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REVIEW ARTICLE

Exploring HIV Testing Models for Differentiated Service Delivery in Southern Africa: A Systematic Review

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A B S T R A C T

Background: Targeting HIV testing services, as the World Health Organization (WHO) recommended in 2015, fast-tracks the identification of individuals with HIV and addresses the persisting HIV testing gap which might delay epidemic control. Following this recommendation, different models of targeted testing have been implemented, exposing varied interpretations by different countries. This study identifies, aggregates, and synthesizes targeted HIV testing models to develop a concise targeted testing package which can increase the identification of people with HIV.

Methods: A systematic literature search in PubMed, Scopus and Web of Science databases identified cross-sectional studies of people (18 years and above) from Southern Africa published between 2016 and 2021. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines were applied, and the quality of studies was evaluated using the Joanna Brigs Institute tool (JBI). Data were extracted using a guided matrix to identify the target population, testing models, description, and positivity ratio. Conclusions and methodological suggestions were narratively synthesized.

Results: The authors identified 574 studies; 42 full-text articles were screened which yielded 29 studies of moderate quality (71%) meeting the eligibility criteria. Of these, 25 studies (86.2%) were quantitative. From the included studies, similar models were synthesized, and 12 targeted testing models emerged. Prioritized models were Index testing, described in 3 (10.3%) of the studies, scoring the highest positivity ratio of >30%. Six studies (20.7%) described male-targeted models with yields influenced by age, economic status, and educational level, with a positivity ratio of 10% among first-time testers. In contrast, four (13.8%) described Key and Vulnerable Populations (KVP) focused models (positivity ratio of 37.5%) and recency-informed targeted testing (13.1% positivity ratio).

Conclusion: This review provides a critical overview and insights into the targeted testing models implemented in Southern Africa. Synthesizing comparable models can meet the various needs of unique populations comprehensively and increase positivity ratio. The recommended models can improve the efficiency of programs in targeting HIV testing services.

Keywords: Targeted HIV Testing, HIV Testing Services, Positivity Ratio, Southern Africa, Systematic Review, Differentiated HIV Testing

Introduction

In 2015, the World Health Organization (WHO) issued their updated guidelines on HIV testing which consolidated the then-existing guidance about the provision of HIV testing services (HTS)

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and addressed issues and elements for effective delivery of HTS common in a variety of settings, contexts and diverse populations globally (1). A key aspect of these guidelines was a prominence on targeted testing, a deliberate shift from testing for coverage. Accordingly, different nations adopted and adapted the guidelines with wide-ranging interpretations and implementation modalities.

The thrust of Targeted testing isprioritizing HIV testing to individuals who are likely to test positive, infomred bytheir risk profile and preferred sexual practices. (2,3). In contrast with testing for coverage, targeted testing focuses on volumes and geographical coverage, without regard for individual risk profiles. In practical implementation, targeted tersting needs to be guided by apparatuses such as risk screening tools, inorder to determine eligibility for an HIV test when individuals present for testing. Targeted testing aims to offer differentiated testing, reduce testing volumes, improve efficiency and increase positivity ratio (4,5). Furthermore, ingenuities such as index contact tracing and testing as well asoffering HIV testing to high-risk groups are innovations currently being promoted in pursuance of targeting HIV testing Services (6).

For Subsaharan Africa, Targeted testing is particular importantance on account of the disproportionate burden of HIV that it bears, even up to date. It is a region where HIV/AIDS caused 336,175 deaths and higher than 20 million Disability Adjusted Life Years (DALYs) in 2017 alone (7,8). Southern Africa remains the epicentre of HIV/AIDS where the global top 10 high-burdened countries are allwithin the Southern Africa Development Community (SADC). Swaziland tops the list with an adult prevalence of 27.2% in 2021 (9), Lesotho is second (25%), Botswana third (21.9%), South Africa fourth(18.9%), Namibia fifth (13.8 %), and Zimbabwe comes sixth with a prevalence of 13.5% (9).

