

The PrEP Pharmacy Reach Study: Protocol for the creation of maps to visualize the impact of expanding access to HIV prevention services through pharmacies

Kristin R V Harrington, Chante Hamilton, Daniel I Alohan, Alexis Hudson, Henry N Young, Natalie D Crawford

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Table of Contents

Original Manuscript 5

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Abstract

Background: Inequities in pre-exposure prophylaxis (PrEP) uptake span across populations and geographic regions. The accessibility of pharmacies positions them as a vital resource for expanding PrEP access and supporting uptake and adherence through HIV prevention programs.

Objective: The aim of this study is to identify, map, and describe the potential impact of expanding PrEP access and HIV prevention services to pharmacies across the United States.

Methods: We will create local and state maps to help visualize the impact of expanding access to HIV prevention services through pharmacies. Data will be obtained from three main data sources for pharmacy locations, PrEP-prescribing locations, and HIV cases per 100,000 persons. We will geocode pharmacies and PrEP-prescribing locations with Google application programming interfaces (APIs) via the ggmap package in R. Maps will be created by overlaying several different layers of general maps and aggregated data including base maps, choropleth maps, dot density maps. To quantitatively examine the potential impact of expanding HIV prevention services, we will calculate a PrEP facility-to-need ratio (PfnR) as the total number of facilities (PrEP-prescribing or pharmacies) divided by the number of HIV cases per 100,000 persons.

Results: Overall, maps depicted far greater accessibility to local pharmacies compared to PrEP-prescribing facilities. When taken within the context of HIV cases per 100,000 persons, pharmacies were more prevalent than PrEP-prescribing facilities in areas with higher HIV caseloads.

Conclusions: This work has critical implications for state and national policies focused on avenues to increase PrEP access and uptake and subsequently reduce HIV transmission in their regions.

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Background: Inequities in pre-exposure prophylaxis (PrEP) uptake span across populations and geographic regions. The accessibility of pharmacies positions them as a vital resource for expanding PrEP access and supporting uptake and adherence through HIV prevention programs.

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Conclusions: This work has critical implications for state and national policies focused on avenues to increase PrEP access and uptake and subsequently reduce HIV transmission in their regions.

Introduction

There are over 1.1 million people living with HIV in the United States, with almost 40,000 new cases diagnosed in 2022.¹ Pre-exposure prophylaxis, or PrEP, significantly reduces the risk of HIV transmission, with an effectiveness of over 99% when taken consistently.²⁻⁴ Inequities in PrEP uptake span across populations, risk groups and geographic regions. The overall rate of PrEP use in 2021 was 129 per 100,000 persons with the lowest rate of PrEP use among Latino populations and similar rates of use among Black and White populations.⁵ People who inject drugs (PWID) have a significantly increased risk of HIV transmission and consistently have some of the lowest rates of PrEP use compared to other key populations.⁶ Further, although most men who have sex with men (MSM) are aware of PrEP, large discrepancies remain in reported PrEP use. For example, despite a greater need, about 15% fewer Black MSM report PrEP use compared to white MSM.⁷ Although the Southern United States comprises over half of new HIV diagnoses and almost half of all HIV cases¹, PrEP use is relatively stagnant in this region, reflecting difficulties in access and availability of PrEP.⁶

The Centers for Disease Control and Prevention, National Institutes of Health, and other public health organizations have recently emphasized the role of pharmacies in achieving the goals of the Ending the HIV Epidemic Initiative (EHE).^{8,9} EHE aims to reduce the number of new HIV infections in the United States by 90% by 2030, with a focus on priority jurisdictions with >50% of new HIV diagnoses.¹⁰ Pharmacies provide convenient and accessible care for the majority of Americans, with over 95% of the population living within 5 miles of one.¹¹ Their extended operating hours, including evenings, weekends, and holidays make them an ideal option for individuals who cannot visit clinics during standard hours.¹² This accessibility positions pharmacies as a vital resource for expanding PrEP access and supporting adherence, advancing public health efforts nationwide but especially in communities with fewer healthcare facilities (cite). Pharmacists have demonstrated their capability in supporting the provision of

