

HIV-Experienced Clinician Workforce Capacity: Urban-Rural Disparities in the US South

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Key points: HIV-experienced clinicians disproportionately practice in metropolitan areas, with significantly lower HIV-experienced clinician workforce capacity in rural versus urban communities. As the HIV epidemic is increasingly represented in rural areas, policies to improve equitable access to HIV-experienced clinical care are essential.

Abstract

Background: HIV-experienced clinicians are critical for positive outcomes along the HIV care continuum. However, access to HIV-experienced clinicians may be limited, particularly in nonmetropolitan areas, where HIV is increasing. We examined HIV clinician workforce capacity, focusing on HIV experience and urban-rural differences, in the US South.

Methods: We used Medicaid claims and clinician characteristics (Medicaid Analytic eXtract (MAX) and MAX Provider Characteristics, 2009-2011), county-level rurality (National Center for Health Statistics, 2013) and diagnosed HIV cases (AIDSVu, 2014) to assess HIV clinician capacity in 14 states. We assumed clinicians accepting Medicaid approximated the region's HIV workforce, since three-quarters of clinicians accept Medicaid insurance. HIV-experienced clinicians were defined as those providing care to ≥ 10 Medicaid enrollees over three years. We assessed HIV workforce capacity with county-level clinician-to-population ratios, using Wilcoxon-Mann-Whitney tests to compare urban-rural differences.

Results: We identified $n=5,012$ clinicians providing routine HIV management, of whom 28% were HIV-experienced. HIV-experienced clinicians were more likely to specialize in infectious diseases (48% vs 6%, $p<0.001$) and practice in urban areas (96% vs 83%, $p<0.001$) compared to non-HIV-experienced clinicians. The median clinician-to-population ratio for all HIV clinicians was 13.3 (interquartile range 38.0), with no significant urban-rural differences. When considering HIV experience, 81% of counties had no HIV-experienced clinicians, and rural counties generally had fewer HIV-experienced clinicians per 1,000 diagnosed HIV cases ($p<0.001$).

Conclusions: Significant urban-rural disparities exist in HIV-experienced workforce capacity for Southern US communities. Policies to improve equity in access to HIV-experienced clinical care for both urban and rural communities are urgently needed.

Keywords: HIV, rural, urban, disparities, health workforce

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Introduction

Achieving national targets for people living with HIV (PLWH), promoting health equity, and ending the United States' (US) HIV epidemic by 2030 [1, 2] requires renewed efforts to provide accessible, high-quality HIV care. Critical to this effort is a robust and experienced HIV clinician workforce, since greater clinician experience in managing HIV is associated with improved clinical outcomes for PLWH, including viral suppression [3, 4]. However, a significant shortage in HIV care clinicians is anticipated [5, 6]; HIV medical organizations report challenges with physician recruitment and retention [7]; and infectious disease fellowship training slots, a key source for future HIV clinicians, are not being filled [8].

Compounding concerns about HIV clinician supply and experience, questions remain about geographic equity in accessing HIV clinical care. The majority of HIV clinicians currently practice or plan to practice in urban areas [5, 9], mirroring the historic urban concentration of HIV cases. Simultaneously, the epidemic is increasingly shifting toward nonurban areas [10]. PLWH in rural areas experience more limited geographic access to HIV care [11, 12], more advanced HIV disease at diagnosis [13], lower retention in HIV care, and lower rates of viral suppression, compared to those living in the most urban communities [14].

Accessibility of experienced HIV clinicians in rural areas is critical to promote access to care and improve health equity for all PLWH. Leveraging comprehensive administrative claims data from 14 Southern states, we examined urban-rural disparities in HIV clinician workforce capacity, particularly among HIV-experienced clinicians.

Methods

Data

To identify adults receiving routine HIV care and their clinicians, we used administrative claims data from the Medicaid Analytic eXtract (MAX) for adults aged 19-64 years in 14 Southern states including the District of Columbia (DC), 2009-2011. These states include some of the highest rates of newly diagnosed HIV cases nationally [2]. The MAX data include Medicaid claims for outpatient medical visits and filled prescriptions, enrollee-level demographic information, and national provider identifiers (NPIs) for clinicians providing outpatient services. To identify the clinicians' practice locations, we used the MAX Provider Characteristics (MAX PC) dataset (2009-2011), which provides demographic and practice-related information for clinicians who submitted medical claims to Medicaid. Data usability of the claims and clinician characteristics was assessed for all 16 states plus DC in the Southern region; three states—South Carolina, Texas, and Virginia—did not meet data usability criteria for quality and completeness (e.g., correct reporting of NPIs; percentage of enrollees with claims) and were excluded (**Supplementary Material**). To estimate HIV clinician capacity and urban-rural differences, we used county-level diagnosed HIV case counts for 2014 for counties reporting at least five diagnosed HIV cases in the included states (n=926 counties including DC) [15].

