Prescription Drug Costs in Flint, Michigan

BY

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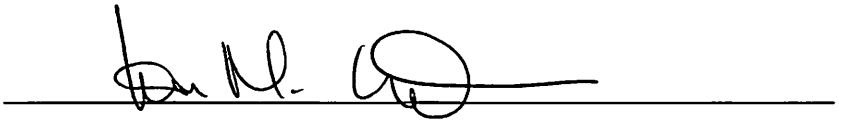
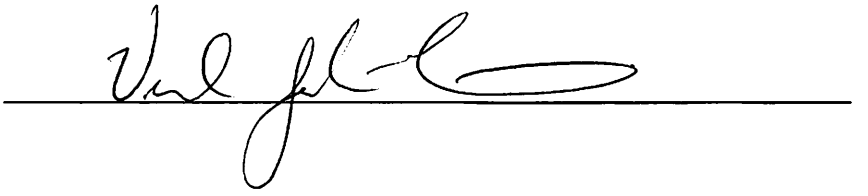


First Reader: Assistant Professor Lisa M. Lapeyrouse, Ph.D.



Second Reader: Assistant Professor Vicki Johnson-Lawrence, Ph.D.

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Dedication

This work is dedicated to my daughter, Olivia Ashton, whose unexpected arrival brought meaning and joy to an old man's life, and also to Laura Hatfield, my best friend and confidant, who has helped and supported me throughout my academic career. .

Acknowledgments

Foremost, I would like to express my sincere gratitude to my advisor, Assistant Professor Lisa M. Lapeyrouse, Ph.D. for the continuous support of my study and research, for her patience, motivation, enthusiasm, immense knowledge, and friendship. Her guidance helped me to successfully navigate the Master's program in Health Education and in the writing of this thesis. I could not have imagined having a better advisor and mentor.

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Finally, my sincere thanks also goes to Dr. Suzanne Selig, Ph.D., Professor and Director of the Department of Public Health and Health Sciences at the University of Michigan Flint, who mentored me throughout my academic career and provided unlimited support and encouragement.

Abstract

Objectives. We sought to determine the role of three neighborhood characteristics (median income, crime, and racial/ethnic composition) on the accessibility and price of four commonly prescribed diabetes medications in the city of Flint, Michigan.

Methods. Using 2009-2013 American Community Survey Data, Census block group data was used to identify geographic areas with similar population sizes. A 1-mile radius from the center of each block group selected was used to identify pharmacies. A total of (n = 35) pharmacies were identified using ReferenceUSA data. The identified pharmacies were telephoned and asked the out of pocket costs for a 30 and 90-day supply of four diabetes medications.

Results: With regard to pharmacy accessibility, we found that a majority of the pharmacies included in the study (82%) were located in Census Block Groups with a higher median income (≥ $20,000), while only 36.4% of all pharmacies studied were located in predominantly African-American neighborhoods. Additionally, we found that pharmaceutical prices may also be adversely affected by neighborhood characteristics, with 80% of the higher priced independent pharmacies (Gellad, Choudhry, Friedberg, Brookhart, Haas & Shrank, 2009) found in block groups reporting higher crime figures.

Conclusions: This study offers new data to suggest that diabetic residents living in low income, high crime, predominantly African-American neighborhoods may experience greater difficulty with pharmacy accessibility, and also may pay more for their medications once they have located a pharmacy in their neighborhood.

Word Count: 233

Introduction

Prescription Drug Costs in Flint, Michigan

In any discussion of the management of diabetes, the importance of pharmaceutical access and affordability cannot be overstated. The price of pharmaceuticals can impact a patient's ability to purchase needed medication(s) (Sinha, Hoerger, Rajan, & Pogach, 2010). If a person cannot afford needed prescription medications, they may be less compliant with medicine regimens (Mojtabai & Olfson, 2003). Noncompliance, particularly with regard to diabetes, can lead to further health complications, increasing the risk of disability, disease progression, and mortality (Gaskin, Thorpe Jr, McGinty, Bower, Rohde, Young, LaVeist, & Dubay, 2014). Differences in prescription drug prices may contribute to disparities in health experienced among poor and vulnerable populations, who have limited access to health resources such as pharmacies, and financial resources to afford needed medications (Chernew, Gibson, Yu-Isenberg, Sokol, Rosen, Fendrick, 2008). Additionally, the neighborhood in which an individual resides can also be an important factor in determining that individual's overall health (Cromley, Kleinman, Ramos, Arniella, Viswanathan, Garel, & Horowitz, 2011; Schulz, Zenk, Israel, Mentz, & Stokes, 2008).

People living in low-income neighborhoods are likely to experience multiple dimensions of poor environmental and social quality, including higher-priced yet lower quality foods, poor quality housing, and limited transportation, all of which may lead to poorer health outcomes (Brown, Ang, & Pebley, 2007; Stafford and Marmot, 2003). Further, individuals with chronic conditions, such as diabetes, may be particularly vulnerable to these dimensions of neighborhood deprivation (Brown et al., 2007). For residents with chronic conditions, living in a low-income neighborhood has been linked to functional decline (Brown et al., 2007) and higher

incidence and prevalence rates of diabetes, cardiovascular disease, cancer, and all-cause mortality (Brown et al., 2007; Stafford & Marmot, 2003). Additionally, evidence indicates that low income, economically disadvantaged neighborhoods experience higher rates of crime, which in turn leads to disinvestment and a decrease in community and health resources such as general retail activity, including pharmacies (Raleigh & Galster, 2015; Hipp, 2010; Krivo & Peterson, 1996).

