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Equity in the national rollout of public AIDS treatment in South Africa 2004–08

Zoë M McLaren*

Department of Health Management and Policy, School of Public Health, University of Michigan, 1415 Washington Heights, M3166, Ann Arbor, MI 48109, USA

*Corresponding author. School of Public Health, University of Michigan, 1415 Washington Heights, M3166, Ann Arbor, MI 48109, USA. E-mail: zmclaren@umich.edu

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Low- and middle-income country governments face the challenge of ensuring an equitable distribution of public resources, based on need rather than socioeconomic status, race or political affiliation. This study examines factors that may influence public service provision in developing countries by analysing the 2004–08 implementation of government-provided AIDS treatment in South Africa, the largest programme of its kind in the world. Despite assurances from the National Department of Health, some have raised concerns about whether the rollout was in fact conducted equitably. This study addresses these concerns. This is the first study to assemble high-quality national data on a broad set of census main place (CMP) characteristics that the public health, economic and political science literature have found influence public service provision. Multivariate logistic regression and duration (survival) analysis were used to identify characteristics associated with a more rapid public provision of anti-retroviral therapy (ART) in South Africa. Overall, no clear pattern emerges of the rollout systematically favouring better-off CMPs, and in general the magnitude of statistically significant associations is small. The centralization of the early phases of the rollout to maximize ART enrolment led to higher ART coverage rates in areas where district and regional hospitals were located. Ultimately, these results demonstrate that the provision of life-saving AIDS treatment was not disproportionately delayed in disadvantaged areas. The combination of a clear policy objective, limited bureaucratic discretion and monitoring by civil society ensured equitable access to AIDS treatment. This work highlights the potential for future public investment in South Africa and other developing countries to reduce health and economic disparities.

Keywords Health inequities, health policy, HIV, South Africa

KEY MESSAGES

- This study examines factors that may influence public service provision in developing countries by analysing the 2004–08 implementation of government-provided AIDS treatment in South Africa, the largest programme of its kind in the world.
- Overall, no clear pattern emerges of the rollout systematically favouring better-off counties, and in general the magnitude of statistically significant associations is small. Ultimately, these results demonstrate that the provision of life-saving AIDS treatment was not disproportionately delayed in disadvantaged areas.
- Despite concerns about the equity of public investment, the combination of a clear policy objective, limited bureaucratic discretion and monitoring by civil society enabled the highly centralized ART rollout to achieve equity.
- This work highlights the potential for future public investment in South Africa and other developing countries to reduce health and economic disparities.

Introduction

Low- and middle-income country governments are faced with the formidable challenge of providing basic public services to their dispersed populations using limited resources. They face the additional challenge of ensuring these resources are allocated equitably—based on need rather than socioeconomic status (SES), race or political affiliation (Whitehead 1992; Culyer and Wagstaff 1993; Braveman and Gruskin 2003; Braveman 2006; Cleary *et al.* 2011). Public health programmes that do not specifically target vulnerable populations may reach the most well-off segments of the population first, thereby widening disparities in health outcomes and reducing equity (Victora *et al.* 2000). Curative health care spending in Africa disproportionately favours the better-off over the poor (Castro-Leal *et al.* 1999), and even programmes explicitly targeting the poor may not reach them (Galasso and Ravallion 2005).

Within this context, this study examines whether the 2004–08 public implementation of AIDS treatment in South Africa led to disadvantaged groups experiencing 'systematically' worse access to this $1.2 billion AIDS treatment programme (Culyer and Wagstaff 1993; National Treasury 2007, 2009). Given South Africa's history of apartheid and current level and scope of socioeconomic disparities, there are concerns about whether areas with greater poverty, worse public infrastructure, more informal dwellings, low political mobilization or a greater HIV burden are substantially less likely to have access to this new health intervention than better-off regions. This is one of only a few studies to examine equity in anti-retroviral therapy (ART) access in resource-limited settings (see Cleary 2010 for a review; see also Tsai *et al.* 2009; Okoli and Cleary 2011; Cleary *et al.* 2011, 2012, 2013).

This study evaluates whether (1) the local area had at least one clinic accredited to provide ART for AIDS, (2) the length of time until treatment provision began in the local area and (3) the number of patients treated was commensurate with the number of patients requiring treatment locally. Availability of an accredited clinic was the most salient barrier to access (compared with affordability or acceptability of treatment) between 2004 and 2008 because coverage rates were below 40% of eligible patients (Adam and Johnson 2009). With long queues at every facility, many died waiting to be enrolled on treatment (Nattrass 2007). The robust literature on barriers to ART access in resource-limited settings points to the importance of travel costs, which determine the affordability of this free government programme and could be sizable if no accredited ART clinics are available nearby (Mukherjee *et al.* 2006; Posse *et al.* 2008; Duff *et al.* 2010; Tuller *et al.* 2010; Okoli and Cleary 2011; Kagee *et al.* 2011; Cleary *et al.* 2012, 2013).

South Africa has one of the highest levels of race-based socioeconomic inequality in the world. The Black African population, by far the largest of the nation's four major racial groups (Black African, Coloured, Indian and White), has the highest rates of HIV, poverty and unemployment as well as the worst access to health care (Banerjee *et al.* 2008; Levinsohn *et al.* 2013; McLaren *et al.* 2013). Equity of public investment is an important national concern in South Africa. [See McIntyre and Gilson (2002) for a detailed analysis of South Africa's history of efforts to reduce inequities in health]. For the case of AIDS treatment, in which public programmes may mean the difference between life and death, the stakes for equitable distribution are particularly high.

In 2003, an estimated 600 South Africans died of AIDS each day due to lack of access to treatment (Nattrass 2007). In 2004, South Africa's National Department of Health (DoH) began providing free AIDS treatment in existing public health clinics. Rather than initiating the programme in every clinic simultaneously, the DoH implemented an accreditation process, including clinic site visits, that determined the pace of the rollout. Given the government's stated goal of achieving 'universal care and equitable implementation', the programme provided assistance to the least-resourced areas to ensure their clinics met the requirements for accreditation (Mbewu and Simelela 2003). Between 2004 and 2008, 429 clinics around the country were accredited and more than 500 000 South Africans were enrolled on ART at a cost of approximately $1.2 billion (National Treasury 2007, 2009).

