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Increasing access to HIV testing: Impacts on equity of coverage and uptake from a national campaign in South Africa

by

Brendan Maughan-Brown, Neil D. Lloyd, Jacob Bor, and Atheendar S. Venkataramani

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About the Author(s) and Acknowledgments

Brendan Maughan-Brown, Southern Africa Labour and Development Research Unit, University of Cape Town.
Neil D. Lloyd, Southern Africa Labour and Development Research Unit, University of Cape Town.
Jacob Bor, Center for Global Health and Development, Boston University.
Atheendar S. Venkataramani, Massachusetts General Hospital and Harvard Medical School.

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Abstract

Background: HIV counselling and testing (HCT) is a critical component of HIV prevention and treatment efforts. Between April 2010 and June 2011 South Africa ran an ambitious, multi-sector, campaign aiming to test 15 million people nationwide. We assessed the extent to which this campaign reached (1) those who previously had never tested for HIV and (2) high risk and socioeconomically vulnerable populations.

Methods: We used data from the National Income Dynamics Study (NIDS, n=18,650), a nationally representative panel study in South Africa, to assess the uptake of first-time testing between 2010 and 2012 at the national level and by age, gender, racial, and province-level subgroups. Multivariate logistic regression analyses were used to compare the factors associated with HIV testing in 2010 and 2012, and to assess the characteristics of first-time testers.

Results: The proportion of adults having ever received an HIV test increased from 43.7% (95% CI: 41.48; 45.96) in 2010 to 65.2% [63.28; 67.10] in 2012, as approximately 7.5 million individuals 15 years and older tested for the first time nationally. However, there was large variation in new testing rates across geographic areas and population subgroups. The association between ever testing and both income and self-reported health declined between 2010 and 2012, suggesting the campaign was successful in reaching poorer and healthier individuals. However, disparities in testing by education and gender remained strong between 2010 and 2012.

Conclusion: The provision of HCT services in South Africa led to a steady rise in the proportion of individuals ever tested for HIV and has improved equity of HCT uptake. Future initiatives to increase HCT uptake, both within South Africa and in other countries, would gain from lessons learned from the South African effort. However, new interventions may be required to improve testing rates among the less educated and men, particularly poor men, and to achieve universal HCT access and uptake.

1. Introduction

HIV counselling and testing (HCT) is a pivotal component of global HIV prevention and treatment efforts. HCT is the entry point for antiretroviral therapy (ART), which reduces AIDS-related morbidity and mortality and is associated with extended life expectancy (Bor et al. 2013; Johnson et al., 2013). Universal access to HCT is necessary to reach the UNAIDS 90-90-90 target (UNAIDS, 2014), which is based on the premise that diagnosing 90% of individuals living with HIV, linking 90% of those individuals to treatment, and achieving viral load suppression in 90% of those individuals by 2020, will prevent horizontal and vertical transmission of the disease (Cohen et al., 2011; Montaner et al. 2010, Tanser et al. 2013).[1]

Progress towards the 90-90-90 target in South Africa rests on successful diagnosis and treatment of the estimated 6.4 million individuals living with HIV in the country, the largest HIV epidemic worldwide (Shisana et al. 2014). Access to HIV testing in South Africa has increased steadily since 2002, when only an estimated 19% of individuals 15 years and older had ever had an HIV test (Shisana and Simabi, 2002); by 2008 that proportion grew to nearly 50% (Shisana et al., 2005; 2008).

The provision of HCT services expanded dramatically in 2010, when South Africa launched the largest HCT campaign in the world. The campaign aimed to test 15 million individuals between April 2010 and June 2011 (Health and Development Africa, 2012), and was supported at the highest levels of government, with President Jacob Zuma testing publicly and disclosing the result. While all South Africans were targeted for HCT, special emphasis was placed on men; sexually active individuals aged between 15-49 years; pregnant women; vulnerable and marginalized groups; and individuals presenting with tuberculosis, sexually transmitted infections, and/or opportunistic infections (Department of Health, 2010). The multi-sector campaign was implemented nationwide with the collaboration of government, and the non-governmental, business and entertainment sectors. HIV testing was conducted at health facilities, in local communities (e.g. at mobile health clinics) and at nationally and provincially organised mass events (Health and Development Africa, 2012).

Twenty million HIV tests were conducted between 2010 and the end of 2011, during the period of the national HCT campaign (UNAIDS, 2013; South African National AIDS Council, 2013; Mbengashe et al. 2012). These totals represent data collected by the National Department of Health on the number of tests conducted during these time periods. By 2012, the proportion of South Africans 15 years and older who had ever had an HIV test had increased to an estimated 65% (Shisana et al., 2014, Johnson et al., 2013), with 59% and 71.5% of men and women, respectively, reporting having been tested (Shisana et al. 2014). However, even with the expansion of testing coverage, the percentage of HIV positive individuals aware of their serostatus[2] remained low in 2012: 38% of men and 55% of women (Shisana et al. 2014). This shortfall from the UNAIDS 90% target will only be overcome if programs successfully re-test individuals who have seroconverted since their previous test and provide first-time testing to HIV-positive individuals who have historically been harder to reach with this service. Our current understanding of the extent to which the national HCT campaign reached first time testers is limited. As such, it is important to evaluate the South African campaign along this margin. In addition, success of the HCT campaign depends on addressing disparities in testing and reaching high-risk populations. Inequalities in access to or uptake of HIV testing in South Africa have been well

[1] HCT may also prevent new infections by decreasing risky sexual behaviours among people living with HIV (Allen et al. 1992b; Weinhardt et al. 1999; Boozer and Philipson 2000; Thornton 2008; Delavande and Kohler 2012; Fonner et al. 2012), though the evidence is inconclusive (Baird et al. 2014).

[2] The state of either having or not having detectable antibodies against a specific antigen, as measured by a blood test (serologic test). For example, HIV seropositive *means* that a person has detectable antibodies to HIV; seronegative *means* that a person does not have detectable HIV antibodies (http://aidsinfo.nih.gov/education-materials/glossary/1632/serostatus).

established in the literature. Gender disparities have persisted with significantly fewer men taking up HIV testing (Venkatesh et al. 2011; Shisana et al., 2009; Johnson et al., 2010; Pettifor et al., 2008; Peltzer et al., 2009; Ropelewski et al., 2011). Adolescents and young adults also exhibit lower uptake of HIV testing services (Peltzer et al., 2009). Several socioeconomic barriers to HCT have been identified, as well, with low uptake of HCT being associated with lower levels of education (Pettifor et al., 2008; Peltzer et al., 2009; Mhlongo et al., 2013); less wealth (Pettifor et al., 2008); and unemployment (Peltzer et al., 2009; Venkatesh et al., 2011; Mhlongo et al., 2013). These findings from South Africa are consistent with studies from elsewhere in sub-Saharan Africa that have shown significant gender, age and socioeconomic differentials in the uptake of HIV testing (Obermeyer et al. 2013; Hensen et al. 2014; Creel and Rimal, 2011; Agha, 2012). While, as discussed above, millions of tests were performed as part of South Africa's campaign, there is no evidence to date whether the intervention was successful in reducing disparities in testing rates. The success of HIV testing campaigns with respect to the UNAIDS 90-90-90 target depend critically on this, as for example, less educated individuals may be less likely to test for HIV but at higher risk for HIV (Bärnighausen et al., 2007; Bor & de Neve 2014). Previous studies have identified slower take up of health interventions and risk-reducing behaviours among the less educated, one important source of socioeconomic disparities in health (de Walque 2009; Cutler & Lleras-Muney 2010). Failure to address these disparities in testing will lead to rising socioeconomic disparities in mortality and HIV infection down the road.

In this study, we assess (1) the extent to which the national effort reached those who previously had never tested for HIV and (2) whether the national effort helped overcome persistent socioeconomic barriers to HIV testing and, consequently, improved the equity of access to HIV testing services. We used data from a nationally representative panel study, the National Income Dynamics Study, to assess the uptake of first time testing between 2010 and 2012 nationally, and by province, race, and sex. We analysed HIV testing coverage among populations with high HIV prevalence to assess whether the campaign reached individuals at higher risk of HIV infection and to identify groups in particular need of interventions to encourage testing. We then assessed the characteristics of untested individuals in two separate analyses. First, we compared the factors associated with HIV testing in 2010 to the factors associated with testing in 2012, as changes in the magnitude of the association between testing and socioeconomic factors would be indicative of the program's reach. Second, we focused on those individuals who, in 2010, had never had an HIV test and examined the factors associated with first time testing between 2010 and 2012. This enables us to more directly assess who was left behind by the testing campaign.

We find that there were large increases in the fraction of individuals reporting ever having tested for HIV between 2010-2012. For African individuals, ever-testing rates increased from 34% to 57% for men and 49% to 74% for women. Analyses of ever-testing rates at the provincial level show growth across all areas of the country, though testing coverage remains low among sub-groups in high prevalence areas, such as KwaZulu-Natal, as well as evidence of large within-province variation. The national testing efforts were successful in addressing many of the disparities in testing uptake. We found that testing rate gradients by income declined markedly after national testing efforts commenced. However, gender disparities and education gradients in HIV testing remained strong and, for men, became steeper.

Our findings have a number of important implications for policy and research. Despite significant increases in the number of new testers, a substantial proportion of individuals, even in provinces with high HIV prevalence, remained untested. Part of this shortfall from universal HIV testing coverage appears to be driven by the at best sluggish uptake of testing among less educated individuals. This is despite efforts to reduce the marginal cost of testing, which may explain reducing income gradients in testing. The persistence of education gradients in testing, particularly given

contemporary work showing similar gradients in the demand for HIV prevention products, motivates further research around developing interventions that specifically target less educated individuals (Gummerson et al., 2013; Agüero and Bharadwaj, 2014; Alsan and Cutler, 2013).

While developing interventions targeted to less-educated individuals is perhaps a more long-term objective, our results have specific implications for short-run policymaking, as well. Specifically, our findings reveal that the testing campaign was very successful at reaching people who had never tested. Further, our findings with regard to geographic differences in program efficacy highlight opportunities for better spatial matching of future HCT resources to areas with higher HIV risk burdens.

The remainder of this paper is as follows. In the next section, we describe the methods. In Section 3 we present our results and Section 4 provides a concluding discussion that includes the limitations of our study.

2. Methods

2.1. Data

We used data from the National Income Dynamics Study (SALDRU, 2012 & 2013), a nationally representative panel survey of South Africa. At present, there are three publicly available waves of data, covering the years 2008, 2010/11 and 2012, with a fourth wave in field (De Villiers et al., 2013). The primary objective of NIDS is to understand the dynamics of household income, expenditure, asset wealth, education, health, and other components of well-being in South Africa (Leibbrandt et al., 2009). In addition to collecting detailed information on socioeconomic characteristics and labour market participation, the NIDS surveys field a number of health-related questions, including whether individuals had ever been tested for HIV. While many of the known covariates of HIV testing, such as the self-perceived HIV risk, were not measured by NIDS, the richness of the socio-economic indicators offer an opportunity to examine in detail the socio-economic links to HIV testing.

We used data from the second and third waves of NIDS, given that these waves fielded questions about HIV testing (the 2008 wave of the survey did not). The timing of the second and third waves in 2010/11 and 2012 respectively, makes it possible to observe changes in HIV testing after the period in which the government rolled out a national HCT campaign. Specifically, wave two, which took place between 12 April 2010 and 25 May 2011 was conducted in concert with campaign activities, which occurred between 30 April 2010 and 30 June 2011. Wave three took place in 2012, after the completion of the campaign. Because our baseline and end-line surveys did not coincided with the campaign start and end dates, our estimates of the total number of new testers between 2010/2011 and 2012 should not be interpreted as the number of individuals tested during the campaign.

The first wave of NIDS was administered in 2008 and was sampled using a two-stage design. The original sample consisted of 400 Primary Sampling Units (PSU) randomly drawn from a sample of 3000 PSUs, stratified over 53 districts. Eight non-overlapping samples of dwelling units where then drawn from each PSU. All households residing at the selected dwelling units were sampled and all resident household members made ‘continuous’ sample members (CSM). In wave one 9,600 dwelling units were sampled, but not all were reached and the wave one sample consisted of 7,305 households. In each subsequent wave, NIDS attempted to re-interview each CSM, regardless of whether they had moved from their wave-one dwelling or joined a new household. In addition, the survey allowed for the introduction of new sample members by interviewing all non-CSM individuals residing in the same household as a CSM in a later wave. These individuals entered the sample as

'temporary' sample members (TSM). A portion of these TSMs was interviewed in both wave two and three, but no effort was made to follow them to a new household if they moved in a subsequent wave. The non-response rate from wave 1 to 2, when excluding those that moved out of scope or died between waves, was 19%. The equivalent non-response rate from wave 2 to 3 for CSMs only (excluding deceased and those moved out of scope but including new CSMs from wave 2), was 16%.

