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# Clustering affordable care act qualified health plans to understand how and where insurance facilitates or impedes access to HIV prevention

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## Abstract

**Background** With access to and uptake of pre-exposure prophylaxis (PrEP), the United States can prevent new HIV infections. To end the HIV epidemic, health insurance plans must facilitate access to comprehensive preventive care benefits. Since plan benefit designs vary considerably by plan, it is difficult to systematically determine plans that facilitate and restrict preventive services for PrEP.

**Methods** We applied an unsupervised machine learning method to cluster 17,061 Qualified Health Plans offered to individuals. We examined the clusters to draw conclusions about the types of benefits insurance companies tend to group together in plans. Then we analyzed the geographic distribution of those clusters across the United States to assess geographic inequities in access to HIV preventive care.

**Results** Our method uncovered three cohesive clusters of plans. Plans in Cluster 1: the least restrictive cluster, facilitate access to preventive care using copays over coinsurance on almost all benefits; Cluster 2: the moderately restrictive cluster, plans cover HIV prevention benefits with copays but restrict access to general health benefits with coinsurance; and Cluster 3: the most restrictive cluster, plans cover almost all benefits using coinsurance. Overall, increased prior authorization requirements tend to accompany reductions in out-of-pocket costs. Examining the geographic plan distribution, states with at least one rating area where at least 75% of plans offered are in the most restrictive cluster included: Georgia, Illinois, Missouri, Oklahoma, Texas, Virginia, and Wyoming.

**Conclusions** Insurance plan design is complex. To address the ambitious call to end the HIV epidemic in this country, plans should also take into account both public health and health equity factors to create plan designs that ensure access to critical preventive services for people who need them most. Addressing the growing disparities in PrEP access along racial and ethnic lines should be a national priority, and federal and state insurance regulators as well as insurance plans themselves should be part of the conversation about how to ensure people who would benefit from PrEP can access it. Better state/federal regulation of plan design to ensure access is consistent, equitable, and based on clinical recommendations will reduce the variability across plan designs.

**Keywords** HIV, Pre-exposure prophylaxis, HIV prevention, Health insurance, Insurance benefits, cost sharing insurance, Patient protection and affordable care act, Prior authorization

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## Background

### HIV & HIV prevention in the United States

The human immunodeficiency virus (HIV) infection rate held constant between 2014 and 2018, suggesting that the United States (US) did not make substantial progress to end the HIV epidemic during those years [1]. There are also widening disparities in HIV incidence, with Black or African-American and Hispanic or Latino people accounting for a disproportionate share of new HIV diagnoses [2].

In 2012, the Federal Drug Administration (FDA) approved tenofovir disoproxil fumarate/emtricitabine (TDF/FTC) to be used as HIV Pre-Exposure Prophylaxis (PrEP) among those who are at risk of HIV infection [3]. Daily use of TDF/FTC reduces the risk of acquiring HIV through sex by 99% and by at least 74% among people who inject drugs (PWID) [3]. By 2021, the PrEP market had expanded with FDA approval of tenofovir alafenamide emtricitabine (TAF/FTC) in 2019, the generic formulation of TDF/FTC in 2020 and long-acting injectable cabotegravir in 2021 [4–6].

For the last decade, the US has had the tools to prevent new HIV infections. Yet, there are gaps in service provision networks and other structural barriers that have kept powerful preventive measures from reaching those who most need them [1]. In 2019, the federal initiative to End the HIV Epidemic (EHE) was introduced and funds were allocated to the Phase 1 Jurisdictions, which were the 48 counties that accounted for more than half of new HIV diagnoses in the U.S.in 2016–2017 and the seven states with a large number of HIV diagnoses in rural areas [7]. Increasing PrEP access and uptake is one of the four main goals of the EHE initiative [7], and it is important that people in these jurisdictions have access to plans that reduce barriers to accessing PrEP and other preventive services.

Despite the federal EHE initiative, disparities in PrEP access track along familiar lines of race, ethnicity, income, and geography. The Centers for Disease Control and Prevention (CDC) estimates that in 2022, 94% of White people who could benefit from PrEP have been prescribed it, but only 13% of Black and 24% of Hispanic or Latino people who could benefit have been prescribed PrEP [8]. This is the motivation for the present work — health insurance coverage has a role to play in ensuring those who need HIV preventive care are both informed and able to acquire it easily. And yet, as an opaque and somewhat disparate system, it can be difficult to audit where health insurance impedes and where it facilitates effective care.

### Healthcare insurance as a barrier

Lack of clinicians with PrEP knowledge, absence of health insurance or underinsurance, stigma, and underestimation of personal HIV risk are the most frequently cited barriers to PrEP uptake [9–12]. The U.S. Preventive Services Task Force (USPSTF), an independent panel of volunteer experts, gave PrEP a Grade A rating in 2019, finding that the intervention had a "high certainty that the net benefit is substantial" [13]. The USPSTF recently updated its recommendation in August 2023 to include reference to the newer PrEP medications that were approved after the original recommendation [14]. The Affordable Care Act (ACA) requires most private insurance plans to cover USPSTF Grade A and B rated services without cost sharing, and the implementation of the PrEP USPSTF Grade A has improved access to affordable PrEP, but gaps remain. Even under ACA preventive services requirements, plans may use "reasonable medical management" to limit access to certain services. Analyses have found that these medical management policies are not always in line with clinical best practice and have resulted in PrEP services being denied or coming with unexpected cost sharing [15, 16]. As more medications are approved for PrEP, plans have discretion to prefer one medication over another, meaning that there may still be cost sharing depending on what medication a patient is prescribed. For plans not subject to ACA's preventive services requirements and for HIV services outside of PrEP, how health insurance facilitates (or impedes) access to effective HIV preventive care is understudied [17]. But, cost-sharing, plan tiering, prior authorization (PA), and specialty tiering are identified mechanisms that insurance companies use to guide clients' healthcare decisions, including HIV prevention.