Despite assurances from the DoH, some have raised concerns about whether the rollout was in fact conducted equitably (Benatar 2004; McCoy *et al.* 2005; Scott *et al.* 2005; Nattrass 2007; Schneider and Coetzee 2008). This study addresses these concerns. It is the first evaluation of the implicit (*ex post*) targeting that resulted from the rollout of the largest AIDS treatment programme in the world. A rollout of this size and scope presents an unprecedented opportunity to examine the factors that influence government service provision. This is the first study to assemble high-quality national data at the local level for a broad set of factors that the public health, economic and political science literature have found influence public service provision (Keefer and Khemani 2005; Banerjee *et al.* 2007). Multivariate regression and duration (survival) analysis were used to identify which local characteristics were associated with a more rapid public provision of AIDS treatment in South Africa. Simply put, if the study reveals that more advantaged areas obtained ART access sooner, it suggests that the programme rollout was not equitable and, more important, raises concerns about the degree to which future public investment in South Africa and other developing nations can reduce health and economic disparities.

Context

South Africa is a middle-income country with a per capita GDP of $4695 in 2004, which was similar to that of Costa Rica and Malaysia, and about $1000 higher than Brazil (World Bank 2004). However, it has one of the highest levels of economic inequality in the world, with a Gini coefficient of 67.4 compared with 56.8 for Brazil (World Bank 2004). The unemployment rate in 2004 was ~27% overall, but over 30% for those without a high school education (Banerjee *et al.* 2008). Approximately 10.8% of South Africa's population was HIV-positive and it contains more HIV-positive people than any other country (Shisana *et al.* 2005).

The availability of ART represented a significant improvement in the quality of AIDS care. ART dramatically improves health within 3–6 months of initiation and, in the South African context, increased life expectancy by ~5–7 years (Coetzee *et al.* 2004; Bor *et al.* 2013). Today's HIV-positive individuals on ART have life expectancies that are 70–86% of similar HIV-negative individuals, provided they initiate ART when they become

eligible (Johnson *et al.* 2013). Prior to the government-sponsored ART programme in South Africa, public clinics provided free treatment for opportunistic infections associated with AIDS and palliative care, but no drugs were available to suppress HIV and stall the progression of AIDS. Although ART was available from some private clinics before 2004, the costs were prohibitively high for all but a small fraction of Black Africans (Adam and Johnson 2009).

Before the rollout began, the South African government had been under increasing domestic and international pressure to scale up its ART programme. The delay was due to then-President Thabo Mbeki's scientifically indefensible stance that HIV did not cause AIDS and his insistence that ART did more damage than good to AIDS patients (Nattrass 2007). However, South Africa's provision of AIDS treatment was not initiated until 2004, when it was legally and politically impossible to delay any further. As a result of the prior political foot dragging, the rollout was subject to intense scrutiny from the media and non-governmental organizations (NGOs) like the Treatment Action Campaign to ensure that it was scaled up as quickly as possible (Heywood 2009; Grebe 2011).

A problem with implementation was apparent from the start. To determine when hospitals and clinics could begin enrolling patients on ART, the DoH formed a three-person accreditation team to inspect and accredit extant clinical health settings. Not surprisingly, the small team struggled to respond to the high demand for accreditation, which resulted in a long time lag between when clinics were prepared to begin prescribing ART and when they were granted permission to do so (A Ratshefola, personal communication, former assistant director for the Comprehensive HIV and AIDS Care, Management and Treatment Programme, 29 July 2009). The constant rate of clinic opening shown in Figure 1 provides evidence that the accreditation process was the main bottleneck in providing treatment because it is highly unlikely that factors related to facility readiness to provide ART would have produced such a steady rate of clinic openings. Every month, 8–10 additional clinics began providing ART, representing the accreditation team's capacity rate. In 2008, the programme had been able to meet ~40% of the need for ART, up from 4.9% in 2004 when it began (Adam and Johnson 2009).

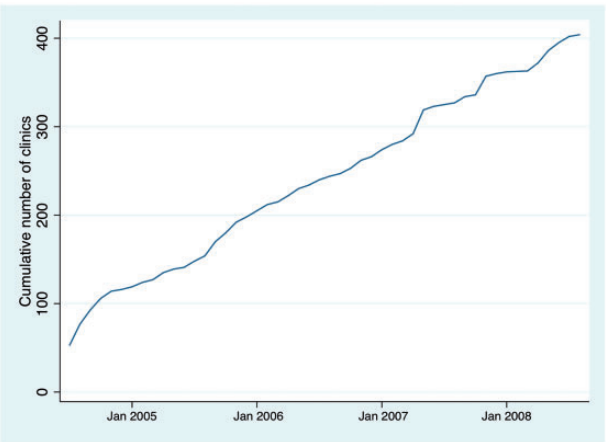

Figure 1 Cumulative number of accredited ART clinics over time in South Africa. Source: author's calculations using Department of Health monthly facility reports for 2004–08

Methods

Data

One strength of this study is that it assembles, for the first time, a large set of census 'main place' (CMP) data from multiple sources including data on population characteristics, economic deprivation, local political alignment, health infrastructure and HIV prevalence, all of which may have influenced the rollout (Supplementary Table S1). CMPs are larger than enumerator areas and smaller than municipalities. The analysis is related to the small area analysis of deprivation in McIntyre *et al.* (2002); however this study uses a much finer geographic unit and analyses measures of deprivation individually rather than in an index. Statistics South Africa provided detailed population and household characteristics from the 2001 census. Poverty rates were determined using the per capita poverty line of 800 Rand/month ($113 in 2001), which corresponds to income categories reported in the 2001 census (Leibbrandt *et al.* 2010). Union membership data were collected from the September 2004 South Africa Labour Force Survey (Statistics South Africa). Vote counts for each political party by CMP were calculated using official results from the national election on 14 April 2004. Measures of health infrastructure and expenditure came from the 2004 *District Health Barometer* (Barron *et al.* 2005) and the United States President's Emergency Plan for AIDS Relief (PEPFAR) annual provincial reports (US President's Emergency Plan for AIDS Relief 2009). Local HIV prevalence rates were calculated using the nationally representative South African National HIV Prevalence, HIV Incidence, Behaviour and Communication Survey conducted in 2005 (Shisana *et al.* 2005). This survey included an opt-out HIV test which had a response rate of 73.3% in the adult sample of 16 398 individuals. The DoH provided dates when public clinics began enrolling patients on ART for the first 4 years of the rollout (April 2004 to August 2008). Unionization and HIV prevalence rates were only available for a 10% sample of CMPs. Rates for CMPs not included in this sub-sample were assumed to be equal to that of the closest sampled CMP.

