Review Article
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Impact of Pre-exposure prophylaxis (PrEP) use on risk perception and behaviour among at risk young people: a narrative review

Abstract

Background: Pre-exposure prophylaxis (PrEP) is a proven strategy for preventing HIV, especially among at- risk young people. However, concerns persist about potential risk compensation behaviors, such as reduced condom use and increased sexually transmitted infections (STIs), which could undermine its benefits. This narrative review explored the impact of PrEP use on risk perception and risk compensation behavior among at-risk young individuals, synthesizing evidence from global studies and highlighting implications for PrEP programs.

Methods: A comprehensive literature search was conducted in PubMed and Google Scholar for studies published between 2012 and 2024. Studies included focused on young people (aged 18–35) and assessed behavioral outcomes post-PrEP initiation. Data were extracted and synthesized into an evidence-based table and analyzed thematically.

Results: Seventeen studies were included, encompassing diverse populations including men who have sex with men (MSM), young women, sex workers, and heterosexual serodiscordant couples. While randomized controlled trials showed minimal risk compensation, observational and cross-sectional studies indicated a trend toward increased condomless sex and STI diagnoses among PrEP users, particularly among MSM in high-income settings. Adherence played a critical role, with risk behaviors more pronounced among non-adherent users. Contextual factors such as gender, age, and socioeconomic conditions influenced PrEP uptake and behavioral outcomes.

Conclusion: Risk compensation following PrEP use is not universal but may occur in specific populations. PrEP remains highly effective in preventing HIV, but its rollout should include behavioral counseling, STI screening, and efforts to address structural and perceptual barriers. Further research is needed in low- and middle-income countries (LMICs) and among adolescent girls and young women (AGYW) to inform inclusive and context-sensitive prevention strategies.

Keywords: Pre-exposure prophylaxis (PrEP), risk compensation, HIV prevention, young people, sexual behavior, condom use, sexually transmitted infections (STIs), adherence, men who have sex with men (MSM), narrative review

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Introduction

HIV remains a significant public health challenge globally with an estimated 0.6% [0.6-0.7%] of adults aged 15–49 years worldwide living with HIV, with the epidemic burden varying considerably between countries and regions.[1] As of 2023, 39.9 million people are living with HIV with an adult prevalence rate of 38.6 million and 1.3 million cases of newly infected HIV infections.[2] In 2012 U.S. Food and Drug Administration (FDA) approved once-daily oral Truvada (emtricitabine and tenofovir disoproxil fumarate), in combination with safer sex practices, to reduce the risk of sexually acquired HIV-1 infection in adults at high risk.[3] When taken consistently, it is 99% effective in preventing HIV.[4–7] Alternatively, the US Food and Drug Administration (FDA) recently approved the long-acting Pre-exposure prophylaxis formulation LAI-PrEP (CAB-LA) having demonstrated high efficacy in preventing HIV acquisition and requires administration once every two months.[8] In addition intravenous, subcutaneous, implants, and transdermal drug delivery systems, as well as extended duration oral drugs are promising strategies being developed to enhance adherence and expand prevention options.[9,10] These long-acting options offer more flexibility and may improve adherence among individuals facing challenges with daily oral medication.[11,12] Despite its benefits, there are concerns that PrEP use may encourage risk compensation behavior, leading to decreased condom use, an increase in the number of sexual partners, and higher rates of sexually transmitted infections (STIs).[13] Mathematical modeling suggests that if risk compensation occurs, PrEP can paradoxically increase the transmission of (TDF/FTC) resistant HIV strains.[14] In addition, PrEP does not prevent other STIs, which could also increase with sexual risk compensation behaviors. On the other hand, some mathematical models indicate that despite potential risk compensation behaviors among those on PrEP, there is a net benefit at the population level through greater healthcare engagement (e.g., increased STI screening and treatment).[15,16] Thus, because TDF/FTC will not always prevent HIV infection and does not prevent other STIs, safer sex/risk reduction counseling and regular HIV testing, are components of the TDF/FTC product label and Risk Evaluation and Mitigation Strategy (REMS) program.[17]

