District-level strategies to control the HIV epidemic in Zimbabwe: a practical example of precision public health.

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Abstract

Objective

We conducted a descriptive cross-sectional study using survey and programme data to assess district-level performance along the HIV care cascade (HIV testing target achievement, linkage to ART, ART coverage) in order to formulate district-specific recommendations, taking into consideration prevalence and yield of testing.

Results

Data from 60 districts were analysed. Most 48 (80.0%) of districts surpassed 90% of their 2018 HIV testing targets. Linkage to ART was less than 90% in 40 (83.3%) of districts. Half (30) of districts had an ART coverage above 90%. Of 30 districts with suboptimal (<90%) ART coverage, 18 had achieved high HIV testing target achievement but suboptimal linkage to ART, 6 had achieved high HIV testing targets and high linkage to ART, 4 had both suboptimal HIV testing target achievement and linkage to ART and 2 had suboptimal HIV testing target achievement and high linkage to ART. Priority should be given to districts with suboptimal ART coverage. Remediation strategies should be tailored to address the poorly performing stage of the cascade in each district.

Introduction

Currently Zimbabwe has about 1.2 million [95% CI; 1.1-1.4 million] people living with HIV (PLHIV) [1]. The number of new HIV infections has decreased by 35.3% from 62 000 [45 000-83 000] to 38 000 [28 000-51 000] between 2010 and 2018. HIV related deaths have decreased by 42.6%, from 54 000 [43 000-68 000] to 22 000 [17 000-27 000] during the same period [1]. From the population impact survey conducted in 2015-16 to assess progress towards the 90-90-90 targets, 74.2% of all PLHIV reported knowing their HIV status, of whom 86.8% were on antiretroviral therapy (ART), of whom 86.5% were virally suppressed [2].

Most countries show national data, without evidence on whether this mirrors the sub-national level. Hence, most national programs, including Zimbabwe, do not provide recommendations adapted to district-level indicators. With dwindling funding, donors call for targeted and cost-effective strategies [3,4]. Advances in information technology provide an opportunity for data-driven health interventions. In our study, we combined mapping data on HIV prevalence [5] with data from the Zimbabwe National...
ART Program 2018. We studied district-level performance along the HIV care cascade (HIV testing target achievement, linkage to ART, ART coverage) and formulated district-level recommendations considering HIV prevalence and HIV testing yield.

Methods
We conducted a descriptive cross-sectional study. District-level HIV prevalence was retrieved from the mapping study [5].

Per district, the number of people tested, the number tested positive and initiated on ART in 2018, and the total number of clients on ART at the end of 2018 were obtained from the Ministry of Health and Child Care (MoHCC) and the District Health Information System 2 (DHIS 2) [6]. Permission was obtained from relevant authorities.

To estimate the 2018 district-level HIV testing achievement, firstly, district-level targets were calculated. These were estimated by apportioning the national target to every district using the estimated number of PLHIV per district [7,8]. Secondly, the testing coverage was calculated by dividing the number of tests done by the district target [9]. The HIV testing yield was calculated by dividing the number of positive tests by the number of tests done per district.

Linkage to ART was estimated by dividing the number of patients started on ART in 2018 by the number of positive tests in the same year (under HIV “Treat All” all those tested positive should be put on ART [10]). ART coverage was estimated by dividing the number of patients reported as active on ART at the end of 2018, divided by the total number of PLHIV in a district.

HIV testing target achievement, linkage to ART, and ART coverage were categorised into low (<70%), medium (70-90%) and high (>90%) and were shown on maps using the geographic information system (GIS).

We also describe district-level performance along the HIV cascade for those districts with suboptimal (<90%) ART coverage. These were grouped as follows: 1) suboptimal HIV testing target achievement / suboptimal linkage to ART, 2) suboptimal HIV testing target achievement / high linkage to ART, 3) high HIV testing target achievement/ suboptimal linkage to ART, and 4) high HIV testing target achievement/ high linkage to ART.
Results

All districts were included in the analysis. HIV prevalence, HIV testing target achievement, linkage to ART and ART coverage are shown in Figure 1.

The highest prevalence was in Bubi District (21.5%) followed by Bulilima (20.8%) and Tsholotsho (20.7%). Most districts 48 (80.0%) surpassed 90% of their 2018 HIV testing target. Only three reported a low (<70%) testing coverage (Insiza 69.2%, Chikomba 62.7%, and Umzingwane 62.5%). The majority of districts 29 (48.3%) had an HIV testing yield between 5-7.5% (Additional file 1).

Linkage to ART was less than 90% in 40 (83.3%) districts.

Half (n=30) of districts had high ART coverage (>90%). ART coverage was suboptimal (<90%) in half (n=30) of districts. ART coverage was low in 6 districts: Gokwe North (39.4%), Gokwe South (44.4%), Umguza (49.7%), Centenary 61.0%, Uzumba-Maramba-Pfungwe (63.0%) and Binga (68.0%).

