Determining the screening frequency for sexually transmitted infections for people who use HIV pre-exposure prophylaxis: a systematic review and meta-analysis

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RESEARCH IN CONTEXT

Evidence before the study

People who use pre-exposure prophylaxis (PrEP) for HIV have high prevalence of sexually transmitted infections (STI) at baseline and high incidence of STI during PrEP use. Although the World Health Organization and several national PrEP guidelines recommend frequent STI screening, there is no consensus on the optimal frequency. We searched PubMed using the terms ("HIV") AND ("pre-exposure prophylaxis" OR "PrEP") AND ("sexually transmitted infection" OR "sexually transmitted disease") AND ("review") on 23rd August 2022. We identified several systematic reviews related to STI prevalence and incidence but none that summarized the impact of different frequency of STI screening among people who use PrEP.

Added value in this study

This systematic review and meta-analysis consolidate the evidence for determining the screening frequency for STIs. For chlamydia and gonorrhoea, the positivity was approximately 50% and 75% lower, respectively, in studies that screened 4-6 monthly compared to studies that screened 2-3 monthly. However, there was no significant difference in the positivity for syphilis in studies that screened 4-6 monthly compared to 2-3 monthly. Adherence of clients to recommendations for 2-3 monthly screening was relatively low for all pathogens. Substantial variations were also found in adherence to 2-3 monthly sample collection for different anatomical sites for gonorrhoea and chlamydia (39-94%). From modelling studies, we found that increased STI screening could reduce STI incidence, and one study from the Netherlands reported that three-monthly screening for chlamydia and gonorrhoea among MSM on PrEP was not cost-effective compared to six-monthly screening. There were also no studies that provided data on antimicrobial resistance (AMR) induced by more frequently diagnosed infections.

Implications of the available evidence

Though frequent STI screening could reduce delayed diagnoses and potentially decrease incidence, there remain significant knowledge gaps regarding optimal STI screening frequency for different STIs among people who use PrEP to guide recommendations. Screening more frequently than every 6 months would need to consider the increased costs, implementation feasibility and possible harms, including gonococcal AMR. Focused screening among people at higher risk of infection who use PrEP may counterbalance some of the challenges described for frequent STI screening.

ABSTRACT

Background

Although the World Health Organization (WHO) recommends 'frequent' screening of sexually transmitted infections (STI) for people who use pre-exposure prophylaxis (PrEP) for HIV, there is no evidence for optimal frequency.

Methods

We searched five databases and used random-effects meta-analysis to calculate pooled estimates of STI test positivity. We narratively synthesized data on secondary outcomes, including adherence to recommended STI screening frequency and changes in STI epidemiology.

Findings

Of 7477 studies, we included 38 for the meta-analysis and 11 for secondary outcomes. With 2-3 monthly STI screening, the pooled positivity was 0·20 (95% confidence interval (CI):0·15-0·25) for chlamydia, 0·17 (95% CI:0·12-0·22) for gonorrhoea and 0·07 (95% CI:0·05-0·08) for syphilis. For chlamydia and gonorrhoea, the positivity was approximately 50% and 75% lower, respectively, in studies that screened 4-6 monthly *versus* 2-3 monthly. There was no significant difference in the positivity for syphilis in studies that screened 4-6 monthly compared to 2-3 monthly. Adherence of clients to recommended screening frequency varied significantly (39-94%) depending on population and country. Modelling studies suggest more frequent STI screening could reduce incidence.

Interpretation

Though more frequent STI screening could reduce delayed diagnoses and incidence, there remain significant knowledge gaps regarding the optimal STI screening frequency.