### Health insurance utilization management techniques that impact patients' use of PrEP

Health insurance companies use cost sharing to incentivize preventive care and discourage less effective care, aligning insurer and patient interests to promote patient health without increasing costs to insurers [18–20]. Despite this, cost sharing is known to decrease overall drug and health service use among socioeconomically disadvantaged populations, increasing disparities in health care [21–23]. Specifically, use of coinsurance over copay, even when the resultant out-of-pocket costs are equivalent, disincentivizes use of specialists, inpatient care, preventive medication, and specialty drugs because coinsurance has cost uncertainty compared to the known cost of a copay [22, 24, 25].

Sometimes, insurance companies place a specific subset of in-network clinicians on an approved Tier 1 list and relegate a second subset of clinicians to Tier 2. The cost sharing for Tier 1 clinicians is often lower to encourage utilization through a process known as Value-Based Cost Sharing [26]. But, tiering also directly limits patient choices of clinicians [27].

PA is a third mechanism insurance companies use to guide patient behavior; it is also a key barrier to PrEP access and adherence [28]. PA is a process that insurance plans use to ensure a medication is appropriate for a specific patient. It usually requires a prescribing provider to document the need for the medication and whether the medication meets the plan's clinical criteria for approval. A 2019 survey suggests that 37% of prescriptions that are rejected at pharmacies due to PA complications are abandoned by patients [29]. When a patient changes plans mid-year or if a plan changes its formulary mid-year, the PA process can become even more cumbersome, leading to disruptions in medication access [30]. A 5–10 day delay in medication access is sufficient time for acquisition of HIV [12]. For people already taking PrEP, remembering to request a refill two weeks ahead of time can be challenging. This leads to a lapse in protection while waiting for a refill and PA. More broadly, physicians agree that PA creates a barrier to efficient and effective care. In a survey run by the American Medical Association in 2022, 94% of physicians reported having observed care delays for patients and 80% reported having observed care abandonment because of PA [31].

Fourth, placing PrEP on a specialty tier, a designation traditionally reserved for drugs that require special administration, allows justification for higher cost and greater restrictions [32]. Specialty drugs are often brand-name high list price medications and cost sharing typically reflects their higher price. For people who need access to specialty tier drugs, finding plans with affordable cost sharing and formulary inclusion is difficult; survey data shows that adults are willing to pay higher premium amounts to obtain better specialty drug coverage benefits [33]. Further, specialty tiering will often require the use of a mail order pharmacy, which is favored by some people for convenience, but people with HIV have reported that it can also introduce barriers related to privacy, timely delivery, or theft [34].

#### Issues of multidimensionality in healthcare research

Health insurance plan data is complex —benefits structures are combined in different ways to create each plan. It is the network of these benefits that collectively enables or limits care. Previous research audited plans by honing in on one aspect of care, PA of PrEP [35]. Other work compared patient satisfaction and health outcomes across plans instead of examining the plans themselves [36, 37]. Health insurance plan data is fundamentally multidimensional; comparing plans and the trade-offs within them requires a method that simultaneously explains variation across multiple factors.

## Methods

### Overview

#### *Data*

We used the 2019 individual marketplace files from the Health Insurance Compare database [38]. This data contain plan design and benefit details for all plans offered in the US through ACA-compliant marketplaces in 2019. We linked the plan design data with 2019 plan-level formulary data from Ideon to obtain PrEP (i.e. TDF/FTC) coverage details for each plan [39]. Of note, only brand-name TDF/FTC was FDA-approved for PrEP in 2019. We considered a unique plan as one with a unique set of benefits, offered in a specific rating area at a specific premium, and not a cost share reduction or child-only derivative of another unique plan [38]. A rating area is a geographical area where a plan is offered. For the purposes of our study, we restricted our consideration of benefits to in-network plan characteristics. Because plan data is from 2019, the analysis does not include the newer formulations of PrEP.

#### *Variables*

Variables were selected for inclusion based on a two-step process. First, we considered variables that describe preventive care. These include HIV-specific preventive care benefits and general health care benefits that support continued physical, emotional, and financial health for people at risk of HIV. In addition to PrEP formulary coverage, HIV specific preventive care benefits that we assessed include diagnostic tests, outpatient mental health services, primary care benefits, specialty care benefits, and outpatient substance use benefits. General health benefits that we assessed include emergency services, hospitalization, maternity and newborn care, prescription drugs, and rehabilitative services [40].

Second, we selected variables that operationalize how insurance companies regulate access to those benefits. These include plan maintenance costs, cost sharing for each benefit, and benefit-specific mechanisms such as PA requirements. Plan maintenance costs include premium, deductible, and maximum out of pocket cost (MOOP). We estimated premiums for single individuals aged 27 given the largest percentage of new infections in 2018 occurred among the 25 to 29 age group [1]. Cost sharing was coded for each of the following benefits as either coinsurance or copay and includes either a coinsurance percentage amount or a copay dollar amount. PA was also included to describe access to PrEP. We did not take advance premium tax credits into account because it has been found that a low percentage of eligible people are receiving the credit [41].

## Definition of restrictiveness

We defined more restrictive plans as those that utilized a greater number of plan factors known to increase time to care, contribute to care abandonment, increase out of pocket costs, or open up opportunities for patients to experience stigma [42]. Specifically, we considered using coinsurance over copay, covering valuable care with a two-tiered structure, requiring prior authorization, and utilizing a specialty tier as more restrictive plan structure [22]. Higher cost sharing, higher deductibles, higher premiums, and higher MOOPs are also characteristics of more restrictive plans [22, 42].

### Clustering

We used a clustering algorithm, an unsupervised machine learning technique that accounts for multiple dimensions at once, to discover clusters of similar plans [43, 44]. We examined the clusters to draw conclusions about the types of benefits insurance companies tend to group together in plans.

