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Web Annex L: Symptom and risk-based screening to optimize HIV testing services: a scoping review

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Contents

Symptom and risk-based screening to optimize HIV testing services: a scoping review

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Abstract

Introduction: The cost and challenges of identifying the remaining people with HIV who do not know their status is increasing. Given constraints on programme resources and the desire for higher testing yields, many HIV programmes are using screening tools based on symptoms, testing history, demographics and other risks to inform decisions about who receives HIV testing. To better understand these tools and their potential risks and benefits, we conducted a scoping review synthesizing the contemporary literature and programmatic use of screening tools in HIV Testing Services.

Methods: We searched four electronic databases and seven conferences for literature published between 1 January 2010 and 31 December 2018. Programmatic screening tools and data were also solicited from national programmes, key experts and donors.

Results: Twenty-nine screening tools from peer-reviewed literature and 47 screening tools from national and donor-funded programmes were identified in the search. Twenty-five percent (n=19/76) of all tools were validated, and most validated tools were implemented in countries with low HIV prevalence (63%, n=12/19). In validated tools, the most common screening question for adults was the date of last HIV test. For children, the most common screening questions were related to symptoms, general health and family status, such as orphanhood. Screening for HTS exhibited a dose-response between increasing risk score and HIV positivity, but missed a varying proportion of people with HIV excluded in the risk screening.

Conclusions: Screening tools may offer an effective way to focus HIV testing resources during a time of changing epidemics and declining resources. Benefits may be greater where HIV testing is not routinely offered ('screening in' people for HIV testing), such as in low prevalence settings and amongst subpopulations with low HIV prevalence, such as children and adolescents. High HIV prevalence settings need to be cautious about screening tools as they may be missing a significant proportion of people with undiagnosed HIV.

Introduction

Globally 37.9 million people have HIV – and 8.1 million (21%) are unaware of their HIV status (1). This gap in knowledge of HIV status contributes to morbidity and mortality, and is a missed opportunity to prevent onward transmission by initiating effective antiretroviral therapy (ART). Diagnosing the remaining people with HIV through HIV testing services (HTS) and linking them to ART is a global priority.

National programmes are implementing HTS in an effort to achieve the United Nations' Fast Track Strategy for ending the HIV epidemic – starting with diagnosing 95% of people with HIV by 2030 (2). As programmes scale-up and attain, or come close to meeting, testing and treatment targets, identifying the remaining people with HIV who do not know their status is becoming challenging and costly. HIV positivity (or yield) in HTS programmes is steadily declining in many high burden settings despite increases in testing (3). Additionally, available resources for HIV fell by nearly US$ 1 billion between 2017 and 2018 (1). Optimizing declining or static resources with focused, differentiated HTS approaches is essential (4, 5).

One approach proposed to further focus HTS efforts toward those in greatest need is the use of screening tools to inform decisions about who receives HIV testing. Screening tools to identify individuals who might benefit from pre-exposure prophylaxis have been shown to be accurate in identifying people with greater HIV risk and useful to help support offer of a relatively costly intervention (6-9). Less is known about the use of screening tools for HTS. To date, screening tools for HTS have been applied largely in clinical settings to screen people in or out of testing based on symptoms, testing history, risk behaviours or other demographic characteristics, with varying effects. In some programmes, the use of screening tools suggests increased positivity, but others also highlight potential for missed opportunities to identify a significant proportion of people with undiagnosed infections (10).

Despite varying results and lack of systematic evaluation of many HTS screening tools, programme implementers are considering their routine use in services to increase the efficiency and cost-effectiveness of HTS efforts. Little is known about the potential negative consequences of these tools or their feasibility and acceptability to both providers and clients. To better understand the potential risks and benefits, we conducted a scoping review synthesizing the contemporary literature and programmatic use of HTS screening tools (11, 12).

Methods

Search strategy

We used two strategies to identify HTS screening tools: (i) searching peer-reviewed literature; and (ii) collecting screening tools used programmatically.

To identify screening tools in peer-reviewed literature, we searched four electronic databases (PubMed, Embase, ScienceDirect, Web of Science) for articles published between 1 January 2010 and 31 December 2018. We also searched for scientific abstracts from five major HIV conferences (AIDS, CROI, HIVR4P, IAS, ICASA) for recent studies employing screening tools. The full search strategy and key terms searched is described in Appendix 1.

Programmatic screening tools were also solicited from national HIV programmes, Ministries of Health, key experts, and implementing partners and donors, particularly the U.S. President's Emergency Plan for AIDS Relief (PEPFAR) and World Health Organization (WHO) country offices.

Records from peer-reviewed literature and programmes were assessed for inclusion by a single reviewer. The reviewer assessed eligibility of peer-reviewed literature by screening titles and abstracts to remove records that were not relevant. Then, full-text articles were obtained and reviewed to make a final inclusion decision. There were no

geographic or language restrictions or conditions on study design. Records in languages other than English were translated using Google Translate to identify and extract relevant information.

Inclusion criteria

Records from peer-reviewed literature were included if they described use of a HIV screening tool and reported relevant HIV testing outcomes. Screening tools from programmes were included if they screened clients based on demographic characteristics, symptoms or indicator conditions, behavioural risk factors or HIV testing history.

Outcomes

Relevant outcomes of interest included sensitivity of the HIV screening tool [defined as the proportion of true positives that are correctly identified], specificity of the HIV screening tool [defined as proportion of true negatives that are correctly identified], positive predictive value (PPV), negative predictive value (NPV), and the proportion of individuals screened who tested HIV positive, initiated treatment, or tested negative and linked to prevention services, acceptability of HIV screening amongst healthcare providers and clients and feasibility of implementation. Cost or cost-effectiveness of screening for HTS was also an outcome of interest. Additionally, we were interested in recording validation methods used to assess the dependability and accuracy of screening tools to identify people living with HIV (PLHIV).

Data extraction

Data were extracted from full-text peer-reviewed articles using an Excel extraction tool. From each included record, the following information was extracted and populated in the extraction tool: location, target population, sample size, study design, setting, country HIV prevalence, HTS outcomes, screening tool performance and study limitations. From all records, details and components of the screening tool were extracted, including a description of the screening questions and the number of questions asked. Operational details and processes were also collected, including who conducted the screening, the time allotted to screening or other programmatic factors and cost or cost-effectiveness of using screening tools.

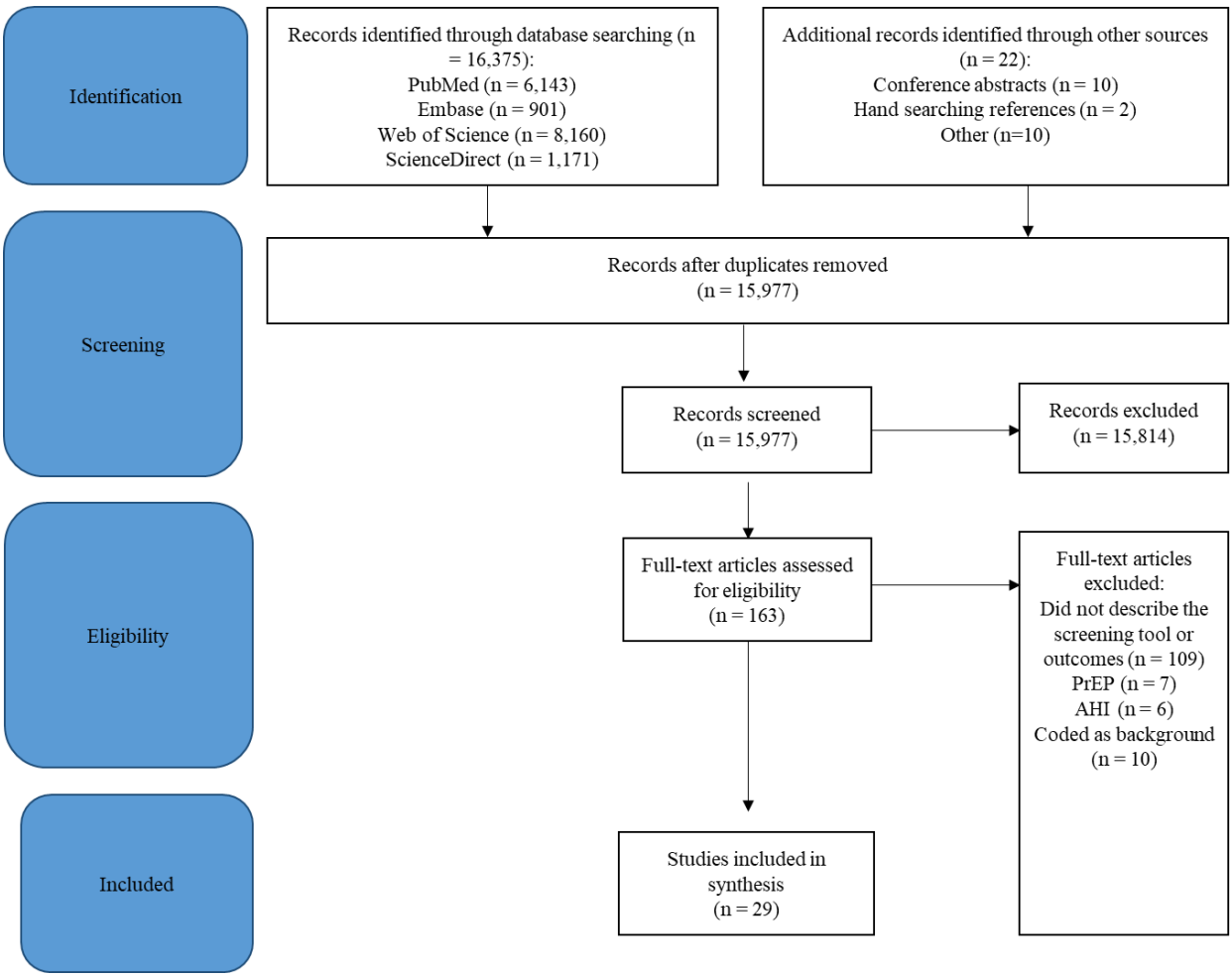
Analysis and reporting

The results were organised by country HIV prevalence (high prevalence ≥5% or low prevalence <5%), which was obtained from 2018 UNAIDS estimates on the AIDSInfo database (13). Results were also analysed by target population [children (0-9), adolescents (10-19), adults (15+), and key populations (men who have sex with men (MSM), sex workers, people who inject drugs (PWID), people in prison and transgender people)]. Screening tool characteristics and outcomes were summarized in tables.

Results

Characteristics of screening tools

Across the literature and programme tool search, 76 screening tools were identified in total. In the peer-reviewed literature search, 16,397 records were identified and screened. After title, abstract and full-text screening, 29 met the inclusion criteria (Figure 1) (10, 14-41). One record was published in Spanish (14) and another in Chinese (41). Forty-seven programmatic screening tools from 16 countries were identified in addition to the literature review. All included records are summarised in Appendix 2 (tools from peer-reviewed literature) and Appendix 3 (programme tools).



Abbreviations: PrEP: Pre-exposure prophlyaxis; AHI: Acute HIV infection
Figure 1. Diagram of studies included from peer-reviewed literature search

Half of the included records from peer-reviewed literature were published in 2018 and all of the programme tools were currently in use in HTS programmes at the time of data collection.

In the peer-reviewed literature, most studies had cross-sectional observational designs and none were RCTs. Fifteen (52%) were specifically designed to validate a HIV screening tool (10, 15, 16, 22, 24, 26-35).

Included records were from all WHO regions except Eastern Mediterranean. Thirteen studies from peer-reviewed literature and 44 programme tools were conducted in sub-Saharan Africa (10, 15, 17-19, 21, 22, 24-27, 35). Four studies and three programme tools were implemented in Europe (14, 20, 37, 38). An additional eight studies were conducted in the Americas (28-34, 36), and two each in the Western Pacific (16, 40) and Southeast Asia (23, 41) regions (Figure 2). The majority of studies from peer-reviewed literature (66%, n=19/29) were conducted in low HIV prevalence countries (14, 16, 18, 20, 21, 23, 28-34, 36-41) and most programme tools were conducted in high HIV prevalence countries.

The majority of screening tools were implemented in health facility settings (80%, n=61/76) followed by community-based settings (16%, n=12/76), both (1%, n=1/76) or unspecified settings (3%, n=2/76). Within facilities, screening tools were used in emergency departments (ED) (20, 29, 31, 32, 38), STI clinics (28, 29, 33), primary care (14, 35, 37, 38), outpatient departments (n=3) (16, 29, 39), and other inpatient settings (10, 16, 29, 39, 41). Within community settings, they were used in correctional facilities (29, 36), surveys (15), community-based organizations (29), and home or mobile

testing sites. Screening tools were primarily implemented by a trained lay provider or health worker, with only two records reporting on use of a client self-administered tool (20, 38).

Thirty screening tools were used to screen children or adolescents (39%, 30/76), another 33 were for adults (43%, n=33/76) and nine were used for all ages (12%, n=9/76). Four tools were implemented specifically for key populations (5%, n=4/76), though many other tools for adults included questions related to key population behaviours.

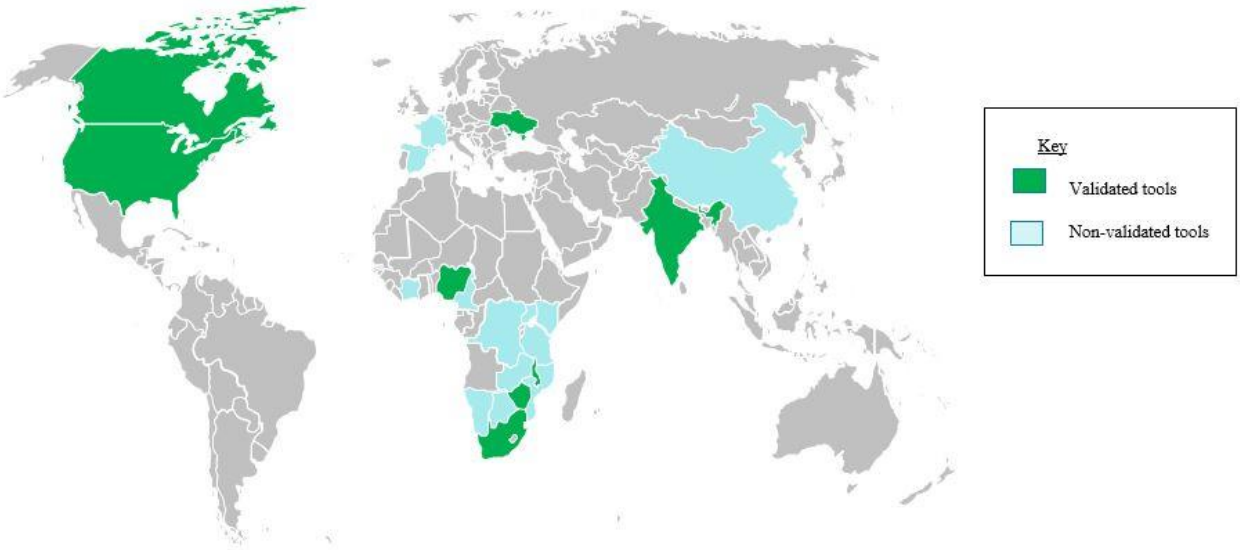


Figure 2. Countries with validated and non-validated HIV screening tools identified in the literature search and program screening tool collection

Development and validation of screening tools

Twenty-five percent (n=19/76) of all tools were validated (Figure 2). Most validated tools were implemented in low HIV prevalence countries (63%, n=12/19) and were identified from the peer-reviewed literature (79%, n=15/19). HTS screening tools in the published literature were validated by either internal validation, in which the authors randomly divide the dataset into a derivation and validation sample to develop and test the tool, or comprehensive internal and external validation, in which authors also tested the tool on an external sample. Tool performance was assessed by calculating the area under the receiver operating characteristic curve (AUC), sensitivity, specificity, PPV and NPV. In programmes, validation was done by retrospectively analyzing screening and testing records and calculating tool performance with sensitivity, specificity, PPV and NPV.