INTRODUCTION

Following a series of successful trials and demonstration studies, the World Health Organization (WHO) together with national and international agencies have recommend pre-exposure prophylaxis (PrEP) for those at substantial risk of HIV or would like to use PrEP.[1] People who would benefit most from PrEP often have sub-optimal condom use,[2] resulting in elevated risk of sexually transmitted infections (STI). Therefore, there is recognition that PrEP programs are a gateway to offering STI services, including screening, treatment, vaccination (for human papillomavirus, hepatitis A and B) or mental health support where needed.[3-6]

Although WHO and other national guidelines suggests three-monthly STI screening for people who use PrEP, there is no current evidence for the optimal time interval to offer STI screening for people who use PrEP.[1, 7] More frequent STI screening could lead to more new infections identified, earlier treatment and potentially reduce STI incidence at the population level. However, from the public health perspective, it is critical to consider the effectiveness, cost-effectiveness, feasibility, acceptability and adherence to different time intervals for STI screening, particularly given the financial constraints for providing molecular testing for STIs in resource-limited settings.[8] More frequent STI screening could lead to antibiotic overuse and induce antimicrobial resistance.[9] WHO recommends differentiated and simplified approaches to PrEP delivery, which support less frequent clinic visits to increase access, acceptability, feasibility and coverage. If more frequent STI screening is needed, STI self-tests may be an important approach to lower the frequency of clinic visits, however, affordable and accurate chlamydia/gonorrhoea self-tests are not yet available. However, providing online postal STI services integrated into PrEP programs may be a feasible approach.[10] The optimal screening frequency also depends on the natural

history of the pathogen, its infectiveness, and the disease burden of each STI by population and setting.

Hence, we conducted a systematic review and meta-analysis to assess the STIs' positivity according to different screening frequency. Secondary outcomes included the feasibility, client adherence to recommended STI screening frequency, cost-effectiveness and the changes in STI epidemiology of different STI screening frequencies.

METHODS

This review was conducted following the Cochrane Handbook for Systematic Reviews of Interventions, version 6.3. [11] We searched five databases: Ovid MEDLINE, Ovid EMBASE, Web of Science, GlobalHealth, CIANHL Econlit with the following inclusion criteria: English language, humans, search starting from 2010 to 28 December 2021.The keywords within our search strategy were words related to HIV, PrEP, STI and screening. See Appendix A for more details of our search strategy.

Two reviewers independently screened the title and abstracts using Covidence (CK and VZ). Discrepancies were resolved by a third reviewer (JO). Inclusion criteria were primary studies that included data on STI positivity rate (chlamydia, gonorrhoea and syphilis) among people who use PrEP and mentioned the frequency of STI screening (i.e. testing of asymptomatic people). We also included studies that described the effect (if any) on STI epidemiology or the feasibility and client adherence to different STI screening frequencies. We excluded systematic reviews, letters that contained no new data, editorials, duplicated results from the same study, and laboratory studies about STI diagnostic performance. Full texts were screened according to the eligibility criteria and data were extracted by two reviewers

independently (CK and VZ), and discrepancies were resolved by a third reviewer (JO). As positivity may be influenced by the background prevalence of STIs in each study setting and population, we also extracted data related to the latest year of the study, study duration, country income level, study setting, and study population.

We defined the positivity of the three STIs using positivity per person screened over the study duration. We did not distinguish the number of recurrent infections as this data was not commonly reported. For example, if an individual had two positive tests in a year, they would be defined as test positive per person in one year (not two positives in the same year). We defined positivity as a positive test result for syphilis, chlamydia or gonorrhoea, independent of anatomic sites where samples were collected. If a study included an interventional arm that could impact the STI positivity, we extracted data from the non-interventional arm.

We used random-effects meta-analysis to calculate across pooled estimates of STI positivity to account for sampling error and heterogeneity. We included studies in the meta-analysis that described STI screening frequency and contained data on positivity for chlamydia, gonorrhoea and/or syphilis. Modelling studies were excluded. Pooled estimates and 95% confidence intervals (CI) were generated using Freeman-Tukey-type double arcsine transformation to adjust for variance instability.[12] Statistical heterogeneity between studies was assessed using the I^2 statistic. Random-effects meta-regression models were conducted to examine the impact of STI screening frequency, the study duration, country income level, type of study and latest year of study on the effect size. For the multivariable model, we included all variables with a p-value of <0.20, and used the backward elimination process until all variables had a p-value of <0·05. A separate multivariable model was developed for each pathogen. Funnel plots were generated to assess the possibility of small study effects

which can be caused by publication bias. Egger's test was performed to confirm the presence of this bias.[13] All analyses were conducted using STATA 17.0 (StataCorp LP, College Station, Texas, USA). We evaluated the methodological quality of included studies using the Joanna Briggs Institute (JBI)'s critical assessment tools. [14] This study is registered with PROSPERO (CRD42022300053).