The geographic distribution of ART clinics in South Africa in 2008, 4 years into the rollout, closely maps the distribution of the population (Figure 2). The analysis includes all public facilities in South Africa that were accredited by the DoH to provide ART, including AIDS wards, tuberculosis (TB) wards, maternity wards and primary health care facilities. About two-thirds of the ART sites operational in 2008 were in hospitals and one-third were in smaller health clinics and community health centres.

Table 1 shows descriptive statistics for the factors that may influence the speed of the rollout of ART and which are included in the analysis. The CMP is the main unit of analysis because it approximates the service area of a clinic. South Africa has 3109 CMPs, which may comprise a small city, a suburb or a tribal area; however, 128 of these were vacant or contained no housing units at the time of the 2001 census resulting in an analysis sample of 2981 CMPs. Only 2526 CMPs had available data on local HIV prevalence. The inter-quartile

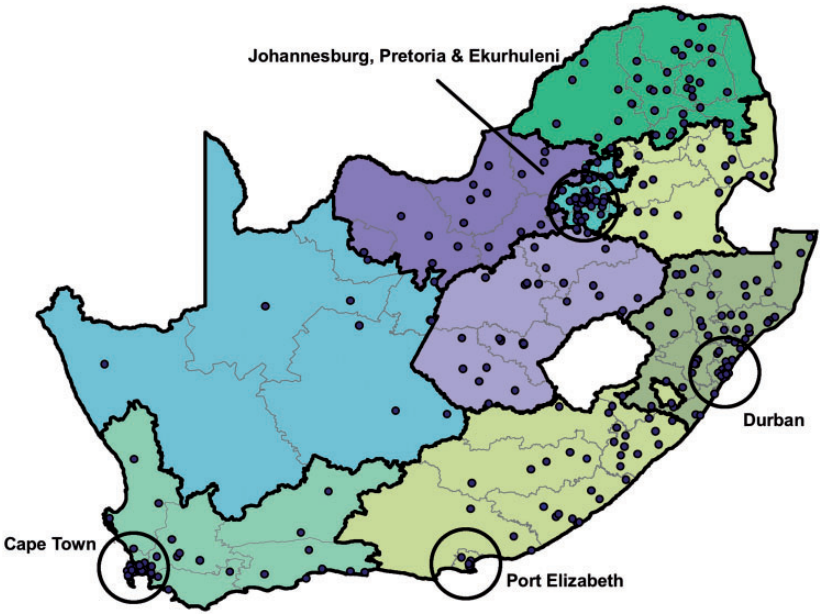

Figure 2 Geographic distribution of accredited ART clinics in August 2008. Map shows province boundaries (in black), district boundaries (in gray) and the six metropolitan areas (labelled). Reproduced with permission from McLaren (2010)

Table 1 Descriptive statistics of CMP sample

Variable	Average	Std. Dev	Median	Min	Max
CMP population	131 190	224 150	45 750	0	1 009 040
% Black African	79.15	22.71	85.23	1.23	99.95
% White	9.19	7.43	9.1	0.01	39.54
% No education	10.38	6.52	9.1	0	100
% African men below poverty line	16.26	7.73	13.61	6.77	67.91
% No cell phone	0.39	0.63	0.34	0	100
% Informal housing	0.2	0.26	0.12	0	37.5
% No piped water	0.14	0.29	0.02	0	100
% No electricity	0.2	0.32	0.11	0	100
% Workers unionized	27.55	20.46	25	0	100
ANC party most votes	0.79	0.4	1	0	1
DA party most votes	0.11	0.32	0	0	1
IFP party most votes	0.08	0.27	0	0	1
Other small party most votes	0.02	0.12	0	0	1
HIV prevalence rate	14.14	9.38	12.24	0	57.14
At least 1 PEPFAR facility in CMP	0.17	0.37	0	0	1
Per capita health expenditure (2001 Rand)	187.3	104.13	150	42	389

Sample includes 2981 South African CMPs inhabited at the time of the 2001 census. Weighted by population.

CMP size range is 1–35 mi^2 with a median area of 5 mi^2. The median population is ~46 000 with no CMP having more than 1 010 000 residents. Consistent with national figures, ~80% of the sample is Black African and 9% is White. Approximately 10% of the sample reports having no formal education and 16% of men report an annual income of less than 9600 Rand (about $1370 in 2001). South Africa is a middle-income country with high inequality, so only some parts of the country have poor access to basic services. The mean percentage of residents without piped water, without electricity, without cell phone access and living in informal housing (urban settlements) is below 1%. The unions are a powerful political force and membership rates are high—approximately 28% nationally. Approximately 79% of South Africans lived in a CMP where the African National Congress party (ANC) won a plurality (more votes than any other party) in the 2004 national

election. The democratic alliance (DA) and Inkatha Freedom Party (IFP) are regionally based in the Western Cape and KwaZulu-Natal, respectively, and held important pluralities in CMPs in those regions. Another 25 small political parties won pluralities in CMPs whose combined population accounts for 2% of South Africa's population. The HIV prevalence rate varies widely across CMPs but is 14% in this sample. PEPFAR ran and supported ART clinics in 255 CMPs across South Africa during the rollout, which account for 17% of the population. Finally, 2001 annual per capita health expenditure by the government averaged 187 Rand (about $27 in 2001), and was higher in high population density areas, where most hospitals are located.

Analysis

Multivariate regression and duration (survival) analysis were used to evaluate the relative importance of a large set of CMP characteristics in determining (1) whether AIDS treatment was provided within a CMP, (2) the length of time until treatment provision began in a CMP and (3) whether the number of patients treated was commensurate with the number of patients requiring treatment locally. First, the following multivariate logistic regression for CMP i in province j was estimated:

$$\mathrm{ART}_{\mathrm{Clinic}_{ij}} = \Lambda(\beta_0 + \phi' X_{ij} + \alpha_j + \epsilon) \quad (1)$$

where $\mathrm{ART}_{\mathrm{Clinic}}$ is an indicator variable for the presence of an ART clinic accredited during the first 4 years of the rollout, β is the constant, X_{ij} is a vector of CMP characteristics, α is a set of eight province control variables and $\Lambda()$ is the logistic function. The X_{ij} vector includes the set of control variables listed in Table 1.