Residents in low-income neighborhoods are typically undersupplied with health services such as community pharmacies (Stanley, Cantor, & Guarnaccia, 2008), causing residents to experience significant travel distances and financial barriers when attempting to access healthcare (Bowie, Beere, Griffin, Campbell, & Kingham, 2013). Also, many low-income neighborhoods are characterized as "medication deserts," which are defined as "the low availability of the most commonly dispensed prescription medications in these areas" (Amstislavski, Matthews, Sheffield, Maroko & Weedon, 2012; Morrison, Wallenstein, Natale, Senzel, & Huang, 2000). Medication deserts are an especially significant barrier to care for low-income neighborhoods, because the community pharmacy is a critical source medication and other health services to residents (Amstislavski et al., 2012). Further evidence indicates that many essential community health resources in low-income areas, such as pharmacies, appear to capitalize on resident dependence by charging higher drug prices than in more affluent neighborhoods (Cave, 2006).

Health resources, such as pharmacies, may be limited in low-income neighborhoods. Pharmacies in low-income neighborhoods may charge more for commonly prescribed medications, due to the increased costs of operation attributable to higher crime rates and greater security costs, such as higher insurance premiums, alarm systems, and guards, etc.

As a result of these increased operating costs, the pharmacies may pass the cost of operating in lower income neighborhoods on to their customers, thus decreasing the ability of the consumer to obtain or maintain their medication regimen (Cave, 2006). These costs may therefore contribute to poorer health outcomes experienced by the residents of low-income neighborhoods, who have limited access to health resources such as pharmacies and financial resources to afford needed medications (Chernew, et al., 2008).

To date, no studies investigate the relationship of neighborhood characteristics (i.e. median income, crime and race/ethnicity) and pharmacy access. Further, only one study was identified that examined the relationship between higher pharmacy prices and low income areas (Gellad et al. 2009). Given these gaps in the existing literature, the purpose of the current research is to answer the following two questions: (1). Is there a relationship between neighborhood characteristics (median income, crime, and racial/ethnic composition) and access to pharmacies, and (2). Is there a relationship between neighborhood characteristics and pharmacy prices?

Review of Literature

Pharmacy Access

Medication adherence is a critical factor in any successful therapeutic regimen (Sherbourne, Hays, Ordway, DiMatteo, & Kravitz, 1991), particularly with regard to the management of chronic conditions such as diabetes (Sinha et al., 2010). If a chronically ill patient is to obtain needed medications, ready access to pharmacies is also critically necessary (Stanley et al., 2008).

People in low-income neighborhoods, particularly low-income minority communities, suffer disproportionally more from chronic diseases and premature death (Kawakami, Winkleby, Skog, Szulkin, & Sundquist, 2011). A factor contributing to this increased health risk is lack of health care access as well as quality of care (Hawthorne & Kwan, 2013). For example, urban neighborhood residents, especially those with lower incomes, are often faced with a problematic and highly unequal landscape of healthcare providers. As doctors and pharmacies leave declining urban neighborhoods and seek to relocate to more affluent suburban neighborhoods, the remaining inner-city residents are left with fewer and fewer healthcare resources (Hawthorne & Kwan, 2013).

People in low-income communities often live in medically underserved areas, meaning they have limited access to health care services such as pharmacies. Pharmacies are important because in low-income communities, pharmacies not only provide access to needed pharmaceuticals, but act as a primary source of health information to low-income residents (Amstislavski et al., 2012). Without access to pharmacies, low-income residents may be less capable of receiving needed health information and medication to manage their chronic conditions, thus further exacerbating health inequities experienced by low-income residents and communities alike.

Complicating issues of access, is research that finds that not only do low-income communities face limited access to pharmacies, but may also lack access to commonly prescribed medications (Morrison et al., 2000). This combination of limited access to pharmacies, as well as limited access to commonly prescribed medications, makes the management of chronic conditions harder for low-income residents.

Prescription Drug Prices

Differences in prescription drug prices may contribute to disparities in health experienced among poor and vulnerable populations, who have limited access to health resources such as pharmacies, and financial resources to afford needed medications (Chernew et al., 2008). Additionally, studies indicate that poor adherence to medication regimens is associated with low income level and high out-of-pocket spending for drugs (Mojtabai & Olfson, 2003). Further, research performed by Gallad et al. (2008), found that individuals living in low-income zip codes pay more for prescription drugs than individuals living in more affluent zip codes.

Population Size of Neighborhood with Regard to Pharmacy Accessibility and Price

Based on comparisons of pharmacy access between small and large neighborhoods, research suggests that high-income neighborhoods with greater population density have better pharmacy access, primarily due to the presence of larger numbers of chain pharmacies (Amstislavski et al., 2012; Gellad et al., 2009; Stratton, 2001). A chain pharmacy is defined as any pharmacy that has four or more retail locations, while an independent pharmacy generally has a single location and is owned by the proprietor (Doucette, Brooks, Sorofman, & Wong, 1999). On average, chain pharmacies offer lower prices because they purchase greater amounts of medications and supplies. This is based on the needs of multiple locations, which allows chain pharmacies to negotiate a better price from wholesalers and manufacturers (Gellad et al., 2009). Based on this research, we hypothesized that high income neighborhoods with a larger population size and greater infrastructure would equal more customers, greater competition, and would have better pharmacy access and lower prescription costs.