Ethics information

No ethical clearance was required.

Role of funding source

WHO technical staff were involved in the study design and interpretation of results as part of ongoing guideline development.

RESULTS

Of 7477 studies identified, we included 46 studies: 38 had data for the meta-analysis and the remaining studies contained data for secondary outcomes (Figure 1). Table 1 demonstrates that two- to three-monthly STI screening (compared to longer screening intervals) appeared more common in studies with data collected after 2015, from high-income countries, and for men who have sex with men (MSM).

STI positivity

In total, 38 studies met the inclusion criteria for evaluating STI positivity. Several observations should be noted (Table 2). First, in PrEP programs with 2-3 monthly STI screening, the overall pooled positivity of 0.20 (95% confidence interval (CI): 0.15-0.25) for chlamydia, 0.17 (95% CI: 0.12-0.22) for gonorrhoea and 0.07 (95% CI: 0.05-0.08) for

syphilis. Second, in studies that screened 2-3 monthly compared to studies that screened 4-6 monthly for syphilis, there were no significant differences in the positivity. However, for chlamydia and gonorrhoea, the positivity was approximately 50% and 75% lower, respectively, in studies that screened 4-6 monthly compared to studies that screened 2-3 monthly. There was large heterogeneity in STI positivity among studies not explained by sampling error. Supplementary Table 1 provides further details of included studies. Supplementary Table 2 presents the pooled positivity according to the study duration, demonstrating the increase of proportion who tested positive over longer observation times. Supplementary Tables 3-5 provides meta-regression analyses. STI screening frequency and latest year of study was significantly associated with chlamydia positivity. STI screening frequency and study duration was significantly associated with gonorrhoea and syphilis positivity. Supplementary Figures 1-8 presents the Forest plots according to pathogen and STI screening frequency. We found no evidence for publication bias (Supplementary Figures 9-11).

Secondary outcomes

Adherence to recommended STI screening frequency

Seven studies assessed stakeholder adherence to recommended STI screening frequency in people who use PrEP.[15-21] Survey data from the US-based ARTnet study (N=631 MSM) found differences in adherence by anatomical site screened, with blood samples having the highest level of consistent screening (87%), followed by a urine sample or urethral swab (78%), rectal swab (57%), or pharyngeal swab (64%). In this study, 'consistent screening' meant participants self-reported 'always' or 'sometimes' receiving screening for STIs at PrEP check-up visits within 12 months, with most people who use PrEP (82%) attending PrEP visits every three months. Adherence also varied between age groups; older users disclosed

the lowest level of consistent STI screening compared to younger MSM for all anatomical sites. MSM with recent STI exposure reported more consistent STI screening for urogenital and rectal STIs.[15]

The Sibanye Health Project conducted in South Africa between 2015 and 2016 reported varying screening rates between anatomical sites. Participants returned for STI and HIV screening 6 and 12 months after PrEP initiation. Of the 201 participants, 193 (96%) attended at least one visit where follow-up STI screening was offered. Acceptance of at least one urethral chlamydia/gonorrhoea test (94%) and syphilis (94%) was high, with lower acceptance of rectal screening at 75%. Demographic characteristics, study location, participant characteristics or behaviours did not influence screening behaviours.[19] A retrospective cohort study conducted in people who use PrEP in Israel found inconsistent adherence to recommended six-monthly STI screening, and adherence differed by type of test. There was a total of 3·1 chlamydia/gonorrhoea tests conducted per person-year follow-up and 2·8 syphilis tests conducted per person-year follow-up.[16]

