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Quantifying the Relationship Among Socioeconomic Status and Prevalence of HIV Diagnoses Using 2018 Greater Atlanta Metropolitan Area Zip Codes

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Abstract

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by

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Introduction: HIV has been a public health concern for many decades. While cases have decreased slightly, public health professionals are still far from ending the HIV/AIDS epidemic. In order to properly address how to implement policy changes and promote healthy behaviors, dimensions of social determinants of health, specifically socioeconomic status, must be analyzed. By understanding the influence of social factors, conclusions can be made about health habits, decisions, and choices. While there is no cure for HIV, understanding social contributions can help decrease incidence rates.

Aim: The purpose of this study is to quantify the relationship between socioeconomic status, a social determinant of health, and HIV diagnoses. This analysis aims to analyze which social variables are better predictors for prevalence of HIV diagnoses. This study can be duplicated to show social variables as predictors for any communicable or non-communicable disease.

Methods: A 2018 dataset was downloaded from AIDSVu that included 133 zip codes in the greater Atlanta metropolitan area. The independent variables of interest were median household income, percent of the population living in poverty, percent of the population with a

high school education, and percent of the population living with severe housing cost burden. The outcome of interest was HIV diagnoses per 100,000 in each zip code. County populations were obtained using the U.S. Census Bureau for the year 2020. Poisson regression was used to determine the association between each social variable and the total number of HIV cases per 100,000.

Results: 128 zip codes were included in the analysis. The independent variables were dichotomized into high and low groups, with the cut off being equal to the Georgia state median. Both the univariate and multivariable regression models showed statistical significance between low median household incomes, high levels of people living in poverty, low levels of high school education, and higher percentages of the population living with severe housing cost burden. In the univariate model, percent of the population living in poverty held the highest HIV diagnoses prevalence ratio with an IRR of 3.39, followed by percent living in severe housing cost burden (IRR = 2.92), median household income (IRR = 2.66), and lastly high school education (IRR = 1.46). In the multivariable association, the prevalence ratios are attenuated due to confounding of variables.

Discussion: The multivariable regression model shows a statistically significant relationship between individuals negatively impacted by social determinants of health when compared to individuals not negatively impacted. Social behavior within each population needs to be understood before effective health policies and interventions can be implemented. The built environment for zip codes with larger percentages of individuals living in poverty needs to be addressed before HIV preventative measures can be put in place. Educating individuals on HIV

transmission is fundamental on slowing the spread, but population education levels must be considered first. Low-income areas (below the Georgia state average) are more likely to have individuals living below the poverty level, with severe housing cost burden, and less than a high school education. These areas should be targeted to HIV prevention before areas with higher rates.

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by

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Approval page

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Author's Statement Page

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Chapter I: Introduction

Background:

Human immunodeficiency virus (HIV) is a communicable disease spread from person-to-person through direct contact with bodily fluids [1]. HIV is commonly spread throughout humans through sexual intercourse and sharing needles or other drug injection equipment [2]. Like all communicable diseases, it is important to report and monitor the prevalence of disease in order to evaluate prevention and control programs [3]. While there is currently no cure for HIV, there are many measures in place to help prevent the spread of disease. Despite efforts by public health officials, HIV is still an ongoing epidemic, and prevalence is still on the rise. Being a communicable disease that becomes chronic, HIV is unique in its role in nature and nurture.

Health People 2030 defines social determinants of health (SDOH) as "the conditions in environments where people are born, live, learn, work, play, worship, and age that affect a wide range of health, functioning, and quality-of-life outcomes and risks" [4]. The five domains that make up these social determinants are economic stability, education access and quality, healthcare access and quality, neighborhood and built environment, and social and community context [5]. The variables used in this analysis are heavily related to economic stability. Economic stability means "that people have the resources essential to a healthy life" [6]. For example, access to transportation can impact access to healthcare, nutritious food options, and safe places to exercise.