PrEP services from initiation to ongoing management.^{13–15} Further, previous research highlights the potential of pharmacies as accessible sites for delivering HIV-related services, supported by a body of systematic literature reviews that examine the integration of HIV prevention resources, such as PrEP into pharmacy practice.^{16–19}

Inequities in access and availability of services within public health often display geographic patterns given local differences in epidemiology, policies, and resources. Spatial mapping of disease patterns has the ability to identify high-risk regions and inform evidence-based public health interventions.^{20,21} The use of maps in policy and decision-making offers substantial benefits, by enabling the identification of underserved regions, guiding the strategic allocation of resources and uncovering patterns and disparities that may not be readily apparent in other data representations.^{11,22}

Geospatial analyses have been instrumental in identifying inequities in the availability of HIV prevention services in areas with high HIV burden. Previous work has highlighted the limited geographic accessibility of PrEP clinics, particularly in the Southern United States where HIV prevalence is high, revealing significant gaps in service coverage for regions with substantial unmet need.²³ Other studies have demonstrated the utility of AIDSVu in visualizing geographic inequities in HIV prevention and care, providing a useful tool for identifying areas where interventions are needed most.²² Building on this foundation, recent work has demonstrated the potential of pharmacies to bridge these gaps by mapping their locations alongside PrEP prescribing sites in underserved communities.²⁴

This study builds on previous research by expanding mapping of pharmacies offering HIV prevention services, specifically PrEP, across the United States. By combining geographic data with key indicators such as HIV prevalence and socioeconomic factors, this study assesses the

potential reach of pharmacies in addressing PrEP. This approach identifies geographic gaps in PrEP access, offering valuable information to inform the development of targeted strategies to address these disparities. We aim to identify, map, and describe the potential impact of expanding PrEP access and HIV prevention services to pharmacies across the United States. The findings from this study have the potential to guide local and state-level policy initiatives aimed at enhancing PrEP accessibility through pharmacies. Additionally, this research may serve as a model for similar efforts in other areas of healthcare delivery, demonstrating how geographic data and health indicators can be used to optimize resource allocation. Ultimately, this work has broader implications for improving health equity by addressing inequities in HIV prevention and ensuring that at-risk populations have access to necessary healthcare services.

Methods

Overview

This is a protocol for the creation of maps to help visualize the impact of expanding access to HIV prevention services through pharmacies. These maps allow for the examination of geographic distributions of current PrEP-prescribing locations compared with pharmacy locations. We further describe the creation of PrEP facility-to-need ratios to quantitatively describe the potential reach of pharmacies to expand PrEP access. Similar implementation of this protocol has been described previously.²⁴

Data Sources

We utilized three main data sources for the creation of our maps. Pharmacy locations for pharmacies across the United States were obtained from the National Council for Prescription Drug Programs (NCPDP).²⁵ This dataset included pharmacy street address, contact information, provider type, accessibility services, and levels of delivery services provided. PrEP-prescribing locations were obtained from the National Prevention Information Network (NPIN).²⁶ This

platform, managed by the Centers for Disease Control and Prevention (CDC), provided aggregated street addresses and latitude and longitude coordinates for PrEP-prescribing locations. Data on HIV cases per 100,000 persons were collected at the state, county, and zip code levels from AIDSVu for states, counties, and cities.²⁷ AIDSVu is a publicly available database and interactive mapping tool that integrates data from the CDC and local health departments.²⁸ Website users may explore the HIV epidemic using multiple outcome measures at different spatial scales. Datasets are freely available for download for different outcomes at various levels of spatial granularity.

Geocoding

To geocode pharmacies and PrEP-prescribing locations, we utilized Google application programming interfaces (APIs) via the ggmap package in R.²⁹ This application converts street addresses to latitude and longitude coordinates that can then be plotted on maps. State, county, and zip code boundary files were gathered from the US Census Bureau using the R package tigris, version 1.5.³⁰ Street addresses for all locations were geocoded to latitude and longitude coordinates. Quality checks were implemented at this stage, including plotting points and confirming coordinates were within correct state and county boundaries. For locations outside of expected boundaries, locations were manually geocoded using provided address.