Data from a US commercial insurance claims database between 2011-2015 in 3498 people who use PrEP found that at six months, 49% screened for syphilis and 39% screened for chlamydia or gonorrhoea. Although screening occurred less frequently than recommended, rates increased over the review period. For example, in 2011, 38.6% had tested for syphilis, and 24.4% had tested for chlamydia and gonorrhoea by 12 months after PrEP initiation; this increased in 2015, where 69.7% had tested for syphilis and 60.8% for chlamydia and gonorrhoea by 12 months after PrEP initiation.[17] A study from an academic clinic in the US, reported that STI screening rates decreased as the duration of time on PrEP increased, which corresponded to an increased rate of STI diagnoses in follow-up.[20] This same study

reported higher adherence levels than others, with STI screening uptake at six months at 73%, 72% and 85% for chlamydia, gonorrhoea, and syphilis, respectively. Those diagnosed with an STI at baseline were more likely to meet six-monthly recommendations for screening than those without an STI at baseline (86% vs 57%). Those enrolled in the medication management program were also more likely to meet guideline recommendations than those who were not (86% vs 52%). Furthermore, self-referred patients had higher adherence than those who had been referred through their primary care physicians or via word of mouth.[20] Other factors also influenced STI screening frequency; a study amongst 67 people who used PrEP in Hong Kong who obtained PrEP in Thailand found that participants who perceived that they were at high risk for STIs were more likely to engage in screening during follow-up. Conversely, participants who perceived that testing providers would think they were engaging in risky behaviours due to PrEP use were less likely to take up STI screening. This study had a low adherence rate, with just 47·8% of participants reporting STI screening uptake at three months.[18]

A US study investigated self-reported rectal STI screening in the prior 12 months among 88 MSM who used PrEP. This study found that 69·3% of people who used PrEP reported being screened for a rectal STI in the last 12 months. MSM who had increased vulnerability for STIs, such as a previous syphilis diagnosis and engaging in condomless anal sex with casual partners, were more likely to accept rectal STI screening. Having a provider who offered HIV screening was also found to increase the likelihood of MSM on PrEP being screened for rectal STI.[21]

Feasibility

Ryan *et al.* described the impact of PrEP implementation during the PrEPX study on healthcare delivery, including STI screening, on existing health services in Victoria, Australia.[22] Victorian sexual health and primary care services had high feasibility to accommodate the increased demand for three-monthly STI screening after rapid PrEP implementation in a large cohort (over 2000 participants in under three months). This was achieved through close collaboration with various stakeholders, including community members, clinicians, pharmacists and researchers. However, it should be noted that this study was limited to five large clinics, and this high feasibility may not reflect the ability of smaller clinics to respond to increased STI screening demand for people who use PrEP.[22]

Cost-effectiveness

Whilst we did not identify cost-effectiveness analyses as part of our search strategy, during the review of the paper, it was brought to our attention that a study from the Netherlands among MSM PrEP users demonstrated that three-monthly screening for chlamydia and gonorrhoea was not cost-effective compared to six-monthly screening.[23]

Change in STI epidemiology according to different STI screening frequencies

Two modelling studies and one demonstration project (prospective, open-label cohort study) investigated the change in STI epidemiology according to different STI screening frequencies. A US mathematical modelling study investigated the impact of STI screening frequency on gonorrhoea and chlamydia incidence in MSM after PrEP initiation. They report the combined gonorrhoea and chlamydia observed incidence would decrease with increasing STI screening frequency: from 1·85 per 100 person-years (6 monthly screening) to 0·93 per 100 person-years (3 monthly screening).[24] The change of STI screening frequency from 6 months to 3 months would detect more incident infections so that earlier treatment could reduce

population-level incidence. A Canadian modelling study that investigated the change in gonorrhoea prevalence according to STI screening frequency suggested that STI screening every three months as per Canada's public health guidelines was insufficient to prevent increased gonorrhoea levels after PrEP initiation. Their model showed that screening once every two months minimised gonorrhoea prevalence while allowing for flexibility in other parameters influencing STI levels, such as lower condom use. Furthermore, screening every two months with a 10-25% reduction in risky behaviour worked synergistically to maintain gonorrhoea levels at pre-PrEP levels. However, the authors acknowledged that two-monthly screening might not be feasible due to low adherence by users and financial constraints of health providers. Their models also indicated that as condom usage decreased, the benefits of high STI screening frequency were counteracted. When longer screening intervals were modelled, gonorrhoea prevalence increased dramatically (five-yearly screening: 60%, biannual screening: 50%), reinforcing the importance of regular monitoring.[25]