The results from the placebo-controlled PrEP efficacy trials supporting FDA approval indicated no risk compensation.[7,18] However, sexual practices were self-reported and participants in these studies

were counseled that PrEP was unproven and there was no guarantee of reducing the risk of acquiring HIV. Data since FDA approval (July 2012) suggest variability in sexual behavior in response to PrEP.[19] A recent demonstration study (n=112) found a significant reduction in condom use and an increase in STIs in the 12 months following PrEP initiation.[20] Thus, sexual risk compensation remains a concern for PrEP as an HIV prevention strategy. This review aims to synthesize existing evidence on PrEP-associated risk compensation among at-risk young people and provide insights into mitigation strategies.

Methods

A narrative review of relevant literature was conducted, adhering to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.[21] The quality of evidence was assessed using the Grading of Recommendations Assessment, Development, and Evaluation framework,[22] commonly used internationally to aid decisions by policy-makers and ensure a systematic and transparent approach in the development of clinical practice recommendations.

Search strategy and selection criteria

Electronic searches were conducted in PubMed and Google Scholar to identify relevant interventional studies published between 2012 to 2024. Search terms that related to 'HIV' were combined with search terms related to 'PrEP' or 'tenofovir'. The search terms included: "Pre-exposure prophylaxis," "PrEP," "risk compensation," "sexual risk behavior," "young people," "adolescents," "condom use," "HIV prevention," and "STIs." The search was limited to studies published in English. No restrictions were placed based on the location of the intervention or the date of publication.

Study criteria

Inclusion and exclusion criteria

This review included only studies investigating the relationship between PrEP use and risk compensation behavior among young people (aged 18-35). Studies assessing changes in condom use, number of sexual partners, STI incidence, and risk perception post-PrEP initiation. Randomized controlled trials (RCTs), cohort studies, and cross-sectional studies were also included. Studies do not report behavioral outcomes related to risk compensation. Non-peer-reviewed articles and opinion pieces are excluded from this review. The review synthesized findings from studies conducted between 2012 and 2024.

Data extraction and synthesis

Data were extracted using a standardized form to include study design, sample size, key findings, and conclusions. Studies were synthesized into an evidenced-based table and analyzed narratively into themes based on the key behavioral outcomes: condom use, number of sexual partners, STI incidence, and risk perception (Figure 1).