Map Creation

Maps were created by overlaying several different layers of general maps and aggregated data. Base maps including landmass areas and roads were obtained by using functions from the sf package in R.^{31,32} Sequential steps in the creation of state and city maps are displayed in Figures 1 and 3, respectively. First, landmass areas were plotted and overlaid with major roadways (Figures 1A, 1B, and 3A). Next, a choropleth map was overlaid displaying the number of HIV cases per 100,000 persons (Figures 1C and 3B). Choropleth maps of HIV cases per

100,000 persons were indexed to the state, county, and zip code levels for either state or city maps depending on the available level of granularity of data from AIDSVu. To better distinguish spatial boundaries, county borders were then layered on top for both states and cities, followed by additional boundaries for zip code borders for cities (Figures 1D, 3C, and 3D). The next layer was a dot density plot for pharmacies, where one point corresponded to five pharmacy locations to better visualize locations given the generally large number of existing pharmacies (Figures 1E and 3E). This was subsequently followed by a point layer depicting the geocoded PrEP-prescribing locations, where each point represented a specific location (Figures 1F and 3F). Last, city labels were applied for further spatial context (Figures 2 and 4).

Statistical Analysis

To quantitatively examine the potential impact of expanding HIV prevention services, we calculated a PrEP facility-to-need ratio (PfnR) as the total number of facilities (PrEP-prescribing or pharmacies) divided by the number of HIV cases per 100,000 persons. Lower PfnRs indicate lower capacity to meet the needs of the HIV risk population. Additionally, we calculated the fold-change difference between PfnR estimates between PrEP-prescribing facilities and pharmacies within the same spatial area. Higher values indicate greater potential impact of expansion of HIV prevention services to pharmacies.

Results

Maps were created for 50 states, 54 cities, and one US territory. In general, maps depicted far greater accessibility to local pharmacies compared to PrEP-prescribing facilities. When taken in the context of HIV cases per 100,000 persons, pharmacies were more prevalent than PrEP-prescribing facilities in areas with higher HIV caseloads. These trends persisted at state, county, and zip code levels across the majority of states. Some regions had more aptly placed PrEP-prescribing locations across their areas including areas with higher HIV caseloads, while there

were some states that had more rural regions with a paucity of both pharmacies and PrEP-prescribing facilities.

Mean PfnRs for pharmacy locations at the state level ranged from 0.04 in Mississippi to 1.3 in Alaska, with mean PfnRs for PrEP-prescribing facilities ranging from 0.0004 in Puerto Rico to 0.19 in Alaska. Estimated fold-increase for expansion of HIV prevention services to pharmacies was the lowest in Idaho (6.4) and highest in Puerto Rico (120.3). Overall, fold-increases were greatest for Midwestern and Southern states, and lowest for Western and Northeastern states.

Discussion

To our knowledge, this was the first study to spatially examine the distribution of pharmacies and PrEP-prescribing facilities within the context of HIV prevalence across the United States. This work will help to identify the areas of greatest need for PrEP availability and HIV prevention services. Further, the methods outlined in this protocol have the potential to be applied to a number of other health conditions, spanning infectious diseases and non-communicable diseases. Other demographic indicators may be substituted in for disease prevalence if examining risk factors.

We acknowledge that this work is subject to a number of limitations. First, maps were limited to the granularity and accuracy of the data provided. Thus, for some states (e.g., Alaska), the number of HIV cases per 100,000 persons was unavailable at the county or zip code level, so one estimate was provided for the entire state. This limits the ability to develop interpretations at a level more granular than the state level. Further, these differences in spatial granularity across regions limit our ability to make comparisons across dissimilar spatial scales (i.e., comparing a state PfnR to a county PfnR in a different state). Regarding accessibility of data, some states do not provide HIV case data for all counties, resulting in several counties and zip codes with

estimates that are unavailable. This data may be withheld by states or censored by AIDSVu for many reasons including privacy concerns if only very few cases live in a spatial area, or uncertainty in counts leading to unstable estimates.