Income

Affluent neighborhoods are positively associated with the availability of health enhancing services and resources, such as pharmacies (Wen, Browning, & Cagney, 2003). Conversely, residents in less affluent neighborhoods are typically undersupplied with pharmacies (Cave, 2006). To underscore this point, a study by Amstislavski et al.(2012) found that low income neighborhoods experience economic barriers in the accessibility of pharmacies and the procurement of medication in low income neighborhoods (Amstislavski et al., 2012). Finally, there is evidence to suggest that pharmacies in less affluent neighborhoods capitalize on resident dependence by having higher drug costs than in more affluent neighborhoods (Cave, 2006)

The Effect of Crime in Informing Neighborhood Characteristics

Neighborhoods with more crime tend to experience increasing levels of residential instability, more impoverished residents, and a worsening retail pharmacy environment (Hipp, 2010). As a number of U.S. cities continue to decline, the remaining neighborhoods within the affected cities empty out and decay, leaving only those residents who cannot afford to move. The consequences of such urban depopulation, disinvestment, and abandonment often results in higher crime rates among affected neighborhoods (Raleigh & Galster, 2015). Studies suggest that low-income neighborhoods experience higher rates of crime which in turn leads to a decrease in community and health resources such as retail pharmacy outlets, particularly chain pharmacies (Brown et al., 2007; Stafford & Marmot, 2003). Due to increased expenses related to operating in high crime areas (higher insurance premiums, alarm systems, and guards), independent pharmacies in low-income, high crime areas often charge more for commonly prescribed medications than in more affluent areas (Gellad et al., 2009).

Race/Ethnicity

While the racial or ethnic composition of a neighborhood does not in itself predict high levels of crime or low income for its residents, long-standing practices of racial residential segregation have concentrated black poverty in the small number of areas where African-Americans live. In other words, because blacks are not spread evenly across the urban area, their poverty cannot be evenly distributed across space (Peterson & Krivo, 1999). In contrast, whites experience low levels of concentrated disadvantage because whites themselves have low rates of disadvantage and they insulate themselves from black disadvantage through segregation (Peterson & Krivo, 1999).

Many areas in the United States are racially segregated (LaVeist, Thorpe Jr, Bowen-Reid, Jackson, Gary, Gaskin & Browne, 2007), where differences in social and environmental health-risk exposures as well as infrastructure supportive of a healthy lifestyle vary by race. For example, racial segregation leads to race differences in the availability of critical community resources such as supermarkets and pharmacies (La Veist, et al., 2007). Stanley et al (2008) reports that African-Americans were almost twice as likely and Hispanics were 1.5 times as likely to report a prescription drug access problem compared with whites (Stanley et al., 2008). Additionally, (Morrison, Wallenstein, Natale, Senzel, & Huang, 2000) conducted a survey of pharmacies in New York City and found that the availability of common medications reduced as the proportion of racial/ethnic minorities increased (Morrison et al (2000)

In 2012, Kwate et al. (2012) examined retail redlining in New York City. Retail redlining is defined as "spatial discrimination whereby retailers, particularly chain stores, failed to serve neighborhoods or target them for unfavorable treatment based on the racial composition of the customers and/or the store operators" (Kwate, Meng Loh, White, & Saldana, 2012, p. 634). The study found that while retail demand was often similar across areas of varied racial and

socioeconomic composition, as the percent of black residents in a neighborhood increased, the distance to the nearest pharmacy also increased. In particular, Kwate et al. (2012) found that chain pharmacies have less coverage of urban communities with a low percentage of white residents (Kwate et al., 2012).

Purpose of This Study

In this research study we aim to answer two questions:

1. Is there a relationship between neighborhood characteristics (median income, crime, and percent African American) and access to pharmacies?
2. Is there a relationship between neighborhood characteristics and pharmacy prices?

The implications of this research study is that we will gain important knowledge about local community health resources such as the relationship between neighborhood characteristics, pharmacy access, and variability among diabetes prescription drug costs. This information can be used to inform diabetic patients about the benefits of comparison-shopping for needed prescription medications as well as help public health professionals advocate for standard prescription pricing.

Study Design and Methodology

Study Setting

Flint Michigan was chosen as the site of this study for three primary reasons. First, Flint is recognized as a food desert (McMillan, 2016). If the city lacks supermarkets, they may also lack other important retail outlets, such as pharmacies. Second, Flint has gained national attention as a site of environmental injustice, in which access to affordable and healthy food and safe water is limited (Kennedy, 2015). Finally, Flint residents suffer disproportionately more from a number of chronic conditions (Community health needs assessment report, 2016) than other cities of comparable size, which may be exacerbated by a lack of access to pharmacies and affordable medication.

Measures

Three neighborhood characteristics were chosen as independent variables. The three selected are: median income, crime of all types reported by the Flint Police Department between January and March of 2015, and percent African American.

