

# Individual Versus Community-Level Risk Compensation Following Preexposure Prophylaxis of HIV

We analyzed the concept of risk compensation and how it has been applied in HIV prevention, paying particular attention to the strategy of HIV preexposure prophylaxis (PrEP). In risk compensation, reduced perceptions of risk after the introduction of a preventative intervention lead to more frequent risk-taking behavior. Such a change may undermine the intervention's protective benefits.

We found that many studies purporting to investigate risk compensation do not assess or report changes in perceptions of risk, instead relying on behavioral measures. Our analysis suggests a complex and sometimes counterintuitive relationship between the introduction of a new prevention intervention, perceptions of HIV risk, and subsequent changes in behavior.

As PrEP is introduced, we believe comprehensive assessment of community-level risk compensation—that is, changes in risk perceptions and behavior as a result of increased optimism about avoiding HIV among people not directly protected by PrEP—should not be omitted. We therefore suggest ways to assess prevention optimism and community-level risk compensation. (*Am J Public Health*. 2017;107:1568–1571. doi:10.2105/AJPH.2017.303930)

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See also Landers and Kapadia, p. 1534.

**P**reexposure prophylaxis (PrEP) is one of the most significant developments in HIV prevention, providing an alternative and supplement to prevention methods such as condoms. PrEP involves HIV-negative people regularly taking antiretroviral drugs to prevent HIV infection.<sup>1,2</sup> It has been found to be highly effective in preventing HIV acquisition in multiple population groups, particularly gay and bisexual men, as long as recipients regularly take the prescribed drugs (at least four doses per week).<sup>3</sup> However, the development of PrEP has not been without controversy. Before the efficacy of PrEP was demonstrated, researchers were already concerned that “PrEP may be used as a justification for increasing the frequency or types of risk-taking behaviors, which could result in higher rates of sexually transmitted infections and fuel HIV transmission.”<sup>4(p864)</sup> The concept of increased risk taking undermining the effectiveness of an intervention is often referred to as “risk compensation,”<sup>5,6</sup> and the implementation of PrEP has intensified debates about it.

Risk compensation is a concept derived from risk homeostasis theory.<sup>7,8</sup> It suggests that people continually evaluate the potential risks and benefits of their actions for their health

and safety and recalibrate their actions if they perceive that they are exceeding their target or acceptable level of risk. A key part of risk compensation theory is that the benefits of an intervention (e.g., seatbelts) can be outweighed over time as people begin to feel safer and then increase their risk-taking behavior (e.g., driving faster or more dangerously). The theory contends that an intervention may fail unless the target or acceptable level of risk is reduced, that is, unless people are motivated, educated, or incentivized to behave more prudently.

## RISK COMPENSATION

We considered how risk compensation has been used in the HIV field, particularly in relation to PrEP. We discuss the theory of risk compensation and how it has been measured. We suggest alternative ways to assess the impact of PrEP, including evaluating “prevention optimism.” We argue that researchers and evaluators need

to consider the impact of PrEP on community norms and practices and not only on the immediate recipients of the intervention.

Risk compensation theory relies on a rational actor model of human behavior, which is derived from classic economic theory and has not been without its critics.<sup>9,10</sup> The idea that risk compensation is inevitable is contested, particularly when highly effective interventions are introduced. Also, it is not straightforward to measure people's target levels of risk, making the theory difficult to test. Because of the variability in findings (in road safety and other areas), researchers suggest that more attention needs to be paid to the conditions under which risk compensation does and does not occur.

## RISK COMPENSATION AND HIV

Risk compensation has garnered attention as a way to understand why the uptake of HIV prevention measures sometimes fail to achieve a reduction in HIV infections

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This article was accepted May 16, 2017.  
doi: 10.2105/AJPH.2017.303930

and as something to monitor when introducing new interventions.<sup>5,6</sup> It has been investigated in relation to condoms, HIV treatment, male circumcision, and PrEP as well as potential future strategies (e.g., microbicides and vaccines). If HIV interventions lead to a reduced perception of risk and subsequent adoption of compensatory behavior such as more sexual partners or more acts of condomless sex, then risk compensation is considered to have occurred.