A study which examined STI incidence in the US PrEP Demonstration Project suggested that quarterly STI screening was superior to biannual screening for detection of asymptomatic STIs for people who use PrEP in this cohort. In total, 557 MSM and TGW received STI screening every three months over 48 weeks in US STI clinics. Had screening been done every six months rather than three months, identification of 62/181 (34·3%) gonorrhoea, 84/210 (40·0%) chlamydia, and 11/54 (20·4%) syphilis cases would have been delayed by up to 3 months, thus prolonging the period of infectivity for each case.[26]

DISCUSSION

This systematic review consolidates the evidence within the published literature regarding the STI positivity, client adherence to STI screening frequency recommendations, feasibility, cost-effectiveness and modelled impact on STI epidemics of screening at different frequencies. We found that increasing screening frequency was generally associated with increased positivity. However, adherence to recommended STI screening frequency varied significantly, including substantial variations in anatomical testing sites. More data is needed regarding the feasibility of healthcare clinics to accommodate the increased offer of STI screening with the scaling up of PrEP. From modelling studies, we found that increased STI screening could reduce STI incidence, and one cost-effectiveness analysis from the Netherlands reported that three-monthly screening for chlamydia and gonorrhoea was not cost-effective compared to six-monthly screening. There were no studies that provided data on AMR induced by more frequently diagnosed infections that required treatment.

Our overall STI positivity was consistent with the baseline STI prevalence among people who use PrEP in another systematic review,[27] reflecting the high STI burden among people who use PrEP. So, optimising STI screening frequency to improve the detection and treatment of STIs for people who use PrEP may reduce their overall burden of STIs. Interestingly, we observed that studies with 2-3 or 4-6 monthly frequency of syphilis screening did not significantly differ in positivity. However, for chlamydia and gonorrhoea, the positivity was 50% and 75% lower, respectively, in studies with 4-6 monthly compared with 2-3 monthly screening. The larger difference in gonorrhoea positivity may be due to the possibility for gonorrhoea to naturally clear faster than chlamydia.[28, 29] Thus, our findings suggest that screening more frequently would be ideal if the aim is to identify chlamydia and/or gonorrhoea more quickly.[26]

Whilst using three-monthly rather than six-monthly STI screening could detect more infections,[30] an important consideration for recommending frequent STI screening is the increased need for antibiotics. An analysis of national and sentinel surveillance data in England (2015-2019) indicated that there was increasing gonococcal antimicrobial resistance (AMR), especially among MSM populations compared to heterosexual couples.[31] In an age where antibiotic stewardship is increasingly critical, it is important to limit antibiotic use to only when necessary. It is theorised that intensive STI screening has been linked to AMR within the UK and USA.[31] So, an alternate approach might be to vary STI screening frequency for people who use PrEP depending on subpopulations with different levels of risk for STIs. There is also evidence that a minority of people who use PrEP contribute to most STIs detected.[32] Thus, improving better identification of those at higher risk for STIs may allow for a targeted approach to STI screening to optimise resource use and reduce the overuse of antibiotics.