While HIV is a communicable disease, it is also chronic. Transmission of HIV can be prevented by educating individuals on safe sex measures, as well as providing necessary

medications such as pre-exposure prophylaxis (PrEP) and post-exposure prophylaxis (PEP) that help prevent infection. With any communicable disease, a comprehensive approach to understanding all factors, both social and biomedical, that contribute to the spread of disease is crucial. Social factors include but are not limited to the five domains of social determinants of health outlined by Health People 2030 [7]. Without understanding how variables related to socioeconomic status are detrimental to an individual's health, public health professionals cannot intervene and act accordingly. It is vital to understand the impact of social determinants of health, specifically socioeconomic status, at the community level before implementing interventions and resources. By understanding the social factors which contribute to HIV incidence and care outcomes, public health professionals can improve interventions and target resources based on population need.

Purpose:

The purpose of this study is to quantify the relationship between socioeconomic status as a social determinant of health, and the prevalence of HIV diagnoses per 100,000 people, aged fifteen or older, in the Greater Atlanta Metropolitan region. Quantifying this relationship will show which social variables are better predictors for HIV prevalence. This will allow for the appropriate intervention methods to be implemented. We hypothesize that areas with lower levels of education, greater levels of housing cost burden, higher numbers of individuals living in poverty, and low percentages of high school education will have a higher prevalence of HIV diagnoses. If a community is negatively impacted by more than one variable, the knowledge of HIV information, access to HIV care, and probability of reaching viral suppression among those

living with HIV is potentially lower than in communities not negatively impacted by one or more of these factors [8].

Research Questions:

1. Which social determinants of health are most attributable to men living with HIV in Atlanta, Georgia?
2. How much do these social determinants of health contribute to HIV prevalence in Atlanta zip codes?

Chapter II*:* Literature Review

Social Determinants of Health:

There have been many studies conducted, both nationally and regionally, that show the disparities related to social determinants of health (SDOH) and disease. It is known that less economic stability, lower levels of education, little to no access to health care, and disadvantaged social and built environment negatively contribute to a healthy lifestyle [9]. Studies have also shown that SDOH largely contribute to health inequalities and disparities [10]. Significant social disparities, such as low socioeconomic status, are a part of multiple health factors, especially life expectancy [11]. This is relevant to HIV, as HIV is an infectious disease that impacts people from all socioeconomic backgrounds. HIV is also a lifelong disease, not only weakening the immune system over time, but potentially leading to Acquired Immune Deficiency Syndrome (AIDS). For example, decreased access to care can impact screening and testing rates, which leads to a high percentage of undiagnosed HIV cases in the population [12]. Among those who are diagnosed, there are lower levels of viral suppression due to little to no access to HIV care, and not being aware of the infection. This is important as viral suppression prevents sexual transmission of HIV.

The Southern states of the United States have higher HIV incidence rates than any other region in the U.S. [13]. These 16 states, which populate roughly 38% of the U.S. population, account for more than 50% of new HIV cases annually [14]. In 2017, the Southern states had a greater HIV incidence rate than all other states combined [15]. Despite the Southern states

being disproportionately affected by HIV cases, African Americans in the South are even more likely to be disproportionately affected by HIV, accounting for more than half of all new HIV diagnoses in the region [16]. Residents in these states are more likely to live in rural areas, with less access to healthcare and more unstable built environments. These states also have lower levels of education [17], as well as higher rates of poverty [18]. Combining these social determinants, along with race, can make HIV diagnosis, treatment, and prevention challenging for some individuals living in the South.

HIV:

The current treatment option for HIV is antiretroviral therapy (ART). ART involves taking a regimen of medications every day. This is used by people who are already diagnosed with HIV [19]. ART is beneficial for people living with HIV because it treats their infection and prevents immune decline, but it also benefits public health in the community by preventing onward transmission through sexual intercourse. Social determinants of health play an important role in treatment for HIV, as access and adherence to ART are not available to all [20].