There are several observations we can draw from previous research on risk compensation and HIV. First, most studies rely on behavioral measures (e.g., number of partners or condomless sex), without measuring or reporting on attitudinal changes or perceptions of risk.<sup>11,12</sup> Failing to assess perceived risk overlooks a key part of risk compensation theory<sup>7,8</sup> and means that changes in sexual behavior are assumed to be evidence of risk compensation, rather than demonstrating that changes in attitudes or perception precede changes in behavior. Second, even when attitudes and risk perceptions are measured, the temporal relationship with behavior may not be clear. This relationship is important because some prospective studies have found that more frequent engagement in condomless sex, for example, can precede the development of optimistic attitudes about avoiding HIV.<sup>13</sup>

Third, studies of risk compensation and HIV sometimes show no change in behavior, or even change in a counterintuitive direction. For example, a meta-analysis found that HIV-positive people in treatment or with an undetectable viral load were no more likely to engage in condomless sex than were other people living with HIV,<sup>14</sup> whereas large

randomized trials in Africa have found little evidence that medical male circumcision leads to increased sexual activity or more condomless sex.<sup>15,16</sup>

Fourth, changes in behavior may be rendered irrelevant because a prevention strategy is so effective that there is little chance of increased HIV transmission, despite changes in perceived risk or sexual behavior. For example, studies have found that adopting condom use may precede people having more partners or engaging in more frequent sex, but there is little evidence that this leads to an increased risk of HIV.<sup>12</sup> When efficacy is lower, risk compensation may pose a greater problem. The promotion of male circumcision as a population-level prevention strategy, for example, has been controversial because of its moderate efficacy and lack of protection for female partners.<sup>17</sup>

Finally, most research on risk compensation and HIV focuses on individuals who receive or use an intervention, rather than considering the effect of interventions on risk perceptions and behavior in the broader community.<sup>5</sup> An example of a compensatory effect occurring beyond those who are the direct targets of an intervention is that of HIV treatment optimism: the belief that it is easier to avoid HIV (or less serious to contract HIV) as a result of effective antiretroviral treatment.<sup>18,19</sup> People with optimistic beliefs about avoiding HIV because of treatment have been found to be nearly twice as likely to report condomless sex as are their more skeptical peers, regardless of their HIV status.<sup>14</sup> This finding suggests that it is important to assess how the introduction of a new intervention (like PrEP) affects risk perceptions and sexual behavior at a community level, not just among those receiving the intervention.

## PREEXPOSURE PROPHYLAXIS AND RISK COMPENSATION

PrEP researchers were cognizant of the potential for risk compensation, and the first large randomized controlled trials monitored the sexual behavior of participants over time.<sup>1,2,4</sup> The trials did not focus on perceptions of risk (as participants did not officially know whether they were receiving PrEP or a placebo). The first completed studies found that the combined drugs tenofovir and emtricitabine reduced the risk of HIV infection by 44% to 75% (modified intention-to-treat analysis), with higher efficacy among people who had detectable drug levels. The studies found no evidence of increased condomless sex during the trial period (in fact, condom use increased).<sup>1,2</sup> A recent systematic review and meta-analysis of 18 trials found that PrEP reduced the risk of HIV infection by 70%, compared with placebo, as long as participants were at least 70% adherent.<sup>3</sup> The review also found no evidence of increased risk-taking behavior in the studies.

To assess risk compensation related to PrEP, we recommend examining situations outside randomized controlled trials in which users know that they are receiving an active drug that is effective in preventing HIV.<sup>20</sup> The open-label extension of the international iPrEx (Iniciativa Profilaxis Preeposición or Preeposición Prophylaxis Initiative) study found that, after a year's follow-up, PrEP users were slightly more likely than were nonusers to report receptive condomless sex (25% vs 20%), whereas other behaviors remained unchanged.<sup>21</sup> The level of HIV risk reduction observed in the study was 51%,

which is higher than in the placebo-controlled phase.<sup>1</sup> A large, open-label trial in the United Kingdom found that PrEP reduced the risk of HIV infection by 86% among gay and bisexual men<sup>22</sup> and that after one year PrEP users were more likely than were nonusers to report recent, receptive condomless sex (21% vs 12%).