Sample Selection

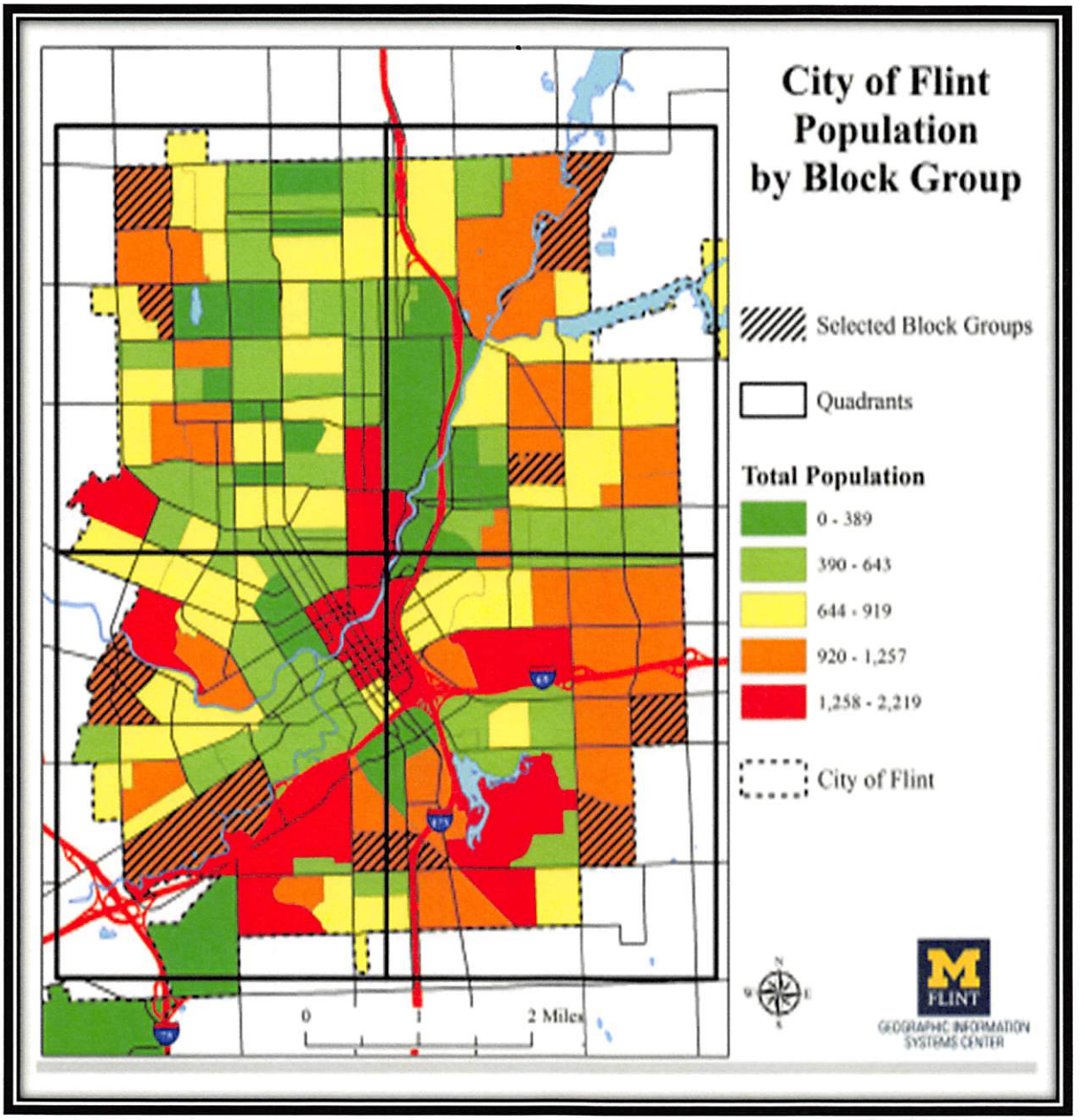
The sample population was selected with the aid of GIS, or Geographic Information System technology. GIS technology can be defined as a computer system with the capacity to capture, store, analyze, and display geographically referenced information (Musa, Chiang, Bavley, Keating, Lakew, Tsou, & Hoven, 2013). GIS analysis enabled us to select neighborhoods based on our variables of interest, namely population size, income, and racial/ethnic composition.

Using 2009-2013 American Community Survey Data, Census block group data was used to identify geographic areas with similar population sizes. Census Block Groups (CBG) of approximately 900-1,200 people were selected. As shown in table 12, the most populous and geographically diverse CBGs identified in the ACS data set, were those "neighborhoods" composed of 900-1220 residents. Given their population size and geographic diversity, these CBGs were considered to be ideal locations for studying access to retail establishments i.e., pharmacies. To ensure racial/ethnic and economic diversity, block groups were selected from four different geographic regions of the city of Flint. Northwest (quadrant 1), Northeast (quadrant 2), Southeast (quadrant 3), and Southwest (quadrant 4).

Table 12 displays a map of the City of Flint population by block group:

Table 12

City of Flint Population by Block Group

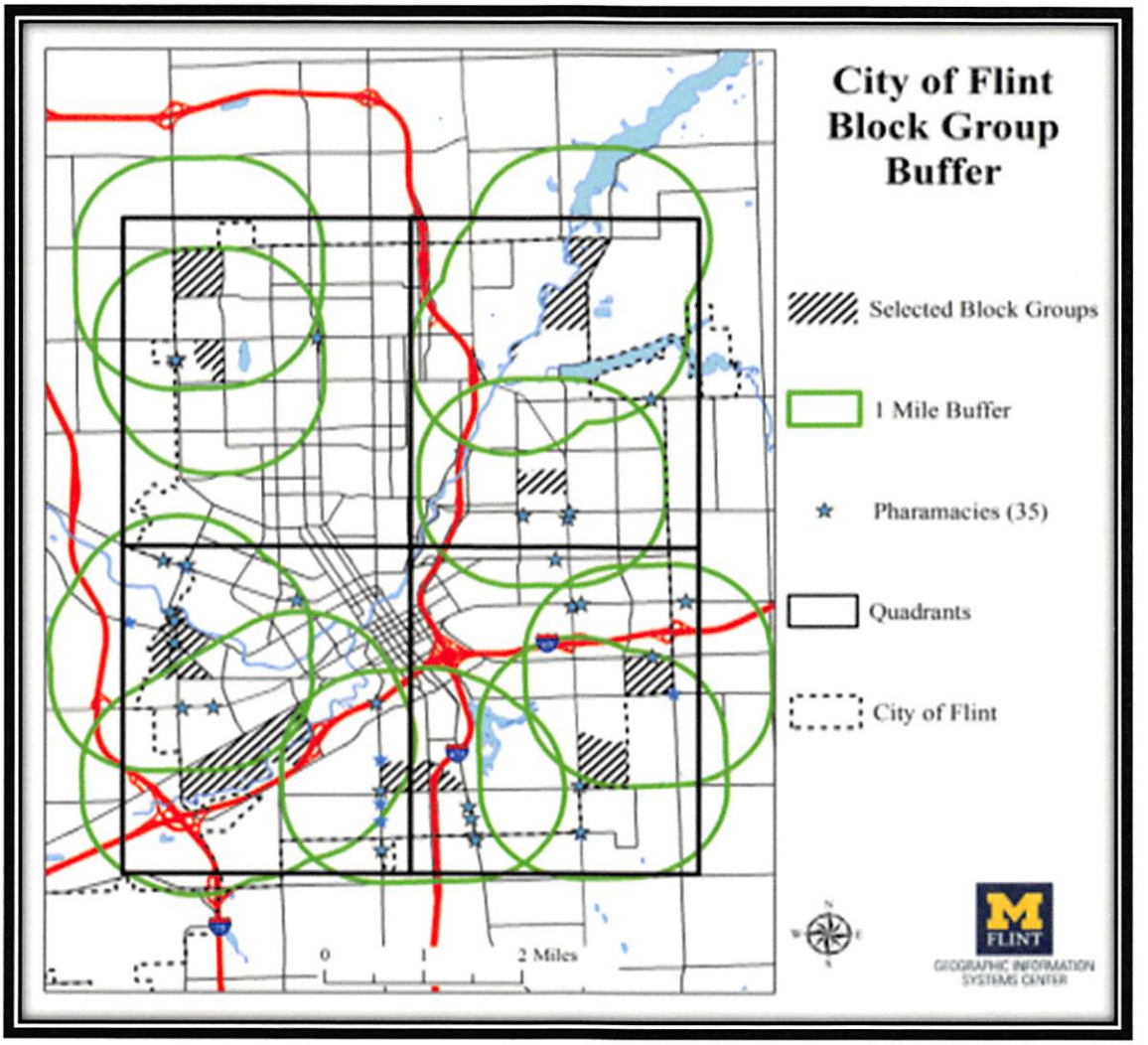


Sample: Pharmacy Identification

A 1-mile radius from the center of each block group selected was used to identify pharmacies. A total of 35 pharmacies were identified using ReferenceUSA data (n = 35).

Table 13

City of Flint Block Group Buffer



Data Collection Techniques

IRB Statement

This research study was approved by the Institutional Review Board of the University of Michigan-Flint.

The identified pharmacies were telephoned and asked the out of pocket costs for a 30 and 90-day supply of four commonly prescribed medications for diabetes: Glipizide 5mg (Glipizide: an oral and short-acting diabetes medicine that helps control blood sugar levels by helping the pancreas produce insulin); Metformin 500mg (Metformin: an oral and short acting diabetes medicine that helps control blood sugar levels); U-100 Humulin N (100 Humulin N: an injectable, human product form of insulin), and U-100 Novolin N (U-100 Novolin N: an injectable, human product form of insulin)

Over a two-week period, the pharmacies identified in the sample were called, and the out-of-pocket prices for a 30 and 90 day supply of Glipizide 5 mg and Metformin 500 mg was requested, as well as the prices for Humulin N (100 unit vial) and Novolin N (100 unit vial)

Data Analysis and Results

. As mentioned previously, eight of the pharmacies included in the sample had closed; four pharmacies did not dispense medications to the general public, and one pharmacy refused to participate, stating that they did not sell diabetes medications. With regard to chain pharmacies, the prices indicated for the Rite Aid pharmacies was based on the use of their RX discount card, which is offered to anyone without health insurance, free of charge. The prices indicated for the Walgreens pharmacies, however, did not include the use of their RX discount card, because the price for the card is $20. Table 14 displays this information.

Table 14

Sample Size

n = 35 Identified Pharmacies

Status	Number	Percentage
Closed	**8**	**22.8%**
Do not dispense medications to the general public	**4**	**11.4%**
Refused to participate	**1**	**2.86%**
Total sample	**22**	**62.9%**

To answer our first research question about the relationship between neighborhood characteristics and access to pharmacies, we examined median income, crime, and racial/ethnic composition relative to access to pharmacies. The following tables display the results.

Table 1

Block Group Rank by Median Income and Number of Pharmacies

(Lowest = 8; Highest = 1)

CBG	Median Income	Rank	# of Pharmacies
A	16,455	8	3
C	16,600	7	1
F	17,143	6	2
I	21,016	5	9
B	23,750	4	1
D	24,464	3	4
H	30,038	2	8
E	33,750	1	5

(Note - mean of total sample = 22,902; range = 17295; standard deviation = 6433. 868399; median = 22383)

Of the 33 pharmacies included in the study, 82% of the pharmacies were located in CBGs with a median income of ≥ $20,000, 42% of the pharmacies were located in CBGs with a median income = $20,000 - $29,999, and 39% of pharmacies were located In CBGs with a median income of ≥ $30,000. The data suggests that median income may play a role in determining the number of pharmacies (and therefore pharmacy access) to be found in a given neighborhood.

Table 2

Block Group, Median Income, and Number of (independent vs. Chain) Pharmacies

CBG	Median Income	Rank	# of Independent Pharmacies	# of Chain Pharmacies	Total Pharmacies
A	16,455	8	2	1	3
C	16,600	7	0	1	1
F	17,143	6	0	2	2
I	21,016	5	5	4	9
B	23,750	4	1	0	1
D	24,464	3	1	3	4
H	30,038	2	5	3	8
E	33,750	1	1	4	5

Because chain pharmacies generally offer lower prices than independent pharmacies (Gellad et al., 2009), their placement is important when discussing pharmaceutical affordability and access. Six pharmacies were located within the three CBGs composing the lowest income category for an average of two pharmacies; 14 pharmacies were located within the three CBGs composing the middle income category for an average of 4.6 pharmacies, and 13 pharmacies were located within the two CBGs composing the highest income category for an average of 6.5 pharmacies. The data suggests that median income may play a role in the placement of chain pharmacies, and therefore pharmaceutical access and affordability.