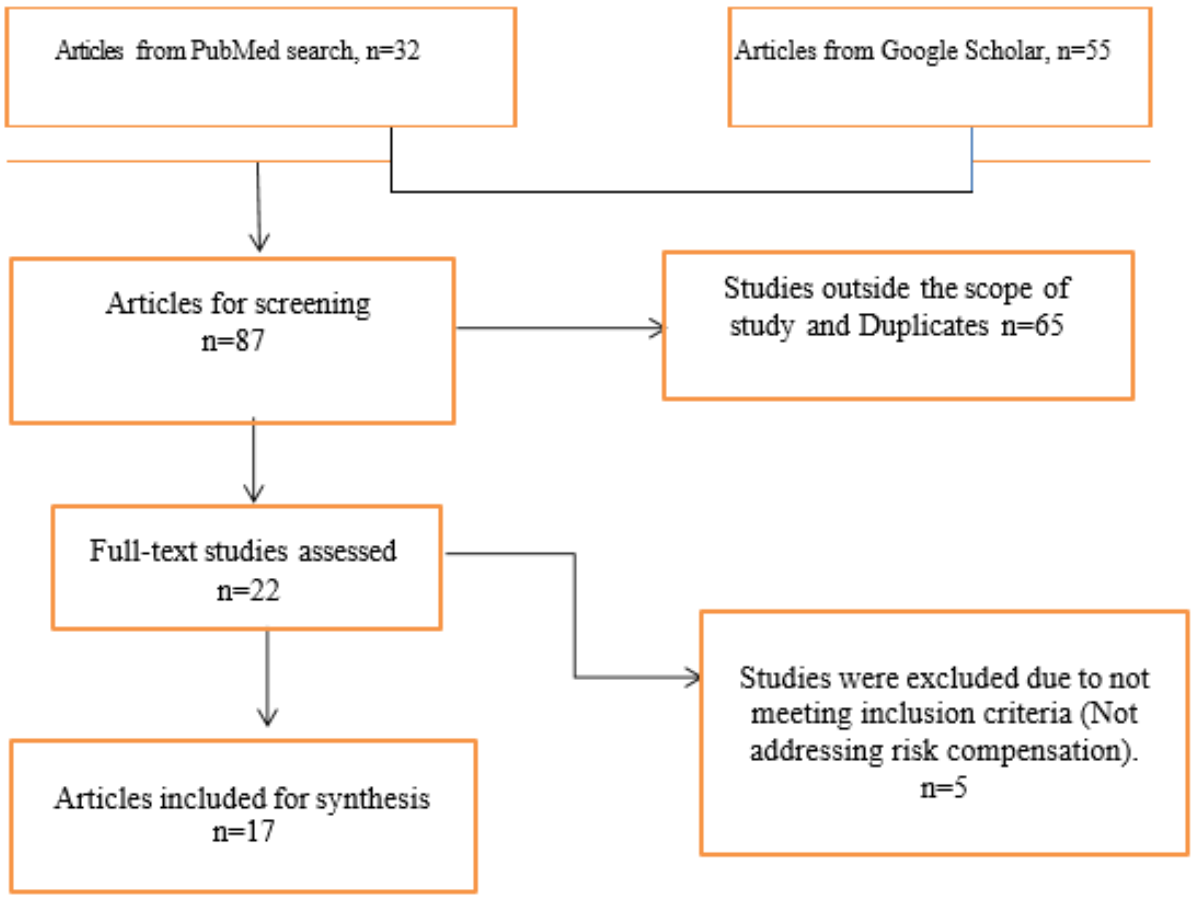

Figure 1 Study articles selection process flow chart.

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Results

The review synthesized findings from 17 studies conducted between 2012 and 2024. However, since PrEP was approved by the FDA in July 2012, most studies on behavioral risk compensation took place after PrEP approval. This review cut across diverse populations including MSM, YMSM, FSWs, heterosexual sero-discordant couples, and general high-risk individuals. Most studies reported a trend towards increased sexual risk-taking behaviors such as condomless anal sex (CAS) and multiple sexual partners among PrEP users with several also highlighting a concurrent increase in sexually transmitted infections (STIs) (Table 1).