Second, duration (survival) analysis was used to model the time until a clinic is accredited within the CMP. In this model, the hazard function is the instantaneous probability of a clinic opening in the CMP at time t conditional on the CMP not having an open clinic before time t. To identify the determinants of obtaining an ART clinic, the hazard ratio (HR), which defines how the hazard function changes when the CMP characteristics (X_{ij}) change, is reported and evaluated. The model estimates the baseline Weibull hazard function for the period of study and determines the percentage shift up or down of the function due to the covariates. Results are expressed as a shift in the likelihood of having an accredited clinic at time t.

Third, the following equation was estimated using an ordinary least squares (OLS) regression of the ART coverage rate (number of enrolled patients divided by the CMP population) at time t in CMP i using a similar equation (1) as above:

$$\mathrm{ART}_{\mathrm{Coverage\ Rate}_{ijt}} = \beta_0 + \phi' X_i + \alpha_j + \epsilon \quad (2)$$

To minimize bias, the CMP population was used as the denominator in the dependent variable rather than the imputed HIV prevalence rate. The HIV prevalence survey was not stratified at the CMP level, and prevalence rates are therefore more likely to be missing for CMPs that are small, less populous or remote. The inclusion of province indicator variables controls for differences in HIV prevalence rate across provinces however.

In all analyses, standard errors are clustered by municipality to adjust for within-municipality correlation of unobserved shocks. (There are 253 municipalities, which contain on average 12 CMPs). The robustness of results was determined by adding variables sequentially to regression specifications and testing for interaction terms. All analyses were performed in Stata version 11.

Results

Table 2 presents evidence on which CMP characteristics were associated with improved access to AIDS treatment, measured by (1) the likelihood that an ART clinic was accredited in the CMP (Panel A: logistic regression) and (2) the length of time from the beginning of the rollout until a clinic was accredited (Panel B: duration analysis). Overall, no clear pattern emerges of the rollout systematically favouring better-off CMPs, and in general the magnitude of statistically significant associations is small. The logistic and duration analyses produce consistent results: factors that increased the likelihood of accreditation in a CMP also reduced the time to accreditation.

Panel A reports marginal effects and Panel B shows HRs. A marginal effect greater than zero indicates that the factor is associated with an increased likelihood of clinic accreditation, while a HR $>$ 1 indicates an increase in the hazard of accreditation at time t conditional on not being accredited before time t. Ninety-five per cent confidence intervals (CIs) are in brackets and P-values appear in the adjacent column. Because the marginal effects and HRs are consistent across columns within each panel, the discussion focuses on the columns with the full set of control variables (columns 2 and 4).

The first row demonstrates that CMPs with more residents had better access to ART clinics. Each additional CMP resident statistically significantly increased the likelihood of having an accredited clinic in the CMP by 0.3 percentage points (CI 0.002 to 0.003, $P < 0.001$; Panel A) and increased the hazard of accreditation by 0.08% (CI 0.005 to 0.010%, $P < 0.001$; Panel B).

There was no clear pattern of the rollout favouring well-off areas: although some of the measures of economic deprivation were associated with greater access to ART, others were associated with worse access. Overall the point estimates were small. A 1% increase in the percentage of adults with no education in a CMP was associated with a 0.5 percentage point reduction in the likelihood of having ART access within the CMP (CI −0.007 to −0.003, $P < 0.001$; Panel A) and a 4.5% decrease in the hazard of accreditation (CI −0.069 to −0.023, $P < 0.001$; Panel B). On the other hand, a greater percentage of men below the poverty line was associated with a statistically significant 0.2 percentage point increase in the likelihood of ART access in the CMP (CI 0.001 to 0.003, P 0.001) but no statistically significant change in the hazard. The fraction of households without cell phone access was a strong predictor of poor ART access. Each additional percentage point was associated with a 16.5 percentage point decrease in the likelihood of ART access in the CMP (CI −0.302 to −0.029, P 0.018) and an 84.2% decrease in the hazard of accreditation (CI −3.079 to −0.615, P 0.003). There was no statistically significant relationship between the likelihood of accreditation or the hazard of accreditation and any of the other measures of SES (residents living in informal housing, without access to piped water and without access to electricity).

Table 2 Effect of local characteristics on whether AIDS treatment was provided in a CMP (Panel A) and the length of time until treatment was provided (Panel B)

	Panel A: multivariate logit regression				**Panel B: duration analysis**			
	Was an ART clinic accredited?				Time until accredited			
Variable	Marg eff	*P*	Marg eff	*P*	HR	*P*	HR	*P*
Total population	0.003***	< 0.001	0.003***	< 0.001	1.008***	< 0.001	1.008***	< 0.001
	[0.002 to 0.003]		[0.002 to 0.003]		[0.005 to 0.010]		[0.005 to 0.010]	
% of CMP population African	0.002***	< 0.001	0.002***	0.003	1.014**	0.027	1.015**	0.025
	[0.001 to 0.003]		[0.001 to 0.003]		[0.002 to 0.026]		[0.002 to 0.027]	
% White	< 0.001	0.957	−0.001	0.329	0.998	0.875	0.987	0.393
	[−0.002 to 0.002]		[−0.004 to 0.001]		[−0.029 to 0.025]		[−0.043 to 0.017]	
% of CMP no education	−0.007***	<0.001	−0.005***	<0.001	0.931***	<0.001	0.955***	<0.001
	[−0.009 to −0.005]		[−0.007 to −0.003]		[−0.091 to −0.052]		[−0.069 to −0.023]	
% Men below poverty line	0.002***	0.001	0.002***	0.001	0.995	0.579	0.999	0.895
	[0.001 to 0.003]		[0.001 to 0.003]		[−0.021 to 0.012]		[−0.014 to 0.012]	
% No cell phone			−0.165**	0.018			0.158***	0.003
			[−0.302 to −0.029]				[−3.079 to −0.615]	
% Holds informal housing			−0.006	0.914			0.911	0.862
			[−0.115 to 0.103]				[−1.153 to 0.966]	
% Holds no piped water			−0.057	0.230			0.556	0.209
			[−0.149 to 0.036]				[−1.500 to 0.327]	
% Holds no electricity			0.046	0.135			1.417	0.472
			[−0.014 to 0.107]				[−0.602 to 1.300]	
% Workers unionized			<0.001*	0.070			1.007***	0.002
			[−0.000 to 0.001]				[0.002 to 0.011]	
DA party most votes			0.029	0.116			1.271	0.260
			[−0.007 to 0.066]				[−0.177 to 0.657]	
IFP party most votes			0.031	0.192			1.052	0.842
			[−0.016 to 0.078]				[−0.447 to 0.548]	
Other small party most votes			−0.145***	0.002			0.106***	<0.001
			[−0.238 to −0.051]				[−3.384 to −1.103]	
HIV prevalence rate			<0.001	0.414			1.006	0.322
			[−0.001 to 0.001]				[−0.005 to 0.016]	
PEPFAR present in CMP			−0.002	0.930			1.227	0.277
			[−0.037 to 0.034]				[−0.164 to 0.573]	
Per cap health expenditure			<0.001	0.175			1.003	0.103
			[−0.000 to 0.000]				[−0.001 to 0.006]	
N	2981		2526		2981		2526	

