Individual access to healthy food

An analysis of food access in suburban and urban United States

Joost Blaakmeer
2041944
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Summary

This thesis analyses the individual access to healthy food in the United States by exploring the question to what extent spatial differences between urban and suburban areas, such as differences in density, can influence individual access to healthy food. Reduced healthy food access can have negative health consequences, making it important to know which factors influence this. Previous research has revealed that food deserts exist in the United States. These are areas where inhabitants have a reduced access to healthy food. In this thesis the effects of this reduced access to healthy food on the individual level are compared between suburban and urban areas. This distinction is important as the traditional concentration of poverty in urban areas in the United States is slowly changing while poverty levels rise in suburban areas.

By gathering individual data on urban and suburban Americans through an online survey the relations between area type, preferred mode of transport, car access, income and the travel time to the nearest supermarket are recorded and analyzed. Results show that people in low income groups generally travel longer to their nearest supermarket than those who do not belong to low income groups. Those who do not have access to a car also see reduced access to healthy food. Summarizing the results this thesis does not find basis to claim that spatial characteristics of suburban areas are a strong influence on individual access to healthy food. This thesis finds that food deserts can exist for specific groups of people whilst not existing for others living in the same area. Transport types, car access and income are essential factors that can cause people to have a reduced access to healthy food and play a more important role than the spatial differences between urban and suburban areas.

Contents

Introduction

Poverty is often associated with malnutrition (Blakely, Hales, Kieft, Wilson & Woodward, 2005), but when looking at the United States a striking form of malnutrition is seen: poor counties across the United States show higher obesity rates than wealthy counties (Levine, 2011). Previous research has revealed a strong correlation between diet quality and the availability, accessibility and affordability of healthy foods in stores (Jiao, Moudon, Ulmer, Hurvitz & Drewnowski, 2012). Diet quality is also strongly linked to having a high BMI according to Sundararajan, Campbell, Choi & Sarma (2014). One of the causes for this pattern is the lack of access to affordable healthy food in low income areas (Levine, 2011). These so called "food deserts" are defined as: "areas characterized by relatively poor access to healthy and affordable food" (Beaulac, Kristjansson & Cummins, 2009).

Many studies have been done on food deserts. Most of these studies in the spatial sciences have focussed on proving the existence of food deserts with technical means. These include market-based studies: studies that compare various food items across different stores and target groups (Powell, Slater, Mirtcheva, Bao & Chaloupka, 2007). Extensive spatial analysis is also common, often by using GIS software to analyze food desert locations (White, Bunting, Williams, Raybould, Adamson and & Mathers, 2003; Li and Kim, 2017). According to Beaulac et. al. (2009) the outcomes were mainly compared within types of store rather than across neighborhoods. While there have been studies on the individual level, a qualitative approach was used (Whelan, Wrigley, Warm and Cannings, 2002). In their literature review, Li and Kim (2017) also found few studies on the individual level that take into account mode of transportation. The aim of this thesis is to examine whether or not this lack of access to healthy food on a spatial level also translates to the individual level, but to do this by gathering quantitative data in the form of a survey among Americans.

Previous research on food deserts has mostly focused on the urban-rural distinction, whilst mostly ignoring the spatial differences between suburban and urban areas (Beaulac et. al. 2009). As urban and suburban areas have different spatial characteristics (Giarratani and Rogers, 1991) this might be of influence on the prevalence of food deserts. Because of these spatial differences suburban areas are expected more likely to have longer travel distances and reduced available transport options. For this reason, the survey results will be analyzed by comparing urban and suburban areas. Previous research has shown that different modes of transport are of influence on the size of one's activity space (Hirsch et al. 2014). Urban and suburban areas might differ in the effects that a decreased activity space has on the access to healthy food. This study aims to analyze whether the spatial characteristics of these areas are of influence on healthy food access and what the effect is of having access to a car.

This leads to the following research question: *To what extent does a difference in spatial characteristics influence the individual access to healthy food in the United States?* To be able to answer this research question the following sub questions are examined: *Is there a difference in healthy food access between urban and suburban areas?; To what extent does food access differ for different modes of transport between area types? Do people with low incomes have reduced access to healthy food between area types?; To what extent does car access influence the access*

to healthy food in urban and suburban areas? By answering these research questions an extra dimension can be added to the argument for the existence of food deserts. This study aims to show if the variables of influence on food deserts, in this case income, car access and area type, are also of influence on the individual level.

First the theoretical framework for the research is laid out. This provides more information about previous research on access to healthy food and why the distinction between the spatial differences of urban and suburban areas deserves special attention. Furthermore, the significance of the availability of different forms of transport is discussed. Secondly the methodology of the study is explained after which the primary results are presented, followed by a further analysis and answering of the main research question in the conclusion.

Theoretical framework

Food deserts

Food deserts are often defined by physical distance from healthy food (Jiao, Moudon, Ulmer, Hurvitz and Drewnowski, 2012). The definition of a food desert used for this study is a travel time of more than 10 minutes away from the nearest grocery store or supermarket. This is based on research by Jiao et. al. (2011; 2012) which found that 60% of respondents travels less than 10 minutes to their nearest supermarket. A comparison of 49 different studies on food deserts, using varying definitions and in various countries, shows that food deserts have only been consistently proven to exist in the United States (Beaulac et. al. 2009). These studies found a reduced level of access to healthy food among Americans living in low income and minority areas. Additionally, previous studies on food deserts in the United States made a distinction between the prevalence of food deserts in urban areas and rural areas (Morris, Neuhauser and Campbell, 1992). Evidence found in these studies was inconclusive as several studies found the type of area to be of influence on food deserts whilst several others failed to find this relation (Beaulac et. al. 2009).