In these open-label studies, changes in behavior did not diminish the efficacy of PrEP in preventing HIV infection. Increased condomless sex, along with the increased monitoring that PrEP users receive, may, however, contribute to the high rates of other sexually transmitted infections that have been observed among PrEP users.<sup>23</sup> However, because PrEP is not designed to reduce the risk of sexually transmitted infections, increases in sexually transmitted infections should perhaps be considered unintended consequences of PrEP rather than a failure of the HIV-related intervention. How to manage sexually transmitted infections as PrEP use increases remains a subject of debate.

## PREVENTION OPTIMISM

The effect of PrEP on risk perceptions and sexual practices at a community level has not been systematically assessed. In San Francisco, California, one of the first locations to embrace PrEP, an analysis by Chen et al. of behavioral surveillance indicates that consistent condom use by HIV-negative gay and bisexual men (including men not using PrEP) has declined more rapidly since PrEP was introduced.<sup>24</sup> The authors suggest that some men “have given

**EXAMPLES OF MEASURES OF HIV PREVENTION OPTIMISM RELATED TO PrEP**

Item	Measured Aspects of Prevention Optimism
How likely do you think it is that you will become HIV positive? <sup>a</sup>	Individual's perceived risk of HIV infection
Because of PrEP, I am less likely to get HIV. <sup>b</sup>	Personal optimism
It is safe for me to have sex without condoms if I am using PrEP. <sup>b</sup>	Personal optimism, direct protection
It is safe for me to have sex without condoms if my partners are using PrEP. <sup>b</sup>	Personal optimism, direct protection
It is safe for me to have sex without condoms because other people are using PrEP. <sup>b</sup>	Personal optimism, indirect protection
Sex without condoms has become safer because of PrEP.	Community-level optimism
Because of PrEP, fewer people will get infected with HIV. <sup>b</sup>	Community-level optimism
The availability of PrEP makes condom use less important. <sup>b</sup>	Community-level optimism
As more people use PrEP, condom use becomes less important. <sup>b</sup>	Community-level optimism

Note. PrEP = preexposure prophylaxis.

<sup>a</sup>Score from very unlikely to very likely (5-point scale).

<sup>b</sup>Score from strongly disagree to strongly agree (5-point scale).

up consistent condom use under the assumption that other men will be using PrEP.<sup>24(p2794)</sup>

Although the uptake of PrEP can be tracked using behavioral surveillance, it is difficult to determine whether changes in behavior are a result of risk compensation without assessing attitudes to PrEP and the perceived risk of acquiring HIV. The cross-sectional nature of most behavioral surveillance also means that it is not possible to see if changes in attitudes lead to changes in behavior (or vice versa). We are therefore advocating cross-sectional and prospective research on what we call “prevention optimism.”

We derived the concept of prevention optimism from previous work on HIV treatment optimism.<sup>14,18,19</sup> We define prevention optimism as the belief that it is easier to avoid HIV infection or transmission because of PrEP and that it is more acceptable and safer to engage in condomless sex because the risk of HIV is perceived to be reduced. We have included

a suggested list of measures to assess prevention optimism in the box on this page.

Optimistic attitudes could develop at a community level and subsequently affect practice through contact with PrEP users (as sexual partners, friends, or peers) or through learning about PrEP through media and word of mouth. Both of these mechanisms could lead to a belief that PrEP is effective and that the risk of condomless sex has been reduced because of PrEP.