There are two large decisions to make in cluster analysis. The first is selecting the distance metric to calculate the pairwise distance between all data points. The second is choosing the clustering algorithm which iteratively joins or separates clusters based on specific priorities. We chose Gower's distance, which is a well-documented metric that balances variables that are on different scales [44, 45]. It is one of the only options that minimizes the bias introduced by mixing categorical and quantitative variables in a distance calculation [45–48]. For the clustering algorithm, we went with a hierarchical clustering approach which iteratively lumps points and groups of points together based on specific decision criteria. This was appropriate given the clustering method is interpretable and more repeatable. Adding a cluster separates an existing cluster whereas removing a cluster joins two existing clusters. This helps with transparency when making the qualitative decision to select a final cluster solution. Gower initially also designed his distance metric to work within a hierarchical clustering framework [49]. Ward's method of hierarchical clustering prioritizes clustering points into groups that are well-defined and tightly grouped all together. Other hierarchical clustering methods focus more on average characteristics of clusters, or on joining clusters based on the distances between the closest or furthest points in the clusters. Because Ward's method focuses on making clusters that are tight, it boosts interpretability [50]. We used R and R Studio to code the variables and to run the machine learning.

### Evaluating clustering methods

As an unsupervised machine learning method, clustering discovers relationships that were not previously known to exist. We calculated Cophenetic Correlation (CPCC), a 0 to 1 metric that describes whether measured distances in the distance matrix covary with the predicted distances in the hierarchical tree [51, 52]. We also calculated silhouette distance to assess cluster definition for a range of cluster solutions, from 2 to 10 clusters [53]. Ultimately, clustering is only useful if it provides interpretable results. We qualitatively inspected potential cluster solutions to assess model fit and chose the final solution.

### Geographic analysis

We report the percent of plans in each cluster by county, and using R, we mapped the proportion of plans in each Rating Area that fall into each cluster. We report the states that have at least one rating area where at least 75% of plans offered are in the most restrictive cluster, and we report the states where moderately restrictive plans are most prevalent. We report states that have rating areas with high and low rates of the least restrictive plans. We also highlight states that have heterogeneity of the options.

## Results

The 2019 dataset includes 17,061 unique plans with complete data. Descriptive statistics for all plans and benefits are reported in Additional file 1, Tables A1-A3.

### Cluster fit

The predicted pairwise distances between points were well correlated with the original distances (CPCC=0.683). Average silhouette distances were greatest for the two and three cluster solutions (Silhouette=0.463 & 0.414, respectively). At four clusters, the average silhouette dipped to 0.347 then tapered downward to 0.287 as the number of clusters increased to 10. Cluster solutions are most useful when knowing cluster membership provides concrete information about an individual plan. Coinsurance percentages near 0% and near 100% provide more certainty that an individual plan in a cluster takes on a specific characteristic. This was most true for the three-cluster solution. A further presentation of the considered cluster solutions can be found in Additional file 2.

### Three clusters of health insurance plans

Our chosen solution has three distinct clusters with increasing levels of restrictiveness of care. Cluster 1, the least restrictive cluster, contains 42% ($n$=7167) of the considered plans. Cluster 2, the moderately restrictive cluster, contains 37.1% ($n$=6329) of the considered plans. Cluster 3, the most restrictive cluster, contains 20.9% ($n$=3565) of the considered plans. Full descriptive statistics for each cluster are reported in Additional File 3, Tables A4-A12.

Figure 1 compares percentage of plans using coinsurance, the median coinsurance levels, and the median copay amounts for each benefit in each cluster. It also provides the benefit details for all plans as a reference.

Plans in Cluster 1, the least restrictive cluster, almost completely eliminate coinsurance usage across all benefits. They also reduce copay amounts, with median copays of $0 for benefits such as ambulance, diagnostic tests, emergency room care, habilitation services, inpatient birth, inpatient physician care, and outpatient mental health services.

Plans in Cluster 2, the moderately restrictive cluster, relax key restrictions around preventive care for HIV and add certainty into payment amounts. However, they still do not facilitate optimal financial security and access to the range of services necessary for HIV prevention. Plans in Cluster 2 have coinsurance percentages for outpatient mental health services, primary care benefits, and specialty care benefits that are close to 0%. That said, the copays used for specialty care benefits are generally higher than those used for specialty care benefits across all plans (Cluster 2 Median [IQR] = $60 [25]; All Plans Median [IQR] = $50 [45]).

In terms of facilitating general health and financial stability, plans in Cluster 2 facilitate increased access to generic drugs (4.4% have coinsurance) and low copays (Median [IQR] = $15 [14]). While the percentage with coinsurance for Emergency Care decreased relative to Cluster 3 (66–55%), the copays among the Cluster 2 plans were still high (Median [IQR] = $350 [250]). Overall, Cluster 2 provides greater access to HIV preventive care than Cluster 3 with Cluster 2 having less co-insurance for diagnostic tests and specialty care. Additionally, Cluster 3 does not have better access to the care necessary for general health than Cluster 2. Cluster 2 has less coinsurance for emergency room, generic drugs, habilitation services, inpatient physician, outpatient mental health, and primary care physician.

Plans in Cluster 3, the most restrictive cluster, have high coinsurance percentages, relative to the overall average, for all benefits. Benefits that are important to HIV prevention including diagnostic tests, outpatient mental health services, and specialty care benefits are restricted through coinsurance usage in more than 90% of plans. While coinsurance for primary care benefits is not used among plans in the cluster (62.2%), it is used in a far greater percentage across all plans (13.0%).