A 2021 study by Menza et al concluded people with HIV are adversely impacted by exposure to social and economic disadvantage [21]. Using data from Medical Monitoring Project, a yearly cross-section study of people living with HIV in the United States, from years 2015 through 2019, HIV care outcomes were assessed [15]. These SDOH variables include education level, health literacy, poverty, food insecurity, gap in health coverage, emergency medical visits, homelessness, need for transportation help, criminal justice involvement, and history of sexual or physical intimate partner violence. A majority of this population (83%) reported having at least one of these SDOH variables. The authors also observed a dose

response of the number of concurrent negative SDOH factors experienced. Among the sample of 15,964 people living with HIV (PLWH), individuals experiencing multiple negative SDOH factors were more likely to miss a medical appointment, less likely to report excellent adherence in the prior 30 days, and less likely to achieve viral suppression in the prior year [16].

A similar study was conducted by Rojas et al to understand the association between SDOH and HIV control, specifically in Miami-Dade County, Florida [22]. This study represented all five SDOH stated by Healthy People 2020: economic stability, education, social and community context, health and healthcare, and neighborhood and built environment [23]. The cross-sectional study included all people living with HIV with an unsuppressed viral load age 15 and up. The results of the analysis show that education and economic stability, along with healthcare determinants, have a statistically significant impact on HIV prevalence. There was a significant association between these variables when compared with white race [24]. White race is associated with a decrease in people living with unsuppressed HIV infection, specifically among those from low socioeconomic backgrounds [25]. The study concluded that reducing poverty while increasing education rates and providing more health insurance could increase viral suppression among people living with HIV.

Benson et al conducted a study that examined the impact of social determinants of health in HIV patients in the United States, specifically looking at antiretroviral therapy (ART) adherence [26]. ART is a treatment for people with HIV to help reach viral suppression and involves taking medicine prescribed by a healthcare provider [27]. The findings showed poor or suboptimal adherence to ART among individuals with lower education status, those unemployed, those without health insurance, and racial minorities [28]. Poor or suboptimal

ART adherence was associated with higher prevalence rates of HIV, and higher rates of mortality. It was concluded that social determinants, including education, employment status and access to healthcare are detrimental factors for those living with HIV in the United States.

An ecologic study of HIV diagnosis rates from 2013-2017 in Florida used social disorganization components for 910 postal codes to assess the relationship between social disorganization and HIV diagnoses [29]. A total 16 variables were included in the study. Each variable addressed a specific social determinant, including but not limited to: public assistance usage, education level, income, and employment status. The study stratified results into rural and urban classification for each postal code. In urban areas, the LatinX/immigrant density index had the highest correlation to HIV diagnosis rates [30]. In rural areas, greater residential instability and higher social disadvantage scores were associated with increased HIV diagnosis rates. These results are similar to others in that rural areas have more social disadvantages and are associated with higher incidences of HIV. These findings add to the role of socioeconomic status and neighborhood context in HIV diagnosis and prevention [31].

Modeling Methods:

Modeling methods to assess the relationship between social determinants of health and HIV outcomes are well developed. These methods have been summarized by Hogan et al. These methods for modeling approaches, both mathematical and statistical, support the "growing evidence for key social determinants of health in understanding morbidity and mortality outcomes globally" [32]. The author states that stigma, racism, poverty, and access to health and social services represent concepts affecting the overall health of the population through relationships to individual characteristics, behaviors, and treatment outcomes [33]. The article gives examples of studies that use regression models to characterize explained and unexplained variations in one or more outcome variables (Y), based on data drawn from a target population [34]. Multivariable regression has proven to be successful in modeling the impact of social determinants of health and disease outcomes.