2.2. Sample Sizes

The NIDS surveys were designed to be representative of the complete adult population (ages 15 and older) living in South Africa in 2010/2011 and 2012. In NIDS wave two (2010/11) 16,893 adults (15 years and older) successfully completed the adult questionnaire, and 16,683 answered the HIV testing question. Additionally, during a second attempt to find respondents, 727 adults completed a shorter version of the questionnaire that did not include the HIV testing question. In wave three, 18,707 adults successfully completed the survey, with 18,650 providing a response to the HIV testing question. The larger sample size in wave three was due to the fact that NIDS fieldworkers managed to locate and interview individuals in wave one who were not interviewed in wave two (De Villiers at al., 2013). There was minimal missing data on HIV testing in both waves: variable non-response rate was 1.2% in wave one and 0.3% in wave three. These two samples of 16,683 and 18,650 in waves two and three respectively are used for the cross-sectional analysis of this paper. Another sample, 'the balanced panel', was created by including only those respondents that provided an answer to the HIV testing question in both waves two and three (12,034 adults). This sample includes both CSMs and TSMs, as some of the latter were successfully interviewed in both waves two and three.[3]

2.3. HIV Testing Variables

With regards to HIV testing, NIDS fielded the following question: "I do not want to know the result, but have you ever had an HIV test?" Possible response options included "Yes", "No," "Don't know," and "Refuse [to answer]." Two variables were created using the responses to this question. The first was a binary variable = 1 for individuals who reported having been tested for HIV and = 0 for individuals who have never had an HIV test. This variable identifies HIV testing history. The second variable is derived from the balanced panel. Restricting the data to only those individuals who had never tested for HIV by 2010/11, our variable separates individuals who subsequently reported never having had an HIV test in 2012 (=0) to those who did test for the first time between the surveys (=1).

2.4. Socioeconomic Variables

A full description of our socioeconomic, and other, variables are presented in Table 1. We focus on two measures of socioeconomic status. The first is per capita household income, which is used in log form in the regression analyses. Given potential measurement error in survey measures of income (Deaton, 1997), we additionally explored the sensitivity of our results to measures such as household poverty, consumption expenditures, and asset ownership. Second, we created an education variable to represent years of completed education (0-18, with 18 indicating someone with any postgraduate tertiary education). We also control for current enrolment in an education institution.

[3] An additional 721 individuals were interviewed in both waves but did not answer the HIV testing question in one of the waves: 182 of these individuals responded "refuse" or "don't know" to the question in either wave, while 539 were interviewed in phase 2 of wave two and were not asked the HIV testing question. There is some evidence to suggest that these 539 individuals who were not asked the HIV testing question in wave two were more likely to have come from the Western Cape and were more likely to have been African (results available upon request), but the sample is small and likely to have minimal, if any, impact on our results.

2.5. Health variables

We use an indicator of self-perceived health at the time of the interview measured on a 5-point scale from "excellent" to "poor." Given that little is known about the relationship between mental health and HIV testing uptake we also utilized a measure of depression that was based on the Center for Epidemiologic Studies Depression (CESD) scale (Radloff, 1997). Other health-related measures used as control variables include alcohol consumption and an indicator of ever being pregnant between our surveys to control for HIV testing women routinely receive from antenatal clinics.

2.6. Demographic and control variables

The demographic variables assessed in this analysis include age, gender, race, marital status, employment status and religiosity. We also control for geographical location (rural and urban categories; and province), and the date of interviews.

3. Analysis

We first estimate HIV testing coverage in the 2010/11 and 2012 waves, doing so for the full sample, and for geographic and age-gender-race subgroups. We then run a set of multivariate logistic regression models to assess the socioeconomic and demographic factors associated with ever having had an HIV test using both the 2010/11 and 2012 cross-sectional datasets. We compare the coefficient estimates across the two waves to assess whether the national testing campaign ameliorated or exacerbated any socioeconomic gradients in the probability of testing.

Next, we use the panel sample to examine the determinants of testing among those who did not report ever having been tested for HIV at baseline (wave 2). This analysis builds on the cross-sectional regressions by explicitly examining, who among the previously never tested was left behind after the national testing campaign was completed.[4]

It is important to bear in mind, as mentioned above, that because the second wave of NIDS was fielded *during* the national test campaign, comparisons of the second and third waves may lead to biased estimates of the reach of the testing campaign among groups with previously low access or uptake of testing. Additionally, the descriptive nature of the analysis means that we cannot fully attribute the changes we observe to the testing program, as other national trends in testing access and uptake could be playing a role (for example, testing rates were rising even prior to the national campaign).

In all of our models, we adjust standard errors to account for the two-stage survey design, allowing for clustering at the wave one cluster level.[5] Notably, corrections are not made for stratification, which makes the standard errors reported here more conservative. All analyses were conducted with Stata 13.0 (Stata Corporation, College Station, Texas, United States of America).

[4] The comparability of the results from the cross sectional analysis and the analyses using the balanced panel also provides a sense of the extent to which selective attrition may be driving our results. We explore the point of attrition more formally in Appendix 3.

[5] See Wittenberg (2013) for a more detailed discussion of cluster correction in the NIDS panel data.

Table 1. Independent Variables

Socioeconomic Variables	
Income	Income is used in log form and is calculated using NIDS's household income variable (with full imputations) divided by household size. See Argent (2009) for a full discussion on the construction of this variable.
Expenditure	Household expenditure, which includes expenditure on food non-food items, with full imputations (for a full discussion see Finn et al., 2009). The non-food items included are rent (explicit or implied), transport, leisure, health, utilities, education, household items, insurance, clothing, alcohol and tobacco, and miscellaneous.
Expenditure quartiles	An expenditure quartile variable was created using the aforementioned household expenditure variable (with full imputations). The quartiles were estimated using cross-sectional weights across the full sample (children, adults and proxies).
Assets	NIDS asked all adults whether or not they owned the following 10 assets: radio; hi-fi stereo, CD player or MPS player; sewing/knitting machine; motor vehicle (private) in running condition; bakkie (South African equivalent of a pick-up) or truck in running condition; motorcycle/scooter; bicycle; computer; camera; cell phone. We constructed an asset variable by counting the number of assets that each individual owned.
Poverty	An individual is defined as poor if their per capita real household income is below R662 (in 2010 rands). This poverty line was based on 2008 poverty line of R515 (approximately $62 in 2008) which is widely used in the literature (Woolard and Leibbrandt, 2005).
Education	The education variable represents years of completed education. The range of the variable is 0 to 18 (someone with more than a Bachelor's degree).
Health variables	
Subjective health	Self-perceived health was measured using an ordinal scale from 1-5 where 1 is "excellent" and 5 "poor". Interviewees were asked the question, "How would you describe your health at present? Would you say it is excellent, very good, good, fair, or poor?" A binary variable was created to identify individuals who reported "poor" or "fair" (=1) and those who reported "excellent", "very good" or "good" (=0).
Depression scale	NIDS asked the standard 10 questions used to form the CESD scale. Previous analysis indicates that responses to two of these questions were influenced by the response option running in the opposite direction compared to the other 8 questions (Ardington and Case, 2010). We therefore dropped these two questions and use a continuous 8-question scale as a measure of mental health. The ten questions are asked in the form of phrases with which the respondents are asked to rank their agreement on a scale of 1 to 4 with1 meaning "Rarely or none of the time" and 4 meaning "All of the time". The eight questions used to construct our mental health scale were: (1) I was bothered by things that usually don't bother me; (2) I had trouble keeping my mind on what I was doing; (3) I felt depressed; (4) I felt that everything I did was an effort; (5) I felt fearful; (6) My sleep was restless; (7) I felt lonely; (8) I could not "get going" The two inverted, and therefore excluded, questions were (1) I felt hopeful about the future, and (2) I was happy.

Table 1. Independent Variables cont.

Alcohol usage	Alcohol usage was reported on an ordinal scale of 1-7 where 1 represented “I have never drank alcohol” and 8 “every day”. A binary variable was created with a value of 1 representing individuals who responded at least “rarely” (scores 3-8) and 0 representing individuals who reported never having consumed alcohol or had stopped drinking.
Pregnant between surveys	A binary indicator or whether women reported giving birth between the surveys.
Demographic and Control variables	
Gender	Males are the base category.
Age	Age in years as both a linear and quadratic variable
Race	The four main population groups in South Africa are included: African (referring to black Africans), Coloured, Indian/Asian, and White. ‘Coloured' is a common and socially acceptable term in South Africa for individuals of mixed race. Africans are the base category.
Labour market status	A broad definition of unemployment is used (combining the searching and non-searching unemployed). Three categories are defined: employed, unemployed and not-economically-active, with the employed as the base category.
Enrolment	The NIDS questionnaire asked all individuals under the age of 30 whether or not they are currently enrolled in an education institution. We created a binary variable = 1 for individuals who were enrolled at the time of the interview and make the assumption that individuals older than 30 were not enrolled.
Marital status	A binary variable = 1 for individuals who were married or living with their partner and 0 otherwise. Note, this variable does not identify whether or not an individual is involved in a sexual relationship with anyone, only that they are either married or living with their partner. The variable is derived directly from the NIDS household roster.
Religious Intensity	Respondents were asked the following question about religion “How important are religious activities in your life? A binary variable was created =1 for the response “important” or “very important” and 0 for “unimportant” or “not important at all”.
Province	There are 9 provinces in South Africa. The base category is KwaZulu-Natal, the province with the highest HIV prevalence in South Africa (Shisana et al., 2014).
Geographical location	Geographical location of current residence was coded into four categories: rural formal, tribal authority area, urban formal and urban informal. Rural formal area refers to predominantly commercial farms, whereas tribal authority area refers to rural areas outside commercial farms with a mixture of traditional and civil authority. Urban formal area refers to areas close to commercial centres with physical infrastructure and formal urban planning, whereas urban informal area refers to informal settlements close to commercial centres with no physical infrastructure or formal urban planning. Urban informal is the base category.

4. Results

4.1. Cross sectional analysis

Here we report estimates of changes in the probability of ever testing for HIV and socioeconomic and demographic factors associated with testing using the wave two (2010/11) and three (2012) cross sectional samples. After discussing the characteristics of the 2010/11 sample (our "baseline" sample), we examine the share of individuals tested for HIV in both waves by gender and race. Additionally, we look at the probability of HIV testing for the black African sample (hereafter referred to as African) at a provincial and district level. Finally, we present the results from the multivariate regression analysis.

4.1a. Sample Characteristics

Sample characteristics in 2010/11, computed using nationally representative weights[6], are reported in Table 2. The sample had an HIV testing coverage of 43.7%. Just over half of the sample was female (53%) and the African sub-population made up roughly 80% of the sample. In terms of socioeconomic characteristics, a large proportion (41.2%) of the sample was living in poverty.[7] The average years of education in the sample was 9.1, with only a third of the sample having achieved matriculation (the South African equivalent of Grade 12). Approximately 15% of the sample was enrolled in some form of education at the time of their interview.[8] The employment rate in the baseline sample was 37.9% and the broad unemployment rate was 27%. This broad unemployment rate may be underestimated given that narrow unemployment rate provided by Statistics South Africa from the Quarterly Labour Force Survey (QLFS) for the time period was approximately 25.2% (StatsSA, 2011a). Close to half of the sample lived in a formal urban area while a third lived in a tribal authority area.[9] As expected, the provincial make up of the sample was fairly similar to that described by Statistics South Africa (2011), with the exception being that our sample had a larger share of the individuals living in Gauteng.

[6] See de Villiers et al. (2013) for a discussion on the NIDS weights. The demographic characteristics of the (weighted) sample closely match those given by Statistics South Africa (2011b), suggesting the validity of the weights.

[7] This is very close to Statistics South Africa's poverty headcount measure of 45.5% for 2011, using a poverty line of R620 (StatsSA, 2014).

[8] As this variable is only defined for individuals younger than 30, this is a lower bound of level of enrollment in our sample.

[9] Rural formal area refers to predominantly commercial farms, whereas tribal authority area refers to rural areas outside commercial farms with a mixture of traditional and civil authority. Urban formal area refers to areas close to commercial centers with physical infrastructure and formal urban planning, whereas urban informal area refers to informal settlements close to commercial centers with no physical infrastructure or formal urban planning.