Table 3

Block Group Rank by Percent African American, and Number of Pharmacies

(Highest % = 8; Lowest = 1)

CBG	% African American	Rank	# of Pharmacies
B	100%	8	1
E	99%	7	5
A	96.3%	6	3
F	73.7%	5	2
C	59.6%	4	1
H	30.7%	3	8
I	17.5%	2	9
D	10.5%	1	4

(Note: total percentage of African-Americans residing in the city of Flint Michigan as of April 1, 2010: 56.6% (Quick Facts, Flint City Michigan, 2016)

A total of (n=12) pharmacies identified were located in predominantly African-American neighborhoods defined as CBGs with ≥ 50% African American residents. In contrast to this, 63.6% of all pharmacies studied were located in neighborhoods with the lowest concentrations of African-Americans, defined as CBGs with ≤ 50% African-American residents. The data suggests a relationship between racial/ethnic neighborhood composition and limited pharmacy placement and therefore accessibility in neighborhoods with a high percentage of African-Americans.

Table 4

Block Group, Percent African American, and Number of (independent vs. Chain) Pharmacies

CBG	% African American	Rank	# of Independent Pharmacies	# of Chain Pharmacies	Total Pharmacies
B	100%	8	1	0	1
E	99%	7	1	4	5
A	96.3%	6	2	1	3
F	73.7%	5	0	2	2
C	59.6%	4	0	1	1
H	30.7%	3	5	3	8
I	17.5%	2	5	4	9
D	10.5%	1	1	3	4

Of the chain pharmacies listed, 38% were located in block groups with an African-American percentage of ≥ 50%. The data suggests that individuals living in a predominantly African-American block group may experience lower chain pharmacy accessibility.

Table 5

Block Group Rank by All Crime, and Number of Pharmacies

(Highest = 8; Lowest = 1)

CBG	All Crime	Rank	# of Pharmacies
H	222	8	8
F	218	7	2
I	184	6	9
A	144	5	3
E	101	4	5
C	97	3	1
D	88	2	4
B	75	1	1

(All Crime = murder, homicide, sexual assault, felonious assault, arson, burglary, and motor vehicle theft as reported by Flint Police Department)

Relative to the amount of crime reported in each block group, 30% of pharmacies were located in CBGs with an all crime rate of ≥ 200; 51.5% of pharmacies were located in CBGs with an all crime rate of = 100-199, and 18% of pharmacies were located in CBGs with an all crime rate of ≤ 99.

Table 6

Block Group, All Crime, and Number of (independent vs. Chain) Pharmacies

GBG	All Crime	Rank	# of Independent Pharmacies	# of Chain Pharmacies	Total Pharmacies
H	222	8	5	3	8
F	218	7	0	2	2
I	184	6	5	4	9
A	144	5	2	1	3
E	101	4	1	4	5
C	97	3	0	1	1
D	88	2	1	3	4
B	75	1	1	0	1

Thirty-three percent of the independent pharmacies included in this study were located in CBGs with an all crime rate of ≥ 200; 53.3% of independent pharmacies were located in CBGs with an all crime rate of = 100-199, and 13.3% of independent pharmacies were located in CBGs with an all crime rate of ≤ 99. Because independent pharmacies tend to have higher prices than chain pharmacies (Gellad et al., 2009), the data suggests that residents of high crime block groups may be more likely to patronize independent pharmacies. As a result, access to lower-priced pharmaceuticals found in chain pharmacies may be impeded

To answer our second research question about the relationship between neighborhood characteristics and pharmaceutical prices, we examined median income, crime, and racial/ethnic composition relative to pharmaceutical prices. The following tables display the results.

Table 9

Block Group, Median Income (Lowest to Highest), percent African-American and RX Prices

(Prices are an average of all Pharmacy Prices from the Block Group)

CBG	% African American	Median Income	Glipizide 5mg (30 day)	Glipizide 5mg (90 day)	Metformin 500 mg (30 day)	Metformin 500 mg (90 day)	U-100 Humulin N	U-100 Novolin N
A (n=3)	100%	16,455	$6.00 (low=4.00 high=8.00)	$17.99 (low=11.99 high=24.00)	$9.99 (low=9.99 high=10.00)	$22.99 (low=15.99 high=30.00)	$221.82 low=143.64 high=300.00)	$222.25 low=144.49 high=300.00)
C (n=1)	99%	16,600	$4.00	$10.00	$4.00	$10.00	$160.79	$146.79
F (n=2)	96.3%	17,143	$8.50 (low=4.00 high=13.00)	$19.50 (low=11.99 high=27.00)	$16.50 (low=9.99 high=23.00)	$36.44 (low=15.99 high=56.89)	$149.50 (low=143.99 high=155.00)	$149.25 (low=144.49 high=154.00)
I (n=9)	73.7%	21,016	$5.54 (low=4.00 high=11.99)	$15.48 (low=11.99 high=22.99)	$12.48 (low=9.99 high=21.99)	$22.44 (low=14.99 high=53.89)	$151.09 (low=123.89 high=203.83)	$151.29 (low=123.22 high=203.83)
B (n=1)	59.6%	23,750	$6.33	$19.00	$9.00	$22.33	$194.55	$194.83
D (n=4)	30.7%	24,464	$7.43 (low=4.00 high=13.39)	$16.93 (low=10.80 high=27.99)	$12.96 (low=4.90 high=23.99)	$29.62 (low=12.99 high=59.89)	$143.65 (low=132.33 high=154.99)	$143.82 (low=133.00 high=153.99)
H (n=8)	17.5%	30,038	$6.42 (low=4.00 high=11.99)	$14.41 (low=6.00 high=24.99)	$10.08 (low=4.00 high=21.99)	$22.08 (low=12.00 high=55.00)	$155.05 (low=136.00 high=201.82)	$159.30 (low=136.00 high=200.72)
E (n=5)	10.5%	33,750	$4.00	$11.99	$9.99	$15.99	$143.64	$144.49