Screening questions to identify PLHIV

Overall, the number of questions asked on a screening tool ranged from 1 to 23, with a median of 9 questions for key populations, 8 questions for children or adolescents and 7 questions for general population adults.

Testing history or date of last HIV test was the most frequent screening question asked across validated tools for general population adults (n=11) (Appendix 4). Behavioural risk questions, such as history of injecting drugs, anal intercourse and condom usage, were more common than questions about STIs or indicator conditions associated with HIV infection, especially for validated questionnaires among key populations (n=3). Questions on demographic characteristic (gender, race/ethnicity, age) were also used. Non-validated screening tools also asked about HIV testing history, symptoms of STIs, TB or other HIV indicator conditions, and risk behaviors associated with HIV infection.

In validated paediatric screening tools (n=5), symptoms of HIV indicator conditions were most frequent. In general, the four characteristics from a tool developed in Zimbabwe (15, 27) were most common for identifying children for HIV testing: orphanhood, reoccurring skin problems, previous hospitalization and general poor health status. Some non-validated screening tools for children (n=7/30) addressed the child's economic or educational situation. Although infrequent in paediatric screening tools (n=8/30), and not occurring in any of the validated tools, some screening questionnaires for children and adolescents asked about risk behaviors, such as engagement in sexual activity or experience of sexual abuse.

Some studies validated and compared individual screening questions for their predictive ability. In Malawi, the screening tool from Zimbabwe was adapted for use amongst 1-15 year olds and evaluated (10). During validation, the study found that being of small stature and having at least one deceased parent had significant associations for identifying children living with HIV. A paediatric screening tool used in India, a low HIV prevalence setting, found that parental factors [having a chronically ill parent, prolonged separation of parents, a parent who is a member of a key population group, or one or both parents deceased] are effective for identifying children for HTS (16). In adult women in high prevalence settings, age <25, being unmarried or not living with a primary partner, and having a curable STI at baseline were the strongest predictors of HIV acquisition on the screening tool (26). In Malawi, the most sensitive (71%) and specific (44%) question on an adult facility-based screening tool was whether the patient received any health services in past month. In Zambia, the He2ro analysis showed that using an algorithm based on the date of last HIV test had a higher HIV positive yield (12%) compared to targeted testing based on other factors (10.4%). Individual questions were also assessed on an adult screening tool in a low prevalence setting in Nigeria, finding the most sensitive question (76%) was whether the client had unprotected sex with a regular partner in the last three months. In a tool from Ukraine, the questions which significantly predicted HIV were having more than one sexual partner, injecting drugs, having sex with a PWID, having anal sex, having a HIV-positive sexual partner and ever being in prison.

Time required for screening

Only one study in Spain reported on the time required for administering screening tools (38). This study reported it took individuals three minutes on average to complete a series of 21 self-administered questions on an electronic tablet. No provider-administered tools were assessed for length of time to implement.

Cost-effectiveness of HTS screening implementation

Three included studies assessed cost-effectiveness of screening for HTS. In a study in France, the incremental cost-effectiveness ratio of the targeted screening compared to non-targeted was EUR 1324 (estimated USD 1476) per new HIV diagnosis. In Spain, the cost of universal HIV testing (USD 4176 per person diagnosed) was higher compared to using a screening tool based on risk behaviours (USD 894) or HIV indicator conditions (USD 542) (37). In India, it was also found that screening-in all TB patients for HIV testing would be cost-effective, increasing life expectancy by 16.91 years with an ICER of USD 730 per year of life saved, compared to selectively screening-in for HTS based on regional HIV prevalence (40).

Screening tool performance outcomes

Sensitivity and/or specificity of screening tools were reported in a subset of the included records (n=17) (Fig. 3.). Sensitivity among children and adolescents (n=5) ranged from 56-100% and specificity ranged from 40-81%. Tools for adults (n=9) performed between 75-100% sensitivity and 25-61% specificity. For tools reporting performance among key populations (n=3), sensitivity ranged from 83-86% and specificity from 43-45%.

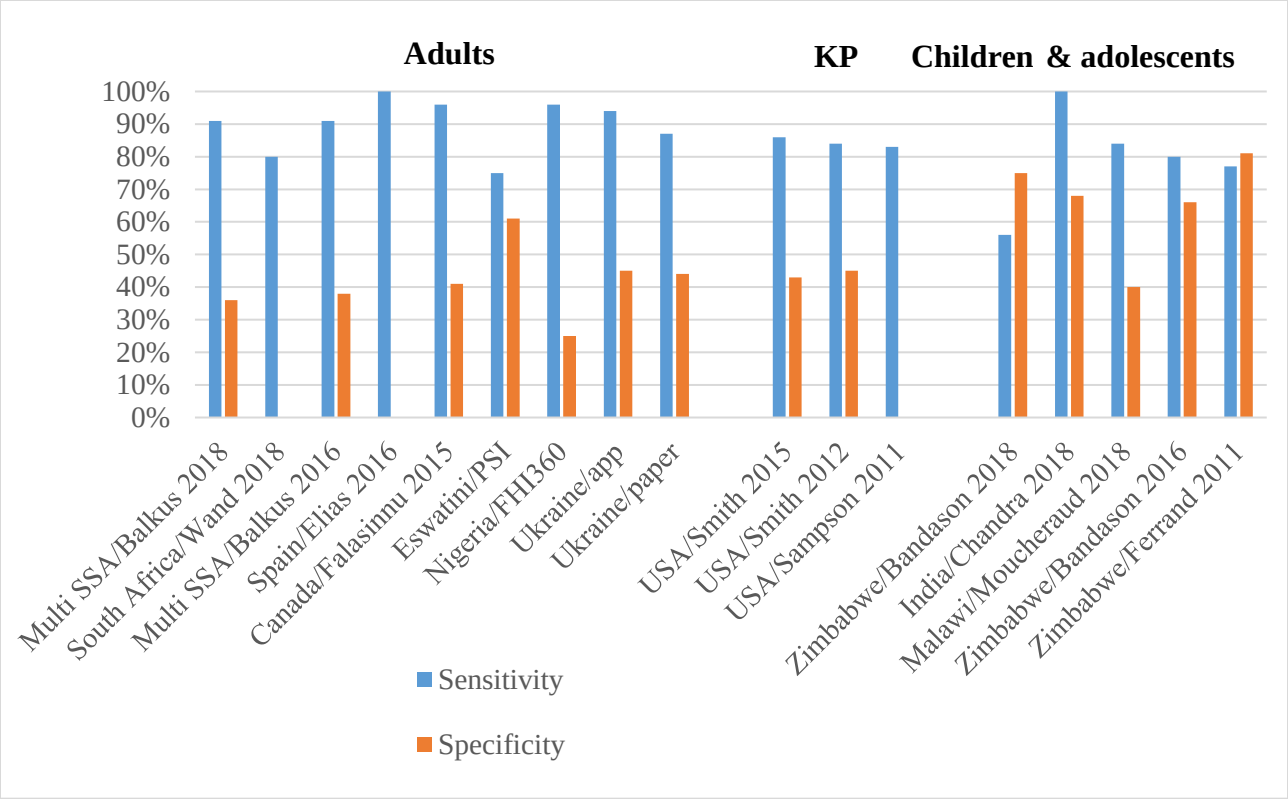


Figure 3. HTS screening tool performance from studies and programmes, by age and key populations

Children and adolescents

Ten studies assessed the performance of screening tools among infants and children (age <10) (n=8) (10, 15-19, 21, 27) and adolescents (age 10-19) (n=2) (25, 35), of which seven were conducted in high HIV prevalence countries.

High HIV prevalence

In high prevalence settings, paediatric screening tools decreased testing and improved yield among children and adolescents living with HIV (10, 15, 17)(27, 35). Tools used to screen children in high prevalence settings also had good predictive ability. Bandason et al. developed a four-question screening tool which improved identification of children and adolescents with undiagnosed HIV and demonstrated a dose-response relationship between a child's number of HIV risk factors and HIV positivity. The Bandason screening for older children (6-15 years old) in Zimbabwe demonstrated 10.4% PPV and 98.4% NPV, one of the highest tool performance outcomes found in this scoping review (27). The tool was subsequently adapted in Zambia, Malawi, Uganda and Nigeria (10, 18, 19, 21, 25). The screenings regularly demonstrated high performance, including a 2018 validated tool implemented in a community setting (15) which reported high NPV [99.2% (95% CI: 98.9-99.5)] and reduced testing by 55%. In Malawi, when a child had one risk factor, the screening tool demonstrated a PPV of 1.5% and a NPV of 99.6% (10). In Uganda, community-based screening of orphans and vulnerable children (0-17 years old) found that HIV positivity was more likely as scores increased; 13.8% of children with four risk factors tested HIV-positive, 25.4% with five risk factors and 39% with six (19). Screening tools also showed evidence of improved HTS uptake among adolescents in Zambia (69.5% determined "at risk" by the screening tool took up testing vs. 49.1% determined "not at risk").

At times, somewhat lower predictive ability of screenings was noted in high prevalence settings. In Zimbabwe, a screening tool for adolescents (10-18 years old) correctly classified the HIV status of only 79% of 255 participants (35). A Bandason tool implemented in Zambia found that 0.6% of those not indicated to test were true HIV-positive, showing that even a predictive screening tool can miss opportunities to diagnose HIV (25).

Low HIV prevalence

Two studies adapted the paediatric Bandason tool to a low HIV prevalence, facility-based setting in Nigeria (18, 21). These resulted in higher coverage of HTS among children and adolescents (27%) and increased diagnoses (36%) (21). As in high prevalence settings, there was a dose-response relationship between increased risk scores and HIV positivity. HIV positivity grew significantly from 1.3% among those scoring one on the screening tool to 25% among those scoring four ($p<0.001$) (18).

An additional study in a paediatric facility in India found PPV increased from 2% to 5.86% when testing was offered for children who had either two clinical signs of HIV and at least one parental factor or three clinical signs of HIV. In this validated screening, no children with undiagnosed HIV were missed (NPV=100%). (16).

Key populations

Four studies were specifically among key populations [two for MSM (23, 34), one for PWID (30) and one for people in prisons (36)]. All included studies with HIV screenings of key populations were conducted in very low HIV prevalence settings.

Low HIV prevalence

A risk scoring model among MSM in the United States resulted in 1.9% PPV and 99.5% NPV among MSM with risk scores ≥10 (34). Likewise, a model in China performed with a sensitivity of 86.2% and a specificity of 42.5% in PWID scoring ≥46 out of 100 (30). Another HIV screening was developed for use in prisons in the United States which scored prisoners based on age, race/ethnicity, date of last HIV test and having a male sexual partner (36). This screening tool reduced excess testing by 50% with a sensitivity of 82.6% (95% CI: 71.2%-94.0%) for individuals scoring ≥3 out of 6.

General population adults

Three records from peer-reviewed literature and four programmatic tools in high HIV prevalence settings focused on the use of HTS screening tools for general population adults; six additional studies were in low HIV prevalence settings.

High HIV prevalence

All three records from peer-reviewed literature in high prevalence settings focused on screening women (22, 24, 26). The risk-based algorithms to prioritise high HIV risk women for HTS had 83% and 91% sensitivity. One algorithm showed modest predictive ability, in which women scoring ≥3 had a HIV incidence of 5.21% (95% CI 4.22-6.44) compared to 0.98% (95% CI 0.51-1.88) among women scoring <3 (26).

Overall, the programme data for male and female adults in high prevalence settings shows screening tools can reduce overall testing and increase yields, but also miss some opportunities to test PLHIV. In Eswatini, Population Services International (PSI) validated a screening tool with 93% sensitivity, 31% specificity, 7% PPV and 99% NPV. Screening indicated an HIV test for 70% of patients and increased yield from 5.1% to 6.7%. However, out of 80 new diagnoses, 6 (8%) would have been missed by the tool. In Tanzania, an implemented screening tool also increased yield from 2.6% to 4.2%, yet 1.5% of clients not at risk according to the screening were true HIV-positive, representing some missed diagnoses.

Low HIV prevalence

Four validated studies from the United States and Canada evaluated the Denver HIV risk score (29, 31-33), which demonstrated the utility of screening general population adults in low prevalence settings. The model showed good discrimination between patients with and without HIV in clinical settings (full: AUC=0.86, 95% CI: 0.84-0.88; abbreviated: AUC=0.75, 95% CI: 0.71–0.79) (31, 33). In 2016, the algorithm was validated in community settings where it identified 90% of all HIV infections (based on scoring ≥30) which represented only 63% of the total cohort (29). Another evaluation found a large reduction in the number of HIV tests (10% identified for testing with screening tool vs. 62% in non-targeted strategy) along with better HIV testing uptake and greater yield (32).

Two additional non-validated studies amongst general population adults were conducted in Spain and France, showing high acceptability and improved yield with the use of screening tools. In Spain, a self-administered tool in a primary care had high acceptability among health providers (100%, n=14) because they felt it reminded them to offer an HIV test (86%, n=12) and normalized HIV testing (79%, n=11) (14). In France, a trial in eight EDs using a short screening tool identified a significantly higher proportion of new HIV diagnoses during periods of targeted HIV screening compared to non-targeted control periods (RR=3.7; 95% CI 1.4 to 9.8) (20).