Among similar models of Targeted testing being implemented in Sub-Saharan Africa as a consequence of the WHO guidelines, has been varying perfomances in different settings.Moreover, varied models are also used under the targeted testing mantra, creating fundamental contests for a common understanding of what targeted testing entails in southern Africa. This review was conducted to identify models of targeted HIV testing implemented in Southern Africa, as defined by the Southern Africa Development Community (SADC), highlight key strategies utilized in the models for enhanced positivity ratio, and follow the best guidelines on conducting systematic reviews (10). This study, therefore, provides an overview of the models which are currently implemented; it also aggregates and synthesizes the models to provide a database of models which could be implemented effectively to enhance positivity ratio and accelerate epidemic control.

Materials and Methods

This systematic review was conducted in adherence to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines (11).

Eligibility criteria

The eligibility criteria for studies were articulated based on population, intervention, comparator and outcome (PICO) for the review questions. The authors included original articles published in the English language between January 1st, 2016 and August 31st, 2021. Inclusion criteria consisted of issuing consolidated HTS guidelines, in 2015, which emphasized targeted testing as a shift from testing for coverage (12). Peer-reviewed and cross-sectional studies (qualitative and quantitative) were performed on adult participants (18 and above) and published in peer-reviewed journals which addressed the review questions. Editorial articles, letters to the editors, and conference abstracts were all excepted because of their insufficient information which does not meet the requirementsfor conducting a review.

All studies with pending outcomes and studies that were conducted on participants less than 18 years of age were excluded. Publications made after

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August 31st, 2021 were not included because this was the detrminedcut-off point by the reviewers to obtain adequate studies for the review. The PICOT was therefore: Adults (18 and above), males and females from SADC countries (population), HIV testing (intervention), HIV tested negative (comparator), HIV tested positive (outcome), and January 1st,2016- August 31st, 2021 (time).

Search and study selection

A systematic search was conducted for pertinent articles in the following databases: PubMed, Scopus and Web of Science. Search terms included strings in Medical Subject Headings (MeSH) and free texts with keywords "targeted testing" "HIV Testing" and "HIV testing model". Southern African countries were defined according to the Southern African Development Community (SADC) with a combination of Boolean operators (13).

Studies were filtered to identify articles published between January 1st, 2016 and August 31st 2021 to reduce the number of unrelated articles. Furthermore, the authors conducted a manual search for relevant articles in the references section of articles included in the review to avoid missing any relevant studies.

Two independent authors (HM and MK) then screened all identified articles titles and abstracts. Any reference included by either reviewer at this stage was included for the full-text review. This stage was conducted independently and in duplicate. Disagreements at this stage were reconciled by discussion until a consensus was reached by both authors (HM and MK).

Data extraction and analysis

Mendeley, a research tool designed to collect, organize, and manage research publications, was used to keep a record, and amputate duplicates. All the retrieved studies matching our PICO questions and inclusion criteria were imported to Mendeley. First, the titles of the studies, and then, abstracts were screened; then, they were placed into appropriate subfolders created by Mendeley based on verdicts for inclusion or exclusion. The full texts of all the selected studies were retrieved and assessed for eligibility.

Final data were entered into an Excel spreadsheet (review matrix). The following data were extracted (where available): demographic details and the total number of participants, the type of study, setting, entry points for HIV testing, the models and approaches used, type and roles of health care providers and community actors, and their attributes and contribution to identifying positivity yield considering the set targets.

HM and MK independently extracted and checked the extracted data. Upon disagreements, both reviewers reviewed the final extracted data, and disagreements were resolved through the inclusion of other authors during a discussion on inclusion and exclusion criteria via consensus.

Risk of bias tool: criteria for assessment of quality

The quality of the articles was assessed by a methodological quality assessment tool (Joanna Briggs) for analytical cross-sectional studies (14). This tool was selected for its comprehensiveness and appropriateness for a systematic review of cross-sectional studies; it evaluates eight parameters with four score criteria ranging from "yes", "no", "unclear", and "not applicable". A summary of the quality assessment results obtained from the JBI checklist for all included studies is presented in tabular and graphical form in **Table 1**.