Table 2: Sample characteristics in 2010/11

HIV Testing	% Tested	43.7%
Gender	Male	46.1%
	Female	53.9%
Race	African	79.5%
	Coloured	8.5%
	Asian/Indian	2.3%
	White	9.7%
Age	Mean	36.6
	Median	34
Per capita household income	Mean	3300
	Median	870
Per capita household expenditure	Mean	2022
	Median	592
Poverty	% Per cpita HH Income <R661	41.2%
Years of Education	Mean	9.1
	Median	10
Enrolment	% Enrolled	15.1%
Employment status	Employed	37.9%
	Unemployed (Broad)	14.1%
	Not Economically Active	48.0%
Subjective health	% "Fair"/"Poor"	9.7%
Mental health	Mean depression Score	3.8
	Median depression Score	3
Marital status	% Married/Cohabiting	36.6%
Alcohol usage	% at least "drink very rarely"	26.4%
Religious importance	% "significant"/"very significant"	90.3%
Geographical location	Rural formal	7.6%
	Tribal authority area	32.2%
	Urban formal	50.1%
	Urban informal	10.1%
Province	Western Cape	9.8%
	Eastern Cape	11.9%
	Northern Cape	2.3%
	Free State	5.7%
	Kwazulu-Natal	19.7%
	North West	6.8%
	Gauteng	25.4%
	Mpumalanga	8.0%
	Limpopo	10.3%
Number of observations		16 683

4.1b. HIV Testing Coverage in 2010/11 and 2012

While Table 1 shows that, in 2010/11, 43.7% (95% CI: 41.48; 45.96) of individuals 15 years and older reported ever having been tested for HIV, by 2012, we find that 65.2% (95% CI: 63.28; 67.10) reported having been tested. Corresponding population estimates indicate that 13,040,577 (95% CI: 11,540,290; 14,540,864) individuals 15 years and older had ever been tested for HIV by 2010 and 20,626,025 (95% CI: 18,397,720; 22,854,329) by 2012, an estimated 7.58 million first time testers. Figure 1 illustrates substantial increases in HIV testing coverage across gender and race. Strikingly, despite the HIV prevalence among the African population being about 5 and 50 fold higher than among the coloured and white populations, respectively (Shisana et al., 2014), HIV testing coverage among Africans in 2010 was significantly lower than among the other groups. These racial differences in testing coverage were nullified among women and substantially improved among men by 2012, although rates were relatively low given that one would expect HIV testing to be much higher in higher-prevalence groups. In 2012 HIV-testing coverage was 72% among African woman, only slightly higher than among coloured and white women. Despite an increase in HCT coverage among African men, more than 40% remained untested in 2012.

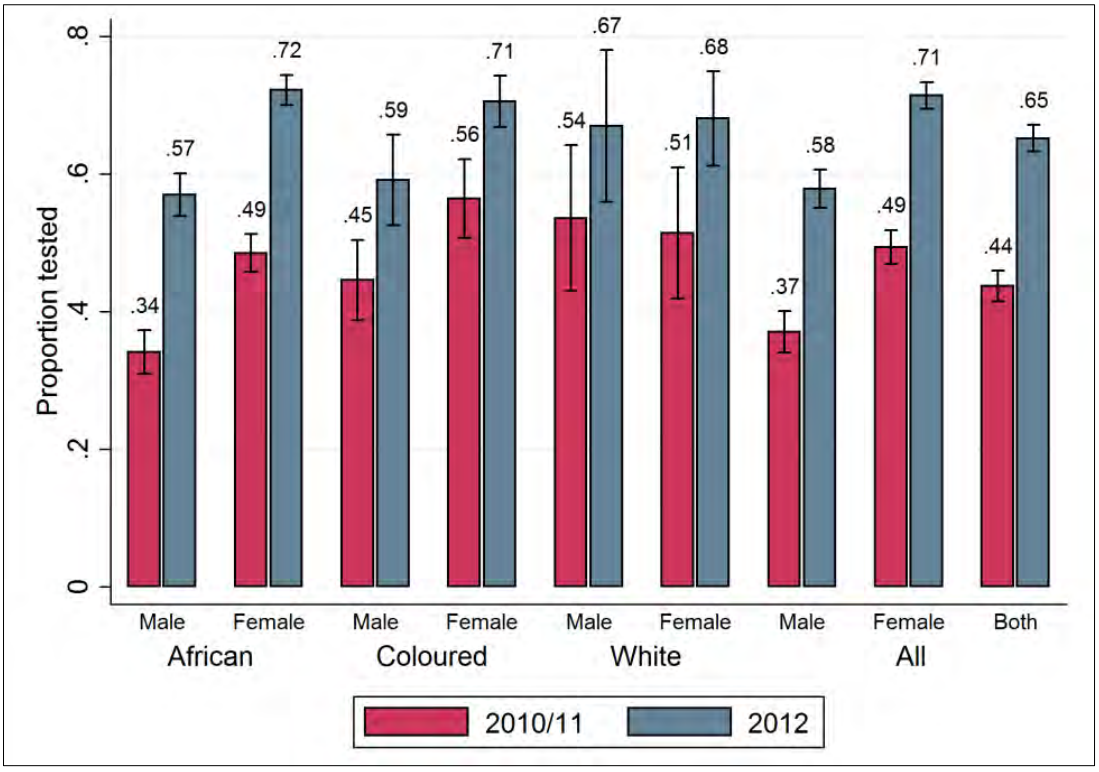

Figure 1: Cross-sectional data from 2010/11 and from 2012 showing the proportion of individuals ever tested for HIV. The data is weighted using the NIDS cross-sectional weights. 95% confidence intervals are displayed.

Figure 2 presents maps of the share of individuals by province, focusing specifically on Africans given they bear the highest burden of HIV risk. Although there has been an improvement in coverage across all provinces, with the exception possibly of young men in Limpopo, there still remains considerable variation in testing rates across provinces even after the national campaign. Moreover, despite significant improvements, the province with the highest burden of disease, KwaZulu-Natal (Shisana et al., 2014), had still not achieved the highest testing coverage by 2012.

Focusing on age and gender variation, the highest testing coverage in 2012 was clearly among 25-54 year old African females, with testing coverage greater than 75% in all provinces. With regards to men, a particular focus of national testing efforts, KwaZulu-Natal continued to have among the lowest test rates through 2012 (along with the Eastern Cape and Limpopo). This is of importance, again, given the high prevalence of HIV in this region. The lowest HIV testing rates were found among 15-24 year old African men with only the Western Cape reaching more than half (57%) of this population and rates the lowest in Limpopo (19%) and KwaZulu-Natal (36%). The coverage of HIV testing was also relatively low among older populations with only the North West and Gauteng reaching more than half of men older than 55 years and only the Western Cape, Northern Cape and Gauteng with the majority of older women tested.

Overall, Figures 1 and 2 show clearly that there has been a nation-wide increase in HIV testing coverage for Africans across gender and age. However, across the age distribution, coverage for men still lags behind that of women. Appendix 1 displays a set of more detailed maps with the unconditional probability of being tested estimated at a district level. The maps focus on 2012 coverage rates and again emphasize the strong geographical variation and differences across gender.

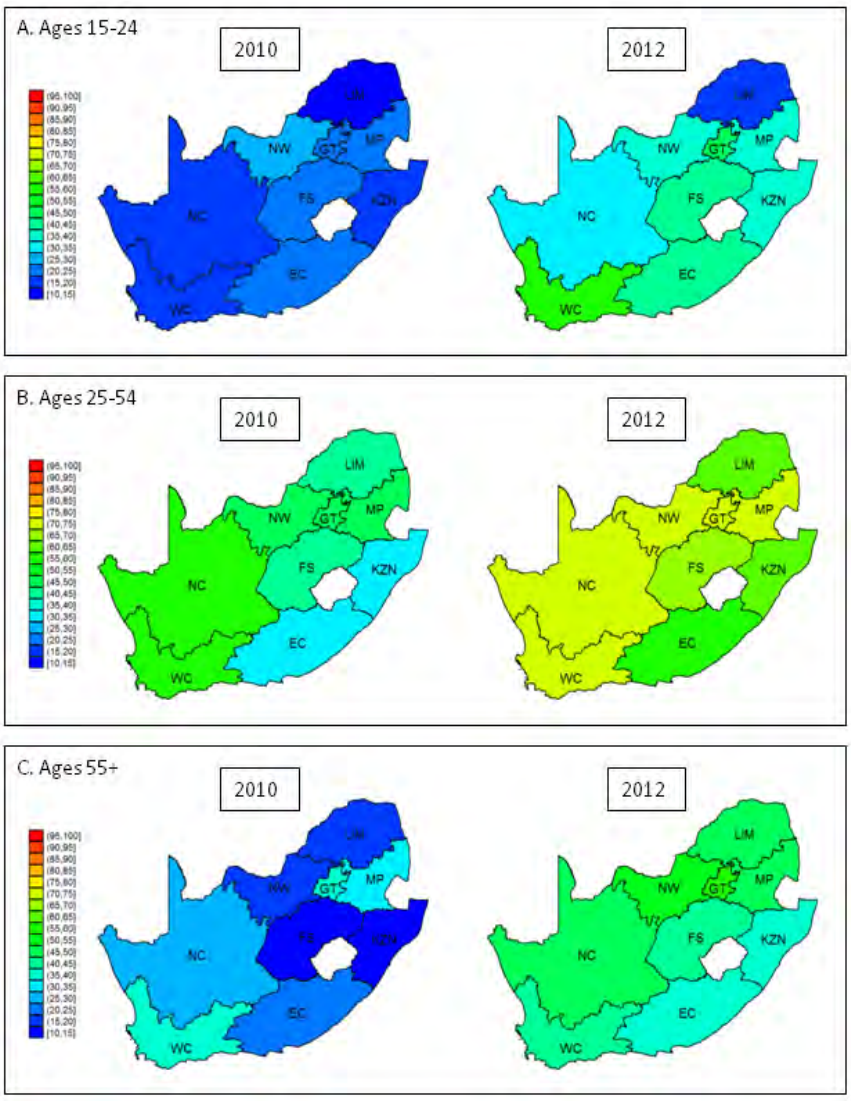

Figure 2: Cross-sectional data from 2010/11 and from 2012 showing the proportion of African males ever tested for HIV in each province. The data is weighted using the NIDS cross-sectional weights. Labels:

WC=Western Cape; NC=Northern Cape; EC=Eastern Cape; FS=Free State; KZN=KwaZulu-Natal; NW=North West; GT=Gauteng; MP=Mpumalanga; and LIM=Limpopo.

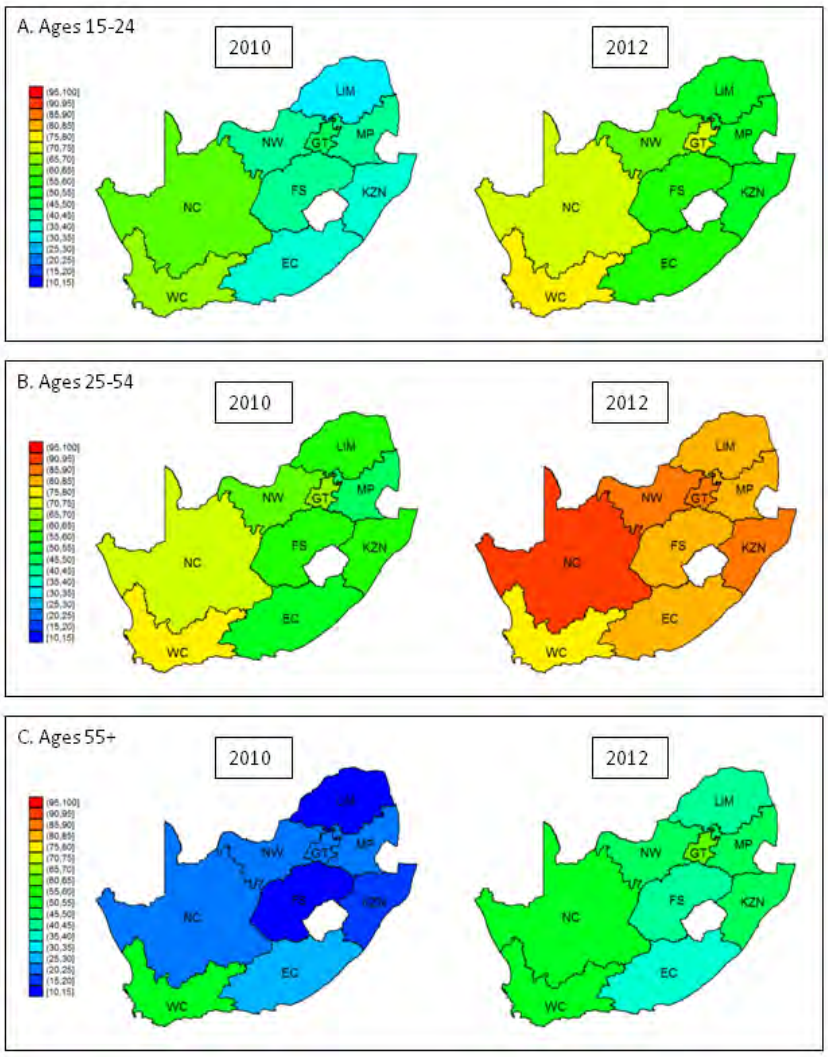

Figure 3: Cross-sectional data from 2010/11 and from 2012 showing the proportion of African females ever tested for HIV in each province. The data is weighted using the NIDS cross-sectional weights. Labels: WC=Western Cape; NC=Northern Cape; EC=Eastern Cape; FS=Free State; KZN=KwaZulu-Natal; NW=North West; GT=Gauteng; MP=Mpumalanga; and LIM=Limpopo.

4.1c. Socioeconomic and demographic correlates of HIV testing

Tables 3 and 4 present estimates from logistic regressions examining the socioeconomic and demographic determinants of having had an HIV test. The tables present the results from the wave two and wave three models in pairs to facilitate a comparison of these results. Table 3 displays the results estimated first for the full sample and then for males and females separately, and Table 4 presents the gender specific estimates for the African sample only.