Programmes in Nigeria and Ukraine highlighted the drawbacks of screening tools that reduce testing and miss people living with undiagnosed HIV. In Nigeria, a tool reduced testing by nearly 77%. Although 5.6% of those tested were positive, true HIV positivity inclusive of people screened out of testing was 8.7%, indicating missed diagnoses. In Ukraine, a programme conducting paper-based and self- or provider-administered app-based tools adapted eligibility to address missed diagnoses. By offering HTS to individuals at medium and high HIV risk, yield increased from 2% to 3% [87% sensitivity, 44% specificity] on the paper tool and from 2% to 4% [94% sensitivity, 45% specificity] on the app. Two individuals with HIV were missed using the paper-based tool (n=2/803) and one using the app (n=1/794). Following these results, programme implementers adjusted the risk classification so that females aged 40-49 years who reported multiple partners and condomless sex in Kyiv were eligible for testing, and subsequently, the screening tool became more effective [100% sensitivity, 40% specificity] with no missed diagnoses (n=0/793).

Discussion

This review found that while evidence on accuracy, effectiveness and feasibility of HIV screening tools is limited, their routine use is increasing. We identified 47 screening tools, many non-validated, that are actively being used by programmes and implementers, mostly in high HIV prevalence settings. Across the tools reviewed, there appears to be benefit for increased coverage of HTS and identification of PLHIV when applying screening tools in low HIV prevalence settings where HIV testing is not routinely offered and among certain populations where coverage may be low, such as children and adolescents. However, application of these tools in high HIV prevalence settings and among key populations, where the standard of care is routine testing to all individuals presenting in clinical settings, has limited evidence especially in terms of feasibility, quality, cost and public health impact.

HIV positivity and prevalence among children is very low and declining globally. In all HIV prevalence settings, there appears to be a rationale in applying screening tools to increase testing and identification of HIV infections in children and adolescents who would otherwise be missed, particularly in settings where sick and hospitalized children and adolescents are not routinely offered HTS. Previous studies have reported low testing coverage in entry points where sick and hospitalized children present (42), in addition to low provider willingness to test children in many settings (43, 44). In Nigeria, where very few children with HIV are enrolled in ART, application of a screening tool increased overall testing coverage by 27% and identified 36% more children with HIV (21). Likewise, in high HIV prevalence settings such as Malawi, Zambia, Zimbabwe and Uganda, screening tools increased yield and reduced the overall number of children and adolescents needed to be tested to identify a child with HIV. In accordance with national guidelines in high prevalence settings, all children should have been tested but in practice many are missed during prevention of mother-to-child transmission of HIV (PMTCT).

The most commonly used paediatric screening identified in this review (27) focused on asking four questions which were well accepted and taken up. The tool was adapted to local contexts in five additional countries with high sensitivity and specificity. While not all tools for children were validated, the vast majority drew from and adapted validated tools. Further piloting and research on the implementation of these tools are needed, particularly within different child and adolescent age bands. Many of the tools reviewed covered a wide range of ages with different risk factors, which may require additional screening questions, such as STI symptoms and sexual activity among adolescents. Sensitive questions on sexual risk behaviours for adolescents should be further examined and assessed.

Low prevalence settings using validated screening tools, while few, generally reported strong benefits related to efficiency and increased offers of HIV testing in settings where routine offer of HIV testing is not practiced. Such settings may benefit from prioritization efforts such as testing guided by screening for HIV indicator conditions and risk behaviours.

For adults, however, screening tools with evidence in high HIV burden settings were limited, but suggested that there was a substantial trade off of missing PLHIV who do not know their status in order to reduce testing and increase HIV positivity yield. Increasing yield may reduce resource use for testing, but should be considered cautiously as it may miss opportunities to test a high number of people living with undiagnosed HIV and there is not available evidence to assess effects on patient flow or provider time required to conduct screenings.

Evidence from this review demonstrated that many programmes are using screening tools without validating the tool's accuracy for identifying people at higher risk of HIV. It is imperative that validation studies be conducted so tools can be improved to reduce missed opportunities to test and treat PLHIV. A standard protocol for validating screening tools would be beneficial. In the absence of validation, simple tools in alignment with WHO's existing recommendations on frequency of retesting, such as a question on whether someone has ever tested for HIV or whether they tested for HIV in past 3-6 months, may be considered but must also be evaluated in pilots and monitored closely.

Across all settings, important issues related to acceptability, feasibility, cost and potential unintended effects emerged. Only one study (14) assessed acceptability of screening tools. While this study reported high patient and provider acceptability, it is far from representative of various populations, settings and contexts. Feasibility was not formally assessed in any study or programmatic tool, but potential challenges were identified particularly with the use of longer questionnaires, provider- versus patient-administered tools and the appropriateness of questions included. Tools included a wide range of questions – with as many as 23 questions being asked – which may impact the cost, time and feasibility of implementing screening systematically. Shorter and simpler screening tools would likely be preferable, though limited data was available on time or staffing required. Only two screening tools were self-administered by clients, but this approach has potential to conserve time and resources in busy testing environments, as well as address privacy concerns.

By its nature, HIV screening tools ask sensitive questions to determine HIV risk, thus, mindfulness of confidentiality is necessary when implementing such screenings. Special consideration needs to be given to the acceptability of these questionnaires, particularly among vulnerable and key populations who may be deterred from seeking testing. Some programmes have worked to reduce stigma in the screening procedure by grouping the behavioural risk questions together such that the client does not specify which exact behaviour they engaged in, yet their overall HIV risk can still be assessed. Developing other best practices for ensuring privacy with provider-administered screenings should also include reflection on when and where screenings are conducted.

In this review, only three studies reported on cost-effectiveness and all three were from low HIV prevalence settings (20, 37, 40). The findings indicated lower costs and greater efficiencies, though the overall public health impact of HTS screening tools and their role in achieving national and global targets is still uncertain. More cost-related evidence is needed, particularly for higher prevalence settings where more people require screening and testing; and the cost of missing a person with undiagnosed HIV may be higher (45-47).

This review was intended to broadly scope the literature and identify programmatic tools and data to assess evidence for the use of HTS screening tools. Scoping reviews are distinct from systematic reviews in the absence of a priori article criteria; although, we comprehensively searched literature published since 2010 and focused exclusively on studies reporting information on HIV risk screening and study outcomes. However, because this was not a systematic review, it is possible that due to the targeted search criteria and single reviewer, relevant articles could have been missed. Furthermore, some articles were only available as conference abstracts and detailed methods or outcomes were unknown. Another limitation is the variation in validation methods which limited the comparability of included studies.

Few studies were validated – and some only described the development and validation of the tool and did not administer an actual screening tool. In these cases, actual implementation of the screening is unknown, and factors related to acceptability, time, cost, and screening efficiency in a real world setting could not be provided. Despite substantial efforts, it is highly likely that other screening tools in use were missed, yet our engagement with experts and programme implementers to share tools and unpublished information was an asset to this review.

Conclusions

Our review shows that programmatic use of screening tools is increasing, with many non-validated tools in use. Use of validated screening tools may offer benefits in identification of additional HIV infections in settings where HIV testing is not routinely offered, such as low prevalence settings and amongst subpopulations with very low HIV prevalence, such as children and adolescents. In high prevalence settings, screening tools generally reduce the number of HIV tests conducted and increased positivity rate. Greater caution is needed with routine use of screening tools in these settings where people with HIV in need of testing and treatment may be missed. Robust assessment of the benefits and risks of screening tools is warranted before they are considered for wider implementation, including further research on acceptability and feasibility of screening tools in a range of settings and service delivery approaches.

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References

1. Communities at the centre: defending rights, breaking barriers, reaching people with HIV services. Geneva: Joint United Nations Programme on HIV/AIDS; 2019 16 July 2019.
2. Fast-Track - Ending the AIDS epidemic by 2030. Geneva: Joint United Nations Programme on HIV and AIDS; 2014.
3. WHO encourages countries to adapt HIV testing strategies in response to changing epidemic. Geneva: World Health Organization; 2019.
4. Differentiated service delivery for HIV: a decision framework for HIV testing services. Geneva: World Health Organization; 2018.
5. Evaluating the impact of PEPFAR's geographic prioritization on health facilities transitioning to central support in Uganda. The U.S. President's Emergency Plan for AIDS Relief (PEPFAR); 2019 Jan 7.
6. Elías MJP, Gómez-Ayerbe C, Elías PP, Muriel A, de Santiago AD, Martinez-Colubi M, et al. Development and Validation of an HIV Risk Exposure and Indicator Conditions Questionnaire to Support Targeted HIV Screening. Medicine. 2016;95(5):e2612-e.
7. Sanders EJ, Wahome E, Powers KA, Werner L, Fegan G, Lavreys L, et al. Targeted screening of at-risk adults for acute HIV-1 infection in sub-Saharan Africa. AIDS. 2015;29 Suppl 3(0 3):S221-S30.
8. Pintye J, Drake AL, Kinuthia J, Unger JA, Matemo D, Heffron RA, et al. A Risk Assessment Tool for Identifying Pregnant and Postpartum Women Who May Benefit From Preexposure Prophylaxis. Clinical Infectious Diseases. 2017;64(6):751-8.
9. Wahome E, Thiong'o AN, Mwashigadi G, Chirro O, Mohamed K, Gichuru E, et al. An Empiric Risk Score to Guide PrEP Targeting Among MSM in Coastal Kenya. AIDS and behavior. 2018.
10. Moucheraud C, Chasweka D, Nyirenda M, Schooley A, Dovel K, Hoffman RM. Simple Screening Tool to Help Identify High-Risk Children for Targeted HIV Testing in Malawian Inpatient Wards. Journal of acquired immune deficiency syndromes (1999). 2018;79(3):352-7.
11. Arksey H, O'Malley L. Scoping studies: towards a methodological framework. International Journal of Social Research Methodology. 2005;8(1):19-32.
12. Studying the Organisation and Delivery of Health Services: Research Methods. Fulop N, Allen P, Clarke A, Black N, editors. London: Routledge; 2001.
13. UNAIDS. AIDSInfo Geneva2018 [Available from: http://aidsinfo.unaids.org/.
14. Agusti C, Martin-Rabadan M, Zarco J, Aguado C, Carrillo R, Codinach R, et al. Early diagnosis of HIV in Primary Care in Spain. Results of a pilot study based on targeted screening based on indicator conditions, behavioral criteria and region of origin. Atencion primaria. 2018;50(3):159-65.
15. Bandason T, Dauya E, Dakshina S, McHugh G, Chonzi P, Munyati S, et al. Screening tool to identify adolescents living with HIV in a community setting in Zimbabwe: A validation study. PloS one. 2018;13(10):e0204891.
16. Chandra J, Sahi PK, Gupta S, Gupta RA, Dutta R, Sherwal BL, et al. Addition of Questions on Parental Factors to the WHO (Integrated Management of Childhood Illnesses) IMCI-HIV Algorithm Improves the Utility of the Algorithm for Diagnosis of HIV Infection in Children. Journal of tropical pediatrics. 2018.
17. Dunlop J, Untiedt S, Makura C, Levin L, editors. Screening tools to identify children and adolescents living with HIV: Increasing case finding in high HIV prevalence settings. International AIDS Conference; 2018 23-27 July 2018; Amsterdam, The Netherlands.
18. Kunle K, Khamofu H, Obiora-Okafo C, Obanubi C, Adedokun O, Oladele E, et al. How Well Does the Bandason HIV Risk Screening Tool Perform in the Nigerian Setting? Findings From a Large-scale Field Implementation. AIDS research and human retroviruses. 2018;34:151-.
19. Kamwesigye N, editor Community-based HIV screening tool identifies children at high risk of testing positive to HIV. International AIDS Conference; 2018 23-27 July 2018; Amsterdam, The Netherlands.
20. Leblanc J, Hejblum G, Costagliola D, Durand-Zaleski I, Lert F, de Truchis P, et al. Targeted HIV Screening in Eight Emergency Departments: The DICI-VIH Cluster-Randomized Two-Period Crossover Trial. Annals of emergency medicine. 2018;72(1):41-53.e9.

21. Olatoregun O, Banigbe B, Njoku K, Okonkwo P, Jolayemi T, Olaitan R, et al., editors. Improvements in pediatric HIV case identification across 17 health facilities in Lagos, Nigeria: a quality improvement collaborative approach. International AIDS Conference; 2018 23-27 July 2018.
22. Wand H, Reddy T, Naidoo S, Moonsamy S, Siva S, Morar NS, et al. A Simple Risk Prediction Algorithm for HIV Transmission: Results from HIV Prevention Trials in KwaZulu Natal, South Africa (2002-2012). AIDS and behavior. 2018;22(1):325-36.
23. Yin L, Zhao Y, Peratikos MB, Song L, Zhang X, Xin R, et al. Risk Prediction Score for HIV Infection: Development and Internal Validation with Cross-Sectional Data from Men Who Have Sex with Men in China. AIDS and behavior. 2018;22(7):2267-76.
24. Balkus JE, Brown E, Palanee T, Nair G, Gafoor Z, Zhang JY, et al. An Empiric HIV Risk Scoring Tool to Predict HIV-1 Acquisition in African Women. Jaids-Journal of Acquired Immune Deficiency Syndromes. 2016;72(3):333-43.
25. Chaila M, Macleod D, Schaap A, Floyd S, Thornicroft M, Hoddinott G, et al., editors. A primary care level algorithm increases yield of HIV-positive adolescents in a community intervention: HPTN071 (PopART) Study, Zambia. International AIDS Society Conference; 2017; Paris, France.
26. Balkus JE, Brown ER, Palanee-Phillips T, Kiweewa FM, Mgodi N, Naidoo L, et al. Performance of a Validated Risk Score to Predict HIV-1 Acquisition Among African Women Participating in a Trial of the Dapivirine Vaginal Ring. Jaids-Journal of Acquired Immune Deficiency Syndromes. 2018;77(1):E8-E10.
27. Bandason T, McHugh G, Dauya E, Mungofa S, Munyati SM, Weiss HA, et al. Validation of a screening tool to identify older children living with HIV in primary care facilities in high HIV prevalence settings. AIDS. 2016;30(5):779-85.
28. Falasinnu T, Gustafson P, Gilbert M, Shoveller J. Validation of the Denver HIV risk score for targeting HIV screening in Vancouver, British Columbia. Sexually transmitted infections. 2015;91:A63-A.
29. Haukoos J, Hopkins E, Bucossi M, Lyons M, Rothman R, White D, et al. Validation of a quantitative HIV risk prediction tool using a national HIV testing cohort. Journal of acquired immune deficiency syndromes (1999). 2015;68(5):599-603.
30. Smith DK, Pan Y, Rose CE, Pals SL, Mehta SH, Kirk GD, et al. A Brief Screening Tool to Assess the Risk of Contracting HIV Infection Among Active Injection Drug Users. Journal of addiction medicine. 2015;9(3):226-32.
31. Hsieh YH, Haukoos JS, Rothman RE. Validation of an abbreviated version of the Denver HIV Risk Score for prediction of HIV infection in an urban ED. American Journal of Emergency Medicine. 2014;32(7):775-9.
32. Haukoos JS, Hopkins E, Bender B, Sasson C, Al-Tayyib AA, Thrun MW, et al. Comparison of Enhanced Targeted Rapid HIV Screening Using the Denver HIV Risk Score to Nontargeted Rapid HIV Screening in the Emergency Department. Annals of emergency medicine. 2013;61(3):353-61.
33. Haukoos JS, Lyons MS, Lindsell CJ, Hopkins E, Bender B, Rothman RE, et al. Derivation and Validation of the Denver Human Immunodeficiency Virus (HIV) Risk Score for Targeted HIV Screening. American journal of epidemiology. 2012;175(8):838-46.
34. Smith DK, Pals SL, Herbst JH, Shinde S, Carey JW. Development of a Clinical Screening Index Predictive of Incident HIV Infection Among Men Who Have Sex With Men in the United States. Jaids-Journal of Acquired Immune Deficiency Syndromes. 2012;60(4):421-7.
35. Ferrand R, Weiss H, Nathoo K, Ndhlovu C, Mungofa S, Munyati S, et al. A primary care level algorithm for identifying HIV-infected adolescents in populations at high risk through mother-to-child transmission. Tropical medicine & international health : TM & IH. 2011;16(3):349–55.
36. Sampson LA, Miller WC, Leone PA. Evaluation of risk score algorithms for the detection of HIV infection and syphilis in North Carolina county jails. Sexually transmitted infections. 2011;87:A210-A.
37. Castañeda MP. Indicator condition, risk-based and universal offer in Primary Care in Madrid ESTVIH Project. [Presentation]. In press.
38. Elias MJ, Gomez-Ayerbe C, Elias PP, Muriel A, de Santiago AD, Martinez-Colubi M, et al. Development and Validation of an HIV Risk Exposure and Indicator Conditions Questionnaire to Support Targeted HIV Screening. Medicine (Baltimore). 2016;95(5):e2612.
39. Joseph R, Musingila PK, Miruka F, Ng'ang'a L, Muttai H, De Cock KM, et al. Expanded HIV testing eligibility increases detection of HIV infections, Western Kenya. Conference on Rotovirus and Opportunitistic Infections; March 4-7; Boston, MA2018.