Particularly for three-monthly screening, there are significant client-, provider- and service-level barriers to complying with this common recommendation. Regarding client-level barriers, a study from Hong Kong showed that STI screening uptake at three months was low (47.8%). The study also found that participants who perceived that providers of STI screening would think they were engaging in risky behaviours due to PrEP use were less likely to take up STI screening.[18] Those who used PrEP informally (i.e., users who obtained PrEP via non-prescription sources; such as online, abroad, friends or other sources) may face unique challenges such as unawareness of the location of testing facilities. Additionally, people who use PrEP intermittently may be less likely to screen frequently for STIs as they may not attend PrEP services on a regular basis. Out-of-pocket cost for increased frequency of STI screening and treatment or transportation when the frequency of screening is shorter than the PrEP follow-up visits[33] can add to the challenges of frequent

screening.[34] Interviews from a younger group of people who would benefit from PrEP also indicated that participants were unwilling to be screened every three months due to perceptions that follow-ups would be time-consuming and inconvenient.[35]

On the other hand, sex-positive and knowledgeable providers were shown to encourage engagement in PrEP-related healthcare, which included STI screening.[18, 21, 36] Additionally, people who use PrEP who had higher vulnerability for STIs were more accepting of frequent STI screening, such as those with positive baseline STI tests,[18, 20] a previous syphilis diagnosis,[15, 21] or users who engage in condomless sex with casual partners.[15] Other factors associated with more recent STI screening included younger age, white race, college education and greater parental support.[15, 35] Specific measures that encouraged adherence to three-monthly STI screening also assisted in overcoming barriers to attendance, such as counselling, appointment reminders and assistance from pharmacy staff.[20]

PrEP programs can also facilitate frequent STI screening by acting as a gateway to engagement with the healthcare system, especially among clients at higher risk of infection who may not otherwise access such services.[37, 38] Initiating PrEP can also have a positive psychological effect, allowing users to feel in control of their sexual health care and helping build rapport with healthcare providers.[36] However, this effect may wane over time, as suggested by one study which showed that users who took PrEP for over one year were far less likely to meet the STI screening recommendations compared to those who had been taking PrEP for a shorter time.[20] People who use PrEP are a heterogeneous group, so further research should focus on subgroups of clients to better understand and address their

unique challenges. Efforts should be made to train PrEP providers in providing inclusive and non-stigmatising sexual health care.

Regarding health care workers-level barriers, inadequate STI-related training and competency of PrEP providers has been a challenge in implementing STI screening.[39] Another study describe providers stating time constraints, cultural and language barriers, and difficulty obtaining a sexual history affected their ability to conduct routine STI screening.[15] Providers' adherence to recommended frequency of screening can also be suboptimal, with one study finding that providers only ordered STI screening in 67% of clients every 6-months.[40] They were also less likely to order STI screening in older users, HIV serodiscordant couples, and for African Americans compared to white patients. Differences in competence also exist between primary care providers and specialists, with a higher proportion of participants receiving more comprehensive care under specialist treatment than in primary care.[41]

Regarding service-level barriers, a recent systematic review of STI screening in PrEP programs found that providers commonly identified that cost was a barrier to implementation of regular STI screening.[39] They also stressed that greater funding would allow them to increase their capacity to screen people who use PrEP. Indeed, high-income countries and countries that have no direct user fee for STI services, such as Australia, the United Kingdom, and France offer more comprehensive STI services than lower-resourced countries which rely on syndromic case management.[39] While logistical challenges exist,[39] PrEP programs in Australia have shown that integrating quarterly STI screening in existing sexual health networks is feasible and effective.[22] At the programmatic level, it is also important to consider the different cost and time to provide test results for syphilis tests, particularly

lateral flow rapid tests (treponemal or duo treponemal/non treponemal tests), when compared to molecular tests for gonorrhoea and chlamydia.