Models 3.1 and 3.2 in Table 3 clearly verify the aforementioned female gender bias in HIV testing. Conditional on the other covariates, men had 50% lower odds of being tested for HIV than women in both waves. Furthermore, this relative gender bias does not appear to have improved significantly in response to the HIV testing campaign, though as shown above, testing rates improved in absolute

terms for both men and women. While the gender coefficient in 2012 is smaller than in 2010/11, the confidence intervals for the *male* odds ratios in 2010/11 and 2012 overlap. In both years, HIV testing was associated positively with age and those reporting their population group as black African, holding other factors constant, had higher odds of being tested than other groups. It is not clear what underlying factor(s) the population group variable is reflecting.

Of note, we find a significant difference in the association between testing and income across waves. While this relationship was positive and statistically significant in all 2010/11 models – that is, individuals in higher income households were more likely to test - the odds ratios became smaller and statistically insignificant in 2012 for the full sample (Model 3.2) and for women (Model 3.6), for whom the sign of the gradient flipped. The change in the HIV testing-income gradient also declined for men, though the relationship remained positive and statistically significant for men in the 2012 wave. We find similar results when examining measures of asset holdings and expenditure (see Appendix 2).

Two factors might explain the disappearance of the HIV testing-income gradient among women. First, it could be explained by diverging income trends for the tested and untested groups; i.e., if individuals who tested experienced falling incomes, or if those who did not test had rising incomes. Second, this could mean that the first time testers were significantly poorer than those already tested in 2010/11; that is, the national campaign was effective in reaching poor sub-populations. We provide confirmatory evidence with regards to the latter point in Section 4.2.

In contrast with income, the education gradient did not change over this period, if anything steeping over the survey waves for both men and women. Individuals who reported a higher education were more likely to have been tested for HIV, with the odds ratio being larger in 2012. This persistence (if not increase) in the education gradient mirrors recent work demonstrating widening education gradients in HIV risk behaviours in sub-Saharan Africa (Gummerson, 2013). The education finding is of substantive interest given that less educated people are at higher risk of contracting HIV in South Africa (Bärninghausen, 2007). This finding also suggests that the effect of education is not just about rising incomes (and the expectation of higher future incomes), but perhaps about differences in cognitive skill and take up of new information (e.g., Cutler & Lleras-Muney 2010).

Poor self-reported health was associated with a higher likelihood of having ever had an HIV test by 2010/11 but not by 2012, both in the full sample and for men and women. Given the timing of HIV testing is unknown, it is difficult to interpret the direction of causality for this relationship. However, self-reported health is associated with functional status and comorbidities (Meng et al, 2014). Under this assumption, our findings indicate that the population ever tested for HIV by 2010 was, on average, in poorer health than the population that had been tested by 2012. This would suggest that during the period of the campaign, individuals who tested for HIV were *relatively healthier* than those tested prior to the campaign.

In terms of variation by province, little difference was found between KwaZulu-Natal (the reference group) and other provinces. Of note, the large differences in HIV testing between the Western Cape – the highest income and lowest HIV prevalence province – and KwaZulu-Natal – the highest prevalence and among the poorest provinces – in 2010/11 were no longer evident in 2012. In addition, the statistically significant difference between 2012 testing rates among men in Limpopo compared to KwaZulu-Natal (Model 3.4) is consistent with Figure 2, which showed little improvement in testing rates among men in Limpopo compared to improvements in other provinces. Finally, among men (Models 3.3 and 3.4) there was some indication of increased access to HIV testing in urban informal areas relative to other areas during the study period.

Table 4 shows the gender-specific estimates for the African sample. The results are very similar to those reported in Table 3. Of note, the odds of testing was positively associated with income for men, but not women in 2012; and years of education in both time periods. Moreover, once again, the education gradient appears to have increased. Given our limited understanding of the relationship between mental health and the uptake of HIV testing, it is also noteworthy that no association was found between these variables in either 2010 or 2012.

Table 3. Logit: Cross-sectional socioeconomic determinants of HIV testing

	All		Males		Females	
Model	3.1 Odds Ratio [95% CI]	3.2 Odds Ratio [95% CI]	3.3 Odds Ratio [95% CI]	3.4 Odds Ratio [95% CI]	3.5 Odds Ratio [95% CI]	3.6 Odds Ratio [95% CI]
Year	2010/11	2012	2010/11	2012	2010/11	2012
Male	0.501*** [0.435 - 0.578]	0.437*** [0.379 - 0.504]				
Age	1.096*** [1.057 - 1.137]	1.141*** [1.108 - 1.175]	1.136*** [1.080 - 1.194]	1.153*** [1.108 - 1.201]	1.066*** [1.020 - 1.114]	1.109*** [1.070 - 1.149]
Age squared	0.999*** [0.998 - 0.999]	0.998*** [0.998 - 0.999]	0.998*** [0.998 - 0.999]	0.999*** [0.998 - 0.999]	0.999*** [0.998 - 0.999]	0.999*** [0.998 - 0.999]
Coloured	0.754* [0.568 - 1.001]	0.800* [0.617 - 1.038]	0.946 [0.706 - 1.268]	0.865 [0.611 - 1.224]	0.685* [0.462 - 1.016]	0.773 [0.529 - 1.128]
Indian/Asian	0.488** [0.273 - 0.874]	0.408*** [0.260 - 0.642]	0.731 [0.328 - 1.629]	0.413** [0.205 - 0.832]	0.394*** [0.232 - 0.669]	0.468** [0.231 - 0.945]
White	0.609*** [0.429 - 0.865]	0.601*** [0.416 - 0.869]	0.662 [0.379 - 1.157]	0.652 [0.368 - 1.156]	0.597** [0.368 - 0.969]	0.574** [0.361 - 0.914]
Log real pc income	1.212*** [1.115 - 1.317]	1.017 [0.949 - 1.091]	1.333*** [1.188 - 1.495]	1.142*** [1.053 - 1.239]	1.145** [1.018 - 1.288]	0.911 [0.799 - 1.038]
Years of education	1.104*** [1.079 - 1.129]	1.124*** [1.102 - 1.146]	1.091*** [1.053 - 1.129]	1.127*** [1.089 - 1.165]	1.108*** [1.079 - 1.138]	1.117*** [1.090 - 1.144]
Enrolled	0.431*** [0.342 - 0.544]	0.591*** [0.484 - 0.721]	0.594*** [0.401 - 0.878]	1.116 [0.806 - 1.544]	0.304*** [0.229 - 0.404]	0.290*** [0.212 - 0.397]
Unemployed	0.873 [0.721 - 1.057]	0.958 [0.766 - 1.197]	0.666** [0.480 - 0.925]	0.987 [0.738 - 1.320]	1.081 [0.844 - 1.384]	0.891 [0.621 - 1.279]
Not econ. active	0.846 [0.690 - 1.039]	0.708*** [0.598 - 0.839]	0.934 [0.723 - 1.206]	0.670*** [0.496 - 0.906]	0.879 [0.679 - 1.137]	0.698*** [0.556 - 0.878]
Married/cohabitating	1.390*** [1.191 - 1.622]	1.223** [1.013 - 1.477]	1.369*** [1.081 - 1.734]	1.140 [0.877 - 1.481]	1.251** [1.022 - 1.531]	1.129 [0.907 - 1.405]
Religious	1.548*** [1.181 - 2.030]	1.119 [0.885 - 1.417]	1.493*** [1.131 - 1.972]	0.921 [0.697 - 1.216]	1.596** [1.029 - 2.476]	1.557** [1.023 - 2.368]
Poor health	1.495*** [1.193 - 1.874]	1.101 [0.905 - 1.340]	1.531** [1.077 - 2.177]	0.976 [0.693 - 1.373]	1.536*** [1.177 - 2.004]	1.216 [0.956 - 1.547]
CESD 8 scale	1.010 [0.992 - 1.028]	0.998 [0.981 - 1.016]	1.026* [0.999 - 1.054]	0.988 [0.963 - 1.013]	1.004 [0.984 - 1.024]	1.010 [0.987 - 1.033]

Table 3. Logit: Cross-sectional socioeconomic determinants of HIV testing cont.

Drinks alcohol	1.061	1.067	1.030	1.000	1.098	1.311**
	[0.884 - 1.274]	[0.920 - 1.238]	[0.818 - 1.298]	[0.827 - 1.209]	[0.848 - 1.421]	[1.015 - 1.693]
Western Cape	1.587***	0.957	1.250	1.038	1.966***	0.917
	[1.120 - 2.251]	[0.654 - 1.400]	[0.809 - 1.932]	[0.639 - 1.687]	[1.245 - 3.105]	[0.551 - 1.526]
Eastern Cape	0.971	0.975	1.017	1.015	0.980	1.002
	[0.647 - 1.458]	[0.754 - 1.260]	[0.579 - 1.788]	[0.684 - 1.507]	[0.668 - 1.437]	[0.724 - 1.386]
Northern Cape	1.370	1.276	1.330	1.112	1.361	1.501*
	[0.925 - 2.028]	[0.864 - 1.885]	[0.797 - 2.220]	[0.602 - 2.056]	[0.914 - 2.028]	[0.985 - 2.288]
Free State	0.839	0.843	0.834	0.948	0.886	0.778
	[0.602 - 1.168]	[0.625 - 1.137]	[0.542 - 1.285]	[0.627 - 1.434]	[0.608 - 1.292]	[0.531 - 1.140]
North West	1.146	1.239	1.349	1.303	0.982	1.238
	[0.741 - 1.774]	[0.952 - 1.612]	[0.807 - 2.252]	[0.894 - 1.900]	[0.623 - 1.546]	[0.876 - 1.749]
Gauteng	0.998	1.124	1.032	0.991	1.018	1.397*
	[0.759 - 1.312]	[0.814 - 1.551]	[0.712 - 1.494]	[0.671 - 1.464]	[0.725 - 1.428]	[0.946 - 2.064]
Mpumalanga	0.771*	0.909	1.124	0.981	0.599***	0.886
	[0.568 - 1.048]	[0.697 - 1.186]	[0.717 - 1.763]	[0.666 - 1.445]	[0.428 - 0.840]	[0.662 - 1.186]
Limpopo	0.843	0.765*	0.862	0.707**	0.822	0.847
	[0.610 - 1.166]	[0.557 - 1.052]	[0.555 - 1.339]	[0.515 - 0.969]	[0.577 - 1.172]	[0.515 - 1.392]
Rural formal	1.313	0.768	1.537*	0.685*	1.119	0.839
	[0.930 - 1.854]	[0.555 - 1.061]	[0.932 - 2.535]	[0.458 - 1.023]	[0.753 - 1.664]	[0.541 - 1.303]
Tribal authority area	1.002	0.756*	1.180	0.688**	0.855	0.808
	[0.735 - 1.366]	[0.567 - 1.008]	[0.761 - 1.830]	[0.479 - 0.986]	[0.579 - 1.263]	[0.574 - 1.137]
Urban formal	1.215	0.853	1.536**	0.820	0.960	0.847
	[0.940 - 1.569]	[0.637 - 1.142]	[1.034 - 2.283]	[0.573 - 1.172]	[0.692 - 1.331]	[0.584 - 1.230]
Date of interview	0.999	1.001	0.999	1.001	0.999	1.001
	[0.998 - 1.001]	[0.999 - 1.003]	[0.997 - 1.001]	[0.998 - 1.003]	[0.998 - 1.001]	[0.999 - 1.004]
Observations	15,845	18,403	6,553	7,432	9,292	10,971
Pseudo R-squared	0.132	0.143	0.136	0.118	0.136	0.168

Notes:

*** p<0.01, ** p<0.05, * p<0.1

95% confidence interval in parenthesis. Dependent variable =1 for individuals who had been tested prior to their interview.