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Table 1. Summary of methodological quality assessment using the Joanna Brigs Institute (JBI) checklist for analytical cross-sectional studies

Parameter	Score			
	Yes	No	Unclear	Not applicable
Were the criteria for inclusion in the sample clearly defined?				
Were the study subjects and the setting described in detail?				
Was the exposure measured validly and reliably?				
Were objectives and standard criteria used for measuring the condition?				
Were confounding factors identified?				
Were strategies to deal with confounding factors stated?				
Were the outcomes measured validly and reliably?				
Was the statistical analysis used appropriately?				

Key

76-100%	51-75%	26-50%	0-25%

Two reviewers, HM and MK, independently assessed the quality of the studies. Disagreements between the authors were resolved by further discussion and consensus. The overall score was 71%, and the best performance was on the first question, defining the criteria clearly for inclusion in the sample which scored 89.7% (26/29); it was followed by measuring outcomes validly and reliably, 82.8% (24/29). The least performed parameter related to the identification of confounding factors was 24.1% (7/29), followed by appropriate strategies to deal with the confounding factors at 17.2% (5/29).

Patient and public involvement statement

The research question for this study was driven by the need to identify, synthesize and develop robust HIV testing models that can attract undiagnosed people living with HIV, suited to their unique needs, to test. Fully applied, the outcome increases positive diagnoses that will stop onward HIV transmission, early treatment and improved prognosis. The results of this study will assist HIV planners to identify and mitigate gaps in the models and methods they are applying in targeting HIV testing. The results have been placed in the public domain through a peer-reviewed publication. Patients were not directly involved in the execution of this study, considering that it is a systematic review whose evidence is based on published studies.

Ethical approval

This study is part of the main study aimed at developing a new model for targeted HIV testing in Zimbabwe. It was approved by the Ministry of Health and Child Care head office, Joint Research Ethics Committee for the University of Zimbabwe, Faculty of Medicine and Health Sciences, Parirenyatwa Group of Hospitals (JREC 280/2021), and Medical Research Council of Zimbabwe (MRCZ/A/2783).

Results

A total of 574 records were identified after conducting a systematic search for articles in PubMed (11 October 2021), Scopus (12 October 2021), Web of Science (13 October 2021) and other sources (15 October 2021). We removed 21 duplicate records, remaining with 553 studies that underwent title and abstract screening. A total of 511 studies did not address the review question and were, therefore, excluded. Full-text screening of the remaining 42 studies yielded 29 studies that met the eligibility criteria and were included in the review. Out of the 13 excluded articles, 6 did not involve SADC countries, 4 were done on

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participants less than 18 years of age and three did not meet the specified study design (Cross-sectional). PRISMA flow diagram for the selection of studies is depicted in **Figure 1.**