The contribution of this proposed project will be a robust examination of pharmacy locations with respect to HIV caseload across the United States. By utilizing NCPDP data, it is likely that we were able to capture all pharmacy locations in the country, resulting in more accurate estimates of the potential impact of expanding HIV prevention services to pharmacies. This work has critical implications for state and national policies focused on avenues to increase PrEP access and uptake and subsequently reduce HIV transmission in their regions.

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Authors' Contributions

KRVH, CH, DIA, AH, HY, and NDC contributed to the study conception and design. The first draft of the paper was written by KRVH and CH, which was reviewed by all the other authors. Feedback from all the other authors was incorporated by KRVH.

Conflicts of Interest

None declared.

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Tables/Figures

Figure 1. Sequential process of the creation of a state map.

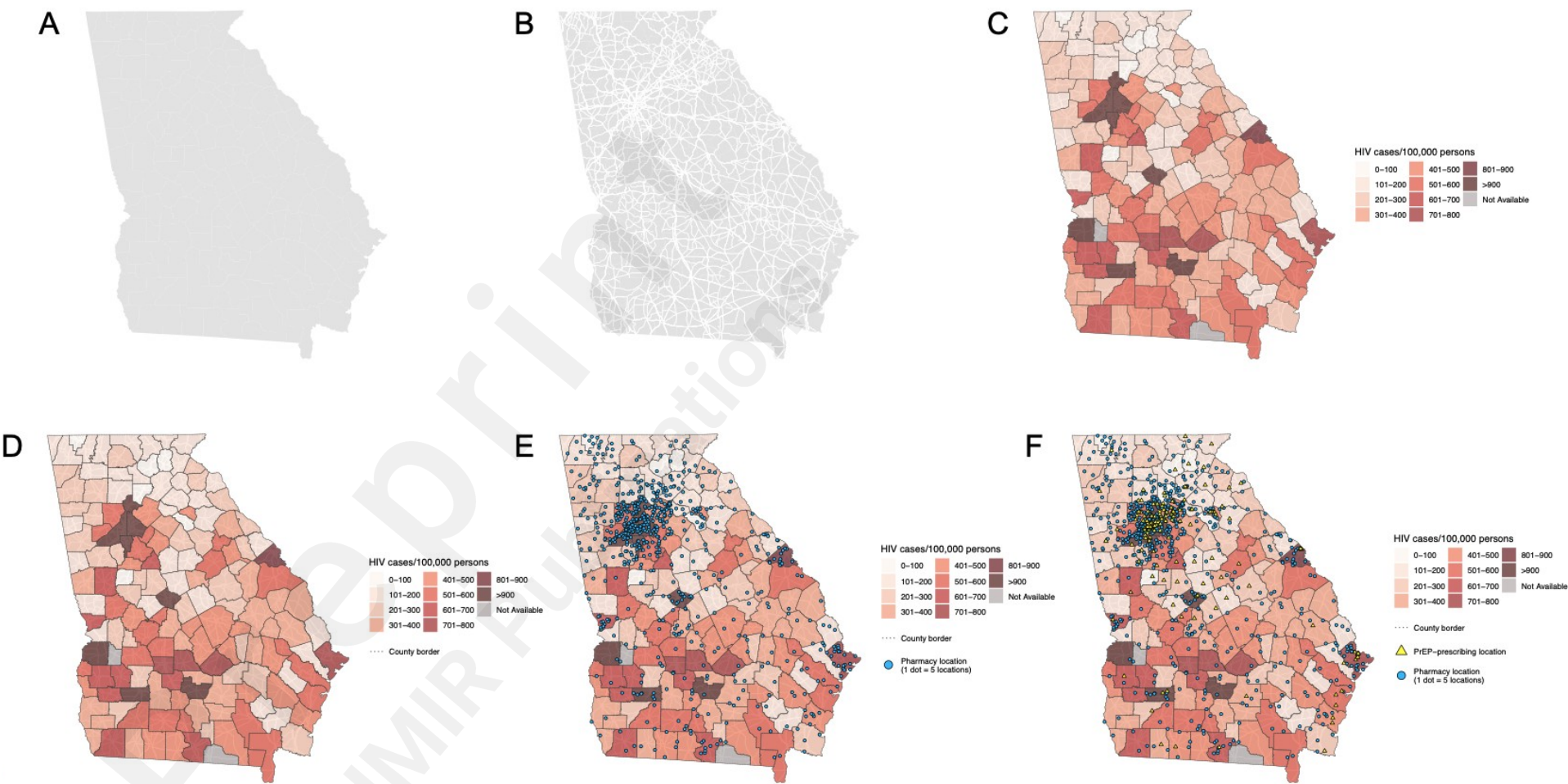


Figure 2. Completed state map of Georgia.

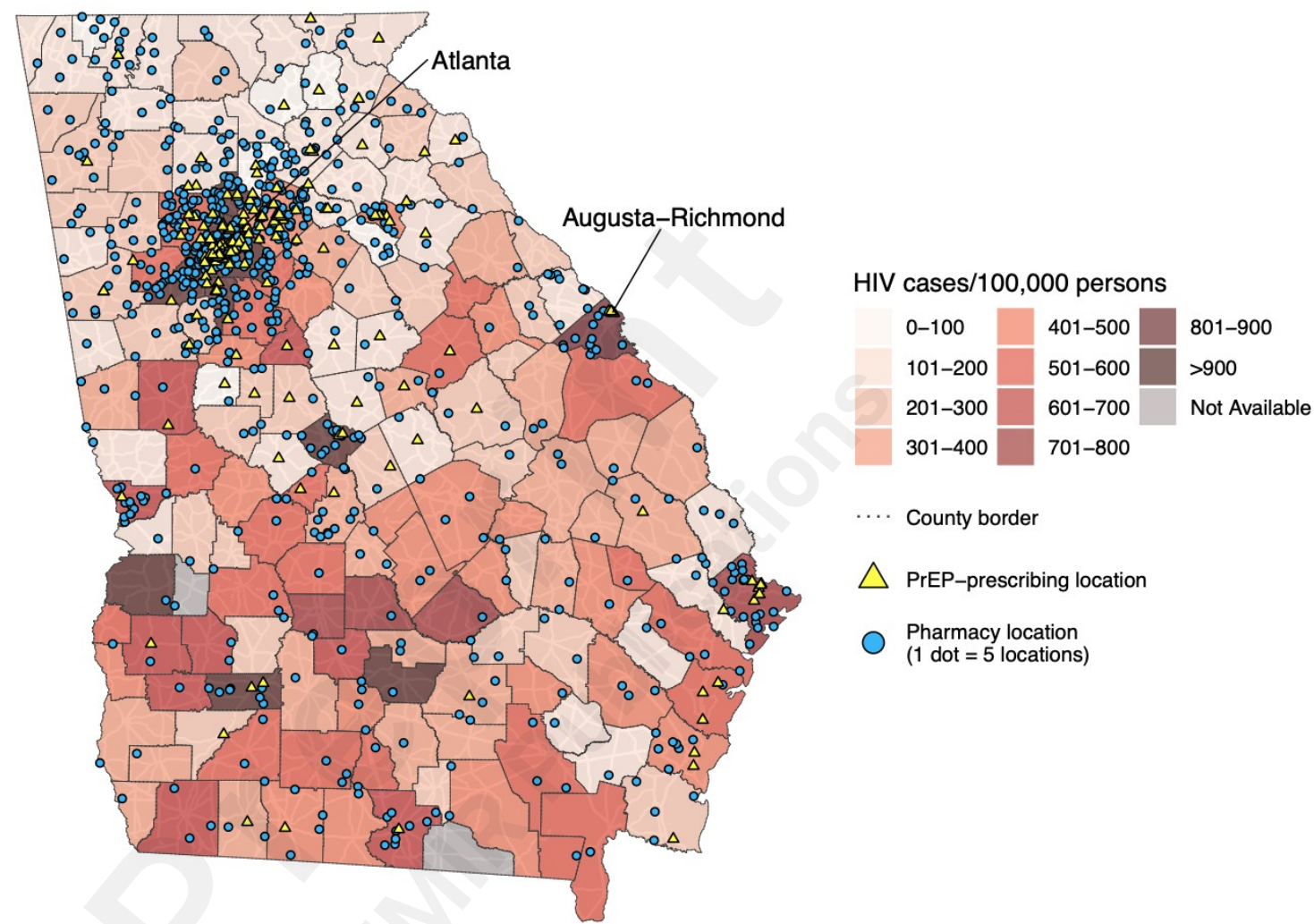


Figure 3. Sequential process of the creation of a city map.