Approach to Construct Sample

Identifying enrollees receiving routine HIV care

We first identified, in the administrative claims, Medicaid enrollees living with HIV (**Figure 1**). We used diagnosis codes from the International Statistical Classification of Diseases

and Related Health Problems, Ninth Revision to identify enrollees living with HIV. We verified HIV status using Current Procedural Terminology codes for HIV-related laboratory management (e.g., receipt of CD4+ T-lymphocyte or plasma HIV measurements) or National Drug Codes for antiretroviral prescriptions. Enrollees were excluded from the sample and considered not living with HIV if they did not have ≥ 1 HIV diagnosis code and ≥ 1 HIV verification code; if they did not have ≥ 2 HIV diagnosis codes ≥ 30 days apart; if their only HIV verification codes occurred before their first HIV diagnosis code; or if their only prescribed antiretroviral drug was emtricitabine/tenofovir for pre-exposure prophylaxis.

We further limited this sample to enrollees receiving routine HIV care, since routine HIV care claims would later be used to identify HIV clinicians. *Routine HIV care* was defined as office-based or outpatient evaluation and management or preventive care services for which an HIV diagnosis code was in the primary diagnosis position (indicating that the medical visit pertained primarily to HIV management). However, in sensitivity analysis, we relaxed this definition by allowing HIV diagnosis codes to occur in either the primary or secondary position. This relaxed definition captured routine HIV-related or non-HIV-related care for PLWH, plus routine HIV care for which diagnosis codes may have been incorrectly entered due to system-level logistical challenges in the electronic medical record [16]. After all exclusions, the baseline sample included 314,220 routine HIV care claims across 40,453 enrollees with HIV.

Identifying HIV clinicians and their practice locations

We used the sample of routine HIV care claims to identify clinicians providing routine HIV management. We assumed this sample approximated the region's HIV workforce, since nearly three-quarters of clinicians accept Medicaid insurance nationally, and Medicaid is the

largest single source of insurance for PLWH [17, 18]. We linked NPIs in the claims and MAX PC dataset to obtain a candidate set of clinicians providing routine HIV care. We removed duplicate NPIs, as well as clinicians in specialties not typically providing routine HIV care (e.g., surgeons), who did not practice in the 14 states, who had missing addresses, or whose address could not be matched to a county. We geocoded clinician practice addresses from the MAX PC [19], using a spatial overlay to identify the county in which each clinician practiced. Counties were classified as rural or urban [20]. Urban counties were those in metropolitan statistical areas, federally defined regions containing urban centers of $\geq 50,000$ population. Rural counties were nonmetropolitan counties, or those outside of metropolitan statistical areas and with population centers of $\leq 49,999$ residents.

Analysis

We summarized the HIV clinician workforce at the clinician and county levels. At the clinician level, we described clinicians by rurality, gender, credential (physician [i.e., MD or DO] or advanced practitioner [i.e., NP or PA]), state, and specialty (physicians only). Physician specialties were categorized as: infectious diseases, internal medicine, other primary care (e.g., family medicine, pediatrics, geriatrics), and other. We also considered *HIV-experienced clinicians*, or clinicians providing care to ≥ 10 enrollees with HIV across three years. While HIV specialty medical societies have used thresholds of 20 or 25 patients with HIV over three years to define ‘HIV specialists’ [21, 22], we conservatively opted for a lower patient threshold to reflect availability of claims data from a single payer and to allow comparability with existing literature [4, 5]. However, in sensitivity analysis, we examined a threshold of ≥ 25 enrollees living with HIV across three years. We examined differences between HIV-experienced and non-HIV-

experienced clinicians for rurality, gender, credential, specialty, and state using chi-squared tests ($p < 0.05$).