It is critical to distinguish between condomless sex with (or among) people using PrEP (direct protection) and condomless sex with people not using PrEP because of the belief that condomless sex has become safer in general through the increased use of PrEP in the population (indirect protection). Believing that PrEP use by others makes condomless sex safer may be particularly inaccurate (and risky) in contexts where HIV infections have not declined after PrEP's introduction or where there is limited use of PrEP. For example,

in San Francisco it may be realistic (and not optimistic) to believe condomless sex has become safer, because HIV infections have continued to decline since PrEP's introduction.<sup>24</sup>

However, in other settings, HIV incidence among gay and bisexual men is stable or increasing,<sup>25</sup> and PrEP use is rare, so it would be optimistic to rely on PrEP use by others and believe that condomless sex is safer. We think this belief in indirect protection as a result of PrEP and a premature reduction in condom use regardless of local epidemic conditions best encapsulates the idea of prevention optimism. In this way, prevention optimism departs theoretically from risk compensation because it encompasses a more diffuse effect at a community level that could impede the population effectiveness of PrEP rather than solely focusing on the behavior of individuals or dyads using PrEP.

Prevention optimism could be assessed in PrEP trials, as has been suggested by others,<sup>20</sup> but we are

particularly interested in optimism and condomless sex among people not using PrEP, that is, community-level risk compensation. This is because current research suggests limited changes in behavior and, when behavior does change, little overall impact on efficacy in preventing HIV among PrEP users. Of more relevance, in our opinion, is increased risk taking by people unprotected (or not directly protected) by PrEP that is driven by unrealistic optimism (particularly in situations in which HIV infection rates are sustained or increasing). For example, over the past 20 years, rates of condomless sex and HIV infection rates have gradually increased among gay and bisexual men in many high-income countries.<sup>25</sup> If prevention optimism leads to increases in condomless sex among those not using PrEP, this could temper or negate the population-level benefits of PrEP use.

To assess changes in perceptions of risk, the development of prevention optimism, and community-level risk compensation, we recommend that measures such as those in the box on the previous page be included in repeated surveys (including behavioral surveillance) and prospective cohort studies. Repeated, cross-sectional studies can assess community-level changes in attitudes and behavior over time, although they cannot assess whether changes in attitudes precede changes in behavior at the individual level. Longitudinal cohort studies could assess whether prevention optimism leads to risk compensation (and increased risk of HIV) among both PrEP users and nonusers, if they monitor participants' perceptions of risk, beliefs about PrEP, sexual behavior, and HIV incidence.

Qualitative research could explore and contextualize changes in risk perception and sexual behavior among PrEP nonusers, especially if interview participants are followed over time. When attempting to ascertain the degree of community-level risk compensation owing to PrEP and prevention optimism, we recommend also assessing attitudes to HIV treatment and treatment optimism<sup>18,19</sup> so that there is a chance to disentangle the effects of different biomedical prevention strategies on perceptions of risk, behavior, and risk of HIV. We are not aware of any such studies, and we encourage our colleagues to consider them.

## CONCLUSIONS

There is ongoing interest in the potential for risk compensation as a result of new HIV prevention interventions, particularly PrEP. Unfortunately, many studies do not report changes in perceived risk, making it difficult to say whether risk compensation has occurred, even if changes in sexual behavior are observed.

Recent research on risk compensation and PrEP has focused largely on the sexual behavior of PrEP users, without considering changes in perceived risk. These studies have identified some changes in behavior that contribute to increased sexually transmitted infections but that do not appear to undermine the efficacy of PrEP in preventing HIV.<sup>3,21–23</sup> In our view, it is equally important to consider the potential for community-level risk compensation as a result of increased optimism about avoiding HIV. We suggest that researchers evaluate whether prevention optimism leads to increased risk taking among

people unprotected by PrEP. We believe it is important to identify this to respond to unintended and unwanted changes in perception and practice, if they occur, and increase the likelihood of curbing or eliminating the sexual transmission of HIV. **AJPH**

## CONTRIBUTORS

M. Holt wrote the first draft of the commentary. Both authors developed the concept for and refined and revised the commentary, and agreed on the final submitted version.

## ACKNOWLEDGMENTS

The Centre for Social Research in Health receives funding from the Australian Government Department of Health.

Both authors declare nonfinancial support from Gilead Sciences, Inc., outside the submitted work.

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