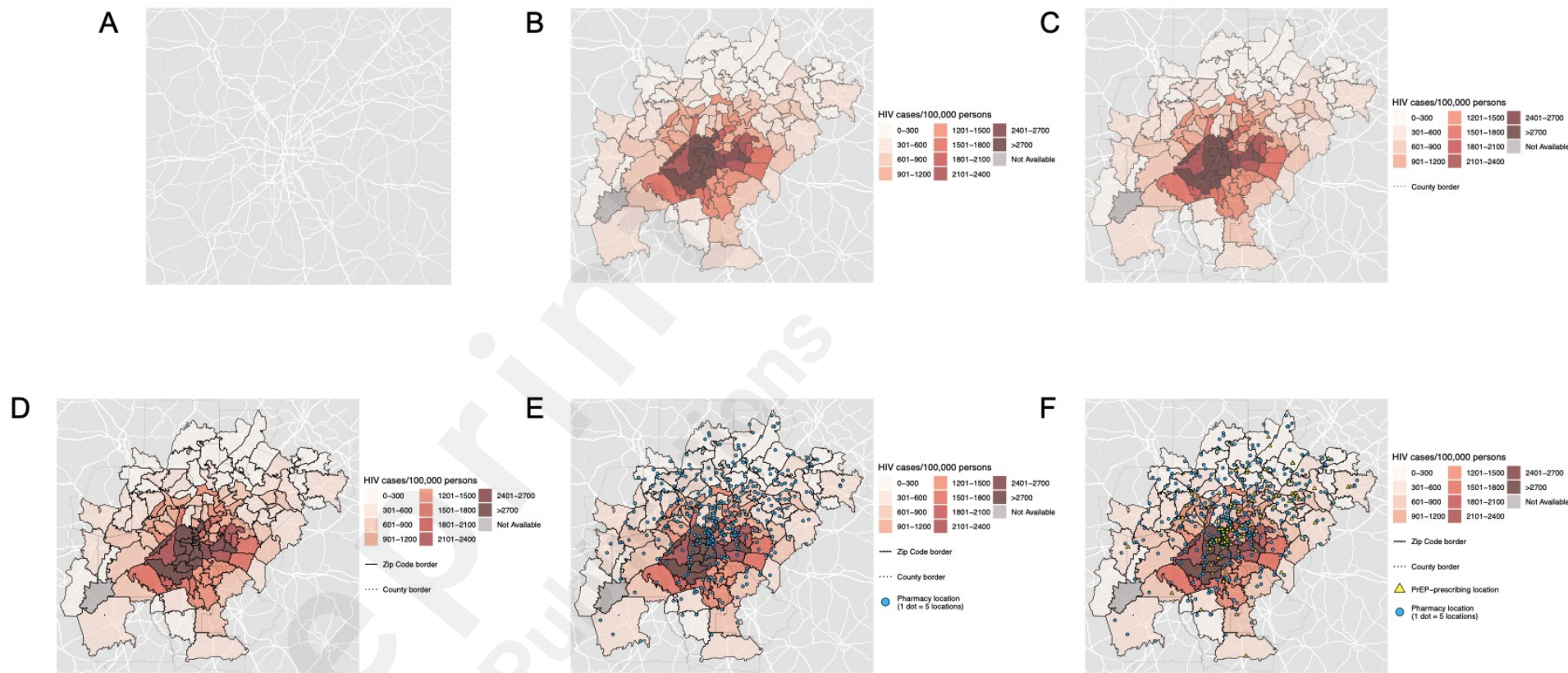


Figure 4. Completed city map of Atlanta.

