there is spatial autocorrelation in the dataset that is being controlled for using the spatial error model.

6. The lack of model fit in these spatial analyses is likely due to the use of the fully standardized ordinary least squares model in the spatial regressions, given that the underlying distribution of the number of community gardens is far from normal. To my knowledge, there is not yet an established method for controlling for spatial clustering using a negative binomial distribution.

7. While the demographics of community garden neighborhoods do not necessarily indicate who participates in the gardens themselves, it does suggest who is more likely to benefit from the community-level health and food resources of community gardens as documented by previous research (Alaimo et al. 2016; Draper and Freedman 2010; Teig et al. 2009; Zoellner et al. 2012).

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Table 1. Summary Ethnic/Racial and Class Demographics

	U.S.	New York City	Census Tracts w/ 1+ Garden
fTotal Population	308,745,538	8,175,133	1,334,930
Percent White	78%	44%	18%
Percent Black	13%	26%	35%
Percent Latino	17%	29%	38%
Percent w/ Bachelor's Deg.+	28%	33%	26%
Median Household Income	$51,914	$50,285	$41,525
Number of Tracts	74,134	2,194	320
Percent Tracts w/ 1+ Garden		14.59%	

Source: US Census 2010; American Community Survey 2010; GrowNYC 2014

Table 2: Odds Ratios from Negative Binomial Regression of Key Covariates and Interactions on the Number of Community Gardens in a Census Tract

	Income Model OR [95% CI]	**Education Model** OR [95% CI]	**Full Model** OR [95% CI]	**Income * Education Model** OR [95% CI]	**Black * Income Model** OR [95% CI]	**Black * Education Model** OR [95% CI]
Percent Black	1.018*** [1.01, 1.02]	1.037*** [1.03, 1.04]	1.034*** [1.03, 1.04]	1.034*** [1.03, 1.04]	1.058*** [1.04, 1.07]	1.053*** [1.04, 1.06]
Percent Latino	1.014*** [1.01, 1.02]	1.043*** [1.03, 1.05]	1.034*** [1.03, 1.04]	1.032*** [1.02, 1.04]	1.036*** [1.03, 1.05]	1.038*** [1.03, 1.05]
Median Household Income	.984*** [.98, .99]		.960*** [.95, .97]	.948*** [.94, .96]	.975*** [.96, .986]	.959*** [.95, .97]
Percent w/ Bachelor's Deg.+		1.033*** [1.02, 1.04]	1.064*** [1.05, 1.08]	1.045*** [1.03, 1.06]	1.060*** [1.05, 1.07]	1.080*** [1.06, 1.10]
Income* Education				1.00030** [1.00007, 1.0005]		
Black * Income					.99952*** [.9993, .9997]	
Black * Education						.99931*** [.9990, .9996]
Total Population	1.099** [1.03, 1.17]	1.076* [1.01, 1.15]	1.021 [.96, 1.09]	1.015 [.96, 1.08]	1.014 [.95, 1.08]	1.010 [.95, 1.07]
Constant	.13*** [.067, .258]	.0061*** [.003,.013]	.031*** [.014, .069]	.064*** [.025, .17]	.015*** [.006, .035]	.017*** [.007, .041]
LnAlpha	1.21*** [.981, 1.44]	1.27*** [1.05, 1.49]	.988*** [.75, 1.22]	.982*** [.75, 1.22]	.965*** [.73, 1.20]	.95*** [.72, 1.19]

Table 2: Odds Ratios from Negative Binomial Regression of Key Covariates and Interactions on the Number of Community Gardens in a Census Tract

Moran's I	.16***	.20***	.045***	.034**	.085***	.034**
Pseudo R^2	.0653	.0745	.1073	.1099	.1144	.1143
Log Likelihood	-1183.21	-1171.59	-1130.03	-1126.83	-1121.05	-1121.19
Akaike Inf. Crit.	2378.41	2355.19	2274.10	2269.65	2258.11	2258.39