In Table 9, the highest reported prices for the medications included in the study are shown in red. All of the highest prices were found in CBGs with a median income of ≤ $20,000, while none were found in the middle income group of $20,000-$29,999 or the highest income group of ≥ $30,000. The data suggests that higher prices are found in CBGs with a median income of ≤ $20,000, which suggests a relationship between median income and pharmaceutical prices. Additionally, the data indicates that the highest pharmaceutical prices were reported in predominantly African-American CBGs (≥ 50%), with none of the highest prices found in CBGs with a lower percentage of African-Americans (< 50%). The data suggests that residents in predominantly African-American neighborhoods may pay higher prices for the medications included in the study.

Table 10

Block Group, All Crime, and RX Prices

(Prices are an average of all Pharmacy Prices from the Block Group)

GBG	All Crime	Glipizide 5mg (30 day)	Glipizide 5mg (90 day)	Metformin 500 mg (30 day)	Metformin 500 mg (90 day)	U-100 Humulin N	U-100 Novolin N
H	222	$6.42	$14.41	$10.08	$22.08	$155.05	$159.30
F	218	$8.50	$19.50	$16.50	$36.44	$149.50	$149.25
I	184	$5.54	$15.48	$12.48	$22.44	$151.09	$151.29
A	144	$6.00	$17.99	$9.99	$22.99	$221.82	$222.25
E	101	$4.00	$11.99	$9.99	$15.99	$143.64	$144.49
C	97	$4.00	$10.00	$4.00	$10.00	$160.79	$146.79
D	88	$7.43	$16.93	$12.96	$29.62	$143.65	$143.82
B	75	$7.00	$21.00	$7.00	$21.00	$140.00	$140.00

The highest prices for all of medications included in the study were found in the CBGs that also reported the greatest amount of crime (≥ 144). The data suggests that neighborhood crime can adversely affect pharmaceutical prices.

Table 11

Within Group Differences

Prices Reported at Walgreen Pharmacies

(Highest Prices Are Shown in Red)

GBG	# of Locations	Glipizide 5mg (30 day)	Glipizide 5mg (90 day)	Metformin 500 mg (30 day)	Metformin 500 mg (90 day)	U-100 Humulin N	U-100 Novolin N
D	1	$13.39	$27.99	$23.99	$59.89	$154.99	$153.99
F	1	$13.00	$27.00	$23.00	$56.89	$155.00	$154.00
H	1	$11.99	$24.99	$21.99	$55.00	Price unavailable at time of query	$153.00
I	1	$11.99	$22.99	$21.99	$53.89	$154.99	$153.99

Of the chain pharmacies included in the study, there were 9 Rite Aid pharmacies, 1 Kroger pharmacy, and 4 Walgreen pharmacies. As was previously mentioned, the Rite Aid pharmacies offered a discount RX card to any patient without insurance, free of charge. As a result, prices offered at the Rite Aid pharmacies seem to be uniform. As may be seen in this table, there was considerable variation in the medication prices reported for the Walgreen pharmacies. Walgreen's also offered a discount RX card, but the price for the card was $20.00; therefore, the prices obtained with the use of the card were not utilized. With regard to the highest prices reported, the data suggests that higher prices are found in those CBG's with an income of below $30,000.

Risk Score Calculation

Subsequent to our examination of individual neighborhood characteristics, pharmacy access, and pharmacy prices for the four selected diabetes medications, we created a summative risk profile. For the 8 block groups, we ranked each using scores 1-8 for median income, crime, and percent African American. Block groups with the lowest median income were assigned higher scores and higher median incomes were assigned lower scores; Block groups with the highest percent of African Americans were assigned higher scores and block groups with lower percentages of African Americans were assigned lower scores; and finally, Block groups with the higher crime levels were assigned higher scores and lower crime areas were assigned lower scores. Each block group received 3 scores, which were added together to produce an overall risk score where higher scores indicate higher risk of not having access to pharmacies and higher risk of paying more for pharmaceuticals.

The results are shown in the following tables:

Table 7

Block Group, Risk Score, and Number of Pharmacies

CBG	Median Income	% African-American	All Crime	Risk Score	# of Pharmacies
A	7	5	4	16	3
F	5	4	6	15	2
C	6	3	2	11	1
H	2	2	7	11	8
B	3	7	1	11	1
I	4	1	5	10	9
E	1	6	3	10	5
D	3	1	2	6	4

With regard to pharmacy accessibility, 54.5% of pharmacies studied are located in low risk CBGs (≤ 10), 30.3% of pharmacies are located in moderate risk CBGs (11-14), and 15.2% of pharmacies studied are located in high risk CBGs (≥ 15). The data suggests that neighborhood characteristics (median income, crime, and percent African-American) play a distinct role when determining pharmacy accessibility.

Table 8

Block Group, Risk Score, and Number of (independent vs. Chain) Pharmacies

CBG	Median Income	% African-American	All Crime	Risk Score	# of Independent Pharmacies	# of Chain Pharmacies	Total Pharmacies
A	7	5	4	16	2	1	3
F	5	4	6	15	0	2	2
C	6	3	2	11	0	1	1
H	2	2	7	11	5	3	8
B	3	7	1	11	1	0	1
I	4	1	5	10	5	4	9
E	1	6	3	10	1	4	5
D	3	1	2	6	1	3	4

In those CBGs with the highest risk (≥ 15), only 13% of independent pharmacies and 16.6% of chain pharmacies were located within these blocks. In the moderate risk CBGs (11-14), 40% of independent pharmacies and 22% of chain pharmacies were located within these blocks, while 46.6% of independent pharmacies and 61% of chain pharmacies were located in the lowest risk CBGs (≤ 10). Not only the total number of pharmacies, but the number of chain pharmacies were dramatically less in the highest risk (≥ 15) CBGs.