Table 1 Evidence-based table of the articles used

Author & Year	Study design	Population	Key findings	Impact on HIV transmission	Recommendation
Hosek et al.,[23]	Pilot randomized controlled trial	68 YMSM (53% African American, 40% Latino)	Sexual risk behavior declined in all study arms, but self-reported PrEP adherence was low (62%)	PrEP adherence was low, limiting effectiveness; intervention was feasible and well-accepted among at-risk youth	Enhanced adherence support is critical for YMSM; nonrandomized open- label trials should explore PrEP use among youth
Milam et al.,[24]	Demonstration study	398 MSM on PrEP (compared with 99 non- PrEP MSM at 2 sites)	Increased condomless receptive anal sex (CRAS) at all study visits; no consistent change in number of HIV+ sex partners or condomless insertive anal sex (CIAS)	No significant differences in STI rates between PrEP and non-PrEP users at 24 weeks	Regular STI screening, behavioral risk reduction, and adherence counseling should be integrated into PrEP services
Hamilton et al.,[25]	An HIV-transmission simulation model was utilized.	The simulation utilized 500,000 eligible individuals of same sex and age with those below 18 years inclusive	There was no significant reduction in new infections after PrEP	Prioritising PrEP for adolescents has little or no impact on incidence.	Resources should not be channeled on specific adolescent populations at greater risk in high incidence and more prone settings.
Mutua et al.,[26]	Randomized controlled trial	67 men who have sex with men (MSM) and 5 female sex workers (FSW). in Kenya	Adherence was significantly lower in intermittent PrEP users (55% for fixed dosing; 26% for post-coital dosing) compared to daily PrEP users (83%)	Lower adherence to intermittent PrEP could reduce its effectiveness in preventing HIV	Further research on intracellular drug levels, adherence barriers, and better sexual activity tracking methods are needed to assess the feasibility of intermittent PrEP
Lal et al.,[20]	Open-label demonstration study	114 individuals at risk of HIV infection in Melbourne	Significant decline in condom use observed over 12 months; increased STI incidence among PrEP users	Incidence of STIs tripled within the first year of PrEP use, despite high medication adherence	Prevention, early detection, and treatment of STIs should be prioritized alongside PrEP interventions
Van Damme et al.,[27]	Randomized controlled trial	2120 HIV-negative women	No significant reduction in HIV incidence between the TDF-FTC and placebo groups (HR=0.94, P=0.81); PrEP users had higher rates of nausea and liver toxicity	Low adherence (<40% of uninfected women had evidence of recent pill use	Address adherence barriers among women, enhance PrEP education and support strategies
Thigpen et al.,[28]	Randomized controlled trial	1219 men and women (45.7% women) in Botswana	Study stopped early due to low retention and logistic issues; no specific risk compensation findings reported	PrEP efficacy was 62.2% in preventing HIV; side effects included nausea, dizziness, and bone mineral density decline	Long-term safety of PrEP, especially on bone mineral density, needs further evaluation
Baeten et al.,[6]	Randomized controlled trial	4747 HIV-Serodiscordant couples (62% male partners)	No direct findings on risk compensation, but PrEP significantly reduced HIV incidence	HIV incidence was 67% lower with TDF and 75% lower with TDF-FTC compared to placebo.	PrEP is highly effective in preventing HIV among heterosexual couples; should be integrated into prevention programs

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Table 1 Continued....