Chapter III: Methods

Study Design:

Publicly available HIV incidence and prevalence data through the Centers for Disease Control and Prevention (CDC) is not available below the county-level. Using HIV-related information available by zip-code from AIDSVu, HIV surveillance can be analyzed at a finer level. Since Atlanta has a diverse population of Black, white, Asian, and Hispanic residents, from a plethora of different backgrounds that reflect all SDOH, this is a prime population to study. HIV incidence is higher in the Southeast than most other regions in the country, and the four major Atlanta counties (Cobb, Dekalb, Fulton and Gwinnett) are considered priority jurisdictions under the federal Ending the HIV Epidemic initiative [35]. Analyzing this population can show how social determinants, specifically socioeconomic status, affect HIV care in specific geographic areas, and where service providers, or treatment centers, are needed.

The data is secondary data from AIDSVu.org [36]. AIDSVu is a public resource showing HIV surveillance data and other population-based information relevant to HIV care and prevention. AIDSVu uses multiple sources including U.S. CDC, U.S. Census, local and state health departments, health care claims databases, and Medicaid. The dataset downloaded included 133 zip codes from counties in the greater Atlanta Metropolitan area. The variables included in this dataset are median household income, percent living in poverty, percent with high school education, and percent living with severe housing cost burden.

Since the dataset from AIDSVu did not contain total populations for each zip code, population data was obtained from the 2020 U.S. Census. The prevalence of HIV diagnoses per

100,000 was determined by dividing the total number of HIV cases in each code over the total population in each zip code.

Variables:

The variables included from all 133 zip codes are: median household income, percent living in poverty, percent with high school education, and percent living with severe housing cost burden. Three of these variables are related to dimensions of socioeconomic status, which is characterized by income, education, and employment [37]. The fourth variable, percent with high school education, is related to education access and quality.

The variables were dichotomized using the state of Georgia average for each variable determined by AIDSVu: median income of $58,634, 14.5% living in poverty, 86.7% with a high school education, and 13.7% living with severe housing cost burden. The average for each variable in the Atlanta zip code dataset was $66,788, 14.8%, 89.2%, and 15.5% respectively.

Analysis:

The impact of HIV in each Atlanta zip code will be analyzed by the defined social determinants of health (SDOH) using univariate and multivariable Poisson regression to identify which key variables of socioeconomic status are associated with prevalence of HIV diagnoses per 100,000, as well as each variables magnitude of impact on HIV care outcomes in Atlanta zip codes. It is hypothesized that the more detrimental social determinants are, the more likely the population is to be affected by HIV diagnoses, treatment, and knowledge. This type of analysis can be replicated for any large city with available zip code level data.

Of the 133 zip codes given in the Atlanta zip code file from AIDSVu, five were excluded. Two zip codes did not have residential populations. Two zip codes were located outside of the Atlanta metro 20-county region, and one zip code had missing income information.

The data were downloaded and analyzed using Statistical Analysis System (SAS) software version 9.4. Statistical significance was determined a priori at alpha of 0.05 ($\alpha = 0.05$).

Chapter IV: Results

Data Summary

Of the 128 zip codes, 30303 had the lowest median income with $22,663. 30327 had the highest median household income with $154,738. 30346 had the lowest percent living in poverty with 1.7%, and 30303 had the highest percent living in poverty with 56.8%. 30021 had the lowest percent with high school education at 65.6%, while 30346 had the highest percent with high school education at 99.2%. 30017 had the lowest percent living with severe housing cost burden at 6.1%. 30303 had the highest percent living with severe housing cost burden at 39.5%.

The total number of HIV diagnoses among all 128 zip codes used in the analysis was 35,954. The overall prevalence per 100,00 people in all 128 zip codes was equal to 113252.16, with an average of 886.31 cases per 100,000. The mean HIV prevalence for zip codes above the median income of $58, 634 was 456.91 (N=52, 40.6.% of zip code population), while the mean HIV prevalence for zip codes at or below the median income of $58, 634 was 1215.90 (N=76, 59.3% of zip code population).