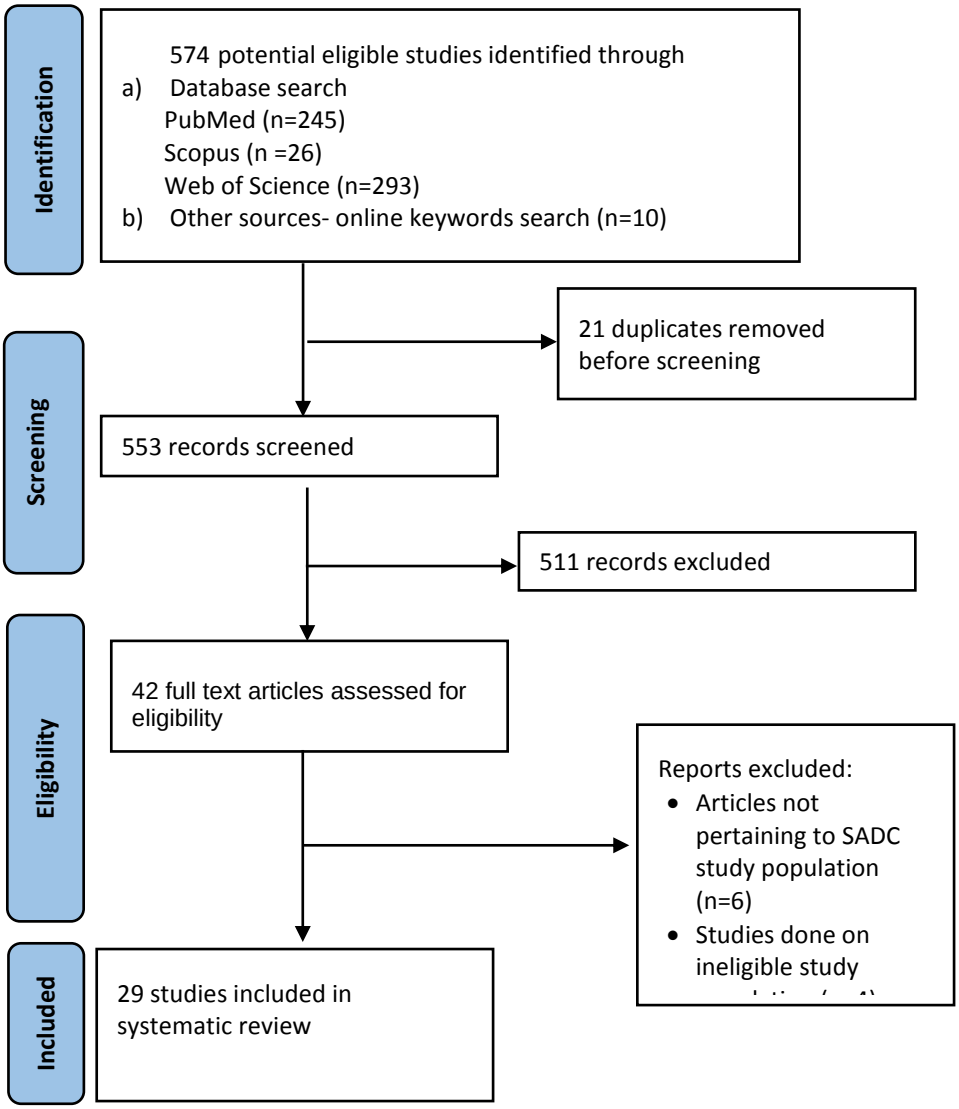


Figure 1. PRISMA flowchart: Exploring HIV Testing Service Models for Enhanced Positivity Yield in Southern Africa, 2022

The final 29 studies were synthesized, 5 of which were from Zimbabwe, (15–19) 2 from Zambia (20), (21), 14 from South Africa (22–35), 5 from Malawi (36–40), and 2 articles were from Mozambique (41,42) one study was multi-national (South Africa, Malawi and Tanzania), (43).

A total of 25 studies (86.2%) used quantitative analysis while the remaining 4 (13.8%) were qualitative. 6 papers (20.7%) described models targeting males for HIV testing, 2 (6.9%) described women-focused models, and 4 (13.8%) described Key and Vulnerable Populations (KVP) models, including Female Sex Workers (FSW) which consisted of outreach, standalone, and moonlight strategies. 5 (17.2%) articles described models targeting couples, including households and partners of pregnant women. These were described as door-to-door and home-based testing and included the distribution of HIVST kits where accepted. 2 (6.9%) of the studies described a model that categorized individuals (predominantly men)

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according to their social/and or economic status to determine the risk for HIV transmission using human-centred design (HCD) to identify approaches that suit each segment; it also divided men according to age categories and testing approaches that would suit each category.

Two (6.9%) papers described "gendered" health institutions (predominantly women) and their role in targeting HIV testing services. 5(17.2%) studies described the value of dedicated HTS sites which may run independently of traditional health facilities to improve access and acceptability for HIV testing. Index testing (Index contact tracing and testing) was mentioned in 3 (10.3%) of the studies using the facility and community approaches. Provider-initiated testing and counselling (PITC) and client-initiated testing and counselling (CITC) were discussed in 7 (24.1%) papers, and for targeting, the screening tools were used to assess eligibility for the testing featured in some of the studies. 1 study (3.4%) concerned the role of recency testing results in targeting HTS; in another study, the use of acute HIV infection (AHI) testing among negative testers, who were index contacts, was stated. The utility of HIVST kits to reach predominantly men is highlighted in the descriptions of the workplace HTS model, mobile testing and tertiary institution initiatives.