The strength of our study is that it systematically reviewed the extant literature to understand the evidence regarding STI screening frequency among people who use PrEP. We also collated data regarding the adherence to recommended STI screening frequency, feasibility, impact on STI epidemics and cost-effectiveness of STI screening at different frequencies, settings and populations. Our study should be read in light of some limitations. First, most studies were from high-income countries. More research is needed from low- and middle-income countries where access to STI services beyond syndromic case management are not ubiquitous and epidemiology might differ significantly. Second, there was substantial between study heterogeneity for pathogen positivity, some of which could be explained by STI screening frequency, latest year of study and study duration. There are other important factors to explain the observed heterogeneity, such as differences in offer of triple anatomical site screening for those at risk (e.g. MSM), background STI positivity, sexual risk behaviours and sexual network structures. Third, almost all studies related to MSM using PrEP, with little data from other populations. Thus, our findings may not be generalisable to non-MSM populations using PrEP and to low- and middle-income countries. Fourth, there remains uncertainty regarding the impact of screening frequency on STI incidence as current evidence arises from modelling studies. Large, multi-country studies will be needed to determine this. Fifth, it was not possible to determine the impact of unscheduled visits when an individual became symptomatic, thus our pooled estimates of positivity are likely to underestimate the true test positivity. For example, one sexual health centre in Australia reported that a substantial proportion of primary (58%) and secondary (44%) syphilis among PrEP users were made at interim STI clinic attendances.[42] This may also explain the observation of the

apparent no statistically significant difference in syphilis positivity in studies screening every 3 months compared with screening every 6 months. However, as defined in our methods, the focus of our review as on STI screening (of asymptomatic people). Last, additional research is needed to determine the benefits and costs associated with more frequent for rectal and pharyngeal chlamydia and gonorrhoea on a population level, as well as the impact on AMR.

In conclusion, although frequent STI screening could reduce delayed diagnoses and potentially decrease incidence, there remain significant knowledge gaps regarding optimal STI screening frequency for different STIs among people on PrEP to guide recommendations. The increased costs and low adherence of screening for STIs more frequently than at every six months needs to be balanced against possible benefits, including implementation feasibility and AMR. However, improving the identification of people who use PrEP that are at higher risk for STIs for more frequent STI screening can optimise resource use and reduce the overuse of antibiotics.

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Data sharing statement

Data will be made available upon request made to the corresponding author.

Declaration of Competing Interest

None of the authors has any competing interests to declare. Some of the authors are present or former staff members of the World Health Organization. The authors alone are responsible for the views expressed in this publication and they do not necessarily represent the views, decisions, or policies of the institutions with which they are affiliated.

Contributions

MM, RB, CC and JO conceived the idea. CK and VZ did the screening and data extraction. JO conducted the statistical analysis. All authors contributed to the interpretation of the results and subsequent edits of the manuscript and had final responsibility for the decision to submit for publication.

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Figure 1 – PRISMA flow diagram