To assess county-level workforce capacity, we calculated clinician-to-population ratios, defined as the number of clinicians in a county per 1,000 diagnosed HIV cases. Diagnosed HIV cases were used as the denominator instead of the general population, as is typical for clinician-to-population ratios, because this better captures the population in need of HIV clinical care. Ratios are reported only for counties with at least five diagnosed HIV cases, with smaller clinician-to-population ratios indicating lower workforce capacity relative to HIV burden in a given county. We summarized county-level clinician-to-population ratios using medians and interquartile ranges (IQRs), comparing ratios for urban and rural counties using Wilcoxon-Mann-Whitney tests ($p < 0.05$). We also considered the special case in which a county has zero HIV clinicians but at least five diagnosed HIV cases, and reported the total number of diagnosed HIV cases in those counties. Data were summarized using Stata 15 and mapped using ArcMap 10.5.

Results

Clinician Characteristics

We identified 5,012 clinicians providing routine HIV care in 14 Southern states (**Table 1**). Thirteen percent practice in rural counties, with over 90% of rural clinicians considered non-HIV-experienced. Nearly 60% of clinicians are men; 82% are physicians and 12% are advanced practitioners. Among physicians ($n=4,094$), internal medicine (33%) and other primary care (44%) are the most common physician specialties; infectious disease specialists comprise less than a fifth of the sample (18%).

Of all identified HIV clinicians, fewer than 30% are considered HIV-experienced. HIV-experienced clinicians are significantly less likely to practice in rural counties (4%) versus non-HIV-experienced clinicians (17%, $p<0.001$). There are no significant differences by gender or credential between HIV-experienced and non-HIV-experienced clinicians, though there are differences by state ($p<0.001$). Nearly half of all HIV-experienced physicians specialize in infectious diseases, compared to 6% among non-HIV-experienced physicians ($p<0.001$).

Workforce Capacity

Of 926 counties assessed, over 40% ($n=373$) have no HIV clinicians. Counties with no HIV clinicians have an estimated 11,987 diagnosed HIV cases, with nearly 60% in rural counties. Across all counties, the median county-level HIV clinician-to-population ratio is 13.3 (IQR 38.0) HIV clinicians per 1,000 diagnosed HIV cases (**Table 2**). Ratios vary widely across states, with medians as low as 0 in Arkansas, Kentucky and West Virginia and as high as 34.5 in Delaware (IQR 14.5). Overall and within states, rural counties have lower workforce capacity, with overall median clinician-to-population ratios of 7.4 (IQR 43.5) versus 16.0 (IQR 32.3) for urban counties; however, these urban-rural differences are not statistically significant with the exception of West Virginia ($p<0.01$).

Considering the $n=1,397$ HIV-experienced clinicians, 81% of counties have no HIV-experienced clinicians, with rural counties less likely to have HIV-experienced clinicians (94%) than urban counties (65%, $p<0.001$; **Figure 2**). Nearly 43,000 people diagnosed with HIV live in counties with no HIV-experienced clinicians, and 47% of these individuals live in rural counties. There is a median of 0 (IQR 0) HIV-experienced clinicians per 1,000 diagnosed HIV cases

across all counties. Overall and in each state except Maryland, ratios are significantly different in rural counties and in urban counties ($p < 0.05$).

Sensitivity Analyses

Relaxing the definition of routine HIV care used to identify HIV clinicians increased the total number of HIV clinicians ($n=6,488$) and overall HIV clinician-to-population ratios (median for all counties 26.0 (IQR 55.6)). However, few ($n=57$) additional HIV-experienced clinicians were identified and median HIV-experienced clinician-to-population ratios were largely unchanged relative to baseline. Additionally, when defining HIV-experienced clinicians as those with ≥ 25 enrollees living with HIV over three years, 15% of HIV clinicians were HIV-experienced, 4% of whom practiced in rural counties. Under this definition, over 56,000 people diagnosed with HIV lived in counties with no HIV-experienced clinicians, with over 60% in urban counties. Overall and in several states, HIV-experienced workforce capacity in rural counties was significantly different from urban counties, $p < 0.01$, although differences were not significant for five states (Arkansas, Georgia, Kentucky, Maryland, and Mississippi).

Discussion

HIV-experienced clinicians disproportionately practice in metropolitan areas, resulting in significant disparities in HIV-experienced clinician workforce capacity in rural versus urban communities. Less than a third of clinicians who provide routine HIV care are HIV-experienced, and over 80% of counties across the South lack an HIV-experienced clinician.