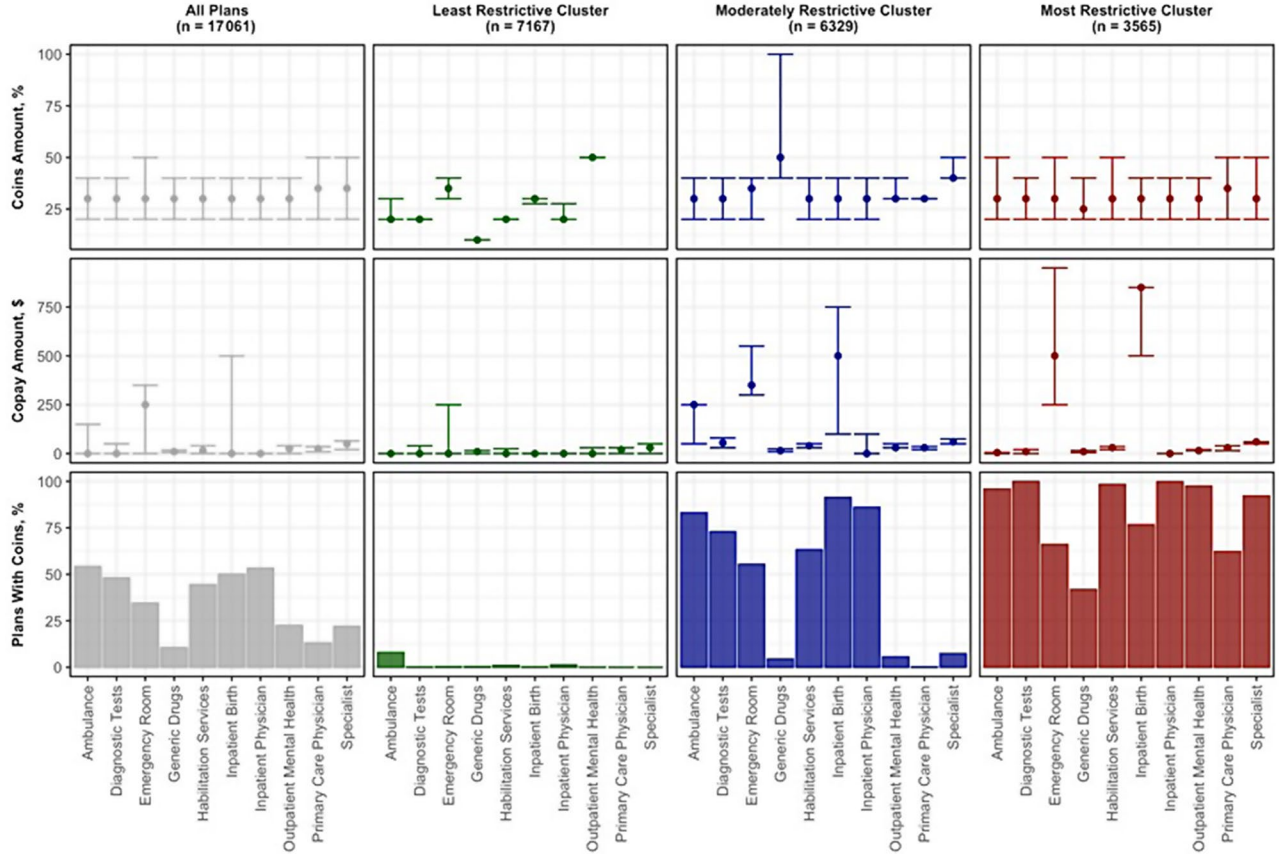


**Fig. 1** Benefit Characteristics for All Plans and by Cluster

Plans in Cluster 3 also defer significant financial risk and cost uncertainty to people in cases of medical emergency. 94.7% of the plans cover ambulance care with coinsurance and 98.7% require enrollees to pay a portion of their inpatient physician hospital bills. While there is more variance in coinsurance usage for emergency room visits with 66% of plans in the cluster taking that strategy, the copayments used by the remaining 34% of plans require a median payment of $500 [IQR=700], which is double the median payment among all plans ($250 [350]).

Figure 2 displays the percentage of plans in each cluster that place specific restrictions on PrEP. Coverage of PrEP was not an influential variable in the clustering process with 98.75% of all plans covered PrEP. Because of this, coverage of PrEP does not vary between clusters. Similar to coinsurance prevalence patterns across other benefits, 72.2% of Cluster 3, 42% of Cluster 2, and only 4.5% of Cluster 1 plans use coinsurance to cover PrEP. This represents a contrast between Cluster 1 and the other two clusters. Use of specialty tiering for PrEP mirrors the restrictiveness pattern and is most prevalent among plans in Cluster 3 (28.0%), but the contrasts are not as stark between the other two clusters (Cluster 2: 22.7%; Cluster 1: 17.3%). This suggests that usage of specialty tiering for PrEP, while still positively correlated with other variables of restrictiveness, is only weakly so. Finally, use of PA for PrEP exhibits a completely different pattern entirely, it is highest in Cluster 2 at 29.4% and very few plans in Cluster 3 use it (4.2%). This suggests that PA is less likely to be imposed when cost restrictions are higher and that "restrictiveness" as captured by coinsurance usage does not correlate positively with "restrictiveness" as measured by PA.

Figure 3 displays distributions of financial cost variables by cluster. Overall, plans in Cluster 1 have the highest median deductible at $6100 as compared to $4000 for Cluster 3 and $3500 for Cluster 2. Despite this, Cluster 2 has the highest median MOOP costs at $7550 as compared to $7150 for Cluster 1 and $6750 for Cluster 3.

This suggests that while Cluster 3 may be the most restrictive, enrollees paying for high-cost care — such as individuals taking preventive medications for PrEP — may actually pay more for their care overall in Cluster 2. Finally, monthly premiums are relatively equivalent between the three groups at $401/month, $420/month and $406/month for Clusters 3, 2, and 1, respectively. This suggests that, in addition to having fewer barriers to care access once enrolled, individuals who are covered by plans in Cluster 1 do not pay more than individuals in Cluster 3 or 2 to maintain their enrollment. Finally, we find that 33% of Cluster 3 plans use a multi-tiered structure as compared to 2.6% in Cluster 2 and 6.0% in Cluster 1.

### Geographic distribution of clusters

Figure 4 displays the proportion of plans in each Rating Area that fall into each cluster. For each county, the percent of plans in each cluster is reported in Additional file 4, Table A13. Overall, we find the highest rates of the most restrictive plans in Wyoming, Virginia, Illinois, Missouri, Texas, Georgia, and Oklahoma. Each of these states has at least one rating area where at least 75% of plans offered are in the most restrictive cluster.