Urban vs. suburban

The distinction between urban and suburban areas is relevant specifically in the American context as American cities have high levels of suburban sprawl and suburbans have different spatial characteristics when compared to urban areas (Giarratani and Rogers, 1991). According to Barrington-Leigh and Millard-Ball (2015) a majority of city road networks in the United States were laid out in an era of private automobile ownership. This is in contrast with the traditional road networks that are found in Europe, these have been in place since well before the rise of private automobile usage and as such are built around a compact historic city center. This difference in the development of road networks is a major cause of an increased level of suburban sprawl in the United States (Barrington-Leigh and Millard-Ball, 2015) and highlights why suburban areas are analyzed as a separate group and not combined with urban areas as most other studies do (Beaulac et. al. 2009).

Suburbanization is a major influence on the spatial characteristics of poverty in the United States (Giarratani and Rogers, 1991). The most notable spatial differences between urban and suburban areas are the lower levels of population density and the high proportion of residential land use in suburban areas. This causes an increased physical distance to public services such as supermarkets and grocery stores (Frenkel and Ashkenazi, 2008). Suburban areas have seen an increase in service coverage, as the more affluent moved from city centers towards suburban areas, many food retailers followed suit. An increasing amount of large scale supermarkets and grocery stores left city centers and as a result contributed to the emergence of food deserts in urban areas (Larsen and Gilliland, 2008).

Modes of transport

Whelan et al., (2002) find that groups vulnerable to having a reduced access to healthy food include those with a low income and restricted mobility. As the availability of public transport in American cities diminishes due to increased car use and reduced funding from governments (Kirouac-Fram, 2012) this disproportionately affects the suburban poor and hampers them in their ability to find employment, access to goods and services and participate in social life in general (Kirouac-Fram, 2012). This reduced level of public transport coupled with the fact that "households in poverty have lower vehicle ownership rates, which has led to an increased use of alternative modes of transportation such as walking and higher vehicle occupancy rates" (US Department of Transportation, 2014) raise expectations that these factors have a strong influence on the existence of food deserts. Transport type is of influence on the size of a person's activity space, people who walk have a smaller activity space than those who use motorized transport (Hirsch et al. 2014). As poor people in general have less car access (US Department of Transportation, 2014) it is thus expected that they will have a smaller activity space than others making it harder for them to reach healthy food.

Income

In the first decade of the 21st century the suburban poor overtook the urban poor in absolute numbers. Between 2000 and 2012 the share of suburban poor grew with 65%, twice the growth rate of urban areas (Kneebone and Berube, 2013). These changes raise the question whether the suburban poor have an increasingly reduced level of access to places where healthy food can be bought and provide a motive to separately analyze suburban areas. This thesis aims to analyze whether the distinction between urban and suburban areas causes differences in the availability of healthy foods. This is relevant because the shift in poverty levels in suburban areas creates a new class of suburban poor that could well be more vulnerable to having reduced access to healthy food.

Conceptual model

Figure 1 shows the relationships between the various concepts this study analyzes. Both area type and income are of influence on car access and the preferred mode of transport people use to access their supermarket as well as direct influence on the individual access to healthy food in the form of the travel time to the nearest supermarket. Having access to a car and which transport mode is preferred influences the level of access to healthy food.