Findings highlight geographic barriers to, and disparities in, access to care. Across 14 states, over 20,000 PLWH live in rural counties with no HIV-experienced clinicians and nearly

7,000 live in rural counties with no HIV clinicians at all; these PLWH may lack access to high-quality HIV care in their communities. This raises concerns as limited geographic access to care appears associated with poorer linkage to care, retention in care, and viral suppression [23, 24]. While the majority of PLWH live in urban counties, the more limited HIV clinician workforce capacity in rural areas may ultimately contribute to the observed urban-rural disparities in HIV care continuum outcomes [10, 14]. Moreover, as the ongoing opioid epidemic leads to new cases of HIV and hepatitis C in rural communities [25], improving the capacity of clinicians experienced in infectious disease management in rural areas is essential.

This study underscores the limited capacity of HIV-experienced clinicians in both rural and urban communities. Using our conservative baseline definition of HIV-experienced clinicians, we identified a pressing gap in service accessibility particularly for rural areas. The more restrictive definition of HIV-experienced clinicians in sensitivity analysis additionally emphasizes limited availability in urban communities, where workforce capacity is similar to that of rural communities in some states. A strong body of literature suggests more experienced HIV clinicians deliver higher quality care: physicians with fewer HIV patients are less likely to prescribe ART [26, 27], while clinicians with higher caseloads (e.g., ≥ 20 or 50 patients with HIV) are more likely to meet key quality metrics for visit frequency or retention in care, CD4 cell count and HIV RNA viral load testing, viral suppression [3, 4] and certain preventive care measures (e.g., tuberculosis testing; lipid panels) [3]. HIV caseload may be more important than physician specialty in predicting quality of care [28], which highlights the implications of limited HIV-experienced clinician capacity, including urban-rural disparities, for achieving national health equity goals and ending the epidemic.

Results are broadly consistent with, yet provide a novel contribution to, the HIV workforce literature. Across the same 14 states we studied, Gilman et al. identified a very similar number of HIV clinicians (n=1,484) providing care to ≥ 10 PLWH in a year [5] as did our analysis at baseline (n=1,397) and when relaxing the definition of routine HIV care used to identify clinicians in sensitivity analysis (n=1,454). Our work identified a similar fraction of HIV-experienced clinicians practicing in rural areas (4%) as the previous study (3%) [5]. In a recent survey, 80% of HIV clinicians were physicians and 43% were women [29], compared to 82% physicians and 35% women in our sample. Building on previous work, this study is the first to our knowledge to provide a fine-grained analysis of the geographic structure of the US HIV workforce and to quantify urban-rural disparities in HIV workforce capacity, including among HIV-experienced clinicians. Finally, previous analyses relied on a national probability sample of HIV clinicians [29] or on a proprietary all-payer administrative claims database supplemented by surveys to identify a sample of HIV clinicians [5]; this study demonstrates that using Medicaid administrative claims alone yields similar results.

Several approaches exist to increase rural access to experienced HIV clinicians. Remote telehealth alternatives may increase access to care for rural PLWH, with some evaluations indicating high uptake and acceptability [30] and improvements in viral suppression [31], although barriers such as state-specific clinician licensure, limited reimbursement for telemedicine, and limitations on prescribing via telemedicine may hinder widespread implementation of telehealth for HIV management [32]. Another alternative is to expand the HIV care capacity of the existing rural clinician workforce. Programs such as the AIDS Education and Training Centers provide training in HIV management [33, 34], but participation may need to be expanded for clinicians to meet the needs of rural PLWH. State-level policy

efforts could involve expanding scope of practice laws for nurse practitioners, who provide HIV care of similar quality as physicians [29, 35] but are prohibited from prescribing medications or practicing independently in many states. Alternatively, states could employ HIV-experienced clinicians at local health departments to provide local care or expand transportation assistance when other solutions are not feasible.

Limitations

We used data from a single insurer (Medicaid, prior to the Affordable Care Act) so cannot draw definitive conclusions about the total clinicians and clinician caseload or level of HIV training. Using a single source risks underestimating the size of, and geographic disparities within, the clinician workforce. However, findings on the size and geographic distribution of the HIV clinician workforce are largely comparable to previous work representing different geographic areas (e.g., state, region, national), and insurance types, including uninsurance [4, 5, 11, 12, 36]. Additionally, current Medicaid claims data are not routinely and widely available, especially since the Affordable Care Act. However, the claims used in the current analysis, while older, represent one of the most comprehensive sources of administrative data for the largest insurer of PLWH and provide important evidence on HIV clinicians' practice patterns. Current and comprehensive data on Medicaid clinicians—including their characteristics, patient volume, and service locations—are also not routinely available. While current and historical clinician data from other sources are accessible (e.g., American Medical Association Physician Masterfile), we used the older Medicaid Provider Characteristics file to remain contemporaneous with our enrollee-level claims data and because the clinician data included additional information (e.g., data on advanced practitioners, clinicians practicing in multiple states) not typically