Figure 1. Maps showing; a) HIV prevalence, b) HIV testing target achievement, c) linkage to ART, d) ART coverage

Table 1 shows district-level performance along the HIV cascade among 30 districts with suboptimal ART coverage (<90%; yellow and red) 1), 4 had both suboptimal HIV testing target achievement and linkage to ART, 18 had high HIV testing target achievement and suboptimal linkage to ART, and 6 had high HIV testing target achievement and high linkage to ART and 2 had suboptimal HIV testing coverage and high linkage to ART.

Table 1: HIV cascade for 30 districts with suboptimal (<90%) ART coverage in 2018, Zimbabwe.

| District     | HIV target testing achievement (%) | Linkage to ART (%) | ART Coverage (%) | Yield (%) | Prevalence (%) |
|--------------|------------------------------------|--------------------|------------------|-----------|---------------|
| Chikomba     | 63                                 | 54                 | 77               | 7         | 13            |
| Mberengwa    | 89                                 | 71                 | 77               | 6         | 17            |
| Chiredzi     | 89                                 | 81                 | 80               | 6         | 13            |
| Bulawayo     | 73                                 | 77                 | 83               | 8         | 16            |

Suboptimal HIV testing target achievement and suboptimal linkage to ART

| District     | HIV target testing achievement (%) | Linkage to ART (%) | ART Coverage (%) | Yield (%) | Prevalence (%) |
|--------------|------------------------------------|--------------------|------------------|-----------|---------------|
| Gokwe North  | 125                                | 63                 | 39               | 4         | 10            |
| Centenary    | 119                                | 55                 | 61               | 6         | 12            |
| Gokwe South  | 129                                | 71                 | 44               | 4         | 12            |

High HIV testing target achievement and suboptimal linkage to ART
| Location      | ART 2017 | ART 2016 | ART 2015 | ART 2014 | ART 2013 |
|--------------|----------|----------|----------|----------|----------|
| Bindura      | 140      | 29       | 75       | 15       | 14       |
| Nyanga       | 123      | 35       | 75       | 7        | 11       |
| Zvishavane   | 117      | 59       | 75       | 8        | 18       |
| Kwekwe       | 115      | 67       | 79       | 8        | 14       |
| Mudzi        | 96       | 43       | 81       | 6        | 12       |
| Makonde      | 189      | 69       | 82       | 6        | 13       |
| Bubi         | 131      | 83       | 70       | 4        | 22       |
| Harare       | 110      | 75       | 78       | 7        | 13       |
| Nkayi        | 179      | 86       | 78       | 3        | 17       |
| Kadoma       | 358      | 72       | 78       | 7        | 13       |
| Mutare       | 206      | 80       | 82       | 4        | 11       |
| Chipinge     | 123      | 81       | 85       | 5        | 11       |
| Mwenezi      | 122      | 76       | 86       | 7        | 15       |
| Masvingo     | 142      | 74       | 88       | 7        | 14       |
| Chimanimani  | 155      | 74       | 88       | 4        | 11       |

**High HIV testing target achievement and high linkage to ART**

| Location      | ART 2017 | ART 2016 | ART 2015 | ART 2014 | ART 2013 |
|--------------|----------|----------|----------|----------|----------|
| Umguza       | 94       | 96       | 50       | 5        | 18       |
| Binga        | 122      | 121      | 68       | 2        | 12       |
| Rushinga     | 137      | 101      | 75       | 2        | 11       |
| Gutu         | 132      | 100      | 77       | 3        | 13       |
| Makoni       | 151      | 90       | 87       | 4        | 12       |
| Kariba       | 184      | 100      | 89       | 5        | 12       |

**Suboptimal HIV testing target achievement and high linkage to ART**

| Location      | ART 2017 | ART 2016 | ART 2015 | ART 2014 | ART 2013 |
|--------------|----------|----------|----------|----------|----------|
| UMP          | 63       | 110      | 63       | 7        | 12       |
| Matobo       | 80       | 105      | 76       | 5        | 19       |

High > 90%, Suboptimal <90%, UMP-Uzumba-Maramba-Pfungwe

**Discussion**

In Zimbabwe, half of the districts had high (>90%) ART coverage, thus achieved the 2nd UNAIDS target[11]. However, there is substantial within-country variation in terms of HIV prevalence, HIV testing coverage, HIV testing yield, linkage to ART, and ART coverage. We proposed four typologies of
districts with gaps along the HIV cascade, for which district-specific recommendations can be formulated.

**Suboptimal HIV testing target achievement and suboptimal linkage to ART**

In 4 districts with suboptimal ART coverage and both suboptimal HIV testing achievement and linkage to ART, both the HIV prevalence and the HIV testing yield was above average. Hence, there is an important unmet need. Therefore, HIV testing services should become more widely available. Widespread door-to-door HIV testing has been shown to increase uptake of HIV testing substantially and should be considered as a priority [12]. In addition, strategies linking those who tested positive to ART should be strengthened (debated in the next paragraph).