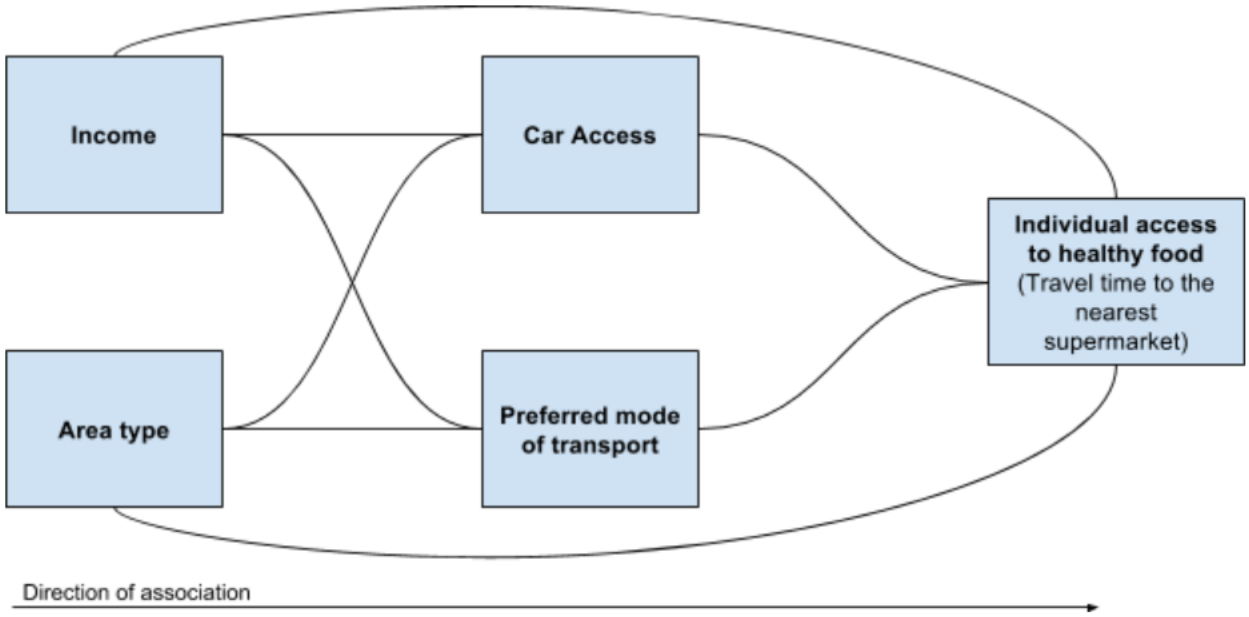

Figure 1. Conceptual model

Hypotheses

The first hypothesis (H_1) follows from the first sub question on the difference in access to healthy food (as measured in travel time to the nearest supermarket) between urban and suburban areas. H_1 expects that inhabitants of suburban areas have a longer travel time to the nearest supermarket than inhabitants of urban areas. The second hypothesis (H_2) is derived from the connection between area type and preferred mode of transport is therefore based on the second sub question about the extent in which travel times differ for different modes of transport. H_2 expects that those who walk to access healthy food have longer travel times than those who drive. Furthermore, travel times for suburban inhabitants are expected to be longer for both walking and driving. Previous research has shown, there is a connection between having a low income and living in a food desert (Levine, 2011). The influence of income on the access to healthy food is the subject of the third hypothesis (H_3), which is based on the third sub question. H_3 expects that a low income has a negative effect on the individual access to healthy food and that low-income groups in suburban areas have worse healthy food areas than low income groups in urban areas. The fourth hypothesis (H_4), which predicts the answer to the fourth sub question, expects that car access is higher in suburban areas than in urban areas. This is expected to be the case due to the increased distance needed to be covered to reach services in suburban areas. Car access is expected to be lower among those with a low income and not having access to a car is expected to have a negative influence on individual access to healthy food. The fifth hypothesis (H_5) expects that people who have a reduced access to healthy food have a lower income and lower level of car access. By testing the validity of these four hypotheses an answer to the main research question can be formulated.

Methodology

Survey method

An online questionnaire was used to analyze participants answers to the various topics outlined in the theoretical framework. Because this thesis is about access to healthy food on an individual level a questionnaire was well suited to gather this type of information as direct input from respondents is required. As it was not feasible to travel to the United States to find people to participate in this questionnaire the social media platform Instagram was used. The target group were followers of the profile “amapaday” (instagram.com/amapaday) because this group is easily accessible and consists of enough people with different demographic backgrounds to be able to get sufficient response. Instagram users are relatively equally divided over the different area types. 39% rural, 28% suburban and 31% urban areas (Pew Research Center, 2016) which makes this a target group where enough suburban and urban dwellers can be reached. A possible drawback is that Instagram users are younger than average (Pew Research Center, 2016) but because of the large sample size enough people from all age groups participated.

Survey distribution and results

The online survey program Qualtrics was used to gather the data. This program was suitable for this survey because it makes it easy to create and distribute an online survey that people can access with their mobile phone. The survey was distributed via Instagram on a population size of 135.000. The survey ran from the 11th until the 27th of November 2017. In total 10868 people filled out the questionnaire, of which there were 4709 Americans that lived in either suburban or urban areas. These 4709 Americans were used for the statistical analysis.

Men are slightly overrepresented, 58% of respondents are male versus 41% female but this is not expected to be of large influence on the findings as the gender is not the main focus. Another factor that should be considered when analyzing survey results is the amount of access American citizens have to the internet. As of 2015, 84% of Americans had access to the internet (Perrin and Duggan, 2015) leaving 16% of Americans not represented by the survey. This might be of extra influence as low-income groups are less likely to have access to the internet [94% internet access for high income groups versus 74% for low income groups (Perrin and Duggan, 2015)]. The disadvantages described above do not weigh up to the ease of access Instagram offers to reach a large public of Americans on an individual level. Considering the time and resource constraints for this study Instagram offers the most convenient and most complete target group. The disadvantages mentioned are to be considered when interpreting the data.