Targeting women at family planning clinics was described in 1 study (3.4%), which included HIVST kits for partners; in a different study, emergency department (ED) testing was addressed which targeted stable patients. 1 article (3.4%) described how digitising HIV test results could enhance the performance of targeting process by flagging out high-frequency testing which does not factor in the risk profile (Table 2).

Table 2. Summary of targeted testing models N=29

Study type	Frequency	%
Men-targeted testing	6	20.7
Female-targeted testing	2	6.9
KVP-targeted for HIV testing	4	13.8
Family/ household-based targeted testing	5	17.2
Socio-economic status informed testing	2	6.9
Index testing	3	10.3
Targeted PITC and CITC	7	24.1
Recency-aided targeted testing and counselling	2	6.9
Targeted HIVST distribution	5	17.2
Emergency department targeted testing	1	3.4
Targeted couple testing	5	17.2
Family planning clinic testing	1	3.4

Provider Initiated Testing and Counselling (PITC),
Client-Initiated Testing and Counselling (CITC)
€HIV Self-testing (HIVST)

Description of the targeted testing models

The following are the models of targeted testing observed in the studies:

Index contact tracing and testing (Index Testing)

As the most prominent testing model, this model was featured in 5 studies (36), (19), (21), (27), (16). The model targeted contacts of identified individuals who tested HIV positive (Index) through an elaborate process of elicitation, tracking and testing. It scored the highest positivity ratio of 28.7% (21) and sustained high positivity ratio of >30% in one study(16). The model can be implemented in the facility as well as in the community.

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Recency-aided targeted testing

This model was demonstrated to score a 23.8% positivity ratio (18). In this model, newly identified HIV-positive individuals are offered a recent test to determine if they caught the infection </> 1 year ago. Among the people identified to have a recent infection, contact testing is offered with enhanced certainty of identifying other individuals who tested positive. This model is complemented by testing for AHI among those who tested negative at HTS and STI clinics, whereby AHI contributed 2.3% of new diagnoses compared with 0.3% at HTS and STI clinics (39).

KVP-targeted HIV testing

This model was identified to take the form of outreach and standalone FSW clinics (41), FSW-friendly clinics within public health institutions (42) which include men who have sex with men (MSM) and transgender (TG)-focused testing sites (25). The model identifies the KVP as a high-risk group who are disadvantaged in accessing HTS on account of their sexual orientation, and therefore, need tailor-made services to meet their unique needs; a high positivity ratio of 37.5% was documented in this model.

Men-targeted HIV Testing

This was a prominent model in the studies. One approach profiled men's risk according to age to effectively target men, describing older men as the priority among all age groups (24). The study further describes this age category as engaging in relationships with the greatest age disparity (on average, 8.0 years younger) which is facilitated by their economic advantage which permits them to engage in transactional sexual relations. It further asserts that not much attention has been paid to older men with financial means having much younger female partners, with relationships driven by transaction and power imbalances. Rather, young girls have been the focus of most of the initiatives.

A related study associated men with higher levels of education having more exposure to HIV/AIDS-related information, advantages of HIV testing, as well as the ability to make good decisions compared with their uneducated counterparts (40).

In another study, "gendered" health institutions, whereby scheduled HIV testing is done according to gender (e.g. scheduled testing for pregnant and lactating women), limit access to HIV testing for men. It further highlights the absence of policy guidance for the frequency of men's testing, leading to men's limited engagement with health services (37). The study recommends a deliberate approach to either rid gendered health institutions or target men as a priority population for HIV testing to enhance the documented 10% positivity ratio among men.

Another model promoted door-to-door testing that focuses on increasing men's access and acceptability for testing. Through this model, 66% of men who accessed testing were first-time testers (38). Another model focused on men with an elaborate socio-economic segmentation that put men into 5 categories according to the wealth index and their associated risk behaviours. The model also applies HCD principles to tailor HIV testing strategies for different classes of men (30).