Table 4. Logit: Socioeconomic covariates of HIV testing for Africans

	4.1	4.2	4.3	4.4
	Odds Ratio	Odds Ratio	Odds Ratio	Odds Ratio
Model	[95% CI]	[95% CI]	[95% CI]	[95% CI]
Gender/Year	Males 2010/11	Males 2012	Females 2010/11	Females 2012
Age	1.139***	1.143***	1.089***	1.097***
	[1.086 - 1.195]	[1.094 - 1.194]	[1.046 - 1.134]	[1.063 - 1.132]
Age squared	0.998***	0.999***	0.999***	0.999***
	[0.998 - 0.999]	[0.998 - 0.999]	[0.998 - 0.999]	[0.998 - 0.999]
Log real pc income	1.319***	1.184***	1.120**	0.896
	[1.174 - 1.482]	[1.084 - 1.293]	[1.023 - 1.225]	[0.767 - 1.046]
Years of education	1.076***	1.123***	1.100***	1.127***
	[1.039 - 1.113]	[1.084 - 1.163]	[1.070 - 1.130]	[1.098 - 1.158]
Enrolled	0.607**	1.072	0.358***	0.258***
	[0.415 - 0.888]	[0.806 - 1.426]	[0.272 - 0.472]	[0.188 - 0.354]
Unemployed	0.718*	0.896	0.983	0.949
	[0.507 - 1.015]	[0.652 - 1.230]	[0.779 - 1.242]	[0.634 - 1.422]
Not economically active	0.913	0.591***	0.806*	0.749***
	[0.706 - 1.181]	[0.434 - 0.806]	[0.640 - 1.013]	[0.601 - 0.933]
Married/cohabitating	1.561***	1.124	1.217*	1.064
	[1.229 - 1.984]	[0.864 - 1.461]	[0.997 - 1.485]	[0.864 - 1.311]
Religious	1.486***	0.997	1.588*	1.279
	[1.108 - 1.994]	[0.743 - 1.339]	[0.975 - 2.587]	[0.927 - 1.764]
Poor health	1.733***	1.001	1.687***	1.093
	[1.235 - 2.432]	[0.695 - 1.440]	[1.284 - 2.216]	[0.851 - 1.403]
Depression scale	1.019	0.989	0.997	1.018
	[0.992 - 1.047]	[0.961 - 1.018]	[0.977 - 1.018]	[0.991 - 1.045]
Drinks alcohol	1.045	0.918	1.126	1.632***
	[0.823 - 1.326]	[0.749 - 1.126]	[0.854 - 1.484]	[1.184 - 2.250]
Western Cape	1.695**	1.425	2.289**	0.899
	[1.075 - 2.673]	[0.773 - 2.628]	[1.024 - 5.117]	[0.447 - 1.810]
Eastern Cape	1.214	1.081	1.203	1.008
	[0.726 - 2.029]	[0.734 - 1.593]	[0.840 - 1.722]	[0.718 - 1.413]
Northern Cape	1.508	1.271	1.593*	1.742**
	[0.923 - 2.463]	[0.825 - 1.960]	[0.982 - 2.585]	[1.049 - 2.895]
Free State	0.869	1.026	0.869	0.745
	[0.553 - 1.365]	[0.692 - 1.520]	[0.584 - 1.293]	[0.494 - 1.124]
North West	1.424	1.266	1.027	1.032
	[0.886 - 2.288]	[0.876 - 1.830]	[0.652 - 1.618]	[0.747 - 1.424]
Gauteng	1.089	1.030	0.979	1.371
	[0.744 - 1.595]	[0.696 - 1.524]	[0.683 - 1.402]	[0.839 - 2.240]
Mpumalanga	1.248	0.986	0.684**	0.846
	[0.795 - 1.959]	[0.665 - 1.463]	[0.488 - 0.959]	[0.634 - 1.128]
Limpopo	0.977	0.704**	0.856	0.790
	[0.628 - 1.520]	[0.510 - 0.971]	[0.593 - 1.237]	[0.473 - 1.318]
Rural formal	1.540	0.649**	1.137	1.097
	[0.899 - 2.638]	[0.425 - 0.991]	[0.742 - 1.741]	[0.681 - 1.768]
Tribal authority area	1.106	0.704*	0.819	0.841
	[0.708 - 1.729]	[0.488 - 1.017]	[0.553 - 1.214]	[0.592 - 1.194]
Urban formal	1.474*	0.780	0.937	0.820
	[0.984 - 2.206]	[0.530 - 1.147]	[0.671 - 1.310]	[0.550 - 1.223]
Date of interview	1.000	1.001	0.999*	1.001
	[0.998 - 1.002]	[0.998 - 1.004]	[0.998 - 1.000]	[0.998 - 1.004]
Observations	5,447	6,094	7,766	9,058
Pseudo R-squared	0.128	0.124	0.144	0.174

Notes:
*** p<0.01, ** p<0.05, * p<0.1
95% confidence interval in parenthesis. Dependent variable =1 for individuals who had been tested prior to their interview.

4.2. Analysis of First-time testers

This section makes use of the balanced panel to examine the baseline socioeconomic characteristics associated with first-time HIV testing between 2010/11 and 2012. We use these findings to help interpret the changes in socioeconomic and demographic factors associated with HIV testing between 2010/11 and 2012, which were reported in the previous section. Since the balanced panel and cross sectional data comprise of different samples, the comparisons we make are only meaningful if the two samples represent populations of similar characteristics. Our attrition analysis (see Appendix 3) found that, with the exception of income, any attrition bias in the covariates was corrected by the use of panel weights. The panel sample had a lower median and mean income to the baseline sample. Importantly, no evidence was found of attrition bias in the dependent (HIV testing) variable.

4.2a. Identification of First-Time Testers

First-time testers are identified as those who answered "no" to having had an HIV test in 2010/11 (wave two), and subsequently answered "yes" in 2012. Although individuals should only switch from "no" to "yes", there were 146 individuals in the balanced panel who reported having been tested in wave two, but then reverted to an untested status in wave three. We made the assumption that these individuals correctly reported their testing-status in wave two. Table 5 presents the changes in HIV testing status for the balanced panel (i.e. individuals interviewed in both 2010/11 and 2012), consisting of 12 034 individuals.

Fifty percent of the untested population of adults aged 15 and older in 2010/11 were tested by 2012. The population totals reported in Table 5 are calculated by weighting up the sample using the NIDS panel weights. The estimates suggest that approximately 7.5 million individuals were tested for the first time between 2010/11 and 2012, representing roughly 28% of the adult sample. Again, because the 2010/11 wave was fielded *during* the rollout of the national testing campaign and the 2012 wave occurred sometime after the end of the campaign, this figure should not be interpreted as the number tested for the first time during the national campaign. Also precluding this interpretation is the fact that we are unable to account for pre-existing trends in testing – it may be the some of these individuals would have tested anyway, even without campaign efforts. Furthermore, HIV testing coverage was 71% in 2012 for the balanced panel sample, which is 6% higher than the figure (65%) derived from the full wave three cross-sectional data (see Section 4.1B).

This discrepancy may be a product of our panel sample being poorer than the cross-sectional sample, as indicated by our attrition analysis. If the campaign reached a greater proportion of poor individuals than before, which our previous analysis suggests, then the panel sample would have been biased in favour of individuals more likely to have an HIV tested. Even if these estimations are slightly inflated due to attrition, the underlying point remains the same: a substantial increase was observed in the number of adults tested for HIV in South Africa for the first time between 2010/11 and 2012.

Table 5. Changes in HIV testing status between 2010/11 and 2012

Wave 2	Wave3	No	Yes	Total
No	Population estimate	7,586,567	7,477,477	15,064,044
	95% CI	[6731892, 8441243]	[6594930, 8360024]	[13492061, 16636028]
	Proportion	50.36	49.64	100
	95% CI	[47.69, 53.03]	[46.97, 52.31]	
	N	3803	3545	7348
Yes/No	Population estimate	7,586,567	18,946,527	26,533,095
	95% CI	[6731892, 8441243]	[16885372, 21007683]	[23841180, 29225009]
	Proportion	28.59	71.41	100
	95% CI	[26.58, 30.61]	[69.39, 73.42]	
	N	3803	8231	12034

Notes: Own calculations using NIDS Waves 2 and 3. Totals and percentages are calculated using panel weights. 95% Confidence Intervals (95% CI) are shown in brackets.

Figure 4 shows the share of first time testers in each province. In all provinces with rates of HIV testing lower than 45% at baseline, close to a third of the population tested for the first time during the study period (range: 29%-31%). While, overall, this represents a vast improvement in testing coverage, roughly a third of the population in four provinces (Eastern Cape, KwaZulu-Natal, North West and Limpopo) still had never had an HIV test.

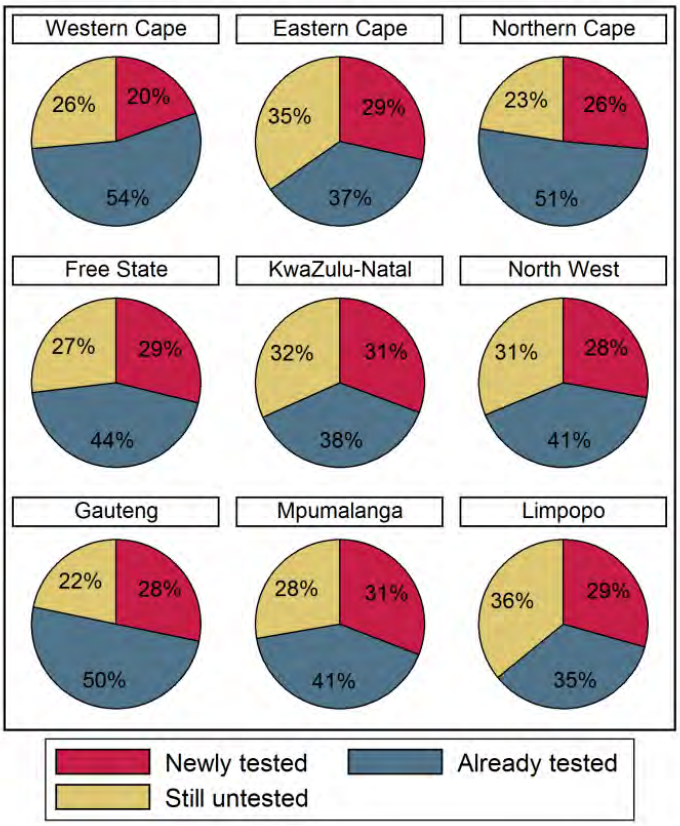

Figure 4: Panel data showing the proportion of "newly tested", "already tested" and "still untested" individuals in 2012 by province of residence. Province of residence is based on data collected in 2010/11. The data is weighted using the NIDS panel weights.

Figure 5 displays, by gender and race, the proportion of the panel sample that were newly tested, had tested prior to 2010/11 interview, and had still not tested by 2012. A dramatic improvement (almost 100% increase) in testing coverage was seen among African men (33% to 63%). Despite this success, however, African men remained the population with the lowest HIV testing coverage in 2012, with over a third still untested. Coloured females had the highest proportion of individuals already tested in 2010/11 (consistent with data presented in Figure 1), but a lower rate of first-time testing than African women. African and Coloured females had the lowest percentage (22% and 23% respectively) still untested in 2012. Slightly higher proportions of men than women were first-time testers in all race groups.

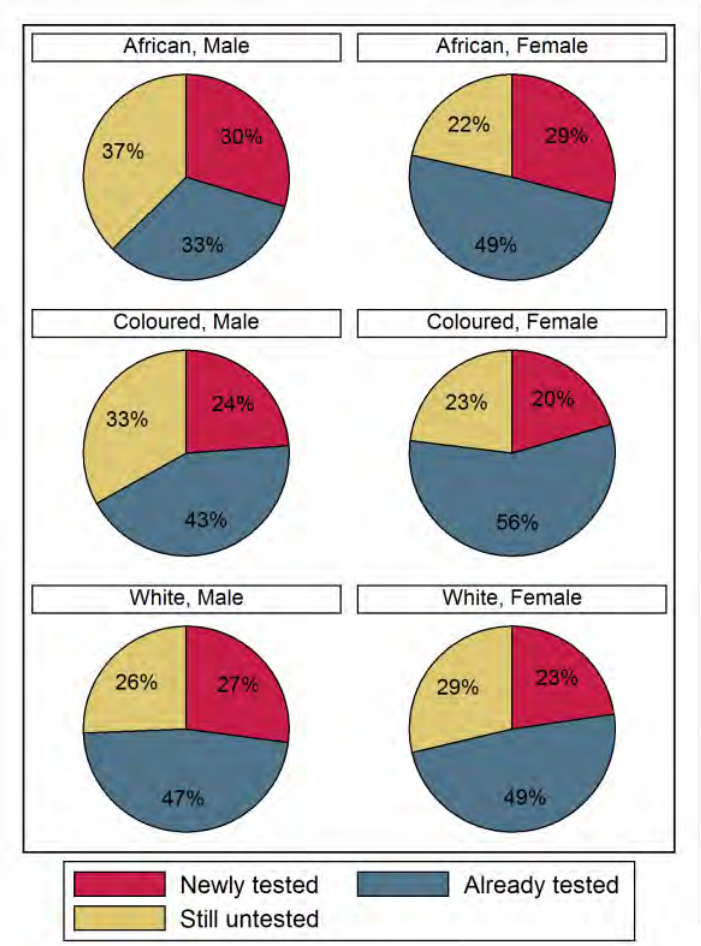

Figure 5: Panel data showing the proportion of "newly tested", "already tested" and "still untested" individuals in 2012 by race and gender. The data is weighted using the NIDS panel weights.

We now turn to an examination of the demographic and socioeconomic factors associated with first time testing. This analysis is conducted with the sample that was untested in 2010/11, and a comparison is made between those who subsequently tested for the first time and those who did not. Table 6 presents the results first for the entire sample (Model 6.1) and then for gender-specific (Models 6.2 and 6.3) and the African gender-specific subsamples (Models 6.4 and 6.5).