The mean HIV prevalence for zip codes above the median income of $58, 634 was 456.91 (N=52, 40.6.% of zip code population), while the mean HIV prevalence for zip codes at or below the median income of $58, 634 was 1215.90 (N=76, 59.3% of zip code population). This corresponds to a 2.66 (95% CI: 2.61, 2.72) fold increase in HIV prevalence among ZIP codes with higher median incomes compared to low. The mean HIV prevalence for zip codes above the median poverty level of 14.5% was 1394.75 (N=77, 60% of zip code population), while the mean

HIV prevalence for zip codes at or below median poverty level of 14.5% was 411.82 (N=51, 39.8% of zip code population). This corresponds to a 3.39 (95% CI: 3.32, 3.46) fold increase in HIV prevalence among ZIP codes with higher percent living in poverty compared to low. The mean HIV prevalence for zip codes above the median high school education of 86.7% was 657.96 (N=38, 29.6% of zip code population), while the mean HIV prevalence for zip codes at or below the median high school education of 86.7% was 966.56 (N=90, 70.3% of the zip code population). This corresponds to a 1.47 (95% CI: 1.44, 1.50) fold increase in HIV prevalence among ZIP codes with lower percentages of high school education compared to high. The mean HIV prevalence for zip codes living above or at the median poverty level of 15.2% was 1201.69 (N=71, 55.5% of zip code population), while the mean HIV prevalence for zip codes at below the median poverty level of 15.2% was 410.87 (N=57, 44.5% of the zip code population). This corresponds to a 2.92 (95% CI: 2.86, 2.99) fold increase in HIV prevalence among ZIP codes with low levels of poverty compared to higher housing cost burden.

Univariate Poisson Regression

First, a univariate Poisson regression model was run for each four variables to determine each independent significance (TABLE 4). All four variables showed statistical significance at an alpha of 0.05 ($\alpha = 0.05$), with a respective p-values of < 0.0001. Of the four variables, percent living in poverty had the highest incidence risk ratio (IRR) of 3.39. People living in poverty have 3.39 times the incidence density ratio compared to those living above the poverty level.

The prevalence of HIV diagnoses per 100,000 people in zip codes with median income <$58,634 is greater than those in zip codes with a median income >$58, 634.The prevalence of

HIV diagnoses per 100,000 people in zip codes with >14.5% of the population living in poverty is greater than those living in zip codes with <14.5% of the population living in poverty. The prevalence of HIV diagnoses per 100,000 people in zip codes with <86.7% of the population with a high school education is greater than those living in zip codes with >86.7% with a high school education. The prevalence of HIV diagnoses per 100,000 people in zip codes >15.2% of the population living with severe housing cost burden is greater than those living in zip codes with <15.2% of the population living in severe housing cost burden.

Multivariable Poisson Regression

Next, a multivariable regression model was used with all four variables (TABLE 4). Again, all four variables showed high levels of statistical significance at an alpha of 0.05 ($\alpha = 0.05$). When all variables were used in the model, the estimated IRR for each was lowered. This shows that the other variables, which represent social determinants of health, interfere with the impact each has on the other. The estimated mean for median household income was only 0.75 (95% CI: 0.72, 0.78), compared to 2.66 when run on its own. People living in poverty have 3.29 (95% CI: 3.17, 3.43) times the incidence density ratio compared to those living above the poverty level. People living in zip codes with less than 86.7% of the population obtaining a high school education have 0.79 (95% CI: 0.77, 0.81) the incidence density ratio compared to those in zip codes with greater than 86.7% of the population having a high school education. Those living with severe housing cost burden have 1.64 (95% CI: 1.58, 1.70) times the incidence ratio density compared to those not living with severe housing cost burden.