Notes:

Number of Observations = 2,133

Two-tailed test; + p<.10; * p<.05; ** p<.01; *** p<.001

Median household income measured in thousands of dollars

Total population measured in thousands of people

Source: US Census 2010; GrowNYC 2014

Table 3: Coefficients from Fully Standardized Spatial Error Regression of Key Covariates and Interactions on the Number of Community Gardens

	Income Model Beta Coef. [Std. Error]	**Education Model** Beta Coef. [Std. Error]	**Full Model** Beta Coef. [Std. Error]	**Income * Education Model** Beta Coef. [Std. Error]	**Black * Income Model** Beta Coef. [Std. Error]	**Black * Education Model** Beta Coef. [Std. Error]
Percent Black	.13*** [.037]	.16*** [.040]	.16*** [.039]	.16*** [.039]	.26*** [.071]	.20** [.064]
Percent Latino	.093** [.034]	.12*** [.037]	.12** [.037]	.12** [.038]	.12** [.037]	.12** [.037]
Median Household Income	-.037 [.029]		-.066+ [.034]	-.068 [.056]	-.036 [.039]	-.067* [.034]
Percent w/ Bachelor's Deg.+		.027 [.037]	.070 [.043]	.067 [.062]	.067 [.043]	.085+ [.047]
Income * Education				.0048 [.085]		
Black * Income					-.11+ [.065]	
Black * Education						-.039 [.051]
Total Population	.020 [.021]	.023 [.021]	.019 [.021]	.018 [.021]	.015 [.021]	.018 [.021]
Constant	-.0029 [.043]	-.0029 [.043]	-.0028 [.042]	-.0028 [.042]	-.0029 [.041]	-.0027 [.042]
Lambda	.57*** [.023]	.58*** [.023]	.57*** [.024]	.57*** [.024]	.56*** [.024]	.57*** [.024]
Moran's I	-.023+	-.023+	-.022	-.021	-.020	-.021

Table 3: Coefficients from Fully Standardized Spatial Error Regression of Key Covariates and Interactions on the Number of Community Gardens

Log Likelihood	-2731.46	-2731.97	-2730.19	-2730.19	-2728.79	-2729.90
Akaike Inf. Crit.	5476.92	5477.94	5476.38	5478.37	5475.58	5477.80

Notes:

Number of Observations = 2,133

Two-tailed test; + p<.10; * p<.05; ** p<.01; *** p<.001

All coefficients presented are fully standardized (Beta) coefficients

Source: US Census 2010; GrowNYC 2014

Table 4: Odds Ratios from Negative Binomial Regression of Founding Year and Key Covariates on the Ethnic/Racial Makeup of Garden Census Tracts

	White OR [95% CI]	**Black** OR [95% CI]	**Latino** OR [95% CI]
Founding Year of Garden	1.012** [1.004, 1.02]	.999 [.99, 1.01]	.997 [.99, 1.00]
Median Household Income	.994 [.99, 1.00]	.997 [.99, 1.00]	.991*** [.99, .99]
Percent w/ Bachelor's Deg.+	1.064*** [1.06, 1.07]	.975*** [.97, .98]	.988*** [.98, .99]
Total Population	1.0062 [.96, 1.05]	.885*** [.85, .92]	1.072*** [1.04, 1.10]
Constant	.00** [.00, .00]	2425.82 [.0027, 2.19e+09]	16501.04+ [.46, 5.97e+08]
LnAlpha	-.19*** [-.34, -.032]	-.61*** [-.74, -.47]	-1.27*** [-1.41, -1.13]
Pseudo/Adjusted R^2	.114	.038	.049
Akaike Inf. Crit.	3205.7	4408.8	4134.8

Notes:

Number of Observations = 488

Two-tailed test; + p<.10; * p<.05; ** p<.01; *** p<.001

Median household income measured in thousands of dollars

Total population measured in thousands of people

Source: US Census 2010; GrowNYC 2014

Table 5: Coefficients from Ordinary Least Squares Regression of Founding Year and Key Covariates on the Class Makeup of Garden Census Tracts

	Income Coef [95% CI]	**Education** Coef [95% CI]
Founding Year of Garden	.099 [-.01, .21]	-.14*** [-.21, -.06]
Percent Black	-.086* [-.16, -.01]	-.41*** [-.45, -.37]
Percent Latino	-.18*** [-.28, -.09]	-.49*** [-.54, -.44]
Median Household Income		.31*** [.26, .37]
Percent w/ Bachelor's Deg.+	.67** [.56, .79]	
Total Population	-1.37*** [-1.95, -.78]	.74*** [.34, 1.14]
Constant	-159.1 [-386.02, 67.87]	316.2*** [163.73, 468.58]
Pseudo/Adjusted R^2	.636	.810
Akaike Inf. Crit.	3847.4	3473.5

Notes:

Number of Observations = 488

Two-tailed test; + p<.10; * p<.05; ** p<.01; *** p<.001

Median household income measured in thousands of dollars

Total population measured in thousands of people