There are no rating areas where more than 75% of the plans offered fall into the moderately restrictive cluster. However, the moderately restrictive plans are most prevalent in Michigan, Utah, Georgia, Rhode Island, Hawaii, and North Carolina. In each of these locations, moderately restrictive plans comprise at least two-thirds of the plans offered.

In Alabama, several rating areas only offer plans that are categorized as least restrictive. Massachusetts and

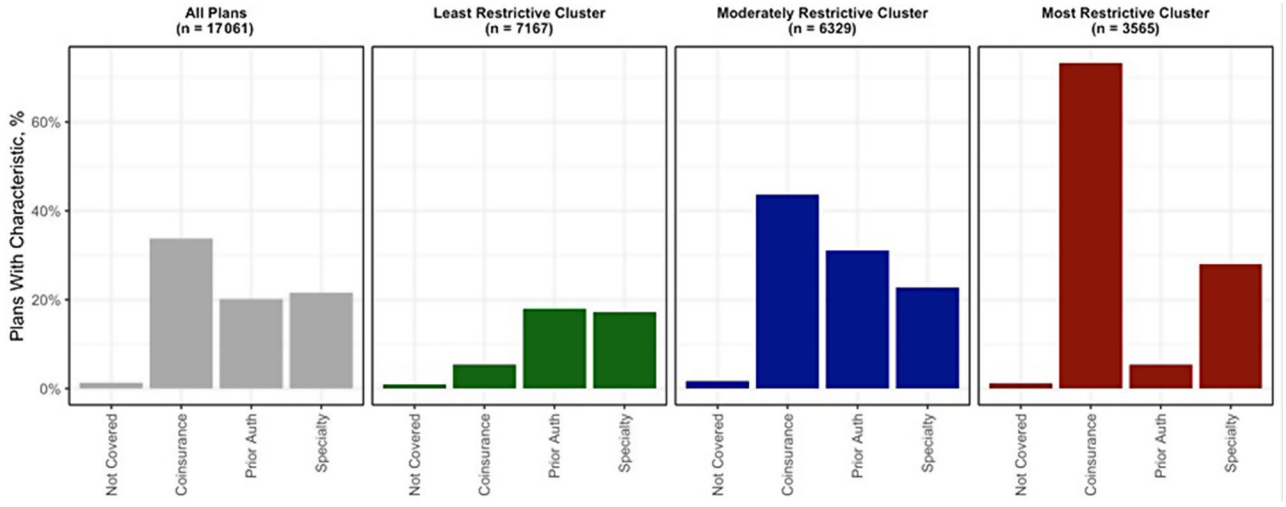


**Fig. 2** PrEP Coverage for All Plans and By Cluster

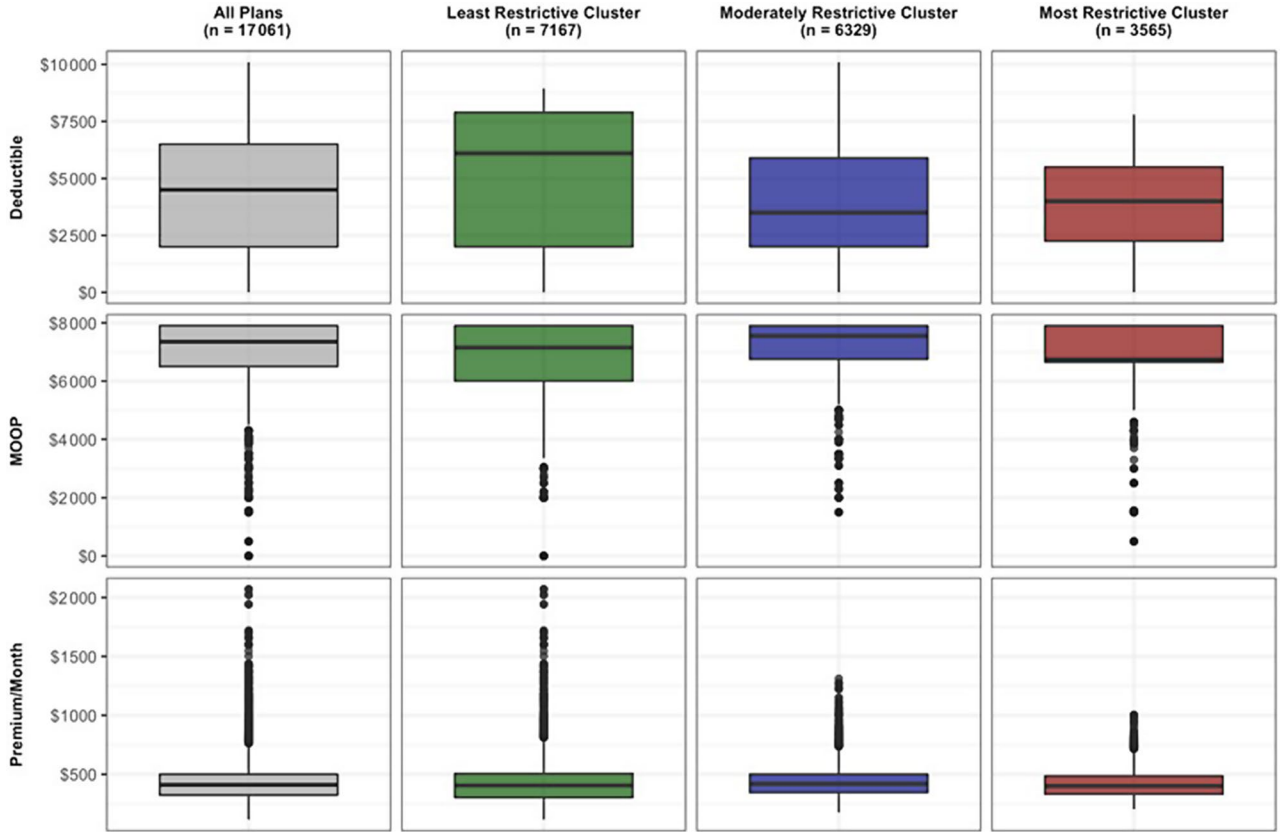


**Fig. 3** Financial Cost Variables for All Plans and By Cluster

South Carolina also have high prevalence of least restrictive plans. Two rating areas in Arkansas do not offer any of the least restrictive plans. This is also the case in three rating areas in Wyoming. One rating area in Washington, four in Maine, and one in Tennessee all have markets in which least restrictive plans comprise less than 10% of the plans offered.