Chapter V: Discussion

This study analyzed the impact of socioeconomic status on HIV prevalence within Atlanta zip codes. Understanding HIV transmission and prevalence from a zip code level is important because socioeconomic status can vary more between two zip codes than between two counties. The results of the analysis support the hypothesis: negative indicators of the social determinants of health, specifically low socioeconomic status, are associated with increased prevalence of HIV diagnoses at the ZIP code level.

The results of this study are consistent with previous studies, indicating social disadvantage is associated with higher incidences of HIV [38]. People living in a zip code with a lower median household income, more people living in poverty, less people with high school education, and more people living with severe housing cost burden are all more likely to come in contact with HIV, not know they have HIV, and or not properly treat their HIV. This is likely because people living with severe housing cost burden and below the poverty level do not have enough money for basic everyday necessities, much less healthcare. This is also likely because zip codes with lower levels of high school education have greater portions of the population without sex education or general HIV knowledge.

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Limitations

AIDSVu only offered zip code information for 134 zip codes in the greater Atlanta area, spanning across 18 counties including Barrow (n=3), Carroll (n=3), Cherokee (n=3), Clayton (n=8), Cobb (n=17), Coweta (n=1), Dekalb (n=27), Douglas (n=4), Fayette (n=3), Forsyth (n=2), Fulton (n=36), Gwinnett (n=16), Henry (n=2), Jackson (n=2), Paulding (n=2), Rockdale (n=2), Spalding (n=1), and Walton (n=1). The four major Atlanta counties (Cobb, Dekalb, Fulton, and Gwinnett) contained all zip codes. The other counties did not contain all zip codes within the county.

Healthy People 2030 lists five domains for social determinants of health, but the dataset from AIDSVu did not include a specific variable that represented access to healthcare. This could show what relationship, if any, there is between healthcare access, and other social variables. It could also show if there is a relationship between health insurance and access to healthcare. Since the state of Georgia has yet to expand Medicaid, studying the relationship between access to healthcare and HIV prevalence can potentially show the need for Medicaid expansion.

Since this is an ecological study, conclusions about individual risk were unable to be made. For example, zip codes with more poverty may have higher HIV prevalence, but we cannot say for certain that these are the same people who are living in poverty and with HIV. There may also be confounding due to unmeasured variables, or it could just be a spurious association.

The median household income cutoff was unable to be determined by what the U.S. Department of Health and Human Services determined to be below the federal poverty line,

$27,180 [39]. The federal poverty line is set by the number of members within a household, and the dataset did not stratify households by number of people. This can cause error when replicating the study, as there is no standard average to reference stratified groups to.

Policy Changes

While there is currently no cure for AIDS, there are many interventions already in place to prevent the spread of HIV, including PrEP and ART. By slowing the spread of HIV, therefore reducing incidence, individuals are less likely to develop AIDS, but the prevalence of HIV is still a concern. While all four variables are associated with the prevalence of HIV diagnoses, percent of the population living in poverty and with severe housing cost burden are slightly more significant than percent of the population living with a lower median household income and percent of the population with a high school education.

There is an association between people living in poverty and people living in severe housing cost burden. If you have severe housing cost burden, you are more than likely living in poverty. While we cannot stop poverty altogether, we can implement health policies to help people with burden. This includes housing vouchers for safe living spaces, and an overall increase in access to affordable housing for all. It is necessary to help these individuals economically and financially, so they are in a better place for healthcare and well-being. Having health professionals setup community events within zip codes of low poverty levels can help individuals learn about healthy habits, for sexually transmitted infections as well as chronic diseases.

EHE

Currently, the CDC has an initiative to help with the HIV/AIDS epidemic titled EHE: Ending the HIV Epidemic in the U.S. [40]. The goal of EHE is to "reduce the number of new HIV infections in the United States by 90% by 2030" [41]. A total of $117 million has been funded to state and local health departments to help rebuild and begin to expand HIV prevention and treatment efforts [42]. This is a promising endeavor as 57 jurisdictions have been chosen specifically based on priority needs for HIV care continuums. All four of Atlanta's main counties, Cobb, Dekalb, Fulton, and Gwinnett are included within these 57 jurisdictions. Since they are already a priority, this will likely help the zip codes that are disproportionately affected by the HIV spread.