Liu et al.,[29]	Randomized, double-blind, placebo- controlled trial	400 MSM who reported anal sex in the past year	No evidence of risk compensation— mean number of partners and proportion reporting unprotected anal sex declined during follow-up	Sexual behavior changes were similar in both the immediate and delayed PrEP arms; drug use (poppers, amphetamines) was independently associated with higher sexual risk	Continued monitoring for risk compensation is necessary; additional support should be provided for MSM engaging in high-risk behaviors
Mugwanya et al.,[30]	Longitudinal analysis from a double-blind RCT	3024 HIV-uninfected partners in serodiscordant heterosexual couples	No significant increase in unprotected sex with HIV-infected study partners after PrEP efficacy was publicly reported; a slight increase in unprotected sex with outside partners, but the effect was small	No significant increase in STIs or pregnancies after participants became aware of PrEP efficacy	PrEP, when provided with a comprehensive prevention package, does not necessarily lead to substantial risk compensation; continued risk reduction counseling is recommended
Grant et al.,[31]	Open-label cohort study (72 weeks)	1603 HIV-negative MSM and transgender women	Higher PrEP uptake among those engaging in condomless receptive anal sex.	HIV incidence was 1.8/100 PY among PrEP users vs. 3.9/100 PY in placebo group; no infections in those taking ≥4 pills/week	PrEP is highly effective in preventing HIV among heterosexual couples; should be integrated into prevention programs
Volk et al.,[32]	Observational study	PrEP users since 2012	Increased PrEP referrals and use; some users reported decreased condom use	No new HIV infections despite high STI rates among PrEP users	Emphasizes the need for continued STI screening and prevention strategies alongside PrEP use
Jenness et al.,[15]	Stochastic network-based mathematical model	MSM in the United State	Full replacement of condoms led to an 8% increase in individual HIV acquisition risk among PrEP users but a 2% overall decline in HIV incidence due to increased PrEP uptake	Risk compensation may not necessarily undermine PrEP's population- level effectiveness but increases individual risk	Clinicians should promote PrEP as a supplement to, not a replacement for, condom use
Newcomb et al.,[33]	Longitudinal cohort study	953 YMSM in Chicago	Higher rates of receptive condomless anal sex (CAS) when on PrEP, including with HIV-positive and unknown-status partners. CAS rates were even higher among PrEP non- adherent individuals	Increased HIV risk if adherence is low; PrEP non- adherent partnerships had the highest rates of CAS, which could limit PrEP's effectiveness	Emphasize adherence support in PrEP programs; targeted interventions to address risk compensation, particularly among non-adherent users
Montano et al.,[34]	Observational study	183 men who have sex with men (MSM) initiating PrEP at an STD clinic in Seattle, Washington, USA	Reporting never using condoms increased (ARR = 1.46; 95% CI: 1.13–1.88) at 12 months post-initiation	STI prevalence increased during PrEP use (49.2%) compared to pre-PrEP (35.0) No new HIV infections reported, suggesting continued effectiveness of PrEP in HIV prevention	Incorporate ongoing sexual health counseling and routine STI screening into PrEP program
Mayanja et al.,[35]	Prospective Cohort study	285 HIV- AGYW in Uganda	PrEP uptake was associated with more sexual partners	Increased behavioural risk and STI incidence	Development of biomedical product should be expedited.
She et al.,[36]	Cross-sectional survey	1,131 MSM in Xi'an, China categorized as: • PrEP-naïve and unwilling (23.52%) • PrEP-naïve but willing (64.98%) • Current or former PrEP users (11.49%)	• PrEP-naïve but willing group had highest sexual act diversity (Shannon index = 1.61) • Highest STI testing rate (73.06%) • Highest syphilis prevalence (7.49%) • Current/former PrEP users had highest oropharyngeal gonorrhea (14.39%) and overall gonorrhea (20.86%)	• Increased STI prevalence, especially among PrEP users • High-risk behaviors persisted among PrEP-naïve but willing and PrEP users	Implement behavioral interventions alongside PrEP • Address low education and younger age as barriers to PrEP use • Intensify STI screening and prevention education

Discussion

This review synthesized findings from 17 studies on the relationship between PrEP use, risk perception, and risk compensation behavior among at-risk young adults. The studies included 7 RCTs, 3 cohort studies, 1 cross-sectional study, 3 observational studies, 3 demonstration studies, and 1 qualitative study, covering diverse populations such as men who have sex with men (MSM), heterosexual adolescents, and young women, and young people in sub-Saharan Africa and high-income countries.

Risk compensation: Evidence from RCTs and cohort studies

Evidence on risk compensation post-PrEP initiation is mixed. Notably, RCTs did not find evidence of significant risk compensation behavior,[28,29] with some even reporting a reduction in unprotected sex and partner numbers during follow-up.[25,30] In addition, some studies showed that risk-reduction counseling provided alongside PrEP could mitigate the likelihood of increased sexual risk behavior.

In contrast, observational studies and cross-sectional surveys reported increased STI incidence or decline in condom use post-PrEP. For instance, Montano et al.,[34] observed rising STI rates among MSM on PrEP in the United States.[34] However, the increase may reflect more frequent STI screening rather than actual behavior change. Newcomb et al.,[33] in a cohort of MSM in Chicago, reported a significant decline in condom use after PrEP initiation, especially with higher rates of receptivity with HIV-positive and unknown-status partners. Several other studies also revealed similar results.[15,20,24,32]