PITC and CITC

This was the most dominant HTS model, addressed in 7 studies (19), (43), (17), (42), (38), (20) (32). The model is described in the context of the service provider initiating HIV testing by offering the service to people who may have been in contact with the health worker for reasons other than an HIV test. The client may also demand the service, hence, CITC. For targeting, risk screening is emphasized which may be aided by the use of screening tools to determine eligibility for an HIV test. It is indicated as a cost-effective, WHO-recommended model that enhances access and acceptability of HTS and can be implemented at the facility as well as the community (38). Another study suggested a model of HIV testing according to cognitive, literacy, and education categorization as a strategy to target PITC and CITC initiatives,

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with a documented positivity ratio of 6.4% (31). In the same study, the emphasis was on ensuring that interventions that lead to accurate HIV risk perception, regular HIV testing, and correct HIV status knowledge in older adults should consider their literacy level of education and cognitive function. PITC and CITC are complemented by digitizing HIV test results to improve efficiency and identify re-testers who may want to test more frequently without regard for the risk profile (32).

Targeted HIV self-testing distribution

Self-screening for HIV was observed to cut across various models of HIV testing as an innovation designed to enhance the acceptability of an HIV test, particularly among subgroups of the population who do not routinely test. It is included in tertiary institutions' testing programs where HIVST addressed a generally low testing frequency, facilitated by the convenience of collecting test kits at a designated spot, and then, testing at the student's convenience (23). It further featured in KP testing initiatives (25), home-based testing programmes (26), distribution to pregnant women, targeting their male partners (27), and more prominently, when used to target men where the blood-based version was found to be the preferred test over the oral HIVST kit; this yielded an overall reactivity ratio of 7% and 10% positivity ratio among first-time testers (35).

Emergency department-targeted testing

In this model, the individuals reporting at the ED, in a stable condition or after being stabilized, are offered an HIV test. a 90% acceptance rate was documented with an overall positivity ratio of 12.5% (29).

Family-based / Household-based Targeted testing

In this model, offering HIV testing to families in their home environment promoted testing, facilitated disclosure among positive testers which include children, and early treatment for them to gain greater and longer benefits from antiretroviral therapy (33). One of the prominent benefits, described in a different study, was family support for the newly identified positive cases when the model is implemented in high-prevalence settings (34). In another study, the door-to-door testing model was suggested as an effective way to reach populations in remote, rural, and high-prevalence areas where access to fixed testing sites was problematic, resulting in an overall positivity ratio of 5%, with 66% of these being first-time testers (38).

Home-based testing, in a project, increased the percentage of HIV-positive individuals who knew their status from 62.9% (95% CI: 59.4% to 66.4%) to 74.2% (95% CI: 70.8% to 77.5%) among men, and from 73.4% (95% CI: 71.5% to 75.4%) to 80.5% (95% CI: 78.6% to 82.4%) among women, demonstrating its effectiveness as a targeted testing strategy (26).

Targeted couple testing

Closely related to home-based testing, this model offers HIV testing to couples within other models such as PITC/CITC (43), door-to-door testing (38), household-based testing (34), and family-based testing (33). The model can be implemented as a standalone, couple-focused initiative for testing, where in an expensive study, the approach was cost-effective and convenient which reduced HIV transmission by 47–79% and prevented an estimated 58% of infections at the US $659 per infection averted (20).

Family planning clinic targeted testing

In this model, women seeking family planning (FP) services were assessed for risk and offered HIV testing services which addressed the HIV risk consistent with the preferred FP choice (27).

Discussion

This systematic review of 29 papers documented 12 models of targeted testing implemented in Southern Africa. The models illustrate how SADC countries have responded to the targeted testing recommendation issued by WHO in 2015, and how these models can be effective in offering HIV testing services to people with the highest need to

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enhance the positivity ratio and and control of the HIV epidemic.

Strengths and limitations

Strengths: The large number of eligible studies obtained through database search facilitated a robust overview of the models utilized in Southern Africa to draw fundamental conclusions on the models for HIV testing. Furthermore, the databases also facilitated in-depth evaluation of the models, their description, and outputs to properly guide what targeted testing has been interpreted within the studied countries.