Model 6.1 indicates that, in the general sample, men had 50% lower odds of having been tested for HIV for the first time than women between 2010 and 2012, conditional on holding other factors constant. In further analysis restricted to individuals living in poverty (results not shown, but available upon request) we found even larger gender disparities in first time testing (OR: 0.39; $p<0.001$).

We find that across all models the association between income and an individual's probability of testing for the first time was not statistically significant. The strongest relationship between income and first time testing was found in Model 6.5, with the direction of the association suggesting that poorer African females may have been slightly more likely to be first-time testers. Additional regression analysis with our measure of expenditure used instead of the income variable provides a further indication of this relationship. African women living in households with lower levels of baseline expenditure were more likely to have been tested between the surveys (OR: 0.891; p-value: 0.082; results available upon request). Whereas historically there was a strong income gradient, this was not evident in new testers. This finding suggests, in the aggregate, that the testing campaign did not discriminate by income as far as its reach among previously never tested individuals. The campaign may however have selectively reached *poorer* African women.

It is important to note that these findings are consistent with the findings from the cross sectional analysis. Income gradients in the cross-sectional analysis may have disappeared because previously never tested individuals were poorer than the average individual in the population. However, focus on the population of never tested individuals alone, whether or not an individual was tested did not depend on income *within this particular subsample.*

Also, consistent with findings from our cross-sectional analysis, Table 6 shows that the relationship between self-report health at baseline and first time testing was not statistically significant. While Table 3 indicated that in 2010/11 those with poorer health were significantly more likely to have ever been tested, the analysis of first time testers indicated that selection into first time testing was not associated with baseline health status. While not statistically significant, the relationship was actually negative. This pattern among the newly tested would have increased the proportion of relatively healthy individuals ever tested by 2012, which is consistent with our previous findings that showed the health gradient in HIV testing disappearing between the 2010/11 and 2012 surveys. The results also suggest that, for all groups, *new testers were likely to be more educated*. This is consistent with our earlier findings of a steepening of the education-HIV testing gradient between survey waves.

Table 6 Logit: Comparing baseline characteristics of 'newly tested' and 'still untested'

	6.1 Odds Ratio [95% CI]	6.2 Odds Ratio [95% CI]	6.3 Odds Ratio [95% CI]	6.4 Odds Ratio [95% CI]	6.5 Odds Ratio [95% CI]
LABELS	All	Males	Females	African Males	African Females
Male	0.508***				
	[0.428 - 0.602]				
Age	1.059***	1.068***	1.053**	1.072***	1.055***
	[1.026 - 1.093]	[1.025 - 1.113]	[1.008 - 1.101]	[1.026 - 1.121]	[1.015 - 1.096]
Age squared	0.999***	0.999***	0.999***	0.999***	0.999***
	[0.999 - 0.999]	[0.999 - 1.000]	[0.999 - 1.000]	[0.999 - 1.000]	[0.999 - 1.000]
Coloured	0.808	0.855	0.844		
	[0.521 - 1.253]	[0.551 - 1.327]	[0.490 - 1.454]		
Indian/Asian	0.379**	0.378*	0.397*		
	[0.179 - 0.800]	[0.125 - 1.148]	[0.154 - 1.024]		
White	0.625*	0.767	0.598		
	[0.369 - 1.058]	[0.367 - 1.606]	[0.304 - 1.175]		
Log real pc income	1.010	1.058	0.967	1.079	0.908
	[0.925 - 1.103]	[0.930 - 1.205]	[0.860 - 1.088]	[0.943 - 1.234]	[0.805 - 1.025]
Years of education	1.097***	1.130***	1.072***	1.141***	1.099***
	[1.068 - 1.125]	[1.084 - 1.178]	[1.035 - 1.110]	[1.087 - 1.197]	[1.063 - 1.137]
Enrolled	0.712**	0.887	0.471***	0.903	0.502***
	[0.539 - 0.941]	[0.599 - 1.314]	[0.306 - 0.723]	[0.607 - 1.345]	[0.335 - 0.751]
Unemployed	1.026	0.911	1.225	0.993	1.173
	[0.780 - 1.350]	[0.605 - 1.370]	[0.842 - 1.780]	[0.641 - 1.537]	[0.782 - 1.760]
Not economically active	1.091	1.124	1.136	1.256	1.075
	[0.870 - 1.367]	[0.789 - 1.601]	[0.853 - 1.513]	[0.864 - 1.826]	[0.784 - 1.473]
Married/cohabitating	1.325***	1.154	1.280*	1.129	1.207
	[1.074 - 1.635]	[0.830 - 1.602]	[0.963 - 1.701]	[0.800 - 1.593]	[0.887 - 1.643]
Religious	1.044	0.997	1.132	1.034	1.148
	[0.924 - 1.180]	[0.834 - 1.193]	[0.937 - 1.368]	[0.860 - 1.243]	[0.967 - 1.362]
Poor health	0.929	0.940	0.936	0.866	0.797
	[0.701 - 1.231]	[0.559 - 1.580]	[0.659 - 1.328]	[0.538 - 1.396]	[0.568 - 1.117]
Pregnant between waves			2.603***		2.519***
			[2.023 - 3.350]		[1.966 - 3.228]
Depression scale	0.995	0.985	1.011	0.985	1.000
	[0.976 - 1.015]	[0.954 - 1.018]	[0.983 - 1.041]	[0.953 - 1.018]	[0.973 - 1.028]
Drinks alcohol	1.177	1.161	1.106	1.196	1.162
	[0.944 - 1.466]	[0.871 - 1.547]	[0.768 - 1.593]	[0.891 - 1.604]	[0.742 - 1.820]
Western Cape	0.682	0.803	0.603	0.936	0.729
	[0.410 - 1.135]	[0.404 - 1.597]	[0.312 - 1.165]	[0.388 - 2.257]	[0.242 - 2.193]
Eastern Cape	0.750*	0.682	0.969	0.643	0.808
	[0.554 - 1.017]	[0.384 - 1.209]	[0.647 - 1.453]	[0.345 - 1.199]	[0.539 - 1.211]
Northern Cape	1.092	0.887	1.503	0.835	1.432
	[0.720 - 1.657]	[0.462 - 1.703]	[0.849 - 2.659]	[0.486 - 1.435]	[0.727 - 2.821]
Free State	0.813	0.774	0.934	0.746	0.902
	[0.559 - 1.182]	[0.481 - 1.245]	[0.580 - 1.505]	[0.450 - 1.235]	[0.537 - 1.516]
North West	0.798	0.871	0.797	0.700	0.787
	[0.569 - 1.120]	[0.525 - 1.444]	[0.503 - 1.263]	[0.445 - 1.101]	[0.499 - 1.243]
Gauteng	0.957	0.896	1.114	0.943	1.098
	[0.691 - 1.324]	[0.574 - 1.399]	[0.636 - 1.952]	[0.575 - 1.548]	[0.546 - 2.207]
Mpumalanga	0.904	0.901	0.955	0.907	0.843
	[0.688 - 1.189]	[0.550 - 1.474]	[0.646 - 1.411]	[0.545 - 1.509]	[0.588 - 1.208]
Limpopo	0.857	0.643**	1.252	0.589***	1.140
	[0.677 - 1.085]	[0.434 - 0.951]	[0.877 - 1.788]	[0.398 - 0.872]	[0.800 - 1.624]
Rural formal	0.852	0.948	0.693	1.169	0.984
	[0.581 - 1.248]	[0.536 - 1.679]	[0.318 - 1.507]	[0.665 - 2.057]	[0.460 - 2.106]
Tribal authority area	0.762*	0.721	0.742	0.767	0.737
	[0.558 - 1.040]	[0.444 - 1.169]	[0.383 - 1.435]	[0.477 - 1.233]	[0.381 - 1.424]
Urban formal	0.814	0.847	0.757	0.797	0.662
	[0.591 - 1.121]	[0.526 - 1.367]	[0.350 - 1.636]	[0.496 - 1.280]	[0.297 - 1.476]
Days between interview	0.999	0.999	1.000	0.998*	1.000
	[0.998 - 1.000]	[0.997 - 1.001]	[0.999 - 1.002]	[0.996 - 1.000]	[0.998 - 1.001]
Observations	7,016	3,110	3,906	2,708	3,373
Pseudo R-squared	0.0745	0.0585	0.102	0.0651	0.103

Notes:
Dependent variable =0 for individuals untested in 2012. *** p<0.01, ** p<0.05, * p<0.1
95% confidence interval in parenthesis. Dependent variable =1 for individuals who were tested for the first time between waves.

5. Discussion

A recent national HIV testing campaign in South Africa conducted more than one HIV test per every three South Africans during a 20-month period, representing a massive escalation in testing (UNAIDS, 2013; South African National AIDS Council, 2013). In this study, we determined the extent to which this campaign reached previously untested populations, one of the stated aims of the campaign (South African National AIDS Council, 2010). We also established which sub-populations remained untested despite the unprecedented effort towards universal HIV testing, which included mass media campaigns, expansion of testing into communities, and active involvement from the business, entertainment and non-government sectors. These populations represent the harder-to-test individuals that will require targeted HIV testing interventions in order to achieve the preventative benefits associated with universal testing and treatment programs, as well as the full survival benefits of early treatment access.

Using two waves from a nationally representative panel study, we found that the proportion of adults who had never tested for HIV dropped by approximately 40% between 2010 and 2012, as testing coverage increased from 43.7% (95% CI: 41.48; 45.96) to 65.2% (95% CI: 63.28; 67.10). Estimates based on these data indicate that approximately 7.6 million individuals tested for the first time between 2010 and 2012. Among a panel sample who had never been tested by 2010/11, we estimate that approximately 50% went on to test for HIV for the first time between 2010 and 2012, an estimated 7.5 million individuals. Based on government estimates that 20 million people tested for HIV during this period, our estimates suggest that over a third of HIV tests conducted were for people who had never tested before. These findings indicate an astonishing success rate, even when the most conservative figures are considered. There is substantial scope for further intervention, however: by 2012, still 35% of the 15 and older population had never been tested for HIV. This is consistent with findings from other national surveys conducted in 2012 indicating that approximately 42% of men and 29% of women 15 years and older had still never been tested for HIV (Shisana et al., 2014; Johnson et al., 2013). On the other hand, our 2010/11 figure of testing coverage among individuals 15 years and older (43.7%), despite being collected more recently, is lower than the proportion who reported ever having had an HIV test (50%) in a 2008 national survey (Shisana et al., 2009). Further research into the discrepancy between these figures would be informative as population estimates of first time testers are determined by baseline testing coverage.

While, on average, we found significant increases in HIV testing coverage, there was significant variation in the proportion ever tested across regions and age groups. For example, in high HIV prevalence regions of the country roughly 40% of young African women (15-24) still had never had an HIV test. HIV testing among African women remains a priority given an estimated HIV incidence of 4.54% among 20-34 year old women in 2012 (Shisana et al., 2014) and the substantial proportion of undiagnosed 15-24 year old HIV positive women living in South Africa (Huerga, 2014). Proportions of young (15-24) black men ever tested also remained relatively low, lower than 20% in some areas. These findings highlight the importance of micro-level evaluation to identify sub-populations with relatively low HIV testing rates.

Reaping the full prevention and therapeutic benefits of HCT (as an entry to ART) requires that people living with HIV are tested, and tested early. Early in the epidemic, it appeared that two groups were likely to test: people who were less likely to have HIV, and people who had HIV and were already sick. The national HCT campaign led to substantial progress, with higher testing rates among people demographically more likely to be HIV infected (based on 'race' and location of residence). Our findings also suggest that expansion of HIV testing into communities may have lead to greater testing rates among poorer individuals, who may also be at greater risk for HIV infection. HIV prevalence in South Africa in 2012 was significantly higher in urban informal areas than urban formal areas (Shisana et al., 2014). At the same time, the relationship between health status and HIV testing history was attenuated, consistent with HIV-infected individuals seeking care earlier. Encouragingly, this suggests improvements in the access and/or uptake of HIV testing among certain populations.

However, equity of HIV testing access did not improve across all socioeconomic lines. Conditional on income, we found persistent disparities by education group. While access to HIV testing may have expanded into poorer areas, reaching more urban informal residents and poorer African women, it was still the more educated individuals who used these services. As a result, the positive association between education and HIV testing, which has existed across sub-Saharan Africa since the pre-treatment era (Cremin et al., 2012), remains persistent in South Africa. This result is consistent with previous studies that have identified slower take up of health interventions among the less educated (de Walque 2009; Cutler & Lleras-Muney 2010). As more educated individuals in South Africa are more likely to be exposed to HIV education campaigns (Peltzer et al. 2012), our finding may, in part, be attributable to the mass media advertising strategy employed by the HIV testing campaign. Finding effective interventions to improve HCT uptake among less educated individuals will be critical for ensuring that HCT efforts truly target individuals, who in both South Africa and elsewhere are at highest risk of contracting HIV (Bärnighausen et al., 2007) and prevent further socioeconomic disparities in HIV-related morbidity and mortality. It would be worthwhile from a programmatic and research perspective to explore the differential campaign effects among the uneducated and the poor. For example, it may be that educational gradients in stigma or HIV knowledge play a role, as well.