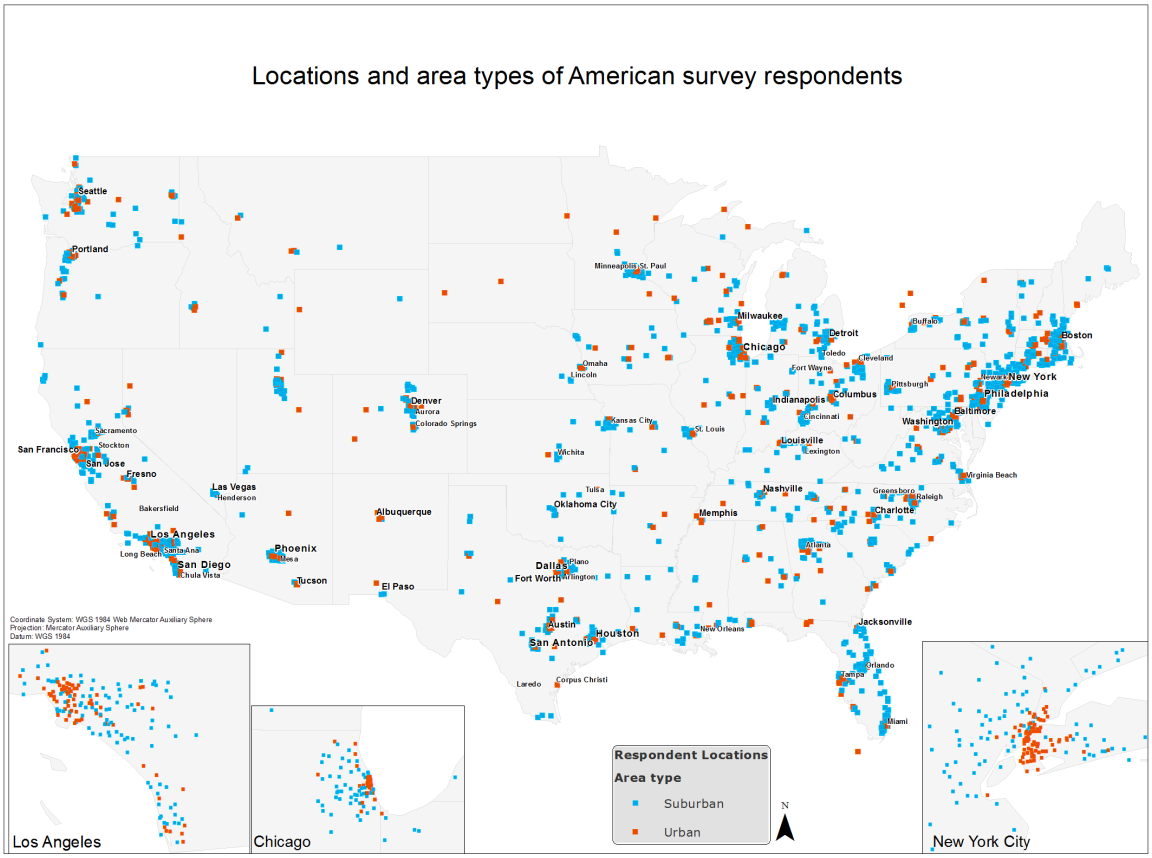

Figure 2. Respondent locations. (See attachment 2 for a larger version)

The questionnaire had a very high response rate: over 4500 Americans from urban and suburban areas all over the United States filled out the questions, this can be seen in their distribution in figure 2. It is difficult to be able to generalize the entire United States based on a questionnaire as cities differ from each other in both demographics and spatial characteristics. This thesis does try to paint a general picture of the entire country, it can be considered that there is enough of a spread of respondents throughout the United States to be able to analyze the country. Figure 2 also shows that all urban areas in the United States with >1 million inhabitants, are represented.

Variables & data analysis

To be able to check H_1, variables on the *area type* respondents live in and their *access to healthy food* are compared. People were asked to self-report in what type of area they live, after which the suburban and urban inhabitants were selected. This method depends on people to assess themselves in what area type they live. A weakness of this is that people can misjudge in which *area type* they live. Figure 2 shows that the distribution of urban and suburban respondents is generally distributed as expected: urban in the city center and suburban on the outskirts. Taking a closer look at New York, Chicago and Los Angeles they all show the same pattern. This is reason to believe that self-reporting area type is accurate enough for the purposes of this study.

To measure the difference in *healthy food access* between *area types* the variable 'minutes of travel time to the nearest supermarket using your preferred mode of transport' was created as an indicator for the level of *healthy food access*. This variable is used in previous research into food deserts (Jiao et. al., 2012). The threshold for an individual to be counted as living in a food desert is when they have a travel duration of more than 10 minutes to reach the nearest grocery store or supermarket (Jiao et. al, 2012). As most supermarkets in the United States offer a broad selection of affordable and healthy foods such as fresh and canned fruits and vegetables, the level of *healthy food access* can be determined by the travel time to the nearest supermarket or large grocery store (United States Department of Agriculture, 2009).

To check H_2 *healthy food access* is measured just as for H_1. Furthermore, respondents were asked to select their *preferred mode of transport* to go grocery shopping. As only the transport types walking and car have seen enough response these transport types are analyzed. These two transport types make up 89,9% of all transport types in urban areas and 97,4% in suburban areas (see table 2 in the results section). The popularity of walking and driving is compared between *area types* as well as an analysis of the average travel time for both transport types.

To analyze the validity of H_3 the variable *income* is introduced. Respondents were asked to which income group they belong. The income groups that respondents could choose from are aligned with the corresponding Federal poverty line of 2017. The first income group is the minimum income level for a one-person household, the second income group for a two-person household etc. (U.S. Department of Health & Human Services, 2017). The reported income will then be divided by the amount of people in a household, giving a binary variable showing whether a household qualifies as a low-income household. *Healthy food access* is then compared between income groups for the *area types*.

H_4 is checked by adding *car access* to the equation. Respondents were asked if they own or have access to a car to use for grocery shopping. The level of *healthy food access* is then compared between those who have car access and those who do not. The influence of *car access* in the different *area types* and different *income levels* are also analyzed.