Notes: Panel A reports marginal effects and Panel B reports HRs. 95% confidence intervals are in brackets and *P*-values appear in adjacent column. All analyses include a set of province control variables. Standard errors are clustered at the municipality level. ***, Significant at the 1% level, **, 5% level, *, 10% level.

Having a greater fraction of CMP workers who are members of unions, which historically have been aligned with the ruling ANC party, very slightly increased the likelihood of a clinic in the CMP (CI 0.000 to 0.001, *P* 0.070) and significantly increased the accreditation hazard (CI 0.002 to 0.011, $P < 0.001$). No evidence indicates that CMPs where a greater share of votes were won by the two main opposition parties (DA and IFP) had better or worse ART access than those won by the ANC. However, CMPs where one of the 25 smaller parties won a plurality of the votes, representing only 2% of the total population, were 14.5 percentage points less likely to have an ART clinic (CI −0.238 to −0.051, *P* 0.002) and had an 89.4% lower hazard of accreditation (CI −3.384 to −1.103, $P < 0.001$).

Neither measure of health infrastructure (per capita health expenditure nor PEPFAR partnership) was statistically significantly associated with greater access to ART. Also, the local HIV rate was not associated with a greater likelihood of having an ART clinic in the CMP and had only a slightly positive point estimate on the accreditation hazard, which was not significant (CI −0.005 to 0.016, *P* 0.322).

The sign, significance level and approximate size of the point estimates were robust to adding the control variables in different combinations and sequences. When interactions between ANC party plurality and a number of measures of deprivation were individually included in the regression, none were statistically significant and none changed the approximate magnitude of the

estimates. Results did not change when including an urban indicator variable or the interaction between the ANC party plurality and the percentage of men below the poverty line (Supplementary Table S2). The variance inflation factor (VIF) due to multicollinearity in the regression was calculated to be no higher than 5 for all control variables in the full specification aside from the percentage of Black African (VIF 9.5) and the Western Cape province control variable (VIF 6.98).

One way to illustrate the magnitude of the effects in Panel A of Table 2 is to recalculate the likelihood of accreditation using a hypothetical scenario, where CMPs in the bottom quintile of the sample distribution of a particular variable are improved to the level of the median CMP. Though such a scenario represents a enormous improvement in the characteristics of the CMP it only raises the likelihood of accreditation by 3.6 percentage points (from 4.7 to 8.3%) for the percentage of CMP residents with no education and decreases it by 3.6 percentage points (from 10.7 to 7.1%) for the percentage of men in a CMP below the poverty line. Though the point estimates in Panel A are statistically significant, they are so small that even large changes in the characteristics of the CMP correspond to relatively small predicted changes in the likelihood of having an accredited clinic within the CMP. On the other hand, the large marginal effect for mobile phone access generates a predicted 9.6 percentage point increase (from 2 to 11.6%) if the bottom quintile of CMPs in mobile phone access were raised to the median level of 34%.

Table 3 shows that the coverage rate (number of enrolled patients as a fraction of the CMP population) was 11.3 percentage points higher for every additional percentage point of Black

Table 3 Effect of local characteristics on local coverage rates of AIDS treatment in a CMP for all facilities (Panel A) and excluding patients at regional and district hospitals (Panel B)

Variable	**Panel A: Multivariate regression**				**Panel B: Multivariate regression**			
	Coverage rate				Coverage rate			
	Marg eff	*P*	Marg eff	*P*	Marg eff	*P*	Marg eff	*P*
Total population	−0.010	0.226	−0.008	0.233	<−0.001	0.981	−0.001	0.574
	[−0.026 to 0.006]		[−0.022 to 0.005]		[−0.004 to 0.004]		[−0.006 to 0.003]	
% of CMP population African	0.161*	0.078	0.113*	0.090	0.005	0.652	0.013	0.404
	[−0.018 to 0.340]		[−0.018 to 0.243]		[−0.015 to 0.025]		[−0.017 to 0.043]	
% White	−0.254*	0.054	−0.319**	0.013	−0.007	0.619	−0.016	0.512
	[−0.512 to 0.005]		[−0.571 to −0.067]		[−0.035 to 0.021]		[−0.066 to 0.033]	
% of CMP population no education	−0.378***	0.009	−0.440**	0.037	0.046	0.575	0.078	0.477
	[−0.662 to −0.093]		[−0.854 to −0.026]		[−0.116 to 0.208]		[−0.137 to 0.294]	
% Men below poverty line	0.138	0.390	0.164	0.410	0.010	0.505	0.016	0.463
	[−0.176 to 0.451]		[−0.226 to 0.554]		[−0.020 to 0.041]		[−0.026 to 0.058]	
% No cell phone			−0.024	0.625			−0.013	0.287
			[−0.120 to 0.072]				[−0.038 to 0.011]	
% Holds informal housing			−0.481**	0.025			−0.080	0.137
			[−0.902 to −0.060]				[−0.185 to 0.025]	
% Holds no piped water			−0.309*	0.056			<0.001	0.994
			[−0.627 to 0.008]				[−0.058 to 0.059]	
% Holds no electricity			0.170	0.170			−0.007	0.852
			[−0.073 to 0.414]				[−0.080 to 0.066]	
% Workers unionized			0.058*	0.094			0.009	0.146
			[−0.010 to 0.126]				[−0.003 to 0.021]	
DA party most votes			3.760*	0.094			0.601	0.493
			[−0.643 to 8.163]				[−1.116 to 2.318]	
IFP party most votes			20.573	0.153			−2.854	0.277
			[−7.643 to 48.788]				[−7.998 to 2.290]	
Other small party most votes			−0.157	0.940			−0.947**	0.025
			[−4.225 to 3.911]				[−1.772 to −0.122]	
HIV prevalence rate			0.087	0.397			−0.007	0.642
			[−0.114 to 0.287]				[−0.038 to 0.024]	
PEPFAR present			−1.475	0.291			−0.536	0.188
			[−4.212 to 1.263]				[−1.335 to 0.263]	
N	149 000		135 100		149 000		135 100	