Furthermore, our results indicate that gender disparities in testing uptake that prevailed in the decade prior to 2010 still persist. While testing rates increased between 2010 and 2012 for both men and women, we found that, among those untested in 2010, the odds of men testing for the first time were half those of women. Our data suggests an increasing gender disparity in HIV testing, which is consistent with other research indicating that HCT uptake has increased more substantially in women than men (Johnson et al. 2014).

Our results have two central implications for HIV policies that aim to improve the equity of HCT uptake and thereby increase the potential efficacy of HIV prevention and treatment initiatives. First, a national scale up of HIV testing that includes extensive media campaigning, and expansion of HCT services into communities and places of work, for example, will improve the equity of individuals ever tested for HIV. Policies and HCT service delivery modes that have been shown to help address current inequities in HCT access should be considered in areas with low HCT uptake. These include the use of mobile clinics conducting HCT (van Schaik et al., 2010; Maheswaran et al.) to reach greater numbers of

men and younger individuals, provider initiated HCT (Kennedy et al., 2013), opt-out testing (Creek et al., 2007; Silvestri et al., 2011), and home-based service provision (Helleringer et al., 2009). Opt-out testing strategies in particular may be effective in reaching less educated men. Results from a Tanzanian study show HCT rates of more than 90% among less educated men in the opt-out model, compare to a figure of closer to 60% with the opt-in model (Baisley et al., 2012). Home-based HCT may be an effective strategy for reaching the poorest populations (Helleringer et al., 2009).

The second central policy implication of our results is that even with the expansion of current HCT services and interventions, universal coverage of HCT services may not be possible without novel interventions. These interventions will need to be designed and targeted to reach the harder-to-test populations that include young adults; men, especially poorer and less educated men; and less educated women. Conditional economic incentives are potential tools that have been shown to increase HIV testing uptake (Thornton 2008) and improve other HIV prevention and treatment outcomes (Galarraga et al., 2014; Baird et al., 2012). Apart from the obvious potential for small incentives to appeal to poorer individuals, incentives may also be able to provide 'psychological cover' for men who are deterred from accessing health services due to considerations of being seen taking an HIV test, such as those concerning their masculinity (Siu et al., 2014). For example, a recent lottery HCT campaign, with cell phone prizes worth R200 (approximately $20 in March, 2015), is believed to have increased HIV testing among men in one of the most remote locations in South Africa (Milan, 2013). New school based HCT initiatives may also be an important component of a strategy to reach younger populations and reduce the large proportion of undiagnosed young HIV positive girls (Huerta, 2014). Recent mathematical models indicate that undiagnosed and asymptomatic HIV-positive individuals are significantly less likely to get tested than HIV-negative peers (Johnson et al. 2014). This finding may reflect socioeconomic barriers to testing but could also be explained by a variety of social and psychological barriers. Interventions that address other persistent barriers to HCT will therefore also need to be considered, such as improving self-perceived risk of HIV infection (Musheke et al., 2013; Hoyos et al., 2013) and reducing both stigmatising attitudes (Mall et al. 2013) and fears of being stigmatised (Maughan-Brown and Nyblade, 2014; Hosseinzadeh et al., 2012).

We acknowledge some limitations of our study. First, as discussed above, the first wave of our data was collected *during* the national testing campaign and, second, we cannot be sure if the differences we find across waves was due to the campaign itself or pre-existing trends in testing. The biases from either source cut in opposite directions. Second, social desirability bias may have influenced self-report measures of HIV testing. Findings from recent mathematical modelling of the South African epidemic indicate that there is a substantial over-reporting of past HIV testing (Johnson et al. 2014). Third, results from our cross-sectional data may have been influenced by a changing composition of the sample rather than changes in patterns of HIV testing. Finally, while the data employed provide excellent measures of socioeconomic and demographic characteristics, data on several possible mediators of the relationship between socioeconomic status and HIV testing were not available including HIV knowledge (Peltzer and Matseke, 2014), perceived stigma (Maughan-Brown and Nyblade, 2014), attitudes to and knowledge of HIV testing (Kalichman and Simbayi, 2003), thus limiting our ability to tease out causal pathways.

In conclusion, the provision of HCT services in South Africa has lead to a steady rise in the proportion of individuals ever tested for HIV and recent campaigns have improved equity of HCT uptake. Future initiatives to increase HCT uptake, both within South Africa and in other countries, would gain from lessons learned from the South African effort. Building on these successes, doing more of the same will be important to keep the momentum of HIV testing, but testing and employing new interventions may be required to achieve universal HCT access and uptake.

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Appendix 1: District Level Maps

In the figures below we display a more detailed view of the geographic variation in HIV testing coverage by providing unconditional probabilities of testing at the district level in 2012. The sample is restricted to black Africans. Figure 6 displays a map for the African adult population. Figure 7 displays maps for African men and women separately. We only report the results for districts with a sample size of at least 100 for the total adult population map and at least 50 observations for the male and female maps. The districts without sufficient observations were largely in the Western Cape, Northern Cape and parts of the Eastern Cape. The districts within provinces with a higher HIV prevalence did have sufficient data. The maps highlight the large variation in HIV testing coverage across districts. Within in Kwazulu-Natal there appear to be areas where about 50% of the adult population was still untested in 2012 – for example, Umgungundlovu District (DC22) which Shisana et al. (2014) show to have a very high HIV prevalence. Similarly, most districts in Limpopo province had a coverage rate of about 50%, while districts in North West, Mpumalanga and Free State were within the 60-70% range in 2012. Testing coverage was the highest within Gauteng districts.

Figure 7 gives the district level coverage rates of 2012 by gender. The areas of high and low coverage were consistent across gender in 2012, but almost all districts had a higher female coverage rate. For men, a number of districts in the Northern parts of Limpopo province had a low coverage rate, together with a few districts in KwaZulu-Natal and northern parts of the Eastern Cape. For women, the districts with a lower coverage rate in 2012 were largely found along the Eastern side of the country, in Limpopo, Mpumalanga, KwaZulu-Natal and north-eastern parts of the Eastern Cape.

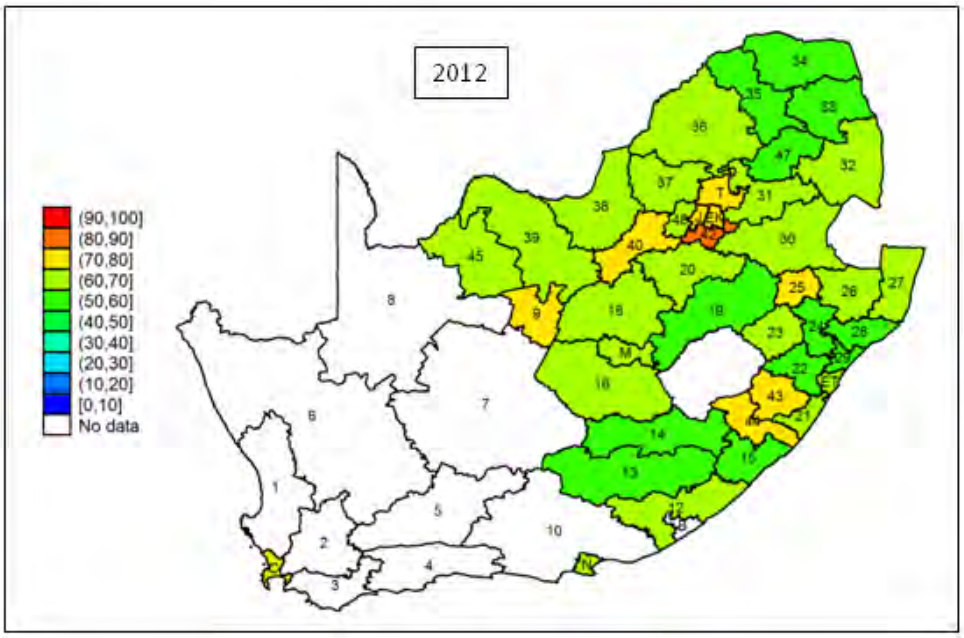

Figure 6: Cross-sectional data from 2012 showing the proportion of African individuals ever tested for HIV in each district. Districts with less than 100 observations are not included. The data is weighted using the NIDS cross-sectional weights. See labels below.

District Labels

DC1	West Coast
DC2	Cape Winelands
DC3	Overberg
DC4	Eden
DC5	Central Karoo
DC6	Namakwa
DC7	Pixley ka Seme
DC8	Siyanda
DC9	Frances Baard
DC10	Cacadu
DC12	Amathole
DC13	Chris Hani
DC14	Joe Gqabi
DC15	O.R.Tambo
DC16	Xhariep
DC18	Lejweleputswa
DC19	Thabo Mofutsanyane
DC20	Fezile Dabi

DC21	Ugu
DC22	UMgungundlovu
DC23	Uthukela
DC24	Umzinyathi
DC25	Amajuba
DC26	Zululand
DC27	Umkhanyakude
DC28	Uthungulu
DC29	iLembe
DC30	Gert Sibande
DC31	Nkangala
DC32	Ehlanzeni
DC33	Mopani
DC34	Vhembe
DC35	Capricorn
DC36	Waterberg
DC37	Bojanala
DC38	Ngaka Modiri Molema

DC39	Dr Ruth Segomotsi Mompati
DC40	Dr Kenneth Kaunda
DC42	Sedibeng
DC43	Sisonke
DC44	Alfred Nzo
DC45	John Taolo Gaetsewe
DC47	Greater Sekhukhune
DC48	West Rand
BUF	Buffalo City
CPT	City of Cape Town
EKU	Ekurhuleni
ETH	eThekwini
JHB	City of Johannesburg
MAN	Mangaung
NMA	Nelson Mandela Bay
TSH	City of Tshwane

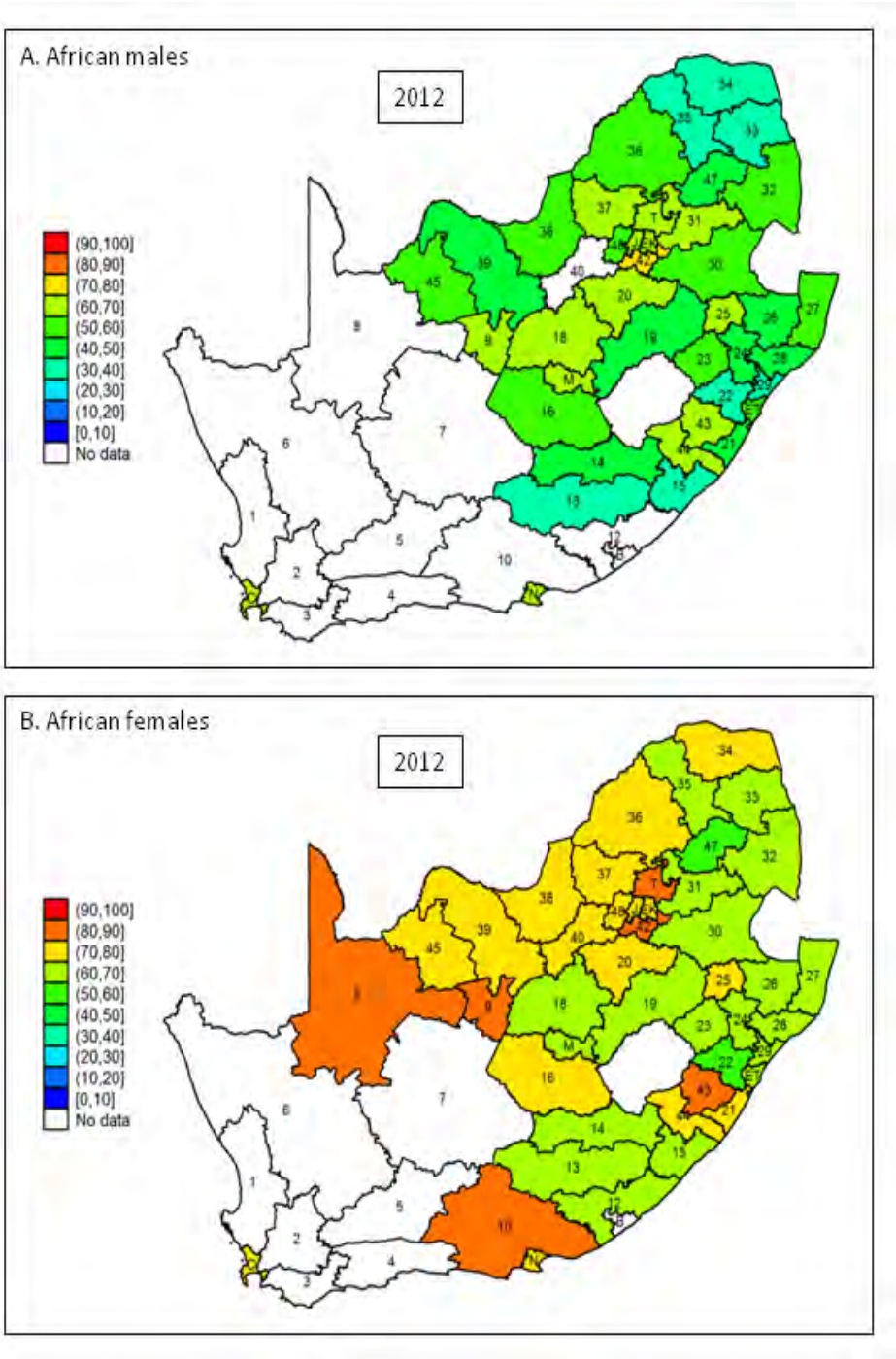

Figure 7: Cross-sectional data from 2012 showing the proportion of African individuals ever tested for HIV in each district. Figure A shows the districts for men and Figure B for women. Districts with less than 50 observations are not included. The data is weighted using the NIDS cross-sectional weights. See labels for Figure 6.