To check H_5 all previously introduced variables are compared for two groups: those who live in a food desert (a travel time of >10 minutes to the nearest supermarket) were compared to those who do not live in a food desert.

To test these various hypotheses t-tests for independent samples were used. Independent sample t-tests compare two independent groups to find if there is statistical evidence that the population means are significantly different. This statistical test is useful to compare the mean travel times against each other for the different variables. The sample is close to normally distributed but nevertheless slightly skewed to the right but due the large number of cases a t-test is a valid statistic to compare averages. This is based on the Central Limit Theorem (Field, 2013, p171-172). Lumlet, Diehr, Emerson and Chen (2002) argue that the major usefulness of the t-test comes from "the fact that in large samples they are valid for any distribution". As the smallest

sample size used for this study is *N = 258*, T-tests for independent samples are an acceptable choice.

Ethical considerations

As far as I can estimate, nobody was harmed directly or indirectly by my thesis. The questions were not very personal or sensitive and respondents could stop with the questionnaire at any time. This was also stressed in the introduction text of the questionnaire. Respondents interested in the results can receive these on the group level but not on the personal level. I have avoided any plagiarism and ensured the quality of my research. This also included working independently and impartially to the best of my knowledge and belief. The data used for this study was gathered and stored anonymously and will not be used for other purposes than academic research.

Results

Food access by area type

To test the expectation that inhabitants of suburban areas have a reduced access to healthy food compared to inhabitants of urban areas (H_1), the average travel time to the nearest supermarket is compared for people living in urban and suburban areas. Urban inhabitants take significantly longer to travel to the nearest supermarket than suburban inhabitants (table 1). Whilst being statistically significant, the practical significance is marginal with the actual time difference being 18 seconds. No indication of a food desert is found in this result as travel times stay well below the 10 minutes that Jiao, Moudon and Drewnowski (2011) have specified to constitute a food desert.

Table 1 - Travel time to the nearest supermarket by area type

	Urban	Suburban	*% difference*
Average travel time to the nearest supermarket (minutes:seconds)	6:21	6:03	*4.96****[1]

*$p < .05$, ***$p < .001$
[1] *$t(4471) = -2,106$*

The fact that the average urbanite takes longer to travel to their nearest supermarket than the average suburbanite contradicts H_1. This result does not necessarily mean that the spatial characteristics of suburban areas that Frenkel and Ashkenazi (2008) describe are not of negative influence on the distance to healthy food. Other factors such as income, car access and preferred modes of transport can compensate for the adverse effects of suburban spatial characteristics. This result could also be influenced by the movement of food retailers towards suburban areas as they follow their high-income clientele, as argued by Larsen and Gilliland (2008). Factors such as income, car access and preferred mode of transport will shed more light on groups with reduced access to healthy food.

Preferred mode of transport by area type

To test the expectation that individuals who walk to access healthy food have longer travel times than those who drive (H_2), the preferred mode of transport is compared for each area type. By doing this a possible explanation for the rejection of H_1, that suburban inhabitants have a reduced access to healthy food when compared to urban inhabitants, presents itself. In line with H_2, table 2 shows that urban inhabitants are significantly more likely to walk to do their groceries when compared to suburban inhabitants. Meanwhile suburban dwellers are significantly more likely to use a car to access healthy food. The preference of walking in urban areas might be dictated by the shorter physical distance to supermarkets whilst increasing the temporal distance due to slower movement speed. Factors such as limited parking space, high parking costs and

congestion levels also might drive urban dwellers to walk more. The preference for using a car in the suburbs can be explained by the spatial characteristics of these areas, the larger distances make it much less feasible to walk to the supermarket. Suburban areas might also see more large-scale retailers with extensive parking facilities, making car access easier. The amount of groceries that the transport modes can carry was not included in this analysis but is also a motive for people to choose driving over walking.

Table 2 - Preferred mode of transport for grocery shopping by area type

		Urban	Suburban	*% difference*
Preferred mode of transport (%)	Walking	25.5	3.3	*22.2***[1]*
	Car	64.4	94.1	*29.7***[2]*
	Other	10.1	2.6	*7.5*

*$p < .05$, ***$p < .001$
[1]t(4541) = -24.204; [2]t(4541) = 28.032;

After looking at the influence of area type on travel times and the preference for walking and driving in urban and suburban areas the logical next step is to combine the two. In contrast to H_2 Table 3 shows no significant difference in driving to get groceries between both area types but comparing walking distances shows an interesting difference. Walking to the nearest supermarket is significantly faster in urban areas. This supports H_2 which expects that the travel time to the nearest supermarket by walking is longer in suburban areas than in urban areas. This can be interpreted as an indication that the sprawling nature of suburban areas influences the necessity of driving to access healthy food. Walking distances in urban areas are short enough for a significant percentage of the population to consider walking to buy their groceries. In contrast, supermarkets in suburban areas are simply too far away for a significant part of the population to access them by foot. This is in line with the findings of Giarratani and Rogers (1991) that due to reduced population density and increased sprawl suburban areas have longer physical travel distances to retail areas. Travel times for suburban inhabitants who walk to do their groceries are getting close to the 10-minute norm that Jiao et al. (2011) use to define a food desert and as such could be seen as a group that has potential to have reduced access to healthy food. Contrary to H_2 comparing driving times does not reveal a difference in travel time between area types.