**High testing target achievement and suboptimal linkage to ART**

Eighteen districts with insufficient ART coverage that meet their HIV testing target but with suboptimal linkage should assess if strategies known to improve linkage to care and ART initiation are in place. These strategies include same-day ART initiation, community (home-based) ART initiation, decentralization of ART services to the primary health care level, and integration of HIV care in other health care services [13–17]. Linkage to ART should be regularly assessed at the health facility level. Those diagnosed with HIV but not started on ART should be tracked. Consent for tracking should be incorporated into the testing strategy [18]. Patients diagnosed at higher level referral health facilities should be initiated on ART before down referral to lower-level health facilities for follow up, with tracking of arrival after referral [19]. Some districts may have specific challenges. Poor linkage to ART around Kwekwe and the surrounding districts might be explained by the presence of illegal artisanal miners in the region. Illegal artisanal miners are highly mobile, and strategies to link and retain these highly mobile populations should be identified [20,21]. Also, in districts bordering Zambia and Mozambique (Centenary, Mudzi and Nyanga), the poor linkage may be due to patients crossing the border due to the economic challenges in Zimbabwe. The Southern African Development Community (SADC) HIV and AIDS Cross Border Initiative should be fully implemented to enable the provision of care and tracking of such patients [22–24].

**High testing target achievement and high linkage to ART**
Some districts with low ART coverage are meeting their HIV testing targets and have high linkage to ART. Other indicators may assist the identification of a district-specific strategy. If the prevalence and HIV testing yield are lower than average, HIV testing may need to be delivered in a more targeted manner. Health facility-based strategies in combination with community testing in high-risk groups, maybe most efficient. Health facility-based strategies that have worked elsewhere include index case testing, targeting sexual partners and HIV-exposed infants, and intensified provider-initiated testing (iPITC) [25–31]. Community testing should prioritize subgroups with a higher prevalence. Key populations and hot spots identified from a mapping exercise conducted in Zimbabwe may guide programming [32]. Social network testing, using peer educators, can be a useful tool to reach some of the key populations [30].

**Suboptimal HIV testing target achievement and high linkage to ART**

There are two districts with suboptimal ART coverage that have suboptimal HIV testing target achievement but high linkage to ART. In both, the HIV prevalence and testing yield are higher than average. Henceforth, HIV testing strategies recommended for high prevalence settings, discussed above, should be considered.

In conclusion, there is substantial within-country variation in terms of HIV prevalence, HIV testing target achievement, HIV testing yield, linkage to ART, and ART coverage. Hence, “one size fit all” approach will unlikely result in achieving the next UNAIDS 95-95-95 targets by the end of 2030. District-level mapping of uncovered needs and gaps along the HIV cascade of care is needed, particularly for districts with low ART coverage.

**Limitations**

Our study is among the first to unpack performance across the HIV cascade of care at the subnational level. To validate our findings, we compare data from a variety of sources. However, there are limitations due to the cross-sectional design of our study. Crossover of patients between prior or later years with 2018 may have occurred, for instance, when patients diagnosed in 2017 started ART in 2018, and those diagnosed in 2018 started ART in 2019. The district targets were calculated by apportioning the total national target to every district using the estimated number of PLHIV without
considering the performance of each district cascade of care. The MoHCC have since started estimating district yearly HIV testing targets by taking into consideration district-specific parameters.

Moreover, district-level data on the 3rd 90, i.e. viral load suppression, was unavailable. Previous studies showed that the retention on ART was high, but that access to viral load monitoring and viral load suppression remained suboptimal [33-35].

Abbreviations
HIV – Human immunodeficiency virus, ART – antiretroviral therapy, PLHIV – people living with HIV, iPITC – intensified provider-initiated testing and counselling

Declarations

Authors’ contributions
RM led the conceptualization of the paper, data analysis and writing of the original draft paper. ZKC developed the maps. TD, LL, ZKC, VWD, JH and SR reviewed all sections of the manuscript. All authors contributed to interpreting the data and editing of the paper, and all approved the final version.

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Availability of data and materials
Zimbabwe data on HIV prevalence and the number of PLHIV is publicly available at (http://ghdx.healthdata.org/ihme-data/africa-hiv-prevalence-geospatialestimates-2000-2017). The data from the Ministry of Health and Child Care on the number on ART per district by the end of 2018 is not available on the public domain. Anyone interested in using the data for scientific purpose is free to request permission from the Director of the AIDS and TB Program, AIDS and TB Unit, Ministry of Health and Child Care, Government of Zimbabwe, 2nd Floor, Mukwati Building, Harare, Zimbabwe. E-mail: atp.director@ymail.com

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**Competing interests**

The authors have no competing interests.

**Ethics approval and consent to participate**

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**Consent for publication**

Not applicable.

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Additional File

Additional file 1: Yield per district among HIV tests performed in 2018 in Zimbabwe (PNG)

Figures

Figure 1

Maps showing: a) HIV prevalence, b) HIV testing target achievement, c) linkage to ART, d) ART coverage

Supplementary Files

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