40. Uhler LM, Kumarasamy N, Mayer KH, Saxena A, Losina E, Muniyandi M, et al. Cost-effectiveness of HIV testing referral strategies among tuberculosis patients in India. PloS one. 2010;5(9).
41. Zeng G, Lu F, Luo X, Zhou QF, Liu W, Huang AL, et al. [Comparison of effectiveness between two HIV screening strategies in outpatient setting]. Zhonghua yu fang yi xue za zhi [Chinese journal of preventive medicine]. 2013;47(11):1010-3.
42. Cohn J, Whitehouse K, Tuttle J, Lueck K, Tran T. Paediatric HIV testing beyond the context of prevention of mother-to-child transmission: a systematic review and meta-analysis. The Lancet HIV. 2016;3(10):e473-e81.
43. Mutambo C, Hlongwana K. Healthcare Workers' Perspectives on the Barriers to Providing HIV Services to Children in Sub-Saharan Africa. AIDS research and treatment. 2019;2019:8056382-.
44. Sibanda EL, Hatzold K, Mugurungi O, Ncube G, Dupwa B, Siraha P, et al. An assessment of the Zimbabwe ministry of health and child welfare provider initiated HIV testing and counselling programme. BMC health services research. 2012;12(1):131.
45. Dowdy DW, Rodriguez RM, Hare CB, Kaplan B. Cost-effectiveness of targeted human immunodeficiency virus screening in an urban emergency department. Academic emergency medicine : official journal of the Society for Academic Emergency Medicine. 2011;18(7):745-53.
46. Gomez-Ayerbe C, Elias MJ, Muriel A, Elias PP, Cano A, Diaz A, et al. Incremental cost per newly diagnosed HIV infection (NDHI): routine (RTS), targeted (TTS), and current clinical practice testing strategies (CPTS). Journal of the International AIDS Society. 2014;17(4 Suppl 3):19606.
47. Venkatesh KK, Becker JE, Kumarasamy N, Nakamura YM, Mayer KH, Losina E, et al. Clinical impact and cost-effectiveness of expanded voluntary HIV testing in India. PloS one. 2013;8(5):e64604.

Appendix 1: Search strategy

Pubmed

A. HIV/AIDS		
#1	hiv[tiab] OR "human immunodeficiency virus"[tiab] OR "acquired immunodeficiency"[tiab] OR "acquired immune deficiency"[tiab] OR aids[tiab] OR "hiv infect*"[tiab] OR "acquired immunodeficiency syndrome"[tiab] OR "acquired immunedeficiency syndrome"[tiab] OR "acquired immuno-deficiency syndrome"[tiab] OR "acquired immune-deficiency syndrome"[tiab] OR "HIV-infected"[tiab] OR "HIV-positive"[tiab] OR HIV/AIDS[tiab] OR HIV[tiab] OR "HIV-1"[tiab] OR "HIV-2"[tiab] OR hiv1[tiab] OR hiv2[tiab] OR "HIV diagnos*"[tiab] OR serodiagnos*[tiab] OR "HIV acquisition"[tiab] OR "acquir* HIV"[tiab]	388,561
#2	"HIV Infections/diagnosis"[Majr:noexp] OR "Acquired Immunodeficiency Syndrome/diagnosis"[Majr] OR "HIV Seropositivity/diagnosis"[Majr] OR "AIDS Serodiagnosis"[Majr] OR "HIV infections/prevention and control"[Mesh]	18,891
#3	#1 OR #2	389,516
B. Risk screening		
#4	"screen* for HIV"[tiab] OR "HIV screen*"[tiab] OR screen*[tiab] OR OR "risk screening"[tiab] OR "risk-based screening"[tiab] OR "risk-based"[tiab] OR "symptom-based screening"[tiab] OR "symptom-based"[tiab] OR "symptom screening"[tiab] OR "risk assessment"[tiab] OR "risk stratification"[tiab] OR "screening tool"[tiab] OR tool*[tiab] OR assessment*[tiab] OR validation[tiab] OR "risk scoring"[tiab] OR "risk score"[tiab] OR "scoring tool"[tiab] OR "risk profiling"[tiab] OR "risk profile"[tiab] OR "risk prediction"[tiab] OR "risk predictor"[tiab]	2.198,850
#5	"Mass Screening/methods"[Mesh] OR "Risk assessment"[Mesh] OR "Decision support techniques"[Mesh] OR "Risk factors"[Mesh] OR "Risk-taking"[Mesh] OR Risk[Mesh]	1,218,480
#6	#4 OR #5	3,175,118
D. Other parameters		
#7	#3 AND #6	84,016
#5	#4 NOT Animals[Mesh]	8,117
#6	#5 AND ("2010/01/01"[Date - Publication] : "3000"[Date - Publication])	6,143

Embase

A. HIV/AIDS		
#1	'human immunodeficiency virus infection'/mj/dm_di OR 'human immunodeficiency virus 1 infection'/mj/dm_di OR 'human immunodeficiency virus 2 infection'/mj/dm_di OR 'acquired immune deficiency syndrome'/mj/dm_di	359,260
#2	hiv OR 'human immunodeficiency virus' OR 'acquired immunodeficiency' OR 'acquired immune deficiency' OR aids:ti	314,325
#3	#1 OR #2	436,180
B. Risk screening		
#4	'screening'/exp OR screen*:ti OR diagnosis:ti OR diagnoses:ti OR serodiagnos*:ti OR "screening tool":ti OR "risk screening":ti OR "risk screener":ti OR "risk tool":ti OR "risk score":ti OR "risk assessment":ti OR "risk scoring":ti OR tool:ti	1,265,027
C. Combining parameters & limitations		
#5	#3 AND #4	26,287
#6	#5 AND [humans]/lim	23,277
#7	#6 AND [2010-2019]/py	901

Web of Science

A. HIV/AIDS		
#1	**TOPIC:** (HIV OR "human immunodeficiency virus" OR "acquired immune deficiency" OR "acquired immunodeficiency" OR "aids")	471,928
#2	**TOPIC:** ("HIV Infections" OR "HIV" OR "hiv" OR "hiv-1" OR "hiv-2" OR "hiv1" OR "hiv2" OR hiv infect* OR "human immunodeficiency virus" OR "human immunedeficiency virus" OR "human immuno-deficiency virus" OR "human immune-deficiency virus" OR ((human immun*) AND ("deficiency virus")) OR "acquired immunodeficiency syndrome" OR "acquired immunedeficiency syndrome" OR "acquired immuno-deficiency syndrome" OR "acquired immune-deficiency syndrome" OR ((acquired immun*) AND ("deficiency syndrome")) OR "Sexually Transmitted Diseases, Viral")	386,482
#3	#1 OR #2	472,279
B. Risk screening		
#4	**TITLE:** (screen* OR diagnos* OR "screening tool" OR "risk screen*" OR "risk assessment" OR "risk score" OR "scoring tool" OR "assessment tool" OR "symptom-based screening" OR "risk-based screening")	877,382
C. Combining search and limitations		
#5	#3 AND #4	15,921
#6	#5 AND Time period=2010-2019	8,160

ScienceDirect

A. HIV/AIDS		
#1	**TITLE**(hiv OR "human immunodeficiency virus" OR "acquired immune deficiency" OR "acquired immunodeficiency" OR "aids")	12,176
B. Risk screening		
#2	**TITLE**(screening tool OR risk screening OR risk assessment OR risk-based screening)	78,556
C. Combined parameters and limitations		
#3	#1 AND #2	46,338
#4	#3 AND dates(2010-2019)	2,920
#18	#4 AND type of article(research article, conference abstract,	1,171

Appendix 2: Article tables for included studies

Study ID	Study setting & HIV prevalence*	Population	Study design & sample size	Screening items & criteria	Summary of findings
General population adults					
Agusti 2018	Spain Facility-based (PC) 0.4% [0.4-0.5]	Adults 16-65yrs	Cross-sectional N=388 Screening not validated	Criteria: Any 1 indicator Symptoms: • STIs • Seborrheic dermatitis / rash • Hepatitis B or C • Dysplasia or cervical / anal cancer • Herpes zoster • Ongoing disease similar to mononucleosis, leukopenia or thrombocytopenia (lasting at least 4 weeks) • Unexplained lymphadenopathy • Candida in oral cavity • Pneumonia (with 24hr hospital admission) • Primary lung cancer • Peripheral neuropathy • Malignant lymphoma Behavior: • Condomless sex with partner of unknown HIV status • Multiple sexual partners • Men who have sex with men (MSM) • Women who have requested emergency contraception • Women who perform or voluntarily interrupted a pregnancy	HIV positivity: 1% (4/388) Screening efficiency: 77.4% of patients had at least one indicator. Linkage: 75% (3/4) Provider acceptability: All participating physicians (100%, 14/14) wanted guide for offering HTS based on behavioral criteria and indicators. All agreed that the behavioral criteria were adequate, but 35.7% (5/14) felt some of the indicators were not useful (particularly, lung cancer, pneumonia requiring hospitalisation of at least 24 hours and oral candida).

Study ID	Study setting & HIV prevalence*	Population	Study design & sample size	Screening items & criteria	Summary of findings
				• Women who have sex with MSM • History of incarceration • Tattoos or body piercings performed without adequate hygienic measures • Sex workers or clients of sex workers • Ever injected drugs or had sexual relations with someone who injects drugs Other: • Country of origin has high (>1%) HIV burden	
Balkus 2018	Multi-country: Malawi, South Africa, Uganda, Zimbabwe 9.6% [9.0 - 10.3]; 18.8% [16.2 - 20.9]; 5.9% [5.5 - 6.1]; 13.3% [11.4 - 14.9]	Women 18-45yrs	RCT N=2539 Screening validated	Criteria: Risk score ≥3 Symptoms: • STI diagnosis at baseline • HSV-2 Behavioral: • Alcohol use in the last 3 months • Partner has other sexual partners (yes or don't know) Other: • Age <25yrs	HIV incidence: 3.7% (95% CI: 3.03-4.52) HIV predictors: When restricted only to South Africa, age <25, being unmarried/not living with partner, and having a curable STI at baseline were the strongest predictors of HIV-1 acquisition. AUC: 0.69 (95% CI 0.64-0.74) indicating modest predictive ability. Sensitivity: 91% using a cut-off of ≥3. Specificity: 36% using a cut-off of ≥3. Screening efficiency: 7% of women scored below two; 65% had a risk score of ≥3.

Study ID	Study setting & HIV prevalence*	Population	Study design & sample size	Screening items & criteria	Summary of findings
					Screening yield: There were no infections among women with risk scores <2. Women with a score of 2 had an incidence <2% per year. Women with score of ≥3 had an HIV incidence of 5.21% (95% CI 4.22-6.44) compared to 0.98% (95% CI 0.51-1.88) among women with a risk score <3.
Joseph 2018†	Kenya Facility-based (OPD & inpatient) 4.8% [4.0 - 5.8]	Adults Age range not available	Cross-sectional N= 88641 Screening not validated	Criteria: 3-12mo or more since last HIV test for expanded HIV testing eligibility Symptoms: NA Behavioral: NA Other: • Date of last HIV test	Screening efficiency: 80% of all people at clinic were eligible for testing with both expanded and MOH eligibility. Overall, 26% (n=18,456) of clients met MOH eligibility criteria: 7% (n=4,921) had never been tested, 15% (n=10,247) reported a negative HIV test in the past >12 months, and 5% (n=3,288) met other criteria. The remaining 74% (n=52,037) met expanded criteria: 52% (n=35,274) reported a negative test in the past 3–12 months, and 23% (n=15,913) had an unverified negative test in the past <3 months. Screening yield: In total, 1.1% (n=740) of clients had a positive HIV test. Although the yield of positive tests was 2.4-fold higher among those meeting MOH criteria (1.9% vs. 0.8%; p<0.001), more than half of all infections (n=406) were found among clients meeting expanded criteria, the majority (77%) reporting a negative test in the past 3–12 months.