Appendix 2: Wealth

The table below uses four different measures of wealth to show the robustness of our income findings displayed in Tables 3 and 4. Model 7.1 is a repeat of Model 3.1 (Table 3) while the second converts the real per capita income variable into a binary poverty indicator variable where poverty is measured as an individual living off less than R661 a month. The odds-ratio attached with *poverty* is significant and less than 1 in 2010/11. This suggests that poor individuals were less likely to be tested for HIV, fitting with the income finding that a higher income was associated with a higher odds of testing. Columns 3 and 4 make use of the household expenditure variable. The odds ratio attached to per capita household expenditure is significant and of a very similar size to that of income. The expenditure quartiles (Model 7.4) suggest the same thing: being in a higher quartile increased your odds of being tested for HIV.

Table 7. Logit: Cross-sectional socioeconomic determinants of HIV testing, 2010/11

	7.1 Odds Ratio [95% CI]	7.2 Odds Ratio [95% CI]	7.3 Odds Ratio [95% CI]	7.4 Odds Ratio [95% CI]	7.5 Odds Ratio [95% CI]
Male	0.501***	0.511***	0.504***	0.505***	0.509***
	[0.435 - 0.578]	[0.444 - 0.590]	[0.437 - 0.581]	[0.438 - 0.582]	[0.442 - 0.587]
Age	1.096***	1.096***	1.093***	1.094***	1.089***
	[1.057 - 1.137]	[1.056 - 1.138]	[1.053 - 1.134]	[1.053 - 1.136]	[1.051 - 1.129]
Age squared	0.999***	0.999***	0.999***	0.999***	0.999***
	[0.998 - 0.999]	[0.998 - 0.999]	[0.998 - 0.999]	[0.998 - 0.999]	[0.998 - 0.999]
Coloured	0.754*	0.794	0.742**	0.767*	0.807
	[0.568 - 1.001]	[0.599 - 1.053]	[0.558 - 0.987]	[0.577 - 1.019]	[0.607 - 1.073]
Indian/Asian	0.488**	0.571*	0.459**	0.511**	0.555*
	[0.273 - 0.874]	[0.304 - 1.073]	[0.251 - 0.842]	[0.273 - 0.955]	[0.297 - 1.037]
White	0.609***	0.761	0.591***	0.679**	0.690**
	[0.429 - 0.865]	[0.540 - 1.073]	[0.414 - 0.843]	[0.481 - 0.959]	[0.487 - 0.977]
Log real pc income	1.212***				
	[1.115 - 1.317]				
Poverty		0.812***			
		[0.705 - 0.936]			
Log real pc expenditure			1.215***		
			[1.130 - 1.305]		
Expenditure Quart 2				0.936	
				[0.789 - 1.110]	
Expenditure Quart 3				1.237**	
				[1.026 - 1.491]	
Expenditure Quart 4				1.494***	
				[1.190 - 1.875]	
Assets					1.079**
					[1.004 - 1.161]
Other controls	Yes	Yes	Yes	Yes	Yes
Observations	15,845	15,845	15,845	15,845	15,845
Pseudo R-squared	0.132	0.129	0.132	0.131	0.129

Notes:
*** p<0.01, ** p<0.05, * p<0.1
95% confidence interval in parenthesis. Dependent variable =1 for individuals who had been tested prior to their interview.
Other controls: education, school enrolment, employment status, marital status, health-related variables, location of residence and date of interview.

Appendix 3: Attrition

There were 4,649 individuals who answered the adult questionnaire in wave two, but not in wave three. This group of attritors comprise both individuals who were not interviewed in wave three and those who were interviewed in wave three but did not provide a response to the HIV testing question. We examine whether the attritors differed from the balanced panel in terms of socioeconomic characteristics and HIV testing history at baseline. While attrition bias in the socioeconomic covariates can be controlled for through the correct use of panel weights, attrition correlated with differential responses to the HIV testing variable would introduce bias into our findings.

We first assessed the characteristics of the attritors with a multivariate logistic regression using a dependent variable =1 for attritors and =0 for the balanced panel, over the full set of baseline covariates used in Model 3.1. We then compared the sample characteristics of the balanced panel (after adjustment using the NIDS wave-two-wave-three panel weights) to the wave 2 cross-section in order to assess whether the panel weights did correct for the attrition within our sample of interest.

The multivariate logistic regression analysis (Table 8) indicates that attrition was higher amongst males, Whites, richer and younger individuals. Such patterns of attrition are fairly standard within the NIDS dataset (Baigerie and Eyal, 2013). Attrition was not associated with higher levels of education after controlling for income. The enrolled and older individuals were less likely to attrit. Moreover, there was no evidence that HIV testing was in any way correlated with attrition.

Table 8: Logistic regression comparing attritors to balanced panel on baseline characteristics

Male	1.493*** [1.305 - 1.708]
Had HIV test	1.009 [0.866 - 1.176]
Age	0.952*** [0.930 - 0.975]
Age squared	1.000*** [1.000 - 1.001]
Coloured	0.964 [0.692 - 1.341]
Indian/Asian	0.761 [0.432 - 1.339]
White	2.014*** [1.385 - 2.927]
Log real pc income	1.110** [1.011 - 1.219]
Years of education	1.008 [0.984 - 1.033]
Enrolled	0.701*** [0.557 - 0.881]
Unemployed	1.044 [0.842 - 1.295]
Not economically active	1.250** [1.030 - 1.515]
Married/cohabitating	0.987 [0.828 - 1.177]
Religious	0.901* [0.807 - 1.006]
Poor health	1.278**

	[1.019 - 1.601]
CESD 8 scale	0.991
	[0.974 - 1.008]
Drinks alcohol	1.076
	[0.897 - 1.289]
Western Cape	0.744
	[0.499 - 1.110]
Eastern Cape	0.923
	[0.681 - 1.250]
Northern Cape	1.021
	[0.677 - 1.540]
Free State	0.525**
	[0.290 - 0.951]
North West	0.892
	[0.606 - 1.313]
Gauteng	0.692*
	[0.472 - 1.016]
Mpumalanga	1.115
	[0.796 - 1.562]
Limpopo	0.600***
	[0.433 - 0.833]
Rural formal	1.862**
	[1.038 - 3.340]
Tribal authority area	1.269
	[0.748 - 2.153]
Urban formal	1.411
	[0.861 - 2.313]
Observations	15,845
Pseudo R-squared	0.0401

Notes: *** p<0.01, ** p<0.05, * p<0.1

95% confidence interval in parenthesis. Dependent variable =1 for individuals who were in the wave 2 cross section but not in the balanced panel (=0).

Column 1 of Table 9 is a replication of Table 2 while column 2 gives the summary statistics for the balanced panel. Both columns 3 and 4 restrict the sample to those untested in 2010 first for the full cross-section and then for the balanced panel. Our comparison of the sample characteristics of the balanced panel and wave 2 cross-sectional sample (columns 1 and 2) showed that the only significant differences between the samples were a lower median household income and expenditure in the balanced panel sample. This indicates that the panel weights correct for a large share of the attrition bias, with the exception possibly of income (two group test gives a p-value of 0.076). The balanced panel may represent a slightly poorer population, but otherwise the balance panel represents a similar population as the cross-sectional sample. We also found significant (p-value = 0.006) differences between the income of the cross-section and balanced panel among those untested by 2010.

To test for attrition bias in the HIV-testing variable, we compare the attritor and balanced panel distributions of the conditional probability of being tested for HIV in 2010/11. We make use of a Kolmogorov-Smirnov test to compare these two distributions (results available on request). Our test found no evidence of a significant difference between the two distributions, suggesting that the attritors did not have a different conditional probability of being tested for HIV at baseline compared to the balance panel sample members. We therefore conclude that attrition is unlikely to have any significant impact on our results.

Table 9: Sample characteristics at baseline (2010)

		2010 Cross Section	2010 Panel	2010 Untested, Cross Section	2010 Untested, Panel
HIV Testing	% Tested at baseline	43.7%	43.2%		
Gender	Male	46.1%	43.9%	51.5%	50.2%
	Female	53.9%	56.1%	48.5%	49.8%
Race	African	79.5%	82.3%	82.2%	83.9%
	Coloured	8.5%	8.5%	7.4%	7.4%
	Asian/Indian	2.3%	2.3%	2.3%	2.4%
	White	9.7%	7.0%	8.2%	6.4%
Age	Mean	36.6	36.8	37	37
	Median	34	34	33	34
Per Capita HH Income	Mean	3300	2453	1882	1650
	Median	870	794	722	674
Per Capita HH Expenditure	Mean	2022	1741	1574	1403
	Median	592	549	480	461
Poverty	% Per capita HH Income <R661	41.2%	43.4%	47.0%	49.2%
Education	Mean	9.1	8.9	8.3	8.1
	At least Grade 9, no Matric	10	10	9	9
Enrolment	% Enrolled	15.1%	15.1%	21.0%	20.6%
Employment Status	Employed	37.9%	37.6%	29.7%	29.5%
	Unemployed (Broad)	14.1%	14.7%	13.9%	14.1%
	Not Economically Active	48.0%	47.7%	56.5%	56.4%
Subjective Health	% "Fair"/"Poor"	9.7%	9.7%	9.5%	9.7%
Mental Health	Mean CESD8 Score	3.8	3.9	3.8	3.9
	Median CESD8 Score	3	3	3	3
Relationship Status	% Married/Cohabiting	36.6%	36.2%	31.0%	31.3%
Alcohol Usage	% at least "drink very rarely"	26.4%	24.7%	24.2%	23.3%
Religious Importance	% "significant"/"very significant"	90.3%	90.6%	88.3%	88.4%
Geographical Location	Rural Formal	7.6%	7.1%	7.5%	7.2%
	Tribal Authority Area	32.2%	33.4%	38.1%	39.6%
	Urban Formal	50.1%	48.7%	43.8%	42.1%
	Urban Informal	10.1%	10.9%	10.6%	11.1%
Province	Western Cape	9.8%	9.7%	7.8%	7.9%
	Eastern Cape	11.9%	12.5%	13.3%	13.9%
	Northern Cape	2.3%	2.3%	2.1%	2.0%
	Free State	5.7%	6.1%	5.7%	6.0%
	Kwazulu-Natal	19.7%	19.1%	21.6%	20.9%
	North West	6.8%	6.7%	6.6%	6.9%
	Gauteng	25.4%	25.7%	22.5%	22.6%
	Mpumalanga	8.0%	7.6%	8.6%	7.8%
	Limpopo	10.3%	10.5%	12.0%	12.0%
Number of observations		16 683	12 034	10 189	7 348

southern africa labour and development research unit

The Southern Africa Labour and Development Research Unit (SALDRU) conducts research directed at improving the well-being of South Africa's poor. It was established in 1975. Over the next two decades the unit's research played a central role in documenting the human costs of apartheid. Key projects from this period included the Farm Labour Conference (1976), the Economics of Health Care Conference (1978), and the Second Carnegie Enquiry into Poverty and Development in South Africa (1983-86). At the urging of the African National Congress, from 1992-1994 SALDRU and the World Bank coordinated the Project for Statistics on Living Standards and Development (PSLSD). This project provide baseline data for the implementation of post-apartheid socio-economic policies through South Africa's first non-racial national sample survey.

In the post-apartheid period, SALDRU has continued to gather data and conduct research directed at informing and assessing anti-poverty policy. In line with its historical contribution, SALDRU's researchers continue to conduct research detailing changing patterns of well-being in South Africa and assessing the impact of government policy on the poor. Current research work falls into the following research themes: post-apartheid poverty; employment and migration dynamics; family support structures in an era of rapid social change; public works and public infrastructure programmes, financial strategies of the poor; common property resources and the poor. Key survey projects include the Langeberg Integrated Family Survey (1999), the Khayelitsha/Mitchell's Plain Survey (2000), the ongoing Cape Area Panel Study (2001-) and the Financial Diaries Project.

www.saldru.uct.ac.za
Level 3, School of Economics Building, Middle Campus, University of Cape Town
Private Bag, Rondebosch 7701, Cape Town, South Africa
Tel: +27 (0)21 650 5696
Fax: +27 (0) 21 650 5797
Web: www.saldru.uct.ac.za