Notes: All analyses include a set of province control variables. Standard errors are clustered at the municipality level. ***, significant at the 1% level; **, 5% level; *, 10% level.

African residents (CI −0.018 to 0.243, *P* 0.090) and 31.9 percentage points lower for every additional percentage point of White residents (CI −0.571 to −0.067, *P* 0.013). Statistically significantly lower coverage rates were found in CMPs with a greater fraction of the population with no education (−0.854 to −0.026, *P* 0.037), living in informal housing (CI −0.902 to −0.060, *P* 0.025) and having no access to piped water (CI −0.627 to 0.008, *P* 0.056). There was an increase in coverage rates where unionization rates were higher and where the DA party won the greatest number of votes; however, these were only marginally significant.

Though these results appear to suggest that lower SES CMPs were disadvantaged in the rollout, Panel B shows that the magnitude and significance are driven by patient enrolment at hospital ART sites. When regional and district hospitals are excluded, the estimates are all much smaller and only one is statistically significant (a small party garnering the most votes).

Discussion

The patterns observed in this study can be explained by the DoH targeting of high population density areas, the pervasiveness of rural poverty and the distribution of political power. As expected, CMPs with large populations and high majorities of Black African residents had better access to ART programmes. The DoH focused its initial accreditation efforts on large hospitals in high population density areas with the aim of efficiently meeting the need for AIDS treatment by enrolling as many people as possible on ART. Both HIV prevalence and poverty rates are highest among Black Africans compared with the other races, so targeting these areas would help meet the need for treatment.

Consistent with the government's stated goals and with the optimal equitable ART allocation model in Wilson and Blower (2005), ART clinics opened earliest in areas of high population density. Though areas with higher education levels were favoured, so were areas with greater poverty, which may reflect an overall shift towards pro-poor health spending in South Africa (Castro-Leal *et al.* 1999; Burger *et al.* 2012). The weak relationship between measures of political power and AIDS treatment access demonstrates that the governing party did not use ART clinics to reward political strongholds. Areas with a higher HIV prevalence rate were no more likely to have an ART clinic and did not experience a statistically significant increase in the hazard of clinic accreditation. Because the HIV prevalence rate varies widely by region, minimal equity requires that clinics be accredited even in regions with low HIV prevalence rates. The placement of hospitals was the primary driver of coverage rates because they made up two-thirds of the ART facilities and enrolled on average twice as many patients per month as clinics.

It is possible to achieve greater equity when resource allocation is not limited by existing infrastructure. The regression results demonstrated a more equitable distribution of accredited clinics (mixed signs, smaller magnitudes, less likely significant) than coverage rates because the greater capacity of hospitals to enrol patients on ART compared with health clinics led to higher coverage rates where district and regional hospitals were located. Centralization is an efficient, if less equitable, strategy. The decentralization of ART as the intervention was scaled up after 2008 surely improved access for underserved areas.

The centralization of the early phases of ART provision has been shown to translate into worse access for rural residents, regardless of SES (Cleary *et al.* 2012). In South Africa, rural CMPs have lower education rates and higher poverty rates, which may explain the significance of these factors in the likelihood of and time to accreditation. The large negative relationship between cell phone access and accreditation can also be explained by rural poverty. At the time of the 2001 census, cell phones were commonplace in South Africa with around 60% of the adult population having access to one. Those who had few resources to purchase a cell phone, little use for one or inadequate signal coverage were likely to be poor or remote, both of which may limit access to health infrastructure.

A number of studies have found that there is greater public investment in areas with higher political mobilization (Besley and Burgess 2002; Banerjee and Somanathan 2007; Mani and Mukand 2007). In South Africa, union workers are more politically mobilized because worker unions have historically been aligned with the ruling ANC party and were involved in the struggle against the apartheid regime. In South Africa's proportional representation electoral system every vote, no matter where it is cast, contributes to the number of representatives at the national and provincial level. However, CMPs where one of the 25 small political parties garnered the most votes in the 2004 election represent 2% of South Africa's population. It is unlikely that the representatives of these areas wield much political power when it comes to distributing public resources.

It is perhaps surprising that the local HIV prevalence rate was not statistically significantly related to any of the measures of access to ART. However, this result can be explained by the considerable across-province variation in HIV prevalence relative to within-province variation. ART clinics were accredited in the Western Cape province in the first month of the rollout though it has one of the lower HIV prevalence rates. It would not be equitable to accredit clinics in only the provinces with the highest rates of HIV.

Limitations

One limitation of this study is that unionization and HIV prevalence rates were not available for all CMPs in the sample. Another data limitation is that it is not possible to determine ART uptake rates because facility catchment areas are undefined, and there is no data available on what fraction of HIV-positive residents are eligible for ART. The analysis does not consider any instances of stock-outs of anti-retrovirals. Future studies should focus on barriers to ART due to affordability and acceptability, which could not be addressed with the data in this study.

Conclusion

Despite concerns that infrastructure constraints or lack of political power might have systematically hampered AIDS treatment provision efforts in poorer areas of South Africa, this study shows that the highly centralized public

implementation of AIDS treatment in South Africa achieved a reasonably equitable distribution of access. The results indicate that, contrary to some perceptions, more advantaged areas were not substantially more likely than disadvantaged ones to gain access to ART or to gain access more quickly during the programme rollout. The centralization of the early phases of the rollout to maximize ART enrolment led to higher ART coverage rates in areas where district and regional hospitals were located. Overall, the accreditation process did not systematically favour CMPs with more economic resources, more political power or better health infrastructure.