States including Oregon, Nevada, Arizona, Louisiana, Montana, Nebraska, Kansas, Minnesota, Iowa, West Virginia, Maryland, and Georgia, have markets with higher degrees of plan heterogeneity. Plans from one cluster do not comprise more than 50% of the market share in most rating areas in those states. In contrast, states like Missouri, Tennessee, Virginia, and Texas have high inter-rating area variability in plan offerings. While less restrictive plans are readily available in one rating area, moving to another rating area within the state restricts an individual's choices.

## Discussion

Interpreting the pattern of insurance plans' use of coinsurance and copay across the three clusters provides key takeaways about how insurance companies construct plans and the impact these decisions have on HIV prevention access. First, the pattern of copays within Cluster 1 suggests that, in general, plans that have lower copays on some benefits tend to have less restrictive copays on other benefits as well. This contrasts Cluster 3 which shows that insurance companies also create plans that have high coinsurance-related restrictiveness. The existence of these clustering patterns show that insurance companies often set benefits at extremes, which may reflect underlying differences in actuarial value of the plans themselves. The ACA categorizes Qualified Health Plans into different "metal levels" reflecting different plan actuarial value. Higher metal level plans (i.e., gold and platinum) have higher actuarial value, with lower deductibles and more use of copays over coinsurance, but also have higher premiums. Lower metal level plans (i.e., silver and bronze) have lower actuarial value, with higher deductibles and more use of coinsurance over copays, but generally have lower premiums.

Adding in considerations from Cluster 2 further draws the tiered systems of restrictiveness into focus. Higher copays for diagnostic tests and Emergency Care are used for plans that do not impose coinsurance. This suggests that, in some plans, coinsurance is swapped for high copays while maintaining the same patterns of coinsurance-based restrictiveness elsewhere.

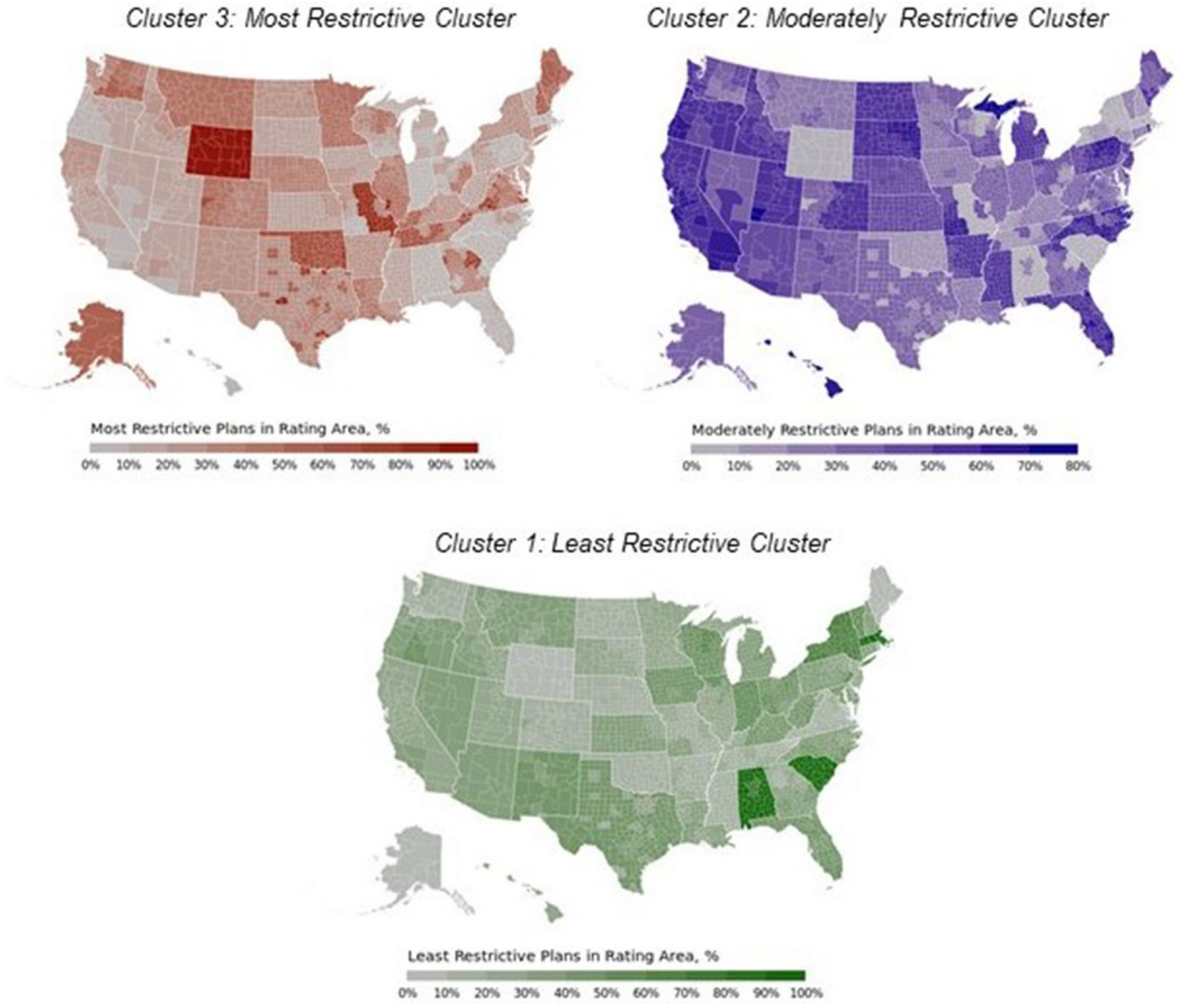


**Fig. 4** Percent of Plans in Rating Area by Cluster

However, the patterns within Cluster 2 support deeper insights as well — specifically that when insurance companies choose to lower some cost sharing, they prioritize access to primary care benefits, specialty care benefits, generic drugs, and outpatient mental health services. These benefits are all important for individuals who take PrEP to maintain general well-being [13]. That said, benefits that provide a financial cushion in more catastrophic events — ambulance, emergency benefits, and inpatient hospital care, remain very expensive for consumers.