Study ID	Study setting & HIV prevalence*	Population	Study design & sample size	Screening items & criteria	Summary of findings
Leblanc 2018	France Facility-based (ED) 0.5% [0.4 - 0.5]	Adults 18-64yrs	Cluster randomised trial N=74161 Screening not validated	Criteria: Any 1 indicator Symptoms: None Behavioral: • Ever male-to-male sexual contact • >5 sexual partners in past 12mo • Ever injection drug use Other: • sub-Saharan African origin or partner of sub-Saharan African origin in past 10 years	HIV positivity: In the intervention arm, 2.4% (95% CI 1.0% to 5.3%) in MSM and 0.5% (95% CI 0.2% to 1.0%) in heterosexuals of sub-Saharan African origin HIV incidence: 3.0 per 10,000 (95% CI: 1.9 to 4.6) in the intervention arm Screening efficiency: 70.5% (n=2818) Screening yield: The proportion of new HIV diagnoses identified during the intervention periods (targeted screening) was significantly higher than during control periods (RR=3.7; 95% CI 1.4 to 9.8). Linkage: 95.5% (n=21) during the intervention compared to 100% (n=6) during the control periods (NS). Cost-effectiveness: The mean incremental cost of the intervention was 2,837 per 10,000 included patients (95% CI EUR 2,298 to EUR 3,445). The incremental cost-effectiveness ratio was EUR 1,324 per new HIV diagnosis.
Wand 2018	South Africa 18.8% [16.2 - 20.9]	Women 16+yrs	Retrospective cohort N=8982	Criteria: Cutoff score of ≥25 Symptoms: • STI diagnosis	HIV positivity: 9% (n=776) HIV incidence: 7.03 per 100 person-years. There was a significant increase in incidence from 1.8 per 100 PY in the

Study ID	Study setting & HIV prevalence*	Population	Study design & sample size	Screening items & criteria	Summary of findings
			Screening validated	Behavioral: • Age at sexual debut (<16) • Multiple sexual partners (≥3) Other: • <25 years old • Single/not cohabiting • Parity (<3) • Using injectable contraceptives	lowest decile of scores (<10) to 13.8 per 100 PY in the highest decile (>=45). HIV predictors: Seven factors were identified as significant predictors of HIV infection: <25 years old, being single/not cohabiting, parity (<3), age at sexual debut (<16), 3+ sexual partners, using injectables for contraception and diagnosis with a STI. Sensitivity: A score of ≥25 (out of 50) had 83% sensitivity in the development dataset (and 80% sensitivity in validation dataset).
Balkus 2016	Multi-country: Kenya, Malawi, South Africa, Tanzania, Uganda & Zimbabwe 4.8% [4.0 - 5.8]; 9.6% [9.0 - 10.3]; 18.8% [16.2 - 20.9]; 4.5% [3.8 - 5.0] 5.9% [5.5 - 6.1]; 13.3% [11.4 - 14.9];	Women 18-45yrs	Prospective cohort N=4834 Screening validated	Criteria: Risk score of ≥5 out of 11 in the full model. Symptoms: • STI diagnosis at baseline • HSV-2 Behavioral: • Alcohol use in the last 3 months • Partner has other sexual partners (yes or don't know) Other: • Age <25yrs • Married or living with husband/primary partner	HIV incidence: 6.05% (95% CI 5.36-6.83), 263 seroconversions during 4,348 person-years of follow-up. HIV incidence was highest in South Africa (7.34%), followed by Uganda (2.07%) and Zimbabwe (0.50%). For the full risk score model, a sharp increase in HIV incidence was observed for risk scores ≥5. Sensitivity: 91% at cutoff score of 5. Specificity: 38% at cutoff score of 5.

Study ID	Study setting & HIV prevalence*	Population	Study design & sample size	Screening items & criteria	Summary of findings
				• Partner does not provide financial or material support	
Elias 2016	Spain Facility-based (ER & PC) 0.4% [0.4 - 0.5]	Adults 18-60yrs	Prospective cohort N=5329	Criteria: NS Symptoms: • Any visit to a health setting last year • STI • Lymphoma • Cervical/anal cancer or dysplasia • Herpes zoster • Hepatitis B or C • Mononucleus-like syndrome • Thrombocytopenia/Unexplained leucopenia • Seborrheic dermatitis • Unexplained fever • Oral or vaginal candidiasis • Oral hairy leukoplakia • Prolonged diarrhea (>3mo) • Mycobacterium Tuberculosis Disease Behavioral: • Condomless sex • Partner is PLHIV • MSM • Blood transfusion • Injecting drugs • Client believes he/she has been exposed to HIV Other: None	HIV positivity: 4.1% Screening efficiency: The HIV RE&IC questionnaire indicated to offer testing to 51.2% of people. Sensitivity: 100%. When considered separately, RE or IC items sensitivity decreases to 86.4% or 91%. NPV: 100%. When IC and risk behaviors are considered separately, the NPV decreases to 99.9%. Time: Median time to self-complete the questionnaire was 3 minutes.

Study ID	Study setting & HIV prevalence*	Population	Study design & sample size	Screening items & criteria	Summary of findings
Falasinnu 2015†	Canada Facility-based (STI) NA	Adults Age range not available	Cross-sectional N=47175 Screening validated	Criteria: HIV testing indicated for scores ≥40. Symptoms: None Behavioral: • Sex with a male (or both males and females) • Vaginal intercourse • Receptive anal intercourse • Injection drug use Other: • Age • Gender • Race/ethnicity • Past HIV testing	HIV positivity: 0.46%. HIV prevalence within each risk group was: 0%, 0.05%, 0.25%, 0.86%, and 1.23%, respectively. Validation details: AUC was 0.80 (95% CI: 0.79–0.81) and the H-L c2 = 8.8, 8 df, p=0.36. Sensitivity: 96% Screening efficiency: 41%.
Zeng 2013†	China Facility-based (hospital) HIV prevalence estimates not available	Adults >15yrs	Cross-sectional N=120363	Criteria: NS Symptoms: NS Behavioral: NS Other: NS	HIV positivity: The overall percentage of newly-identified HIV cases was significantly greater with the non-targeted strategy (0.03% (19/58 057)) than the targeted strategy (0.02% (10/62106)) (P < 0.05). Screening efficiency: During the study period, 9.69% (5627/58057) of all outpatients in J hospital with non-targeted strategy and 1.38% (859/62106) of all outpatients in L hospital with targeted strategy received an HIV test.

Study ID	Study setting & HIV prevalence*	Population	Study design & sample size	Screening items & criteria	Summary of findings
					Screening yield: The detection rate of HIV positives was lower in the non-targeted strategy (0.34% (19/5627)) than the targeted strategy (1.16% (10/859)) ($\chi(2) = 9.66$, $P < 0.05$).
Uhler 2010	India Facility-based (TB) 0.2% [0.2 - 0.3]	Adults 25-45yrs	Modelling N=1475587	Criteria: NS Symptoms: • Signs and symptoms of HIV-related opportunistic infections (NS) • History of STI Behavioral: • History of HIV risk behaviors (NS) Other: None	HIV testing uptake: The overall probability of a TB case being offered and accepting HIV testing in the selective referral strategy was 5.2%; 22.7% in the standard strategy (routine in high prevalence states, selective elsewhere); 66.2% in the routine strategy. Cost: The selective referral strategy, beginning from age 33.50 years, had a projected discounted life expectancy of 16.88 years and a mean lifetime HIV/TB treatment cost of US$100. The current standard increased mean life expectancy to 16.90 years with additional per-person cost of US$10. Cost-effectiveness: The incremental cost-effectiveness ratio in the current standard was US$650/year of life saved (YLS) compared to selective referral. Routine referral of all patients for HIV testing increased life expectancy to 16.91 years, with an incremental cost-effectiveness ratio of US$730/YLS compared to the current standard. Referral of all patients with active TB in

Study ID	Study setting & HIV prevalence*	Population	Study design & sample size	Screening items & criteria	Summary of findings
					India for HIV testing will be both effective and cost-effective.
Castañeda	Spain Facility-based (PC) 0.4% [0.4 - 0.5]	Adults 18-64yrs	Quasi-experimental 1-arm trial N=4287	Criteria: NS Symptoms: None (in risk-based arm) Behavioral: • Injecting drugs (current use or history of use) • Sexual partner is PLHIV • Persons engaged in transactional sex (SWs & clients) • Multiple sexual partners, • People who want to stop using condoms with their stable partner, • Victims of sexual violence, • Occupational or accidental exposure to HIV Other: • People from countries with >1% HIV prevalence and their sexual partners	Screening yield: Universal strategy identified the fewest new patients with HIV (n=2) compared to the risk-based strategy (n=5). The indicator condition strategy identified the most PLHIV (n=8) and had highest diagnostic effectiveness. The most frequent HIV indicator conditions for which an HIV test was requested were candidiasis (27%), herpes zooster (15%) and Seborrheic dermatitis (12%). Feasibility: The risk-based strategy was the strategy least likely to be viewed as feasible for implementing in all primary care settings (only 54% of providers believed it was feasible). Compared to universal strategy, the risk-based and indicator condition strategies did encourage providers to address risky practices associated with HIV with patients (67% and 70%, respectively vs. 57% in universal strategy). Cost: The direct cost of each HIV diagnosis strategy was compared. The universal strategy cost $4176 per person diagnosed compared to $894 in the risk-based strategy and $542 in the indicator condition strategy.
Key populations					

Study ID	Study setting & HIV prevalence*	Population	Study design & sample size	Screening items & criteria	Summary of findings
Yin 2018	China Facility-based NA	MSM Age range not available	Cross-sectional N=3588 Screening not validated	Criteria: Not applicable Symptoms: • Syphilis infection Behavioral: • Illegal drug use in the past 3 months • Alcohol consumption before sex in the past 3 months • Time since sexual debut • Number of lifetime male sexual partners • Number of male sexual partners in the past 3 months • Frequency of receptive anal sex in the past 3 months • Proportion of condom use during receptive anal sex • Frequency of insertive anal sex in the past 3 months • Sex with female partners in the last 3 months Other: • Beijing residency • Number of years living in Beijing	HIV prevalence: 12.7% among MSM with unknown HIV status or who last tested HIV-negative. HIV predictors: Beijing resident (yes vs. no, OR=0.55 95% CI: 0.38-0.81), years living as Beijing resident (10 yrs vs. 2 yrs, OR=0.67 95% CI: 0.52-0.86), illegal drug use in the past 3 months (yes vs. no, OR=4.35 95% CI: 2.43-7.76), alcohol consumption before sex in the past 3 months (often vs. never, OR=2.83 95% CI: 1.48-5.39), time since sexual debut (12yrs vs. 4yrs, OR=1.35 95% CI: 1.02-1.78), number of lifetime male sexual partners (20 vs. 4, OR=1.41 95% CI: 1.13-1.75), number of male sexual partners in the past 3 months (2 vs. 1, OR=0.85 95% CI: 0.73-0.99), frequency of receptive anal sex in the past 3 months (3 vs. 0, OR=1.67 95% CI: 1.25-2.24), proportion of condom use during receptive anal sex (100% vs. 0%, OR=0.49 95% CI: 0.34-0.69), frequency of insertive anal sex in the past 3 months (4 vs. 0, OR=0.78 95% CI: 0.60-1.01), sex with female partners in the last 3 months (yes vs. no, OR=0.53 95% CI: 0.34-0.81), and syphilis infection (yes vs. no, OR=2.89 95% CI: 2.13-3.93).
Smith 2015	USA Facility-based	PWID 18+yrs	Prospective cohort	Criteria: Score ≥46 Symptoms:	HIV predictors: The final logistic regression model included age, engagement in a methadone

Study ID	Study setting & HIV prevalence*	Population	Study design & sample size	Screening items & criteria	Summary of findings
	NA		N=1904 Screening validated	• STI in the past 6mo Behavioral: • Injecting heroin in the past 6mo • Injecting cocaine in the past 6mo • Sharing a cooker in the past 6mo • Sharing needles in the past 6mo • Visiting a shooting gallery in the past 6mo • Participation in a methadone maintenance program in past 6mo • Identifying as an MSM • Having sex with an PWID partner in the past 6 months • Number of heterosexual sex partners Other: • Age • Educational status • Homeless in the past 6mo	maintenance program, and a composite injection risk score obtained by counting the number of the following five behaviors reported during the past six months: injection of heroin, injection of cocaine, sharing a cooker, sharing needles, or visiting a shooting gallery. AUC: 0.720 Sensitivity: 86.2% for a score ≥46/100 Specificity: 42.5% for a score ≥46/100
Smith 2012	USA Facility-based NA	MSM Age range not available	Cross-sectional N=4386 Screening validated	Criteria: Score ≥10 Symptoms: None Behavioral: • Number of male sexual partners in the past 6 mo • Number of times you had receptive anal intercourse with a man in past 6mo	Sensitivity: 84% for a score of ≥10 out of 47. Specificity: 45% for a score of ≥10 out of 47. AUC: 0.74 PPV: 1.9% for individuals scoring ≥10. NPV: 99.5% for individuals scoring ≥10.

Study ID	Study setting & HIV prevalence*	Population	Study design & sample size	Screening items & criteria	Summary of findings
				• Number of male sex partners who were HIV-positive • Number of times had insertive anal intercourse with a man who was HIV-positive • Use of methamphetamines such as crystal or speed in past 6mo • Use of poppers (amyl nitrate) in the past 6mo Other: • Age	
Sampson 2011†	USA Community-based (prisons) NA	People in prisons or other closed settings Age range not available	Cross-sectional N=3610 Screening not validated	Criteria: Score of ≥3 Symptoms: None Behavioral: • Have male sex partners Other: • Age • Race/ethnicity • Date of last HIV test	Screening efficiency: A risk score ≥3 out of 6 will lead to screening <50% of the available inmate population. Sensitivity: 82.6% (95% CI: 71.2%-94.0%)
Children & adolescents					
Bandason 2018	Zimbabwe Community-based (survey) 13.3% [11.4 - 14.9]	Children 8-17yrs	Cross-sectional N=5384 Screening validated	Criteria: Any 1 indicator Symptoms: • Reoccurring skin problems • Previous hospitalisation • Poor health status	HIV positivity: 1.3% (95% CI: 1.0-1.8) (n=71/5384) Sensitivity: 56.3% (95% CI: 44.0-68.1) Specificity: 75.1% (95% CI: 73.9-76.3)

Study ID	Study setting & HIV prevalence*	Population	Study design & sample size	Screening items & criteria	Summary of findings
				Behavioral: None Other: • Orphanhood	PPV: 2.9% (95% CI: 2.1-3.9) NPV: 99.2% (95% CI: 98.9-99.5)
Chandra 2018	India Facility-based (OPD) 0.2% [0.2 - 0.3]	Children 2mo-5yrs	Cross-sectional N=920 Screening validated	Criteria: Two clinical signs plus one parental factor or three clinical signs Symptoms: • Pneumonia • Severe or persistent diarrhea • Acute or chronic ear infection • Very low weight or severe malnutrition • Oral thrush • Parotid enlargement • Generalized lymphadenopathy Behavioral: None Other: • Maternal/paternal chronic ill health • Orphanhood • Prolonged separation of parents • Parents from high risk group	HIV positivity: 2% (18/920) HIV predictors: Of the seven IMNCI-HIV clinical signs, generalized lymphadenopathy ($p<0.001$), oral thrush ($p<0.001$) and persistent diarrhoea ($p<0.002$) were significantly more common in HIV-positive children than in HIV-negative and had a better AUC, PPV and specificity compared with other signs. All parental factors were present significantly more commonly ($p<0.05$) in HIV-positive children than HIV-negative. Maternal illness had the highest AUC (0.77) and Yoden index (0.562) in clinically identifying HIV-positive children. The most common signs among children with an HIV-positive diagnosis were severe malnutrition (62%), while the most common parental factor was prolonged separation of parents (50%). Sensitivity: 100% for two clinical signs plus parental factor or three clinical signs. Specificity: 67.9% for two clinical signs