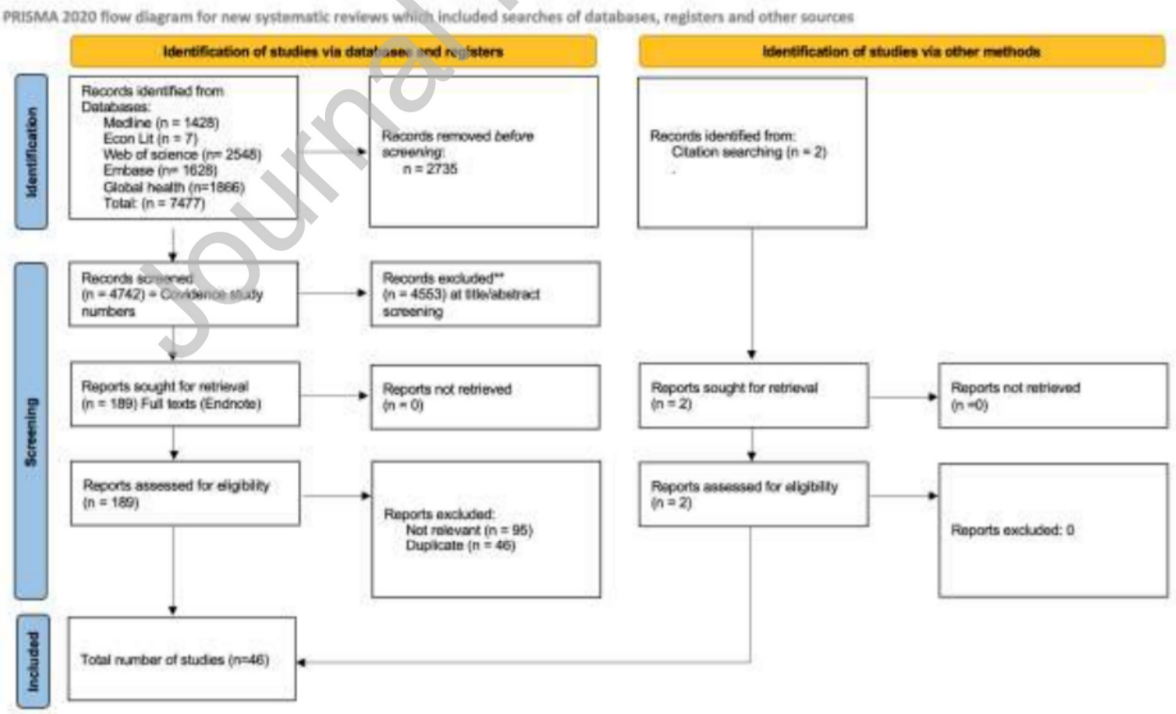

Table 1 Characteristics of included studies, according to sexually transmitted infection (STI) test frequency

Characteristics	All studies (N=46) n (%)	3 monthly (or less) testing[1] (N=24)	≥4-6 monthly testing[1] (N=13)	>6 monthly testing[1] (N=3)
Latest year of study[2]				
Before 2015	4 (8·7%)	1 (2·2)	3 (6·5%)	0 (0·0%)
After 2015	38 (82·6%)	23 (50·0%)	10 (21·7%)	3 (6·5%)
Modelling study (no real-world data)	4 (8·7%)			
Country income level[3]				
Low	0 (0·0%)	0 (0·0%)	0 (0·0%)	0 (0·0%)
Lower-middle	1 (2·2%)	0 (0·0%)	1 (2·2%)	0 (0·0%)
Upper-middle	3 (6·5%)	1 (2·2%)	1 (2·2%)	1 (2·2%)
High	39 (84·8%)	22 (47·8%)	7 (15·2%)	2 (4·3%)
Mixed	3 (6·5%)	1 (2·2%)	3 (6·5%)	0 (0·0%)
Study setting				
Primary level health facilities	22 (47·8%)	16 (34·8%)	5 (10·9%)	1 (2·2%)
Hospitals	7 (15·2%)	3 (6·5%)	3 (6·5%)	1 (2·2%)
Community organisations	4 (8·7%)	2 (4·3%)	3 (6·5%)	0 (0·0%)
Hospitals and community centre	1 (2·2%)	1 (2·2%)	0 (0·0%)	0 (0·0%)

Other	10 (21·7%)	2 (4·3%)	0 (0·0%)	1 (2·2%)
Unclear	2 (4·3%)	0 (0·0%)	2 (4·3%)	0 (0·0%)
Population				
Men who have sex with men	43 (93·5%)	23 (50·0%)	13 (28·3%)	2 (4·3%)
HIV serodiscordant couples	1 (2·2%)	1 (2·2%)	0 (0·0%)	0 (0·0%)
People who use drugs	3 (6·5%)	2 (4·3%)	1 (2·2%)	1 (2·2%)
Trans and gender diverse	12 (26·1%)	8 (17·4%)	4 (8·7%)	1 (2·2%)
Other[4]	7 (15·2%)	5 (10·9%)	1 (2·2%)	1 (2·2%)
Not specified	2 (4·3%)	1 (2·2%)	0 (0·0%)	0 (0·0%)
Primary Outcome				
STI positivity[5]	38 (82·6%)			
Secondary outcomes				
Adherence to STI testing frequency	7 (15·2%)			
Feasibility of STI testing	1 (2·2%)			
Changes in STI epidemiology according to testing frequency	3 (6·5%)			
Cost-effectiveness of STI testing	0 (0·0%)			

[1] Only studies with primary patient data were included in this table. Modelling studies were excluded. One study evaluated both 3 monthly and 6 monthly screening.