### Prior authorization patterns

The lowest rates of PA for PrEP occurred among plans with the most restrictive benefits. This finding suggests that insurance companies use less PA when there are already cost-based restrictions influencing care. Yet, in plans where cost-based restrictions are relaxed, PA is instituted as a control.

This comports with previous work which found that being enrolled in a plan that covers PrEP with coinsurance as opposed to copay lowers the likelihood of PA by a factor of 0.51 when other plan factors are held constant [35]. Lower PA was also associated with other measures of PrEP restrictiveness such as specialty tiering [35]. The findings from this cluster analysis augment those findings to suggest that reduced PA requirements for PrEP are not just related to increased restrictions on PrEP but also increased restrictions on all other plan factors.

### Cost patterns

Monthly premium prices were similar between clusters. This suggests that contrasts on other variables were more useful in determining clusters than contrasts on

premiums. This does not mean that premium amount and restrictiveness are necessarily independent among plans offered by the same insurance company. But it does suggest that, across the US, plans with lesser restrictions do not necessarily cost individuals more per month to remain enrolled. It also suggests that cost-sharing related to PrEP may not be variable across different actuarial value metal levels. The implications of this finding for people who take PrEP are significant — it is possible for insurance companies to provide care that has lowered restrictiveness without raising premiums. To End the HIV Epidemic, insurance companies should be incentivized to offer the least restrictive plans in the regions or jurisdictions that have the highest number of new diagnoses, the South and in EHE Phase 1 Jurisdictions.

That said, plans in Cluster 3 — which required larger and less predictable out-of-pocket costs for services — did have lower median yearly MOOP costs. The MOOP is the maximum amount a plan can charge for patient cost sharing every year and includes deductibles and cost sharing, but not premiums. After a patient hits the MOOP, there is no cost sharing for the rest of the year. The MOOP can be an important backstop in years where out-of-pocket costs are high or a patient experiences a high-cost medical event, but depending on the amount of the MOOP, patients may struggle with cost sharing before the MOOP is hit. Individuals enrolled in Cluster 1 plans have a higher median MOOP, but they also have low copays and a low percentage of Cluster 1 required coinsurance, meaning that patients are less likely to reach that MOOP. Given that Cluster 2 has the highest median MOOP, and a high percentage of plans requiring coinsurance for benefits that would be needed for an emergent event (ambulance, emergency room, inpatient physician), plans in Cluster 2 could quickly become the most burdensome in a catastrophic or emergent event.

#### Intersection of prior authorizations and cost

The relationship between PA use and use of coinsurance creates difficult trade-offs for people needing PrEP. The plans that were less likely to use PA were also the plans more likely to use coinsurance. However, use of either PA or coinsurance can restrict access to PrEP. This means that no one cluster provides optimal coverage.

#### Policy implications: cost sharing for PrEP

Because of the USPSTF Grade A rating for PrEP, individuals covered by most private plans should have access to PrEP without coinsurance or copay. In 2021, federal agencies released guidance clarifying that plans had to cover not just the medication, but also clinic visits, and labs without cost sharing [54]. Despite federal law and guidance, both compliance and enforcement of the requirement to cover the clinic visits and labs without cost sharing has been inconsistent [15, 16, 55]. As discussed above, even within the ACA requirement and federal guidance, plans have discretion to use medical management to limit access to PrEP services and may use prior authorization to preference certain PrEP medications over others. This discretion, combined with plan ACA compliance variability, means that some PrEP services continue to be subject to cost sharing, despite it being very clear that access to these services without cost sharing is important for maintained access to PrEP [56–58].

The gaps in plan compliance with the requirement that all PrEP services – including ancillary services outside of the medication – must be covered without cost sharing is concerning. Strong enforcement of the requirement for PrEP ancillary services to be covered without cost sharing would mostly affect individuals enrolled in plans from Clusters 3 and 2. But usage of coinsurance and elevated copays remain high for diagnostic tests, primary care benefits and specialist care in Cluster 3. Even with lesser restrictiveness in vital services among Cluster 2 plans, costs associated with diagnostic tests remain restrictive. For the USPSTF's regulation to have its intended effect of increasing PrEP access, federal and state insurance regulators must be more vigilant about enforcing the cost sharing protections for associated services outside of medications [12].

Policymakers should also evaluate the type of plan design that is best able to provide equitable access to preventive services. This should include prioritizing plan designs that have lower or no cost sharing for particular services, even beyond the ACA preventive services mandate. Several jurisdictions – including Colorado and the District of Columbia – have applied an equity lens on plan design features, putting in place cost sharing protections that will make a subset of services more affordable for communities disproportionately impacted by particular conditions [59]. These types of state level protections may become even more important as a lawsuit challenging the constitutionality of the ACA preventive services coverage and cost-sharing mandate gains steam [60].

Finally, with increased competitiveness in the PrEP market as generics, different medication formulations, and long-acting injectable PrEP make their way through the FDA pipeline, more policy analysis, by people and groups such as non-profit organizations, advocates, and academic researchers, will be needed to examine how insurance companies react to these innovations and continue to interpret the USPSTF mandate [61].