Study ID	Study setting & HIV prevalence*	Population	Study design & sample size	Screening items & criteria	Summary of findings
					plus parental factor or three clinical signs. PPV: 5.86% for two clinical signs plus parental factor or three clinical signs, compared to 2% in screening without questions on parental factors. NPV: 100% AUC: 0.859 for two clinical signs plus parental factor or three clinical signs.
Dunlop 2018†	South Africa Facility-based 18.8% [16.2 - 20.9]	Children & adolescents 0-19yrs	Cross-sectional N=604 Screening not validated	Criteria: Any 1 indicator Symptoms: Not available Behavioral: Not available Other: Not available	HIV positivity: 6% (n=17/263) Screening efficiency: 77.1% (n=388/503) Screening yield: 30 screened to find 1 HIV-positive individual.
Kunle 2018†	Nigeria Facility-based 1.4%**	Children Age range not available	Cross-sectional N=5921 Screening not validated‡	Criteria: Any 1 indicator Symptoms: • Reoccurring skin problems • Previous hospitalisation • Poor health status Behavioral: None Other: • Orphanhood	HIV positivity: 2% (n=n/a) Screening efficiency: 72% (4238/5921) Screening yield: Of 4,266 children tested, 62% had one point, 33% had two, 4% had three and <1% had four. HIV prevalence increased significantly with an increase in score from 1.3% among those scoring one on the screening tool to 25% among those scoring four (p<0.001). Those who scored two points

Study ID	Study setting & HIV prevalence*	Population	Study design & sample size	Screening items & criteria	Summary of findings
					were twice as likely (p=0.002), those with three points were five times more likely (p<0.0001) and those with four points were sixteen times more likely (p<0.001) to be HIV positive compared to those with only one point.
Kamwesigye 2018†	Uganda Community-based 5.9% [5.5 - 6.1]	Children (OVC) 0-17yrs	Cross-sectional N=65661 Screening not validated‡	Criteria: HIV testing was prioritised for children with unknown HIV status and 4+ risk factors. Symptoms: • Reoccurring skin problems • Previous hospitalisation • Poor health status Behavioral: None Other: • Death of a parent • Chronically ill family member • School performance	HIV positivity: 2.1% Screening yield: 13.8% of children with any four risk factors were HIV-positive, increasing to 25.4% and 39% for children with five and six risk factors, respectively.
Moucheraud 2018	Malawi Facility-based (inpatient) 9.6% [9.0 - 10.3]	Children 1-15yrs	Cross-sectional N=8602 Screening validated	Criteria: Any 1 indicator Symptoms: • Reoccurring skin problems • Frequent sickness (more other children in the last 3 months) • Previous hospitalisation • Shorter/smaller than other children of the same age • Frequent ear discharge	HIV positivity: 1.1% (n=90/8602) Screening details: The most commonly reported items were having been previously hospitalized (42%, n=3588) and being sick often (30.9%, n=2652). Screening yield: Children with a screening score of 1 had double the odds of being HIV positive compared to those with a score of 0. Only 0.4% of children with a score of 0 tested

Study ID	Study setting & HIV prevalence*	Population	Study design & sample size	Screening items & criteria	Summary of findings
				Behavioral: None Other: • Death of a parent	positive versus 13.0% of those with a score of 5. All screening items were significantly associated with HIV infection, including in adjusted models. Being of small/short stature, and having at least 1 deceased parent, had particularly strong associations with HIV status [OR=5.8 (95% CI 3.8–9.0) and 6.6 (95% CI 3.8–11.5), respectively]. Frequent sickness was the most sensitive predictor of HIV status (55.1% 95% CI 44.8%–65.4%), and having a deceased parent was the most specific (96.7% 95% CI 96.4%–97.1%). Sensitivity: 84.4% (95% CI 77.0%–91.9%) when using cutoff score of 1 or higher. A score of 2 or higher had a sensitivity of 61.1% (95% CI 51.0%–71.2%). Specificity: 39.6% (95% CI 38.5%–40.6%) when using cutoff score of 1 or higher. A score of 2 or higher had a specificity of 69.6% (95% CI 68.6%–70.6%). PPV: 1.5% (95% CI 1.1%–1.8%) when using cutoff score of 1. NPV: 99.6% (95% CI 99.3%–99.8%)

Study ID	Study setting & HIV prevalence*	Population	Study design & sample size	Screening items & criteria	Summary of findings
					AUC: The cutoff score of 1 had optimal sensitivity and specificity (partial AUC=0.35, 95% CI 0.30–0.39). Screening yield: One child would be identified as HIV positive for every 67 children tested. Missed HIV positives: 1 child per 250 screened would be falsely miscategorised as HIV negative if this screening was used with cutoff score of 1. False classification of HIV-negative status was rare (n=14).
Olatoregun 2018†	Nigeria Facility-based 1.4%**	Children 0-15yrs	Cross-sectional N=16146 Screening not validated‡	Criteria: Any 1 indicator Symptoms: • Reoccurring skin problems • Previous hospitalisation • Poor health status Behavioral: None Other: • Death of a parent	HIV positivity: 0.43% (n=69/16146), representing a 36% increase in the number of newly-diagnosed children. Testing coverage: Increased by 27% compared to baseline.
Chaila 2017†	Zambia Community-based 11.5% [10.9 - 12.3]	Adolescents 10-14yrs	Cross-sectional N=18040 Screening not validated‡	Criteria: Any 1 indicator Symptoms: • Reoccurring skin problems • Previous hospitalisation • Poor health status	Screening efficiency: 12.1% (n=2181/18040) were considered "at risk" based on the screening. Screening yield: In the "at risk" group, 4.4% (96/2181) self-reported as known HIV+ compared with 0.5% (74/15859) in the "not at risk" group. HIV

Study ID	Study setting & HIV prevalence*	Population	Study design & sample size	Screening items & criteria	Summary of findings
				Behavioral: None Other: • Death of a parent	prevalence among those tested was 2.4% (35/2085) in the "at risk" group, compared with 0.6% (44/7755) in the "not at risk" group. HIV testing uptake: 69.5% (1,449/2,085) in "at risk" group and 49.1% (7,755/15,785) in "not at risk" group.
Bandason 2016	Zimbabwe Facility-based 13.3% [11.4 - 14.9]	Children 6-15yrs	Cross-sectional N=9568 Screening validated	Criteria: Symptoms: • Reoccurring skin problems • Previous hospitalisation • Poor health status Behavioral: None Other: • Death of a parent	HIV positivity: 4.7% (95% CI: 4.2–5.1%), increasing from 1.4% among those scoring zero on the tool to 63.6% among those scoring four (p<0.001). Sensitivity: 80.4% (95% CI: 76.5–84.0%) for cutoff score ≥1. Specificity: 66.3% (95% CI: 65.3–67.2%) for cutoff score ≥1. PPV: 10.4% NPV: 98.6% Screening yield: The number needed to screen to identify one child living with HIV would drop from 22 to 10 if this screening tool was used.
Ferrand 2011	Zimbabwe Facility-based (PC)	Adolescents 10-18yrs	Cross-sectional N=506 Screening validated	Criteria: Not specified Symptoms: • Signs or symptoms of STIs • Reoccurring skin problems • Prior hospitalisation	HIV positivity: 17% (n=86) HIV predictors: Orphanhood, hospitalisation, recurrent skin problems, presentation with a STI and poor functional ability were independently

Study ID	Study setting & HIV prevalence*	Population	Study design & sample size	Screening items & criteria	Summary of findings
	13.3% [11.4 - 14.9]			Behavioral: None Other: • Death of a parent • Poor health affecting daily function in past 3mo	associated with increased risk of HIV infection in the multivariable analysis. Sensitivity: 77% using a cutoff of p=0.12 in the trainer data set; 74.0% (95% CI: 64%–82%) in the test data set. Specificity: 81% using a cutoff of p=0.12 in the trainer data set; 80% (95% CI: 71%–87%) in the test data set. Screening yield: Screening correctly classified HIV status of 79% of participants. The algorithm had high estimated NPV in both low- and high-HIV-prevalence settings, resulting in an estimated 60% decrease in number of adolescents needed to test to identify one HIV-infected individual, compared with universal testing.
Mixed populations					
Haukoos 2015	USA Facility & community-based NA	Adolescents and adults 13+yrs	Cross-sectional N=4830941 Screening validated	Criteria: Not specified Symptoms: None Behavioral: • Sex with a male • Injection drug use Other: • Age • Gender • Race/ethnicity	HIV positivity: 0.6% (n=30,080). The prevalence of newly-diagnosed HIV infection within each of the 5 DHRS risk groups were: 0.20% (95% CI: 0.19% – 0.20%) [n=856/432674]; 0.17% (95% CI: 0.16% – 0.17%) [n=2168/1312427]; 0.39% (95% CI: 0.38% – 0.40%) [n=7771/2003857]; 1.19% (95% CI: 1.16% – 1.21%) [n=9617/811501]; and 3.57% (95% CI: 3.50% – 3.65%) [n=9668/270482].

Study ID	Study setting & HIV prevalence*	Population	Study design & sample size	Screening items & criteria	Summary of findings
				• Past HIV testing	Screening efficiency & yield: The top 3 risk groups (scores ≥30) represented only 63% (n=3085840/4830941) of the cohort, yet 90% (n=27056/30080) of newly-diagnosed HIV infections, whereas the top 2 risk groups (scores ≥40) represented only 22% (n=1081983/4830941) of the cohort, yet 64% (n=19285/30080) of newly-diagnosed HIV infections. Validation details: The risk score demonstrated excellent calibration (predicted vs. observed HIV prevalence; regression slope: 1.09) and good discrimination (AUC: 0.77)
Hseih 2014	USA Facility-based (ED) NA	Adolescents and adults <64yrs	Cross-sectional N=15184 Screening validated	Criteria: Not specified Symptoms: None Behavioral: • Sex with a male • Injection drug use Other: • Age • Gender • Race/ethnicity • Past HIV testing	HIV positivity: 0.75% (n=114/15184). HIV prevalence was 0.41% (95% CI: 0.21% – 0.71%) for those with a score <20; 0.29% (95% CI: 0.14% – 0.52%) with a score of 20–29; 0.65% (95% CI: 0.48% – 0.87%) with a score of 30–39; 2.38% (95% CI: 1.68% – 3.28%) with a score of 40–49; 4.57% (95% CI: 2.09% – 8.67%) with a score ≥50. Validation details: External validation resulted in good discrimination (AUC=0.75, 95% CI: 0.71–0.79). The calibration regression slope was 0.92 and its R2 was 0.78.
Haukoos 2013	USA	Adolescents and adults	Prospective before-after	Criteria: Score ≥30	HIV positivity: 1.3% (95% CI: 0.5%-2.6%, n=7/551) in targeted screening with

Study ID	Study setting & HIV prevalence*	Population	Study design & sample size	Screening items & criteria	Summary of findings
	Facility-based (ED) NA	13+yrs	N=78784 Screening validated[§]	Symptoms: None Behavioral: • Sex with a male • Vaginal intercourse • Receptive anal intercourse • Injection drug use Other: • Age • Gender • Race/ethnicity • Past HIV testing	screening tool; 0.2% (n=7/3591) in non-targeted screening. HIV prevalence was higher among those tested during the targeted screening phase compared to the non-targeted phase (difference 1.1%, 95% CI: 0.1%-2.0%). Screening efficiency: During screening phase, 17726 patients completed the Denver HIV Risk Score and 1718 (10%, 95% CI: 9%-11%) were identified as high risk, of which 1584 (92%) were offered testing. In the non-targeted phase, 19634 (67%) were offered HIV testing. HIV testing uptake: Acceptance and completion of HIV testing was higher during the targeted phase (difference 16.4%, 95% CI: 14.1%-18.9%) compared to the non-targeted phase.
Haukoos 2012	USA Facility-based (STI/ED) NA	Adolescents and adults 13+yrs	Cross-sectional N=92635 Screening validated	Criteria: Score ≥30 Symptoms: None Behavioral: • Sex with a male • Vaginal intercourse • Receptive anal intercourse • Injection drug use Other: • Age	HIV positivity: 0.54% (n=504/92635) in the derivation sample; 0.73% (n=168/22983) in the validation sample. For persons with scores of <20, 20–29, 30–39, 40–49, and 50 in the validation sample, HIV prevalence was 0.31% (95% CI: 0.20-0.45, n=27/8782), 0.41% (95% CI: 0.29-0.57, n=36/8677), 0.99% (95% CI: 0.63-1.47, n=24/2431), 1.59% (95% CI: 1.02-2.36, n=24/1505) and 3.59% (95% CI: 2.73-4.63, n=57/1588), respectively.

Study ID	Study setting & HIV prevalence*	Population	Study design & sample size	Screening items & criteria	Summary of findings
				• Race/ethnicity • Past HIV testing	Screening yield: In the validation sample, the top 3 highest risk groups represented 62.5% (95% CI: 54.7-69.8, n=105/168) of all patients diagnosed with HIV infection yet only 24% (95% CI: 23.5-24.6, n=5524/22983) of the sample. AUC: 0.86 (95% CI: 0.84-0.88) for the derivation sample and 0.75 (95% CI: 0.70-0.78) for the validation sample.

Abbreviations: Area under the Receiver Operating Characteristic curve [AUC]; Confidence Interval [CI]; Emergency department [ED]; Negative Predictive Value [NPV]; Outpatient department [OPD]; Odds Ratio [OR]; Primary care [PC]; Person years [PY]; Positive Predictive Value [PPV], Randomised controled trial [RCT]; Relative Risk/Risk Ratio [RR], Receiver Operating Characteristic [ROC]; Sexually transmitted infection [STI].

*2017 country HIV prevalence estimates for adults (15-49yrs) by UNAIDS sourced from AIDSInfo [www.aidsinfo.unaids.org].

**When UNAIDS HIV prevalence estimates were not available, the authors searched for other estimates. Nigeria data are from NAIS survey conducted in 2018. No HIV prevalence estimates were identified for the USA, Canada or China.

†Conference abstract only.

‡Screening not validated, but adapted from tool validated elsewhere. In most cases, such studies utilized the pediatric HIV screening tool from the validated Bandason 2016 study.