available in other data sources. Given recent challenges in HIV workforce recruitment and retention and an increasing rural epidemic, we expect that our estimates represent a conservative upper bound of HIV workforce capacity and urban-rural disparities. Third, assigning HIV clinicians to a single county does not capture PLWH who cross county boundaries for care or clinicians who practice in multiple counties. Our analysis thus may overestimate the number of counties with zero HIV clinicians and underestimate HIV clinician-to-population ratios. Yet our assignment of HIV clinicians to a single geographic unit (here, the county) is consistent with similar literature on US clinician workforce capacity that relies on clinician-to-population ratios [37, 38]. Further, findings from the current study complement emerging evidence on geographic access to HIV care suggesting increased availability of, and shorter travel to, HIV care, in urban areas [11, 12, 36]. Fourth, the data draw on the National Plan and Provider Enumeration System, a self-report database which clinicians may not regularly update [39], although this source provides the most accurate physician contact information [40]. Finally, we used data from states in a single geographic region, the US South. These states include those with the highest rates of newly diagnosed HIV cases nationally, highlighting the importance of an adequate HIV workforce for those newly diagnosed and diagnosed but uncontrolled. While the rural HIV epidemic is disproportionately represented in the South, we anticipate our main findings regarding the limited HIV workforce capacity in rural areas would generalize to other regions [5].

Conclusions

As the US strives to end the HIV epidemic, structural barriers—including clinician workforce capacity—and resulting disparities in access to care have emerged as critical areas of

focus. Addressing the needs of rural PLWH has become increasingly important given the shift of the epidemic toward rural communities. HIV-experienced clinicians are more likely to practice in urban areas, and significant urban-rural differences exist in county-level HIV-experienced clinician workforce capacity. However, findings also suggest striking gaps in the workforce capacity of HIV-experienced clinicians across both urban and rural locales. Policies that promote a robust and experienced HIV clinician workforce for PLWH, whether in urban or rural communities, are urgently needed.

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RSB and ADK designed the study. YD and RSB analyzed the data and RSB, BD, and ADK aided in data interpretation. RSB and ADK drafted the manuscript and AGR, BD, DEN, FZB, LEY, and LMS and revised the manuscript for important intellectual content.

Disclaimer

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Notes

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Potential conflict of interest

The authors declare no conflicts of interest.

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Table 1. Characteristics of HIV clinicians in 14 US states, 2009-2011 (N (%))

	Total	Non-HIV- experienced†	HIV- experienced†	p-value*
All	5,012	3,615	1,397	
Practice location‡				<0.001
Rural	672 (13%)	613 (17%)	59 (4%)	
Urban	4,340 (87%)	3,002 (83%)	1,338 (96%)	
Gender				0.716
Women	1,777 (35%)	1,268 (35%)	509 (36%)	
Men	2,881 (57%)	2,070 (57%)	811 (58%)	
Missing	354 (7%)	277 (8%)	77 (6%)	
Credential§				0.117
Physician	4,094 (82%)	2,930 (81%)	1,164 (83%)	
Advanced practitioner	577 (12%)	431 (12%)	146 (10%)	
Missing	341 (7%)	254 (7%)	87 (6%)	
Physician specialty (n=4,094)				<0.001
Infectious disease	739 (18%)	179 (6%)	560 (48%)	
Internal medicine	1,358 (33%)	1,045 (36%)	313 (27%)	
Other primary care	1,819 (44%)	1,578 (54%)	241 (21%)	
Other	178 (4%)	128 (4%)	50 (4%)	
State				<0.001
Alabama	155 (3%)	105 (3%)	50 (4%)	
Arkansas	145 (3%)	110 (3%)	35 (2%)	
District of Columbia	94 (2%)	51 (1%)	45 (3%)	
Delaware	88 (2%)	61 (2%)	27 (2%)	
Florida	1,616 (32%)	1,069 (30%)	547 (39%)	
Georgia	527 (11%)	389 (11%)	138 (10%)	
Kentucky	180 (4%)	152 (4%)	28 (2%)	
Louisiana	315 (6%)	223 (6%)	92 (7%)	
Maryland	235 (5%)	165 (5%)	70 (5%)	
Mississippi	291 (6%)	239 (7%)	52 (4%)	
North Carolina	683 (14%)	492 (14%)	191 (14%)	
Oklahoma	201 (4%)	177 (5%)	24 (2%)	
Tennessee	382 (8%)	304 (8%)	78 (6%)	
West Virginia	100 (2%)	78 (2%)	22 (2%)	

Column percentages may not add to 100% due to rounding.