Where resources are limited, explicit rationing (e.g. by geographic region or poverty level) is more equitable than implicit rationing (e.g. first-come first-served) as long as the wealthy or politically powerful are prevented from jumping ahead in the queue (Rosen *et al.* 2005). In practice, explicit targeting by region may be less costly, more efficient and easier to implement than targeting the poor (Rosen *et al.* 2005; Peters *et al.* 2013).

Three factors likely contributed to the achievement of equity in South Africa's AIDS treatment rollout by reducing the amount of discretion the government officials had in determining the order of accreditation (Kaufmann 1997; Vian 2008). First, the programme goal of distributive equity and the concomitant objective to assist underserved areas in meeting accreditation standards likely encouraged programme administrators to ensure the programme reached underserved and potentially disenfranchised populations (Braveman and Gruskin 2003). Second, the high level of scrutiny by civil society, including the media and NGOs such as the Treatment Action Campaign, spread information and maintained time pressure on the DoH, which provided a deterrent to deviating from programme goals (Besley *et al.* 2002; Brunetti and Weder 2003; Heywood 2009; Grebe 2011). Citizens are better able to hold governments accountable when they have more information on government performance (Keefer and Khemani 2005). Third, the intense time pressure on the small accreditation team not only precluded data-driven targeting, but also hindered bureaucratic discretion and provided few opportunities for queue-jumping (Vian 2008). Evidence of this phenomenon has been noted in the fast-paced rollout of family planning programmes in the USA in the 1960s, during which the implementation exigency left little time for targeting, cronyism or corruption (see e.g. Bailey 2012).

Ultimately, these results demonstrate that the provision of life-saving AIDS treatment was not disproportionately delayed in disadvantaged areas beyond reasonable limits of existing infrastructure. Despite concerns about the equity of public investment, the combination of a clear policy objective, limited bureaucratic discretion and close monitoring by civil society ensured equitable access to ART during the initial phase of the large, highly centralized ART rollout in South Africa. This work highlights the potential for future public investment in South Africa and other developing countries to reduce health and economic disparities.

Supplementary Data

Supplementary data are available at *Health Policy and Planning* online.

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References

Adam MA, Johnson LF. 2009. Estimation of adult antiretroviral treatment coverage in South Africa. *South African Medical Journal* **99**: 661–7.

Bailey MJ. 2012. Reexamining the impact of U.S. family planning programs on U.S. fertility: evidence from the war on poverty and early years of title X. *American Economic Journal Applied Economics* **4**: 62–97.

Banerjee A, Galiani S, Levinsohn J, McLaren Z, Woolard I. 2008. Why has unemployment risen in the new South Africa? *Economics of Transition* **16**: 715–40.

Banerjee A, Iyer L, Somanathan R. 2007. Public action for public goods. *Handbook of Development Economics* **4**: 3117–54.

Banerjee A, Somanathan R. 2007. The political economy of public goods: some evidence from India. *Journal of Development Economics* **82**: 287–314.

Barron P, Day C, Loveday M, Monticelli F. 2005. *The District Health Barometer Year 1. January–December 2004*. Durban, South Africa: Health Systems Trust.

Benatar SR. 2004. Health care reform and the crisis of HIV and AIDS in South Africa. *New England Journal of Medicine* **351**: 81–92.

Besley T, Burgess R. 2002. The political economy of government responsiveness: theory and evidence from India. *Quarterly Journal of Economics* **117**: 1415–51.

Besley T, Burgess R, Prat A. 2002. Mass media and political accountability. In: Islam R (ed). *The Right to Tell: The Role of Mass Media in Economic Development*. Washington, DC: World Bank, pp. 45–60.

Bor J, Herbst AJ, Newell ML, Barnighausen T. 2013. Increases in adult life expectancy in rural South Africa: valuing the scale-up of HIV treatment. *Science* **339**: 961.

Braveman P. 2006. Health disparities and health equity: concepts and measurement. *Annual Review Public Health* **27**: 167–94.

Braveman P, Gruskin S. 2003. Defining equity in health. *Journal of Epidemiology and Community Health* **57**: 254–8.

Brunetti A, Weder B. 2003. A free press is bad news for corruption. *Journal of Public Economics* **87**: 1801–24.

Burger R, Bredenkamp C, Grobler C, van der Berg S. 2012. Have public health spending and access in South Africa become more equitable since the end of apartheid? *Development Southern Africa* **29**: 681–703.

Castro-Leal F, Dayton J, Demery L, Mehra K. 1999. Public social spending in Africa: do the poor benefit? *World Bank Research Observer* **14**: 49–72.

Cleary S. 2010. Equity and efficiency in scaling up access to HIV-related interventions in resource-limited settings. *Current Opinion in HIV and AIDS* **5**: 210–4.

Cleary S, Birch S, Chimbindi N, Silal S, McIntyre D. 2013. Investigating the affordability of key health services in South Africa. *Social Science& Medicine* **80**: 37–46.

Cleary S, Silal S, Birch S *et al.* 2011. Equity in the use of antiretroviral treatment in the public health care system in urban South Africa. *Health Policy* **99**: 261–6.

Cleary SM, Birch S, Moshabela M, Schneider H. 2012. Unequal access to ART: exploratory results from rural and urban case studies of ART use. *Sexually Transmitted Infections* **88**: 141–6.

Coetzee D, Hildebrand K, Boulle A *et al.* 2004. Outcomes after two years of providing antiretroviral treatment in Khayelitsha, South Africa. *AIDS* **18**: 887–95.

Culyer AJ, Wagstaff A. 1993. Equity and equality in health and health care. *Journal of Health Economics* **12**: 431–57.

Duff P, Kipp W, Wild TC, Rubaale T, Okech-Ojony J. 2010. Barriers to accessing highly active antiretroviral therapy by HIV-positive women attending an antenatal clinic in a regional hospital in western Uganda. *Journal of the International AIDS Society* **13**: 37.

Galasso E, Ravallion M. 2005. Decentralized targeting of an antipoverty program. *Journal of Public Economics* **89**: 705–27.

Grebe E. 2011. The treatment action campaign's struggle for AIDS treatment in South Africa: coalition-building through networks. *Journal of Southern African Studies* **37**: 849–68.