Limitations: This review was restricted to studies on adults 18 and above. This may have resulted in models that leave out individuals of less than 18. Nevertheless, the findings of this review apply to the adult population.

Interpretation of key findings

This study enumerated imperative insights into HIV-targeted testing models implemented in SADC countries as follows:

First, index testing emerged as one of the most effective models of targeted testing, scoring sustained high positivity ratios of above 30%. This finding was consistent with previous studies which asserted index contact testing as a highly effective model in identifying people with HIV, with a positivity ratio ranging from 35-62% (44–46). The effectiveness of this model can be enhanced if synchronized with recency testing and AHI infection testing (18). All the patients with recent HIV infections can narrow down their contact to sexual contacts within the previous year to improve efficiency in the identification of people with HIV through the diagnosed index case. AHI infection can further be identified among the contacts who tested negative (39).

Second, several models focused on targeting men for HIV testing. They can be combined to develop a model that incorporates age, education, and economic factors in designing profile-informed interventions which appeal more appropriately to the unique needs of different segments of the male population. A deliberate strategy is needed to address the traditional marginalization of men, contributed by "gendered" health institutions and discuss their unmet need for HIV testing as documented in the literature. Men are documented as an underserved community, yet with high positivity rates among the few who get tested, a factor which adds to the justification for increasing focus on them (47–50). This finding is supported by exposure time as men age, their sexually active span increases with a prolonged risk of spreading HIV.

Whereas many initiatives have targeted adolescent girls and young women, not much has been done on the elderly men who might engage in inter-generational relationships (48,51). This leaves a gap in holistically addressing the risk in men. In addition, unlike women, men lack a deliberately designed retesting algorithm, regardless of documented low testing levels associated with high positivity yields.

Third, the use of HIVST as a targeted self-screening test is demonstrated to be effective in improving access and acceptability of HIV testing among both young people and men in tertiary institutions through both primary and secondary distribution of kits. This model was corroborated by other studies in different places (52–55); it has the potential to cover part of the gap in reaching men who have limited access to health facilities and those who may be contacts of index cases identified through other initiatives.

Fourth, PITC and CITIC are traditional HTS delivery approaches for HIV testing in many places, which need risk assessment to be targeted (56–58). Whereas PITC and CITC have improved access to HIV testing services, the model has the risk of increasing testing volumes without corresponding positivity ratio when the person's risk profile is not factored in the eligibility decision for testing. The screening tools, therefore, play a key role in guiding the risk assessment process. These tools need to be evaluated to specify their properties and minimize screening of potential positive testers (59).

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Finally, offering HIV testing services within the FP clinics as demonstrated in the models is well supported in the literature (60,61). Previous studies have reported how women seeking reproductive health services get preoccupied with birth control at the expense of their risk for HIV infection (62,63). This model is therefore scientifically plausible.

Implications for policy and practice

Targeted testing is pivotal in in HTS programming for epidemic control. This review gathered the models utilized to target HIV testing services and formed a database from which HIV testing programs can be deduced based on model descriptions and yields demonstrated in the studies. It demonstrates how SADC nations have interpreted the targeted testing recommendations to form the basis from which other initiatives to strengthen the targeting process can be built.

Conclusion

This review provided a critical synopsis and intuitions into the models for targeted testing implemented in Southern Africa. A variety of the models endeavour to address the unique needs of various populations and their socio-economic class to enhance access to targeted HIV testing services which promote improved positivity ratio by prioritizing individuals who are most likely to obtain HIV-positive results.

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Conflict of interests

The authors declared no conflict of interests.

Authors' contributions

Mugauri HD, Karakadzai M, Chirenda J, Takarinda K, Mugurungi O, and Tshimanga M designed the research; Mugauri HD and Karakadzai M conducted research; Mugauri HD and Takarinda K analyzed data; and Mugauri HD and Mufuta M wrote the paper. Mugauri HD had primary responsibility for the final content. All authors read and approved the final manuscript.

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