Table 3 - Average travel time to the nearest supermarket by area type and preferred mode of transport.

		Average travel time to the nearest supermarket (minutes:seconds)		
		Urban	Suburban	*% difference*
Preferred mode of transport	Walking	7:08	9:28	*32.71*** [1]
	Car	5:45	5:50	*1.45*
	% difference	*24.06*** [2]	*62.29*** [3]	

**p < .05, ***p < .001*
[1] t(489) = 3.449; [2] t(1392) = 5.217; [3] t(2875) = 8.458

Comparing walking to driving shows that driving is significantly faster in both urban and suburban areas (table 3). The 3:38 minutes difference between driving and walking in suburban areas reinforces why 94% of suburban residents use their car to travel to their nearest supermarket: it is much faster.

Food access by income group and area type

The validity of the expectations outlined in H_3, which expects that income has a negative effect on individual access to healthy food is tested by comparing travel times for the different income levels in each area type. Table 4 shows that in both urban and suburban areas people with a low income have significantly longer travel times. Low income households in both area types take significantly longer to travel to their nearest supermarket. Urban low-income households travel significantly longer to their nearest supermarket when compared to their suburban counterparts.

As travel times increase for low income households the first part of H_3, which expected a reduced income to have a negative impact on an individual's access to healthy food, is confirmed. This still leaves the question where the cause for this difference in travel time lies. As this analysis has already shown that traveling by car is the fastest transport option, a longer travel time might well be connected to the access an individual has to a car. Suburban poor have shorter travel times to the nearest supermarket than urban poor. This contradicts the second part of H_3 which expected low income suburban travel times to be longer than in urban areas.

Table 4 - Travel time to the nearest supermarket by income and area type

		Urban	Suburban	*% difference*
Average travel time to the nearest supermarket (minutes:seconds)	Low Income	7:50	6:43	*16.63*[*1]
	≠Low Income	6:01	5:58	*0.84*
	% difference	*30.19*[***2]	*12.57*[***3]	

*$p < .05$, ***$p < .001$
[1] t(541) = -2.564; [2] *t(2857) = -2,761;* [3] *t(1511) = -5,711*

Food access by car access, income group and area type

H_4, which expects that car access is higher in suburban areas is tested by comparing the levels of car access between income types and area types. In both area types there is a significant difference in car ownership between both income levels (table 5). In both area types those not belonging to the low-income group are significantly more likely to have access to a car than those who do have a low income. A difference between area types also exists, low income suburban inhabitants are significantly more likely to have access to a car compared to their urban counterparts, supporting the first part of H_4. People in suburban areas who do not belong to the low-income group are significantly more likely to have access to a car than people in urban areas. These differences can be interpreted as evidence that the spatial characteristics of suburban areas force its inhabitants into using a car.

Table 5 Car access by income group and area type

		Urban	Suburban	*% difference*
% Car access	Low Income	70	87	*17*[***1]
	≠Low Income	83	97	*14*[***2]
	% difference	*13*[***3]	*10*[***4]	
	Total	81	96	*15*[***5]

*$p < .05$, ***$p < .001$
[1] t(553) = 4.789; [2] t(3884) = 16.664; [3] t(1543) = 4.854; [4] t(2894) = 9.444; [5] t(4541) = 17.599

To show the effect of the difference in car access on the level of food access the variable 'average travel time to the nearest supermarket' is added to the analysis, this is shown in table 6. Those who have access to a car have significantly lower travel times than those who do not have access to a car in both income groups and in each of the area types. This confirms the second part of H_4. Three out of four groups are within one minute of the food desert norm. One group, the urban poor without car access, exceeds the food desert norm by 5 seconds. Note that this is the only duration this research has found that would confirm the existence of a food desert as defined by Jiao et. al. (2011). These three groups have an increased risk to have a reduced access to healthy food.

Table 6 - Average travel time to the nearest supermarket by area type, income and car access

		Average travel time to the nearest supermarket (minutes:seconds)					
		All Income Groups			Low Income		
		Urban	Suburban	*% difference*	Urban	Suburban	*% difference*
Car Access	Yes	5:55	5:56	*0.28*	6:53	6:18	*9.26*
	No	8:13	9:05	*10.55*	10:05	9:25	*7.08*
	% difference	*38.87***[1]*	*53.09***[2]*		*46.49***[3]*	*49.47***[4]*	

*$p < .05$, ***$p < .001$

[1] *t(1531) = -7.603;* [2] *t(2938) = -7.429;* [3] *t(258) = -4.290;* [4] *t(281) = -4.180*

Summarizing the results, when taking into account either all income groups or only those with a low income, having access to a car can be linked to having shorter travel times to the nearest supermarket and thus having better access to healthy food. These results are in line with the expectations based on seeing reduced car ownership among low income groups (US Department of Transportation 2014).

Car access and income levels by food access and area type

The previous sections show that reduced car access and low income increase the chance of longer travel times to healthy food. Those without car access are significantly more likely to have a reduced access to healthy food. The same effect is seen when looking at income, and when these factors are combined the effect is even stronger. To see if this is also visible when comparing the characteristics of people living in a food desert to those who do not two groups are compared. Those who report to have a travel time to the nearest supermarket of more than 10 minutes and those with a travel time of 10 minutes or less. For each group the level of car access and percentage of low income households are analyzed in both urban and suburban areas. If previous results can be trusted individuals that have a travel time to the nearest supermarket that is longer than 10 minutes should have a reduced level of car access and be more likely to have a low income, this corresponds with H_5.