Table 12

Block Group, Risk Score, and RX Prices

CBG	Risk Score	Glipizide 5mg (30 day)	Glipizide 5mg (90 day)	Metformin 500 mg (30 day)	Metformin 500 mg (90 day)	U-100 Humulin N	U-100 Novolin N
A	16	$6.00	$17.99	$9.99	$22.99	$221.82	$222.25
F	15	$8.50	$19.50	$16.50	$36.44	$149.50	$149.25
C	11	$4.00	$10.00	$4.00	$10.00	$160.79	$146.79
H	11	$6.42	$14.41	$10.08	$22.08	$155.05	$159.30
B	11	$7.00	$21.00	$7.00	$21.00	$140.00	$140.00
I	10	$5.54	$15.48	$12.48	$22.44	$151.09	$151.29
E	10	$4.00	$11.99	$9.99	$15.99	$143.64	$144.49
D	6	$7.43	$16.93	$12.96	$29.62	$143.65	$143.82

With regard to risk score and pharmaceutical prices, the data provides evidence to suggest that there may be relationships between our risk score measure and higher pharmaceutical prices. All of the highest reported medication prices were found in the highest risk (≥ 15) CBGs, while none of the highest reported prices were found in the moderate risk (11-14), or the lowest risk (≤ 10) CBGs.

Discussion

Our findings are partially consistent with the results of a much larger study performed by Gellad et al. (2008), which found that retail pharmacy prices are higher in poorer zip codes, and that the higher prices were due in part to the larger number of higher-priced independent pharmacies in the poorest zip codes, according to the study. Addressing our first hypothesis regarding the effect of neighborhood characteristics (median income, crime, and percent African-American) on pharmacy accessibility, we found that 82% of the pharmacies included in the study were located in Census Block Groups with a median income of ≥ $20,000. The data suggests that median income may play a role in determining the number of pharmacies (and therefore pharmacy access) located within a given neighborhood. Of the census block groups included in the study, 36.4% of all pharmacies studied were located in predominantly African-American neighborhoods defined as CBGs with ≥ 50% African American residents. In contrast to this, 63.6% of all pharmacies studied were located in neighborhoods with the lowest concentrations of African-Americans, defined as CBGs with ≤ 50% African-American residents. The data suggests a relationship between racial/ethnic neighborhood composition and pharmacy placement and accessibility.

With regard to crime, It should be noted that reported all crime statistics may not be as straightforward as presented because crime is categorized numerically and not by type or severity. Reported crime does not seem to indicate a lower proportion of pharmacies (and therefore access). However, the data does show that 80% of the independent pharmacies included in the study were found in block groups reporting higher crime figures (≥ 144). This is consistent with the findings of Gellad et al. (2008), which found that low income, high crime zip codes had a higher number of high-priced independent pharmacies, which limited the resident's accessibility to the lower prices found in chain pharmacies in more affluent zip codes.

In discussing our second hypothesis, that neighborhood characteristics (median income, crime, and percent African-American) have an adverse effect on pharmacy prices, the data indicates that the above mentioned neighborhood characteristics (median income, crime, and African-American) do indeed have an adverse effect on pharmaceutical prices. Table 9 provides evidence that higher prices are found in CBGs with a median income of ≤ $20,000, while none were found in the middle income group of $20,000-$29,999 or the highest income group of ≥ $30,000. The data suggests that higher prices are found in CBGs with a median income of ≤ $20,000, which points to a relationship between median income and pharmaceutical prices. Additionally, the data indicates that the highest pharmaceutical prices were reported in predominantly African-American CBGs (≥ 50%), with none of the highest prices found in CBGs with a lower percentage of African-Americans (< 50%). The data suggests that residents in predominantly African-American neighborhoods may pay higher prices for the medications included in the study. Finally, the data displayed in Table 10 shows the highest prices for all of medications included in the study were found in the 50% of CBGs that also reported the greatest amount of crime (≥ 144). The data suggests that neighborhood crime can adversely affect pharmaceutical prices.

When we combined all neighborhood characteristics (median income, percent African-American, and crime) into a combined risk score, the results underscore the effects of neighborhood characteristics on pharmacy accessibility and price.

In those block groups with the highest risk profiles (≥ 15), only 13% of independent pharmacies and 16% of chain pharmacies were located within these blocks. Not only the total number of pharmacies, but the number of chain pharmacies (16%) were dramatically less in those block groups with the highest risk scores. The data strongly supports the premise that neighborhood characteristics (median income, percent African-American, and crime) play an important role in determining pharmacy accessibility.

With regard to risk score and pharmaceutical prices, the data provides evidence to suggest that there may be a relationship between our risk score measure and higher pharmaceutical prices. All of the highest reported medication prices were found in the two block groups with the highest risk scores (≥ 15).

As with all research, this research study is not without methodological limitations. Some of the limitations include: small sample size; no block groups selected from the center of the city, and the limited number of medications used in this study.

To conclude, this study offers new data to suggest that diabetic residents living in low income, high crime, predominantly African-American neighborhoods may experience greater difficulty with pharmacy accessibility, and also may pay more for their medications once they have located a pharmacy in their neighborhood. As the cost of diabetic treatment in the United States continues to skyrocket, the subject of pharmacy accessibility and pharmaceutical prices is a subject of paramount importance, particularly for those individuals who reside in neighborhoods with a low median income, have high crime statistics, and live in predominantly African American neighborhoods.

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