Heywood M. 2009. South Africa's treatment action campaign: combining law and social mobilization to realize the right to health. *Journal of Human Rights Practice* **1**: 14–36.

Johnson LF, Mossong J, Dorrington RE *et al.* 2013. Life expectancies of South African adults starting antiretroviral treatment: collaborative analysis of cohort studies. *PLoS Medicine* **10**: e1001418.

Kagee A, Remien RH, Berkman A *et al.* 2011. Structural barriers to ART adherence in Southern Africa: challenges and potential ways forward. *Global Public Health* **6**: 83–97.

Kaufmann D. 1997. Corruption: the facts. *Foreign Policy*. number 107, summer 114–31.

Keefer P, Khemani S. 2005. Democracy, public expenditures, and the poor: understanding political incentives for providing public services. *World Bank Research Observer* **20**: 1–27.

Leibbrandt M, Woolard I, Finn A, Argent J. 2010. *Trends in South African Income Distribution and Poverty since the Fall of Apartheid, OECD Social, Employment and Migration Working Papers No. 101*. Paris: OECD Publishing.

Levinsohn J, McLaren Z, Shisana O, Zuma K. 2013. HIV Status and labor market participation in South Africa. *Review of Economics and Statistics* **95**: 98–108.

Mani A, Mukand S. 2007. Democracy, visibility and public good provision. *Journal of Development Economics* **83**: 506–29.

Mbewu A, Simelela N. 2003. *Operational Plan for Comprehensive HIV and AIDS Care, Management and Treatment for South Africa*. South African Government Information Service. http://www.info.gov.za/issues/hiv/careplan.htm, accessed 19 November 2003.

McCoy D, Chopra M, Loewenson R *et al.* 2005. Expanding access to antiretroviral therapy in sub-Saharan Africa: avoiding the pitfalls and dangers, capitalizing on the opportunities. *American Journal of Public Health* **95**: 18–22.

McIntyre D, Gilson L. 2002. Putting equity in health back onto the social policy agenda: experience from South Africa. *Social Science and Medicine* **54**: 1637–56.

McIntyre D, Muirhead D, Gilson L. 2002. Geographic patterns of deprivation in South Africa: informing health equity analyses and public resource allocation strategies. *Health Policy and Planning* **17**: 30–9.

McLaren Z. 2010. The effect of access to AIDS treatment on employment outcomes in South Africa. Chapter 1 in McLaren Z. *Essays on labor market outcomes in South Africa*. *Ph.D Thesis*. Ann Arbor, MI: University of Michigan. ProQuest/UMI. (Publication No. AAT 3429430).

McLaren Z, Ardington C, Leibbrandt M. 2013. *Distance as a Barrier To Health Care Access in South Africa, Southern Africa Labour and Development Research Unit Working Paper No. 97*. Cape Town: SALDRU, University of Cape Town.

Mukherjee JS, Ivers L, Leandre F *et al.* 2006. Antiretroviral therapy in resource-poor settings decreasing barriers to access and promoting adherence. *Journal of Acquired Immune Deficiency Syndromes* **43**: S123–S126.

National Treasury. 2007. *Provincial Budgets and Expenditure Review: 2003/04–2009/10*. Pretoria: National Treasury.

National Treasury. 2009. *Provincial Budgets and Expenditure Review: 2005/06–2011/12*. Pretoria: National Treasury.

Nattrass N. 2007. *Mortal Combat: AIDS Denialism and the Fight for Antiretrovirals in South Africa*. Durban: University of KwaZulu-Natal Press.

Okoli CI, Cleary SM. 2011. Socioeconomic status and barriers to the use of free antiretroviral treatment for HIV/AIDS in Enugu State, south-eastern Nigeria. *African Journal of AIDS Research* **10**: 149–55.

Peters DH, Sinha G, Bollinger RC. 2013. Scaling up, coverage, and targeting. In: Aral S, Fenton KA, Lipshutz JA (eds). *The New Public Health and STD/HIV Prevention: Personal, Public and Health Systems Approaches*. New York: Springer. Chapter 8. pp.151–64.

Posse M, Meheus F, Van Asten H, Van Der Ven A, Baltussen R. 2008. Barriers to access to antiretroviral treatment in developing countries: a review. *Tropical Medicine & International Health* **13**: 904–13.

Rosen S, Sanne I, Collier A, Simon JL. 2005. Hard choices: rationing antiretroviral therapy for HIV/AIDS in Africa. *Lancet* **365**: 354–6.

Schneider H, Coetzee D. 2008. Strengthening the health system and ensuring equality in the wide scale implementation of an antiretroviral therapy programme in South Africa. *South African Medical Journal* **93**: 772.

Scott V, Chopra M, Conrad L, Ntuli A. 2005. How equitable is the scaling up of HIV service provision in South Africa? *South African Medical Journal* **9**: 109–13.

Shisana O, Rehle TM, Simbayi LC *et al.* 2005. *South African National HIV Prevalence, HIV Incidence, Behaviour and Communication Survey*. Cape Town: Human Sciences Research Council Press.

Tsai AC, Chopra M, Pronyk PM, Martinson NA. 2009. Socioeconomic disparities in access to HIV/AIDS treatment programs in resource-limited settings. *AIDS Care* **21**: 59–63.

Tuller DM, Bangsberg DR, Senkungu J *et al.* 2010. Transportation costs impede sustained adherence and access to HAART in a clinic population in southwestern Uganda: a qualitative study. *AIDS Behavior* **14**: 778–84.

US President's Emergency Plan for AIDS Relief. 2009. *Activities in South Africa Provinces*. Fiscal Year 2009. Pretoria, South Africa.

Vian T. 2008. Review of corruption in the health sector: theory, methods and interventions. *Health Policy and Planning* **23**: 83–94.

Victora CG, Vaughan JP, Barros FC, Silva AC, Tomasi E. 2000. Explaining trends in inequities: evidence from Brazilian child health studies. *Lancet* **356**: 1093–8.

Whitehead M. 1992. The concepts and principles of equity and health. *International Journal of Health Services* **22**: 429–45.

Wilson DP, Blower SM. 2005. Designing equitable antiretroviral allocation strategies in resource-constrained countries. *PLoS Medicine* **2**: e50.

World Bank. 2004. *World Development Indicators: World Bank*. Washington, DC: World Bank.