Table 7 shows a pattern that is already becoming familiar, those who have a long travel time are significantly less likely to have access to a car and are significantly more likely to have a low income confirming H_5. People in urban areas are significantly less likely to have access to a car and significantly more likely to have a low income. The fact that individuals who live in suburban food deserts are significantly less likely to be poor than those in urban areas could signify that people in suburban food desert areas are more capable to deal with the increased distance to healthy food and willingly choose to live further away from places where healthy food can be accessed. The results in table 7 reconfirm previous results that show the connection between car access, income and the access to healthy food.

Table 7 - Car access and low income levels by area type and food access

		10< minutes travel time	>10 minutes travel time	*% difference*
% Car Access	Urban	83	66	*17*** [1]
	Suburban	97	88	*9*** [2]
	% difference	*14*** [3]	*22*** [4]	
	Total	92	79	*13*** [5]
% Low Income	Urban	15.30	34.69	*19.39*** [6]
	Suburban	9.46	15.21	*5.75*** [7]
	% difference	*5.84*** [8]	*19.48*** [9]	
	Total	11.45	23.08	*11.63*** [10]

*$p < .05$, ***$p < .001$

[1] *t(1531) = 5.199;* [2] *t(2938) = 6.788;* [3] *t(4098) = 16.629;* [4] *t(371) = 5.494;* [5] *t(4471) = 8.659;* [6] *t(1511) = -5.988;* [7] *t(2857) = -2.727;* [8] *t(4006) = -5.520;* [9] *t(362) = -4.433;* [10] *t(4370) = -6.468*

Conclusions

The aim of this study was to compare the access to healthy food of individuals in urban and suburban areas in the United States. To analyze this, this thesis asked the following main research question: *to what extent does a difference in spatial characteristics influence the individual access to healthy food in the United States?* One specific group was found to have a reduced level of access to healthy food that is likely to be caused by spatial characteristics: suburban inhabitants who walk to do their groceries travel significantly longer to reach their nearest supermarket than their counterparts in urban areas. By answering the various sub questions in the following paragraphs an answer to the main question is formulated.

Individuals living in urban areas have a slightly longer travel time to their nearest supermarket in comparison to their suburban counterparts. A possible explanation for this counterintuitive result might lay in the increased choice to use walking as preferred mode of transport for grocery shopping in urban areas. Though statistically significant, the practical difference in travel time is negligible. The increased physical distances in suburban areas, outlined by Frenkel and Ashkenazi (2008), might still be of influence on travel times in suburban areas but on its own this factor is not enough to cause a decreased level of access to healthy food. The increased level of coverage recognized by Larsen and Gilliland (2008) could very well compensate for the increased distances in suburban areas. Answering the first sub question: there is a difference in food access between area types, but the practical difference is negligible.

Analysis of food access by walking and driving shows that travel times by driving are shorter than by walking in both area types. Furthermore, suburban inhabitants that walk to reach their nearest supermarket take longer than their urban counterparts. This underlines the difference in the distances needed to be bridged between suburban and urban areas (Barrington-Leigh and Millard-Ball, 2015). This difference is also visible in how many times a mode of transport is used in the different area types. Whilst car users are the majority across both area types, this preference is much stronger in suburban areas where 94.1% of respondents use a car against 64,4% for urban areas. These results are also in line with findings by Kirouac-Fram (2012) that suburban poor are disproportionately affected by not having access to a car. Travel times for individuals that drive to their nearest supermarket do not differ between area types. Factors such as congestion and a reduced amount of parking space in city centers offer possible explanations why urban driving times are not found to be shorter. This might be of interest for further analysis in future research. Together these results give an insight into the extent in which modes of transport differ for different area types which is the subject of the second sub question.

In both urban and suburban areas those with low income have longer travel times to supermarkets, which confirms previous research stating that low income groups have reduced access to healthy food products (Levine, 2011). However, it is suspected that the higher share of car access in suburban areas makes up for the increased distance to services, even among low income groups, this is expanded upon below. The shorter travel times for low income suburban inhabitants, in comparison to urban inhabitants, can also be interpreted as evidence for the effects of the movement of services from downtown to the suburbs as is described by Larsen and Gilliland (2008). These results lead to the following answer to the third sub question: low income groups

have a reduced access to healthy food and urban poor have reduced healthy food access compared to suburban poor. Future research could study whether longer travel times for people with low income is a general phenomenon in the U.S. or whether this is more predominant in food deserts.

Having access to a car is found to be a factor in the level of access to healthy food an individual has, this is true in urban as well as suburban areas. Car access is significantly higher in suburban areas. This is likely a consequence of the spatial characteristics necessitating car access to remain mobile in these areas (Barrington-Leigh and Millard-Ball, 2015). Taking income into account shows that the suburban poor have a higher level of car access than the urban poor. This difference in car access is not found when looking at travel times. In contrast to the comparison of the choice of transport types, this result is not in line with the idea that suburban poor that remain without access to a car are extra hampered in their ability to access healthy food products. This was expected due to their small activity area being a greater hindrance than in urban areas where there is less sprawl (Hirsch et al. 2014; Kirouac-Fram, 2012).