* Statistically significant differences between HIV-experienced and non-HIV-experienced clinicians were assessed using chi-squared tests ($p < 0.05$).

† HIV-experienced clinicians are those who provided HIV care to a minimum of ten Medicaid enrollees living with HIV between 2009 and 2011.

‡ Rurality is defined according to the 2013 National Center for Health Statistics Urban-Rural Classification Scheme: *rural* includes counties in nonmetropolitan areas and *urban* includes counties in metropolitan statistical areas of any size. Delaware has no rural counties and the District of Columbia is counted as a single county. Three states (South Carolina, Texas, Virginia) that were originally considered for inclusion were excluded due to data completeness and quality issues.

§ Physicians include MDs (Doctor of Medicine) and DOs (Doctor of Osteopathy). Advanced practitioners include nurse practitioners and physician assistants.

| Specialties are reported for physicians only (i.e., clinicians with MD or DO credentials).

Table 2. Number of counties and median county-level HIV clinician-to-population ratios (clinicians per 1,000 diagnosed HIV cases)

State	Counties with at least 5 diagnosed HIV cases (frequency)			All HIV clinicians (median (interquartile range))			<i>p</i> *	HIV-experienced clinicians (median (interquartile range))			<i>p</i> *
	All	Rural	Urban	All counties	Rural counties	Urban counties		All counties	Rural counties	Urban counties	
All 14 states	926	531	395	13.3 (38.0)	7.4 (43.5)	16.0 (32.3)	0.13	0.0 (0.0)	0.0 (0.0)	0.0 (4.9)	<0.01
Alabama	67	38	29	11.0 (27.8)	17.0 (38.5)	4.3 (14.4)	0.05	0.0 (0.0)	0.0 (0.0)	0.0 (3.2)	<0.01
Arkansas	71	51	20	0.0 (45.5)	0.0 (52.6)	15.9 (24.8)	0.47	0.0 (0.0)	0.0 (0.0)	0.0 (5.6)	<0.01
DC	1	0	1	6.2 (--)	--	6.2 (--)	--	2.8 (--)	--	2.8 (--)	--
Delaware	3	0	3	34.5 (14.5)	--	34.5 (14.5)	--	8.6 (2.2)	--	8.6 (2.2)	--
Florida	67	23	44	19.3 (20.5)	27.3 (32.3)	19.0 (14.6)	0.69	4.0 (6.7)	0.0 (6.8)	5.0 (6.7)	0.04
Georgia	156	83	73	7.6 (28.4)	0.0 (30.3)	10.7 (23.7)	0.63	0.0 (0.0)	0.0 (0.0)	0.0 (1.8)	<0.01
Kentucky	99	67	32	0.0 (53.4)	0.0 (76.9)	4.4 (37.9)	0.62	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	<0.01
Louisiana	62	28	34	13.5 (28.6)	11.7 (32.8)	14.4 (21.4)	0.71	0.0 (0.0)	0.0 (0.0)	0.0 (5.2)	<0.01
Maryland	24	5	19	6.9 (12.0)	0.0 (16.7)	7.1 (9.4)	0.48	0.0 (0.4)	0.0 (0.0)	0.0 (1.0)	0.16
Mississippi	80	63	17	29.2 (48.0)	27.3 (56.3)	33.9 (31.1)	0.39	0.0 (0.0)	0.0 (0.0)	0.0 (3.5)	0.02
North Carolina	98	52	46	20.0 (42.7)	17.1 (39.1)	24.4 (32.5)	0.28	0.0 (4.1)	0.0 (0.0)	0.0 (9.3)	<0.01

Oklahoma	61	44	17	26.3 (47.1)	26.3 (59.7)	27.4 (22.4)	0.91	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	<0.01
Tennessee	89	48	41	27.0 (56.4)	30.4 (64.6)	24.4 (51.3)	0.69	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	<0.01
West Virginia	48	29	19	0.0 (48.0)	0.0 (0.0)	32.3 (83.3)	<0.01	0.0 (0.0)	0.0 (0.0)	0.0 (14.9)	<0.01

Note: The left panel of clinician-to-population ratios represents the number of clinicians (physicians and advanced practitioners)

providing routine HIV care to any number of Medicaid enrollees living with HIV, per 1,000 diagnosed HIV cases in a county.