§Screening validated in another study by the same authors in the same population.

Appendix 3: Summary of collected programmatic HIV screening tools

Country & Organization	Population	HIV screening questions	Screening tool details
General population adults			
Belgium	Adults	# of questions: 18 Type: Symptoms, STI or indicator condition, HIV exposure related to MSM, injecting drugs and country of origin	Facility-based A list of characteristics of patients at heighted risk for HIV was provided to health providers. Providers were instructed to offer an HIV test at least once per year to patients at heighted risk, including men who have sex with men, people who inject drugs, people originating in sub-Saharan Africa, and people who had a sexual encounter with someone from a high risk group. Providers were also instructed to offer an HIV test if any patient presents with an HIV-indicator condition (STI, Hepatitis B or C, cervical dysplasia, Herpes zoster, Seborrheic dermatitis/ exanthema, unexplained fever or unexplained leukocytopenia/ Thrombocytopenia). If a patient presented with any of seven other symptoms listed on the screening tool, providers were instructed to make an assessment of the patient's country of origin and behavior in order to determine whether to offer an HIV test.
Cameroon	Adults	# of questions: 6 Type: STI symptoms, TB symptoms, HIV exposure (condom use, multiple partners)	Assessment included in register where HIV test result is recorded Multiple choice answers are color coded – if at least one 'red' answer, testing is offered; if four 'yellow' answers, testing is offered; if all answers 'green' then offer HIV prevention counselling only
Cameroon	Adults	# of questions: 7 Type: Symptoms indicative of seroconversion or AIDS-defining illness, HIV exposure by condomless sex, injecting drugs, sex with a partner who they think may be HIV+ or experience of sexual violence	This tool is a flowchart indicating for providers to offer an HIV test to those who have not tested in the last 12 months For those who have tested in the last 12 months, providers offer an HIV test to those reporting high risk since their last test

Eswatini* PSI	Adults	# of questions: 9 Type: Ever tested for HIV, partner's HIV status, condomless sex, pregnancy, contact with bodily fluids, injecting drugs, STI symptoms	Conducted at fixed and mobile testing sites The tool consists of a conversation guide that assists counselors to understand the level of HIV risk through sexual behavior and the testing history of the client The counselor makes a determination of the client's risk of having acquired HIV based on the time interval since the last HIV test and the screening questions. The counselor advises low risk clients that an HIV test is not recommended Tool has been validated. Based on a quick validation analysis, the following performance data was recorded for the tool: Sensitivity=75%; Specificity=61%; PPV=12%; NPV=95%. Screening efficiency reduced the number of people tested (121/300) and increased HIV positive yield from 7.7% to 12.4%. After the quick validation, a larger validation analysis was conducted in which the following performance data was found: Sensitivity=93% ; Specificity=31% ; PPV= 7%; NPV=99%. Screening was conducted for 70% of patients (1097/1574) and HIV positive yield increased from 5.1% to 6.7% with the screening tool. Out of the total number of 80 HIV positive new cases identified, 6 (8%) would have been missed if the recommendations based on the screening tool would be used.
Eswatini	Adults	# of questions: 7 Type: History of STI, needle-sharing, HIV exposure by condomless sex with HIV+ partner or partner with unknown status, multiple partners, contact with bodily fluids, sex under influence of alcohol or drugs	Screening questionnaire for adults found on same page as children's screening. HIV test offered if client has never tested or has not tested in the last 12 months. If tested negative in the last 12 months, conduct screening to determine whether to offer HIV test at this visit
Eswatini AIDSFree / EGPAF	Adults 15+yrs	# of questions: 7 Type: History of STI, needle-sharing, HIV exposure by unprotected sex, multiple partners, contact with bodily fluids	Facility-based Screening assessment initiated if last HIV test was negative <12mo ago 1 "yes" response prompts offer of testing
Malawi** BMGF	Adults	# of questions: 3	Facility-based/OPD in HIVST trial Administered by Facility Expert Clients

		Type: Overall health status, 2 or more health consultations in past 6 months, date of last HIV test	Tool also collected client's sex, age and whether they were motivated to test by a facility health talk Evaluation of screening tool in progress (pilot). The evaluation is testing the screening sensitivity and specificity based on several combinations of screening questions.
Malawi** Partners in Hope	Adults	# of questions: 4 Type: Last HIV >12mo ago, very poor health, 2 or more health consultations in the last month, received health services in last month	Facility-based Aimed to create a short screening that can be conducted in a non-private setting without sensitive questions Men 25 to 49yrs were screened in for testing based on retesting guidelines (not the questionnaire) HIV positivity yield ranged from 5-7% for each individual question. Receiving any health service in last month was most sensitive (71%) and most specific (44%) question
Malawi OneCommunity	Adults >15yrs	# of questions: 19 Type: STI symptoms, TB symptoms, general health, sexual partner or child of PLHIV, client of FSW, KP or high risk occupation, sexual violence, pregnant/breastfeeding, condomless sex, alcohol consumption before or after sex	Community-based Administered by HTS counsellor Tool includes consent form to conduct risk assessment and general questions about last HIV test 1 "yes" response prompts offer of testing
Malawi	Adults 15+yrs	# of questions: 4 Type: Date of last HIV test (initial screening), HIV/TB symptoms, STI symptoms, condomless sex with person who is not your spouse and is HIV+ or unknown status, divorced/separated/widowed	Facility or community-based (in all modalities) In an effort to test more men, providers are instructed not to conduct the screening questionnaire if the client is a man between 25 and 49 years of age. Rather, test for HIV based on retesting guidelines. Validation conducted, but not data available at this time.

Multi-country: Nigeria, Kenya, Zimbabwe FHI360	Adults 16+yrs	# of questions: 5 Type: STI symptoms, TB symptoms, condomless sex, general health condition, sexual partner in chronic ill health or who has died in past 5yrs	Administered by HTS counselor Screening assessment initiated if last HIV test was negative 1 "yes" response prompts offer of testing Tool includes list of types of clients who are eligible for routine testing (i.e. do not need screening), including HIV-negative discordant partner, pregnant woman not tested at first ANC visit, pregnant women at delivery without documented HIV test, breastfeeding women without test in last 3 months or with other HIV risks, client reporting positive HIVST result, etc.
Multi-country: Nigeria, Kenya, Zimbabwe FHI360	Adults	# of questions: 5 Type: STI symptoms, TB symptoms, condomless sex, general wellness	Facility-based/OPD (will also be rolled out in community settings) Administered by CHWs 1 "yes" response prompts offer of testing Includes space to record test result Validation in progress
Mozambique	Adults	# of questions: 13 Type: symptom-based (9) & HIV exposure (condom use, multiple partners, HIV+ partner)	Conduct assessment and then if 1 or more 'yes' response, testing is offered if last HIV test was >3mo ago
Nigeria* FHI360	Adults	# of questions: 9 Type: STI symptoms, Tb symptoms, condomless sex, sexual or needle-sharing partners, date of last HIV test	1 "yes" response prompts offer of testing Formatted as a flowchart to indicate testing Validation completed - Reviewed questionnaire and test results of 1455 clients - In community implementation, HIV positivity identified by screening tool was 5.6%; actual HIV positivity was 8.7% - Sensitivity: 96.1% - Specificity: 24.9% - Also evaluated sensitivity and specificity of individual questions

			- Reduced offer of HTS by 76.9%
Nigeria	Adults	# of questions: 13 Type: Condomless sex, STI symptoms, transactional sex, sexual violence, TB symptoms, blood transfusion, Herpes zoster, skin rash	Facility-based 1 "yes" response prompts offer of testing
Tanzania Bukoba Combination Prevention Evaluation (BCPE)	Adults 15+yrs	# of questions: 14 Type: TB symptoms, STI symptoms, & HIV exposure (unprotected sex, injecting drugs, sex under influence of drugs/alcohol)	Facility and community-based Peer-administered Screening assessment initiated if last negative HIV test >12mo ago 1 "yes" response prompts offer of testing Screening and test result recorded in separate register Validation in progress
Tanzania**	Adults	# of questions: 8 Type: Sexual activity or married, mother is PLHIV, date of last HIV test & result, condomless sex with HIV+ partner	Facility-based/OPD 1 "yes" response prompts offer of testing Client not eligible for HIV testing if tested in the last 3 months Evaluation data is available. Screening increased HIV positive yield from 2.6% to 4.2%. Ineligible clients tested HIV positive (1.5%), representing some missed diagnoses.
Ukraine*	Adults 15-55 yrs	# of questions: 10 Type: Sex, age, region of residence, condomless sex, transactional sex, anal sex, inject drugs, sex with a partner who injects drugs, ever in prison, ever tested for HIV	Self-administered or provider-administered on Telegram App Responses to the screening tool were scored with assigned numerical values depending on the answer. Individuals were informed of their very high, high, middle, low, or very low risk for HIV along with information about locations of HIV testing sites or online HIV test procurement Screening tool was validated

			• When testing individuals at high risk only, HIV yield increased from 2% to 9% with a sensitivity of 76% and a specificity of 84%. Four individuals with HIV were missed (4/794) • When testing individuals at middle and high risk, HIV yield increased from 2% to 4% with a sensitivity of 94% and specificity of 45%. Only one individual with HIV was missed (1/794) • When cases of females aged 40-49 in the Kyiv region with multiple partners and condomless sex were recoded from low HIV risk to middle risk, the screening tool became more effective with 100% sensitivity and 40% specificity and no missed diagnoses (0/793). In this scenario, HIV yield increased from 2% to 4%. • The questions which statistically significantly predicted HIV were having more than one sexual partner, injecting drugs, sex with a PWID, anal sex, HIV+ sexual partner, ever in prison
Ukraine*	Adults	# of questions: 5 (males); 4 (females) Type: Has health provider ever said you were HIV-positive; date of last HIV test; condomless sex with multiple partners; transactional sex; sex with HIV-positive partner; inject drugs; sex with partner who injects drugs; ever in prison; receptive anal sex with male partner (males only); between ages of 30-55yrs (males only)	Paper-based tool depicting flowchart with questions which differed for men and women. Personal questions on HIV sexual risk behaviours are grouped such that patient does not indicate which specific risk behaviour they engaged in Screening tool was validated • When testing individuals at middle and high risk, HIV yield increased from 2% to 3% with a sensitivity of 87% and specificity of 44%. Two individuals with HIV were missed (2/803)
Uganda	Adults	# of questions: 12 Type: "Test today" was indicated for HIV signs & symptoms, recent STI, TB or presumptive TB, recent hospitalization (past 3-6mo), sexual partner is/was HIV+	Facility-based Tool is a flowchart for re-testing for HIV. Time intervals for testing are given depending on the client category from "test today" to "test 4 weeks after exposure" to "test every 3 months." This is not a questionnaire, but it could be used as such to determine the client's category for re-testing
Zambia	Adults 15+yrs	# of questions: 4	1 "yes" response prompts offer of testing Screening questions asked if last HIV test was within the last 12mo

		Type: STI symptoms, TB symptoms, condomless sex with PLHIV or unknown status, sex with someone from online/phone app/bar/gym	If client is a man between 25 and 49 years of age, test for HIV without conducting the screening questions
Zambia** He2ro	Adults 15+yrs	# of questions: 3 Type: Age, sex, date of last HIV test	A simple algorithm based on the date of the client's last HIV test (no testing if last test <6 months ago) was compared to regional algorithms which considered age and sex in determining whether to offer an HIV test. HIV positive yield was compared. Evaluation data is available. The regional simple algorithm had highest yield of HIV positives (12%) compared to machine-learning regression-based targeting (10.4%).
Children & adolescents			
Cameroon KIDSS	Children & adolescents (OVC)	# of questions: 7 (+3 for adolescents) Type: symptom-based, family medical history, child's medical history	HIV assessment includes special screening for adolescents, separate assessment for children who already tested HIV positive Part of a comprehensive initial assessment which also covers education, nutrition, household economic strengthening, GBV, positive parenting Includes summary of assessment and action plan
Cote d'Ivoire Save the Children	Children 0-19yrs	# of questions: 13 (+3 for adolescents 10-19yrs) Type: Family medical history, child's basic needs are met, child-headed household, child works on farm/mine/other seasonal work, orphanhood, victim of violence, symptoms	Screening tool is in French The tool includes a risk assessment of the child/adolescent and an interview with the child's parent If 3 or more "yes" responses, conduct HIV test
Eswatini	Children & adolescents 6-15yrs	# of questions: 4 Type: Death of one or both parents, previous hospitalization, reoccurring skill problems, general health	Screening questionnaire for children found on same page as adult's screening. HIV test offered if client has never tested or has not tested in the last 12 months. If tested negative in the last 12 months, conduct screening to determine whether to offer HIV test at this visit

Malawi 4 Children	Children <18yrs	# of questions: 9 Type: Death or disability of parent or sibling, family member living with HIV, previous hospitalization, malnutrition, general health, disability	Screening questionnaire on tool where responses can be recorded, including a final yes/no determination on child's eligibility for testing and whether or not parental consent has been obtained 1 "yes" response prompts offer of testing
Malawi OneCommunity	Children (OVC) <15yrs	# of questions: 15 Type: Mother PLHIV or FSW, sexually abused/exploited, previous hospitalization, STI symptoms, TB symptoms, general health, malnutrition, child-headed household, pregnant, slow developmental growth	Community-based Administered by HTS counsellor Tool includes parental consent form to conduct risk assessment and general questions about last HIV test 1 "yes" response prompts offer of testing
Malawi	Children	# of questions: 8 Type: TB symptoms, weightloss, death of one or both parents, general health in last 3 months, previous hospitalization	1 "yes" response prompts offer of testing
Malawi	Children <15yrs	# of questions: 8 Type: symptom-based, family medical history, child's medical history	Facility-based/OPD Administered by lay cadres 1 "yes" response prompts offer of testing
Multi-country: Tanzania, Uganda, Zimbabwe	Children (OVC)	# of questions: 7 (+1 adolescents) Type: Previous hospitalization, reoccurring skin problems, orphanhood, general health, health of family members, school achievement, genital discharge/sores (adolescents only)	This is a prototype risk screening tool for orphans and vulnerable children (OVC) Includes one additional question to ask adolescents Instructions are to screen all adolescents in private settings and to refer them systematically for HIV testing if they are sexually-active