#### Geographic implications

In general, EHE jurisdictions vary in what types of plans are available. Rating areas in Oklahoma, for example, have high rates of plans from the most restrictive cluster

while rating areas in South Carolina have high rates of plans from the least restrictive cluster.

We also observe significant stratification in plan types by state with plans in the moderately restrictive cluster occupying the greatest market share overall, specifically in the West, and the least restrictive plans concentrating primarily in the Northeast, Indiana, South Carolina, and Alabama. Given the high number of new diagnoses of HIV in the South, it is encouraging that plans are less restrictive in two Southern states, South Carolina and Alabama. States with markets with higher degrees of heterogeneity allows individuals greater agency when tailoring their benefits to their needs. This emphasizes the importance of state policies and politics in setting health care priorities. For EHE, federal policymakers will have to work with states with differing policy environments to harmonize a collective strategy.

EHE must also focus on reducing PA requirements to make accessing PrEP for people with Cluster 2 and Cluster 1 plans both financially and logistically feasible. Finding higher prevalence of Cluster 2 and Cluster 1 plans in Southern US states, specifically in Florida and Mississippi, compared with other regions comports with prior work demonstrating more PA requirements in the South [35]. Our finding of within-state variability, particularly in Texas, also gives reason for pause. In most rating areas in Texas, individuals have the option to choose between all three types of plans. However, those healthcare options solidify in major city areas and guide individuals toward the most restrictive options. In other words, care is restricted where people with indications for PrEP reside. As recently as 2022, only 40,698 persons in Texas were prescribed PrEP (32.9%) of the 123,790 persons with indications for it [62]. Uptake is lower than that average in the EHE Phase 1 priority jurisdiction areas of Bexar, Dallas, Harris, Tarrant, and Travis County, Texas where 27,817 persons were prescribed PrEP (26.7%) of the 104,190 with indications for it. This pattern, where preventive HIV care is restricted in places people need it most, does not align with ending the HIV epidemic in the United States.

### Limitations and future directions

This work is a first step at using clustering methodologies to audit healthcare offerings across the US, and it has some limitations. First, while the clustering algorithm accounts for as many plan factors as possible, this analysis is still limited to in-network benefits and does not account for the accessibility of in-network providers. An individual may be enrolled in a Cluster 1 plan with access to low copays for vital services for in-network providers, but it is possible the providers in their network are overbooked or geographically distant. Assisters who help people on PrEP make insurance decisions have voiced concerns around this topic [63].

Second, while there were contrasts between clusters on benefit characteristics, the methodology itself does not provide the interpretation. We drew conclusions about restrictiveness and access based on theory about how people act in response to specific plan factors. Our method is expedient in that it requires only administrative data on plan designs. But it would be strengthened by reported experiences of people navigating preventive care for HIV while enrolled in archetypal plans from each cluster.

Thirdly, as an exploratory methodology, clustering is difficult to validate. We justified the solution's fit based on its practical interpretation. And yet, not all aspects of it — the minimal contrasts on specialty tiering, for example — are useful. This reflects the chief issue of clustering data with many dimensions [64]. It is also a reminder that not every dimension falls into a neat three category solution. As an aggregate level descriptor of a complicated system, cluster membership does not strictly imply that a plan has the average cluster characteristics.

Finally, an additional limitation of this study is that we only assessed QHPs, which make up an important, but relatively small proportion of the entire private insurance market. However, the CDC estimates that 63% of people with a PrEP indication have private insurance [65]. and QHP coverage trends may be indicative of broader private insurance trends. While national data on health insurance coverage by race and ethnicity indicates that AIAIN, Hispanic, and NHOPI are more likely than white people to be uninsured [66], more research is needed to understand the race and ethnicity of marketplace enrollees on PrEP.

If this type of method is used to audit plan offerings in the future, more work is needed to strengthen the theory linking specific plan characteristics to people's real-world experiences. This could involve analyzing patient satisfaction data across various plan types or investigating linkages between plan offerings in rating areas and the uptake of preventive services such as PrEP. Tools like the PrEP Coverage Check – A PrEP Verification Tool, a resource for patients and patient navigators to make informed decisions on insurance coverage, has a mechanism in place to report coverage gaps [67]. This crowdsourced data could be leveraged to learn more about the gaps patients encounter when working with their plans.

## Conclusions

Insurance plan design is complex, with plans incorporating an array of clinical, economic, and regulatory factors into what benefits health insurance companies decide to cover, what restrictions they place on those benefits, and the level of cost sharing applied to those benefits.

To address the ambitious call to end the HIV epidemic in this country, plans should also take into account both public health and health equity factors to create plan designs that ensure access to critical preventive services for people who need them most. Addressing the growing disparities in PrEP access along racial and ethnic lines should be a national priority, and federal and state insurance regulators as well as insurance plans themselves should be part of the conversation about how to ensure people who would benefit from PrEP can access it. Our analysis shows that even with ACA preventive services coverage and cost-sharing mandates for PrEP, plan design decisions around consumer cost sharing, provider and drug tiering, and prior authorization still have a dramatic impact on whether patients can access certain services and how much those services will cost. Better state and federal regulation of plan design to ensure access is consistent, equitable, and based on clinical recommendations will reduce the variability across plan designs.

## Supplementary Information

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Supplementary Material 1

Supplementary Material 2

Supplementary Material 3

Supplementary Material 4

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**Author contributions**
S.D.P. and K.A.M. contributed to the conception. S.D.P., K.M.S., and K.A.M. designed the work. K.A.M. acquired the data. S.D.P. and K.M.S. analyzed the data, and all authors interpreted the data. All authors drafted the work and revised it. All authors read and approved the final manuscript.

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**Data availability**
The data that support the findings of this study include publicly-available data from Robert Wood Johnson's HIX Compare and data received from Ideon under a data use agreement. The data use agreement precludes our sharing of the data. Interested parties are referred to these two avenues to access the data.

## Declarations

**Ethics approval and consent to participate**
Not applicable.

**Consent for publication**
Not applicable.

**Competing interests**
The authors declare no competing interests.

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