The right panel restricts the sample to HIV-experienced clinicians, i.e., those who provide HIV care to a minimum of ten

Medicaid enrollees living with HIV. Rurality is defined according to the 2013 National Center for Health Statistics Urban-Rural

Classification Scheme: *rural* includes counties in nonmetropolitan areas and *urban* includes counties in metropolitan statistical

areas of any size. Delaware has no rural counties and the District of Columbia [DC] is counted as a single county. For DC, state-

level HIV prevalence data were used, and (--) indicates that no interquartile range was calculated because DC represents a single

geographic entity.

* Assessed significant urban-rural differences ($p < 0.05$) with Wilcoxon-Mann-Whitney tests.

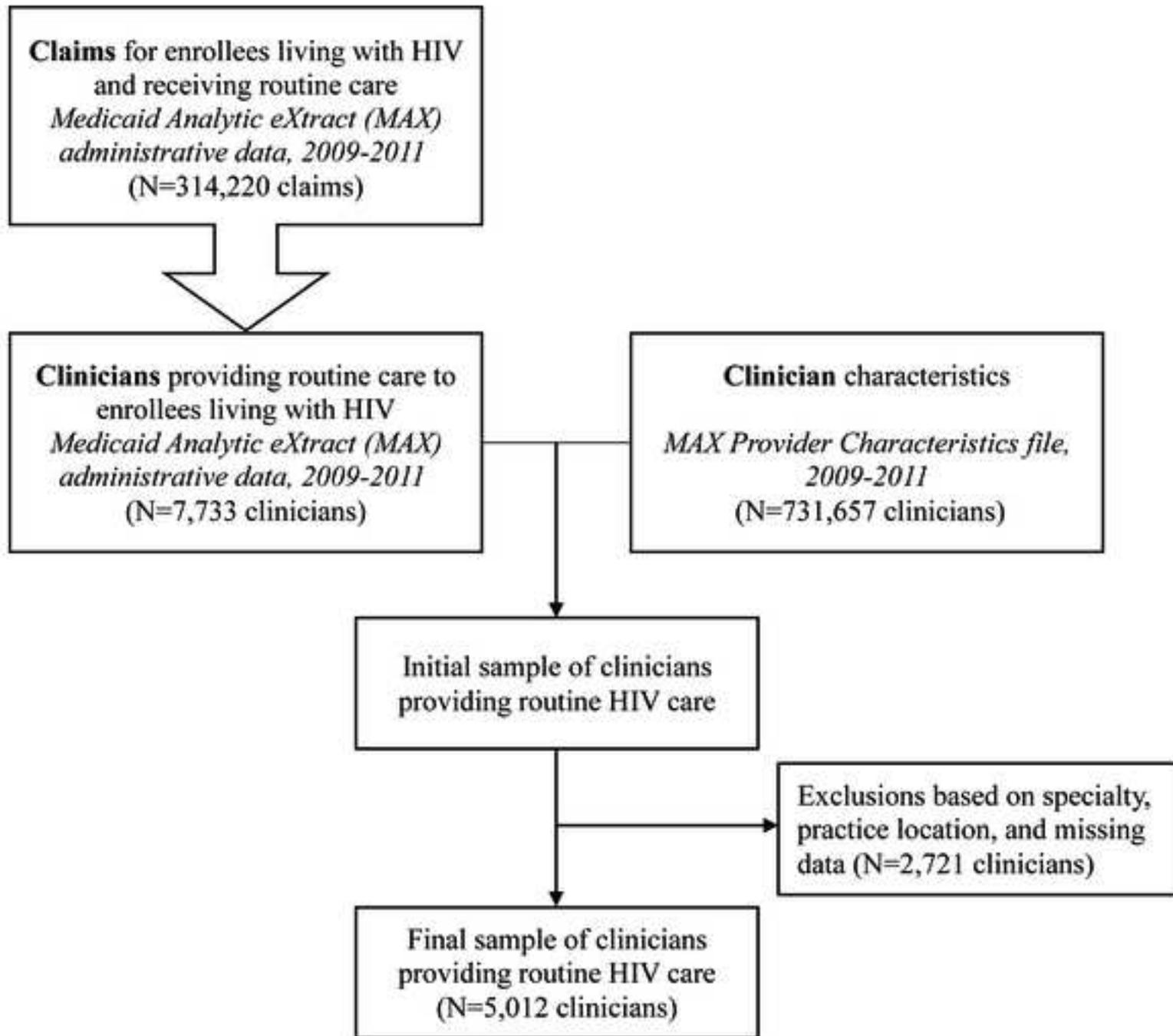
Figure Legends

Figure 1. Process overview for identifying HIV clinicians from claims data

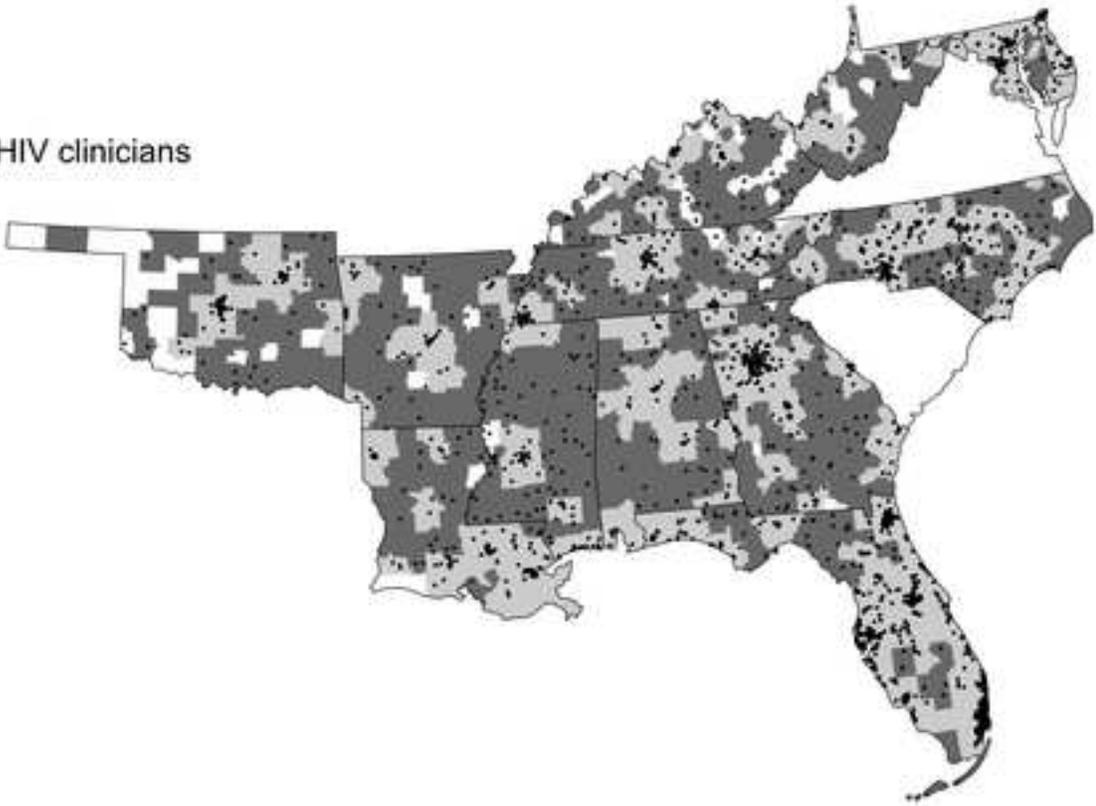
This figure shows an overview of the process for identifying clinicians who provide routine HIV care using administrative claims data. The Medicaid Analytic eXtract (MAX) data used here comprise claims from 14 states for enrollees who qualify for Medicaid based on income or disability criteria, 2009-2011. More detail regarding identification of enrollees living with HIV, claims representing HIV routine care, and HIV clinicians is in the Supplementary Material.

Figure 2. County-level rurality and locations of HIV clinicians

Rural counties with at least five diagnosed HIV cases in 2014 are shaded in dark grey and urban counties with at least five diagnosed HIV cases are in light grey. Data are not available for counties shaded white. HIV clinicians provide routine HIV care to any number of Medicaid enrollees living with HIV, while HIV-experienced clinicians provide HIV care to a minimum of ten Medicaid enrollees living with HIV over three years. HIV clinician workforce capacity is similar across urban and rural counties when considering all HIV clinicians (Panel A), but few HIV-experienced clinicians practice in rural counties (Panel B).



A All HIV clinicians



B HIV-experienced clinicians