Population differences and generalizability gaps

Most risk compensation studies focus on MSM in high-income countries, limiting generalisability. Yet, PrEP roll-out is expanding to young women in sub-Saharan Africa, where HIV incidence remains disproportionately high.[35,37] Moreover, STI risk among women of reproductive age is complicated by factors like power imbalance, transactional sex, and lack of condom negotiation power.[38] These structural determinants rarely feature in risk compensation studies and are crucial in LMICs. A South African study noted that perceived low risk, rather than PrEP use, was the driver of condomless sex.[39]

PrEP as a complement or substitute to condoms

Some studies reported a significant increase in condomless sex among MSM and YMSM on PrEP, particularly among those with low adherence.[24,33,34] A study also reveal that some users start PrEP specifically because they no longer want to use condoms.[33] Differences in condom use substitution are notable across settings. In high-income settings, MSM often have greater autonomy in condom negotiation and may opt-out when on PrEP. Among young women in LMICs, condom use was already low, so PrEP may not reduce condom use further, but rather provide much-needed protection where condoms were never consistently used.[37]

Community-level risk compensation and epidemiological impact

A neglected dimension is community-level behavioral shifts. While individual PrEP users may maintain safe practices, non-users may perceive reduced community HIV risk and relax their prevention behaviors. This could dilute the epidemiological benefits of PrEP. Jenness et al.,[15] used modeling to suggest that modest behavior change among non-users could offset gains from PrEP coverage, especially in high-transmission networks.[15] Importantly, no study reported an increase in HIV incidence among adherent PrEP users, underscoring the effectiveness of PrEP even when behavioral risk increases. Furthermore, the interplay between STI burden and PrEP coverage is complex. With increasing antimicrobial resistance, particularly in gonorrhea and chlamydia, reduced condom use even if HIV prevention remains effective can have significant public health consequences.

Intermittent PrEP and risk perception dynamics

As event-driven or intermittent PrEP becomes more popular, especially among youth, understanding how users perceive their risk at different time points becomes vital. Studies such as Hoornenborg et al.,[40] (AMPrEP study) showed that users tailored their PrEP use to perceived risk,[40] but few tools exist to accurately measure risk perception, and many decisions are made without full awareness of actual risk.[37] Most studies infer risk perception from behavior, which is problematic. A decline in condom use may reflect a sense of protection, a desire for intimacy, or simply structural barriers, and not necessarily a psychological shift in risk perception.

Recommendations

There is the need to expand RCTs and longitudinal studies to include AGYW, heterosexual men, and key populations in LMICs. Secondly, to develop and validate tools to measure risk perception, rather than infer it from behavior. In addition, addressing structural and behavioral determinants of STI prevention beyond HIV, especially among PrEP users, and Promoting combination prevention approaches such as PrEP plus condoms, STI testing, adherence to HIV counseling, and psychosocial support are highly recommended. Investigating community-level effects of PrEP rollout, especially how it shapes broader sexual norms and behaviors is encouraged. When integrated thoughtfully, PrEP remains one of the most transformative HIV prevention tools available today. Its success, however, hinges not only on adherence and access but also on understanding and managing the complex behavioral responses it may trigger in different settings.

Conclusion

This review reveals that while PrEP does not universally lead to risk compensation, modest changes in condom use or STI trends are reported in some populations, particularly MSM in high-income countries. RCTs tend to show minimal or no risk compensation, while cross- sectional and cohort studies provide more variable findings.

The evidence on risk compensation is heavily skewed towards MSM populations, with limited data on AGYW and youth in LMICs, where HIV incidence is highest. Secondly, PrEP is sometimes perceived as a condom substitute, especially where condoms were inconsistently used before PrEP uptake. Thirdly, risk compensation among non-users in high-PrEP availability settings is poorly studied but may impact public health outcomes.

More contextual and longitudinal data are needed, especially to understand the psychosocial dynamics of risk perception, particularly among intermittent users.

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None.

Conflict of interest

The authors declare that there is no conflict of interest.

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