Namibia Project Hope	Children & adolescents (OVC) <18yrs	# of questions: 7 Type: Child sexual activity/pregnancy, age of sexual partner, condomless sex, circumcision, STI symptoms (sores/discharge)	HIV risk assessment tool is incorporated within larger OVC assessment which asks about general health, TB symptoms, food and nutrition, education, psychosocial support, legal protection, economic security, and shelter and care. At the end of the OVC assessment, an individual service plan is noted with actions, which could include HIV testing HIV risk assessment questions are asked directly to the child when they are >12 years old
Namibia Project Hope	Children & adolescents (OVC) <18yrs	# of questions: 10 (child) & 8 (adult) Type: child medical history, child HIV exposure, child living conditions, adult caregiver medical history	Community-based/home Separate sections in assessment for children and adult caregivers If 1 or more 'yes' response, child determined 'vulnerable' and caregiver determined eligible for home-based care Level of care needed determined on scale of 1-5 after assessment completed (criteria unclear from tool)
Nigeria	Children & adolescents (OVC) 0–17yrs	# of questions: 10 (+6 for adolescents) Type: family medical history, child medical history, abuse, blood transfusion, adolescent sexual activity/pregnancy/sexual orientation, adolescent STI symptoms, adolescent household vulnerability	Community-based Consent from caregiver required Children <2yrs referred for EID Separate section with assessment for adolescents (10-17yrs) If caregiver/head of household/parent knows their HIV status, then screening is terminated 1 "yes" response prompts offer of testing
Nigeria	Children	# of questions: 10 Type: family HIV status, child and family medical history, child ever experienced sexual violence,	Consent from caregiver required If child is <18mo, referred for EID 1 "yes" response prompts offer of testing; electronic questionnaire automatically prompts for HTS based on eligibility

		malnutrition, blood transfusion, child sexual activity/pregnancy	
Nigeria HIFASS	Children & adolescents <18yrs	# of questions: 10 (+3 for adolescents) Type: Age, date of last HIV test, parent or sibling living with HIV or TB, general health, previous hospitalization, skin problems, general health of family members, sexual abuse, school achievement, sexual activity (adolescent only), STI symptoms (adolescent only)	1 "yes" response prompts offer of testing After assessment, child and caretaker are referred or escorted to HIV testing
Tanzania PACT/Kizazi Kipya	Children & adolescents (OVC) 0-19yrs	# of questions: 17 (+2 for adolescent boys, +3 for adolescent girls); 9 (HIV+ OVC only) Type: child medical history, child living conditions, family medical history, caregiver HIV exposure via sex work or injecting drugs, child ever experienced abuse, child TB symptoms, child developmental delays, adolescent sexual activity/pregnancy	Community-based/home Child and caregiver interviewed for assessment Administered annually by community case worker volunteers Additional section in assessment for HIV+ children 1 or more 'yes' response indicates referral for HTS for HIV- OVC and in HIV+ section, 1 or more 'no' response indicates referral for care for HIV+ OVC
Tanzania Bukoba Combination Prevention Evaluation (BCPE)	Children <15yrs	# of questions: 10 Type: TB symptoms & HIV exposure (family history of HIV, general poor health, skill problems)	Facility and community-based Peer-administered Screening assessment initiated if last negative HIV test >12mo ago 1 "yes" response prompts offer of testing Screening and test result recorded in separate register Validation in progress

Uganda	Children & adolescents	# of questions: 10 Type: General health, previous hospitalization, death of parent, mother is PLHIV, skin problems, weightloss, STI symptoms, TB history, poor growth, difficulty with daily activities	N/A
Zambia	Children <15yrs	# of questions: 7 Type: Death of parent, parent is HIV+, developmental delays, TB symptoms, ear discharge, skin problems	Screening questionnaire only for children who never tested or who do not have a documented HIV test result 1 "yes" response prompts offer of testing
Zambia ZAMFAM	Children & adolescents 0-17yrs	# of questions: 9 Type: Mother or siblings HIV+, death of a parent, poor health, sexual violence, sexually-active/married, school achievement, engaged in domestic service, age (15+yrs)	Community-based/door-to-door Administered by CHWs or other lay providers Screening questionnaire only for children who have not tested in the last 12mo and who are not HIV+ 1 "yes" response prompts offer of testing
Zimbabwe	Children	# of questions: 4 Type: Previous hospitalization, skin problems, death of parent, general health	Facility-based/OPD Administered by lay providers 1 "yes" response prompts offer of testing Based on Bandason et al. validated screening tool
Zimbabwe	Adolescents 10-19yrs	# of questions: 5 Type: Previous hospitalization, skin problems, death of parent, general health, STI symptoms	Facility-based/OPD Administered by lay providers 2 "yes" response prompts offer of testing Based on Ferrand et al. validated screening tool

Mixed age groups			
Botswana	Adults & children	# of questions: 5 (+3 for children) Type: TB symptoms, HIV status at last test, TB contact in last 2 yrs (children only), decreased playfulness (children only)	Facility-based This tool screens for presumed TB cases and includes a referral for HIV testing Combined adult and pediatric tool with additional questions for children and a key at the bottom outlining the duration of symptoms which are eligible by age (ex: for adults, cough of any duration – but for children, cough of longer than two weeks)
DRC EGPAF	Adults & children	# of questions: 10 (adults), 11 (children) Type: Symptoms, HIV exposure	Combined tool with separate questions for adults and children Adult questionnaire asks about risk behaviors including multiple partners or partner living with HIV 1 "yes" response prompts offer of testing
DRC	Adults, adolescents (15yrs+) & children (<15yrs)	# of questions: 16 (adults), 8 (children), 8 (adolescents) Type: Symptoms, HIV exposure	Facility-based/OPD or in-patient Combined tool with separate questions for adults and children Adolescent questionnaire asks about signs or symptoms of STIs Adult questionnaire asks about risk behaviors incl multiple sexual partners, transactional sex 1 "yes" response prompts offer of testing
Multi-country: Nigeria, Kenya, Zimbabwe FHI360	Adults (15+yrs) & adolescents (10-14yrs)	# of questions: 2 Type: STI or TB symptoms, date of last HIV test & result	Expanded HIV testing decision-making algorithm focused on date of last HIV test and test result. Clients are eligible for testing if their last HIV-negative test was >3 months ago and they were exposed to risks within the last month, their last HIV test was positive and unverified, their last test was HIV-negative and unverified or they have never tested. Clients who have STI or TB symptoms are also eligible.
Tanzania	Children, adolescents & adults	# of questions: 9 (children & adolescents), 12 (adults)	1 "yes" response prompts offer of testing Client will not be offered HTS if they answer "no" to all questions, however, if client is low risk and insists on being tested, HTS will still be offered

	<5 / 5-14 / 15+yrs	Type: Child or adolescent - Malnutrition, TB symptoms, mother has unknown HIV status, sexual violence, medical history, blood transfusion, Adults – date of last HIV test, STI symptoms, health of partner, condomless sex	

*Validation data has been collected for these tools.

**Some evaluation data is available.

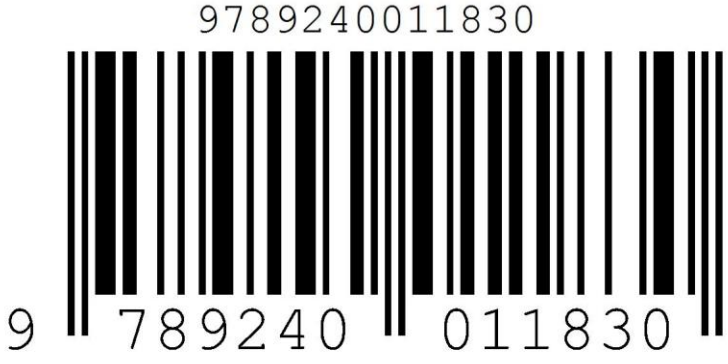
Appendix 4: Frequency of screening questions in validated tools for adults, key populations and children & adolescents (n=19)

Category of screening question	Screening questions	n	%	Citations
	General adult population (n=11)			
Symptoms/ history	Does individual have an STI? Does the individual currently have or have they been treated for an STI in the last 6 months? Has the individual ever experienced symptoms of an STI? Does individual have Herpes Simplex Virus type 2?	6	54.55%	(22, 24, 26) (24); Nigeria (FHI360); Eswatini (PSI)
	Has the individual had the following symptoms in the last 6 months: persistent and unresolved cough for >2 weeks, weight loss, night sweats, prolonged and unresolved skin rash?	1	9.09%	Nigeria (FHI360)
Behaviours (drug)	Does the individual inject drugs? Does the individual inject drugs and share needles, syringes, other drug equipment with others?	7	63.64%	(28, 29, 31, 33); Eswatini (PSI); Ukraine (paper-based) Ukraine (app-based)
	Has the individual used alcohol in the past 3 months?	2	18.18%	(24, 26)
Behaviours (sexual)	Does the individual have sex with males or both males and females? (asked to male clients only) Does the individual have receptive anal intercourse? / anal intercourse with a male partner Does the individual have vaginal intercourse? (yes answer reduces risk score)	6	54.55%	(28, 29, 31, 33); Ukraine (paper-based) Ukraine (app-based)
	Does the individual have a sexual partner who is HIV-positive? Does the individual have a sexual or needle-sharing partner with known or unknown HIV positive status?	3	27.27%	Eswatini (PSI); Nigeria (FHI360); Ukraine (paper-based)
	Has the individual received/provided payment for sex?	2	18.18%	Ukraine (paper-based); Ukraine (app-based)
	Does the individual have a sexual partner with multiple sexual partners (or unknown)?	2	18.18%	(24, 26)
	Does the individual have unprotected (condomless) sex? Has the individual had unprotected penetrative sex (vaginal, anal, oral) in the last 6 months? Does the individual have condomless sex?	3	27.27%	Eswatini (PSI); Nigeria (FHI360); Ukraine (app-based)

	Does the individual use condoms consistently and correctly?			
	Does the individual have more than 2 (3) sexual partners? How many sexual partners does the individual have? Does the individual have more than one sexual partner known or unknown HIV status in the last six months?	4	36.36%	(22); Ukraine (paper-based); Nigeria (FHI360); Eswatini (PSI)
	Was individual's sexual debut before they were 16 years old?	1	9.09%	(22)
	Has the individual ever taken care of someone/came in contact with bodily fluids after their last HIV test/in the past 2 months?	1	9.09%	Eswatini (PSI)
Demographics	What is the individual's age? Is the individual <25 years old?	9	81.82%	(28, 29, 31, 33) (22, 24, 26); Ukraine (paper-based); Ukraine (app-based)
	Is the individual male?	5	45.45%	(28, 29, 31, 33); Ukraine (app-based)
	What is the individual's race/ethnicity? (Is the individual Black or Hispanic?)	4	36.36%	(28, 29, 31, 33)
	Has the individual ever been incarcerated?	2	18.18%	Ukraine (paper-based) Ukraine (app-based)
	Is the individual unmarried or not living with husband/primary partner?	2	18.18%	(22, 24)
	What region of the country does the individual currently live?	1	9.09%	Ukraine (app-based)
Other	Has the individual been tested for HIV before? What was the date of last HIV test?	8	72.73%	(28, 29, 31, 33); Eswatini (PSI); Nigeria (FHI360); Ukraine (paper-based); Ukraine (app-based)
	Has a healthcare provider ever told the individual they were HIV-positive?	1	9.09%	Ukraine (paper-based)
	Does the sexual partner not provide financial or material support to the individual?	1	9.09%	(24)
	Has the individual had less than 3 pregnancies?	1	9.09%	(22)
	Does the individual use injectable contraceptives?	1	9.09%	(22)
	Has the individual been forced to have sex against their will (sexual abuse or rape) in the last 6 months or since last HIV test?	1	9.09%	Nigeria (FHI360)
	Has the individual had a blood transfusion or medical procedure since last HIV test?	1	9.09%	Nigeria (FHI360)
Key populations (n=3)				
Symptoms/	Does the individual have syphilis?	2	66.67%	(23, 30)

history	Has the individual had an STI in the past 6 months?			
Behaviours (drug)	Has the individual consumed alcohol before sex in the past 3 months?	1	33.33%	(23)
	Has individual had sex with a PWID partner in the past 6 months?	1	33.33%	(30)
	Has the individual visited a shooting gallery in the past 6 months? Has the individual participated in a methadone maintenance program in the past 6 months? Has the individual consumed illegal drugs in the past 3 months? In the past 6 months, has the individual injected heroin or cocaine? Has the individual used methamphetamines such as crystal or speed in past 6 months? Has the individual used poppers (amyl nitrate) in the past 6 months?	3	100%	(23, 30, 34)
	In the past 6 months, has the individual shared a cooker or needles?	1	33.33%	(30)
Behaviours (sexual)	How many times did the individual have receptive anal intercourse in the past 3 months (6 months) with a man? How many times did the individual have insertive anal intercourse (with a man who was HIV+) in the past 3 months (6 months)?	2	66.67%	(23, 34)
	How often the individual use condoms during receptive anal intercourse?	1	33.33%	(23)
	What is the number of heterosexual partners in the past 6 months? Has the individual had sex with any female partners in the past 3 months?	2	67.67%	(23, 30)
	What is the number of lifetime male sexual partners of the individual? What is the number of male sexual partners in the past 6 months?	2	67.67%	(23, 34)
	How many male partners were HIV-positive?	1	33.33%	(34)
	When was the individual's sexual debut?	1	33.33%	(23)
Demographics	What age is the individual?	2	66.67%	(30, 34)
	Does the individual identify as MSM?	1	33.33%	(30)
	Is the individual a resident of Beijing?	1	33.33%	(23)

	How many years has individual been a resident of Beijing?			
Other	What is the individual's educational status?	1	33.33%	(30)
	Has the individual been homeless in the past 6 months?	1	33.33%	(30)
Children & adolescents (n=5)				
Symptoms/ history	Has the child ever been admitted to the hospital?	4	80.00%	(10, 15, 27, 35)
	Has the child had poor health in the last 3 months? How do you rate the child's general health (excellent, good, fair, poor)? Is the child sick more often than other children in the past 3 months?	4	80.00%	(10, 15, 27, 35)
	Has the child been having reoccurring skin problems?	4	80.00%	(10, 15, 27, 35)
	Does the child have acute or chronic ear infection? Does the child have frequent ear discharge?	2	20.00%	(10, 16)
	Does the child have pneumonia?	1	20.00%	(16)
	Does the child have persistent or severe diarrhea?	1	20.00%	(16)
	Is the child very low weight or have severe malnutrition?	1	20.00%	(16)
	Does the child have oral thrush?	1	20.00%	(16)
	Does the child have parotid enlargement?	1	20.00%	(16)
	Does the child have generalized lymphadenopathy?	1	20.00%	(16)
	Does the child have signs or symptoms of an STI?	1	20.00%	(35)
Behaviours	None			
Demographics	Are one or both of the child's parents deceased?	5	100.00%	(10, 15, 16, 27, 35)
	Are child's parents from a high risk group?	1	20.00%	(16)
Other	Do child's mother or father have chronic ill health?	1	20.00%	(16)
	Is the child shorter or smaller than other children in their age group?	1	20.00%	(10)
	Has there been prolonged separation of child's parents?	1	20.00%	(16)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