Conclusion

While the social determinants of health may not be immediate predictors for HIV cases, they are still extremely crucial to disease prevalence and care. With all diseases, both communicable and non-communicable, health policy makers and health promoters must take social factors into account. If only two-thirds of a specified population have a high school education, intervention methods must be tailored to their education level. If many people in a specified population have a low median household income, free services must be implemented to treat or prevent disease. Working together with epidemiologists, health policy makers, health promotion advocates, and community organizations to address social determinants will undeniably help the HIV epidemic.

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Appendices:

Table 1: Variables Used in Analysis

VARIABLE	DEFINITION	SOURCE
INC	median household income	AIDSVu
POV	percent living in poverty	AIDSVu
HSE	percent with high school education	AIDSVu
BUR	percent living with severe housing cost burden	AIDSVu
TOTHIV	total number of HIV cases per zip code	AIDSVu
TOTPOP	2020 census data population per zip code	U.S. Census Bureau

Table 2: County Breakdown of Analysis

	Counties	N	%	%
	Barrow	3	0.02325581	2.30%
	Carroll	3	0.02325581	2.30%
	Cherokee	3	0.02325581	2.30%
	Clayton	8	0.0620155	6.20%
	Cobb	17	0.13178295	13.20%
	Coweta	1	0.00775194	0.70%
	Dekalb	27	0.20930233	20.90%
	Douglas	4	0.03100775	3.10%
	Fayette	3	0.02325581	2.30%
	Forsyth	2	0.01550388	1.60%
	Fulton	35	0.27131783	27.10%
	Gwinnett	15	0.11627907	11.60%
	Henry	2	0.01550388	1.60%
	Paulding	2	0.01550388	1.60%
	Rockdale	2	0.01550388	1.60%
	Spalding	1	0.00775194	0.70%
	Walton	1	0.00775194	0.70%
Total	17	129	1	99.80%

Table 3: Mean HIV Prevalence Among Atlanta Area Zip Codes and Social Determinants of Health				
	N	%	Mean HIV Prevalence	SD HIV Prevalence
Total ZIP Codes	128	100	886.32	926.47
Median Income				
≥ $58,634	52	40.6%	456.91	717.28
< $58,634	76	59.3%	1215.90	1031.64
Median Poverty				
≥ 14.5%	77	60%	1394.75	1180.77
< 14.5%	51	39.8%	411.82	545.17
Median High School Education				
≥ 86.7%	38	29.6%	657.96	918.78
< 86.7%	90	70.3%	966.46	1150.12
Median Burden				
≥ 15.2%	71	55.5%	1201.69	1132.35
< 15.2%	57	44.5%	410.87	451.95

*per 100,000

(sum of cases in all ZIPs) / (sum of total population in all ZIPs) * 100,000.

Table 4: Univariate and Multivariable Poisson Regression					
	Univariate Associations			Multivariable Associations	
	IRR	IRR 95% CI		IRR	IRR 95% CI
Median Income					
≥ $58,634	ref	ref		ref	ref
< $58,634	2.6611	(2.6053, 2.7182)		0.7471	(0.7180, 0.7774)
Median Poverty					
≥ 14.5%	ref	ref		ref	ref
< 14.5%	3.3867	(3.3150, 3.4600)		3.2945	(3.1659, 3.4282)
Median High School Education					
≥ 86.7%	ref	ref		ref	ref
< 86.7%	1.4689	(1.4373,1.5011)		0.7894	(0.7710, 0.8083)
Median Burden					
≥ 15.2%	ref	ref		ref	ref
< 15.2%	2.9248	(2.8609, 2.9901)		1.6428	(1.5848, 1.7030)