Comparing those with a reduced access to healthy food to those without shows that income and car access are lower for those who with reduced access to healthy food. Comparing area types shows that urban areas have lower levels of car access and are more likely to have a low income than suburban areas. Future research could investigate if there is a difference in the amount of influence a reduced access to healthy food has for the different area types. These findings confirm what previous research has found to be characteristics of food deserts, namely a reduced level of income (Beaulac et. al., 2009) and car access (US Department of Transportation, 2014). Furthermore, all the results discussed above highlight the importance of separately assessing suburban areas. The results show that suburban areas have different spatial characteristics that seem to have an influence on people's access to healthy food. Being better able to recognize factors that decrease access to healthy food can result in a more direct approach in increasing food access.

To conclude, this study only finds one place where spatial characteristics are of significant negative influence on healthy food access. Due to increased distances in suburban areas those who walk to do their groceries see a reduced level of access to healthy food. This does not mean spatial characteristics are not of influence on the access to healthy food of other groups, but other factors compensate for this disadvantage in spatial characteristics. The analysis shows that food deserts are not confined to local spaces in which everyone has reduced access to healthy food. Food deserts can exist for specific groups of people whilst not existing for others living in the same area. Transport types, car access and income are essential factors that can cause people to have a reduced access to healthy food and play a more important role than the spatial differences between urban and suburban areas.

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Attachments

Attachment 1: Survey

Start of Block: Intro

Intro Thank you for taking the time to fill out this survey. By doing so, you are helping me with my research about the spatial characteristics of a healthy food supply. I'm writing my bachelor thesis about this subject in light of my study Human Geography & Planning at the University of Groningen in the Netherlands. This questionnaire will take about 10 minutes. Please read all questions carefully, there are no right or wrong answers. I am interested in your personal point of view. All responses to this questionnaire are confidential. Please answer all questions. By filling out this questionnaire you have a chance of winning your own custom engraved water bottle by Jace Design. These will be randomly awarded to 3 respondents. To participate enter your email or instagram name at the end of the questionnaire. Participation is NOT required. Once again, thank you for your time! A Map A Day amapaday@gmail.com

End of Block: Intro

Start of Block: Mode of Transport

1 What mode of transport do you most frequently use to travel to buy your groceries?

- ○ Walking
- ○ Cycling
- ○ Car
- ○ Public Transport
- ○ Taxi
- ○ Other
- ○ None

Page Break

2 What is your second most used mode of transport to travel to buy your groceries?

- ○ Walking
- ○ Cycling
- ○ Car
- ○ Public Transport
- ○ Taxi
- ○ Other
- ○ None

Page Break

3 What is the shortest distance you have to travel to your nearest supermarket or grocery store by your preffered mode of transport? State your answer in minutes travel time (one-way trip).

_____

Page Break

4 Do you own or have access to a car?

- ○ Yes
- ○ No

Page Break

5 How often is your household **able to** eat fresh fruits and vegetables?

- ○ Daily
- ○ 4-6 times a week
- ○ 2-3 times a week
- ○ Once a week
- ○ Never

Page Break

6 How **affordable** is the use of public transport to reach your nearest supermarket or grocery store for you? (Skip if you never use public transport)

- ○ Extremely affordable
- ○ Somewhat affordable
- ○ Neither unaffordable nor affordable
- ○ Somewhat unaffordable
- ○ Extremely unaffordable

Page Break

7 How do you rate the **ease of access** to public transport to reach your nearest supermarket or grocery store? (Skip if you never use public transport)

- ○ Extremely easy
- ○ Somewhat easy
- ○ Neither easy nor difficult
- ○ Somewhat difficult
- ○ Extremely difficult

Page Break

8 Please rate how easy it is for you to access a place that sells fresh fruits and vegetables in your neighbourhood.

- ○ Extremely easy
- ○ Somewhat easy
- ○ Neither easy nor difficult
- ○ Somewhat difficult
- ○ Extremely difficult

Page Break

End of Block: Mode of Transport

Start of Block: Demographics

D1 I am

- female
- male
- I don't know / other

D2 What is your age?

_____

Page Break

D3 In which country do you currently reside?

▼ Afghanistan ... Zimbabwe

Page Break

D3B What is your ZIP code?

_____

Page Break

D4 In what type of area do you live?

- ○ Rural
- ○ Suburban
- ○ Urban
- ○ I don't know

Page Break

D5 Which statement best describes your current employment status?

- ○ Working (paid employee)
- ○ Working (self-employed)
- ○ Not working (looking for work)
- ○ Not working (retired)
- ○ Not working (disabled)
- ○ Not working (other) _____
- ○ Prefer not to answer

Page Break

D6 Of how many people does your household consist?

- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5
- ○ 6
- ○ More than 6

Page Break

D6B Please indicate the answer that includes your entire household income in (previous year) before taxes.

- ○ Less than $12,000
- ○ $12,000 to $15,999
- ○ $16,000 to $19,999
- ○ $20,000 to $24,999
- ○ $25,000 to $39,999
- ○ $40,000 to $99,999
- ○ $100,000 or more

Page Break

End of Block: Demographics

Attachement 2