Source: US Census 2010; GrowNYC 2014

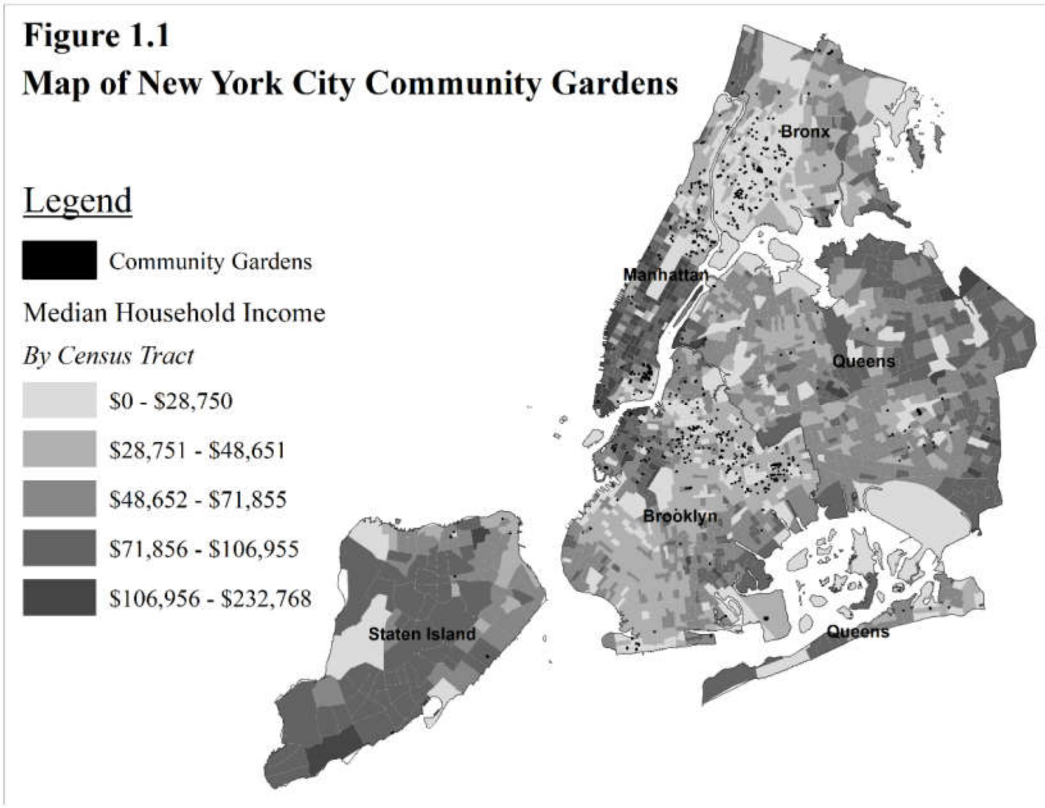

Figure 1.1
Map of New York City Community Gardens

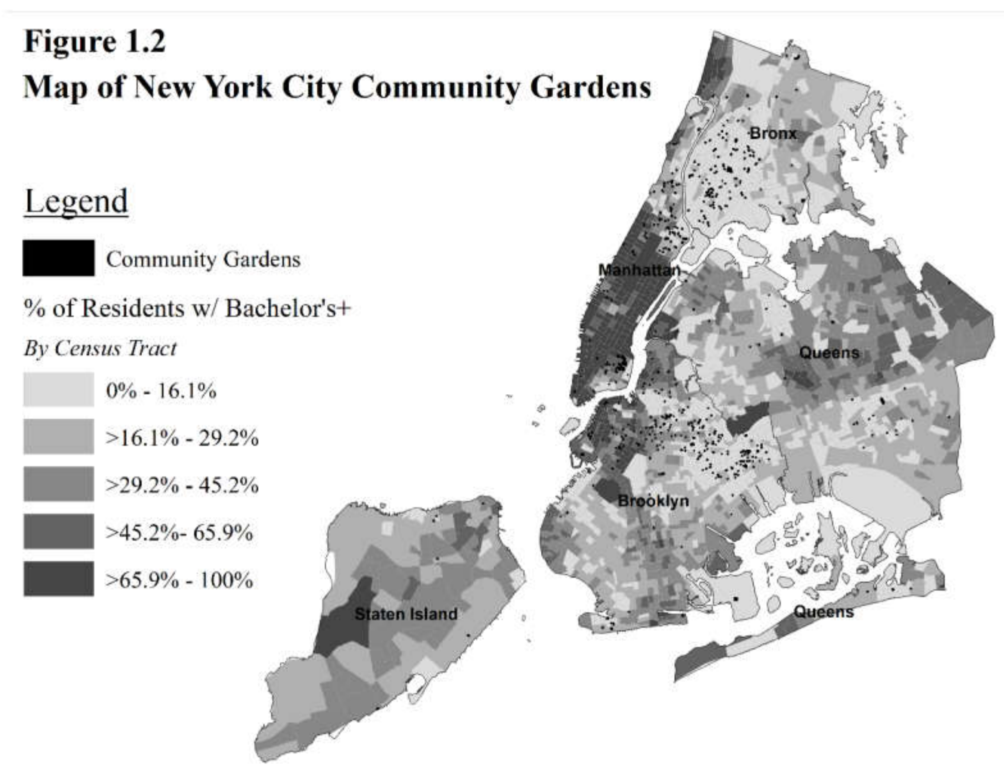

Figure 1.2
Map of New York City Community Gardens

Figure 1.3
Map of New York City Community Gardens

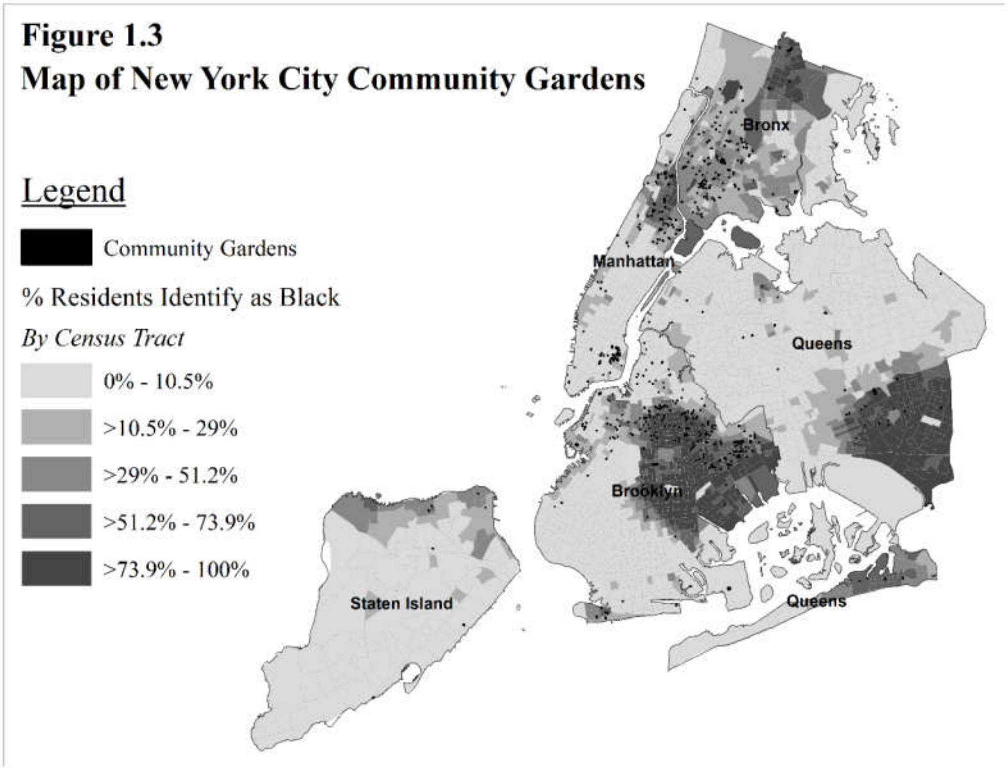

Figure 1.4
Map of New York City Community Gardens

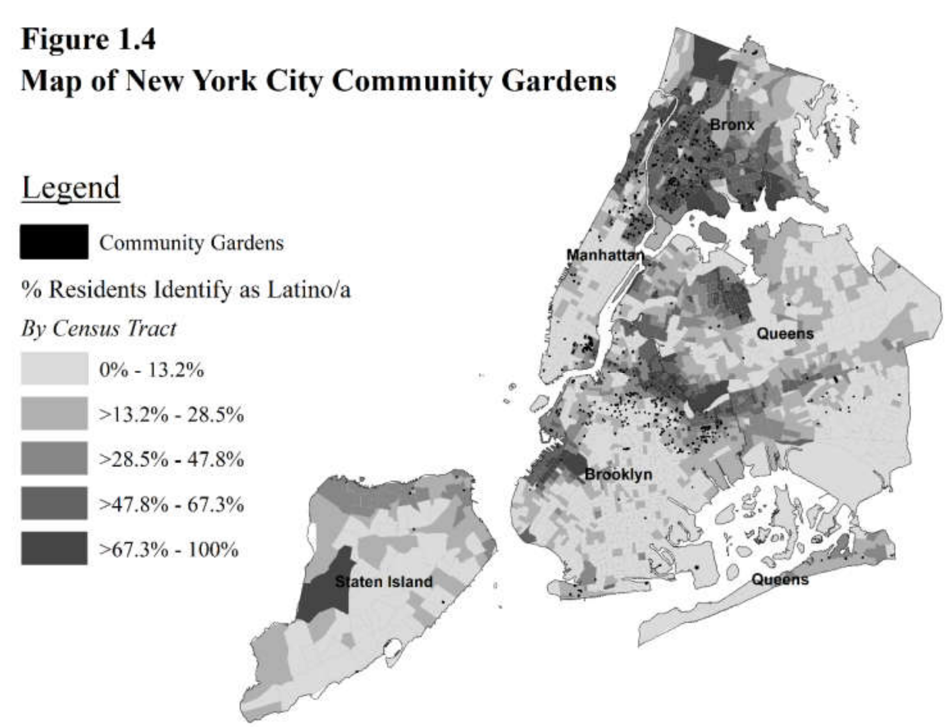

Figure 2. Interactions of Income, Education, and % Black from Negative Binomial Regression Models (See Table 2 for full models)