

Do Behavioral Scientists Really Understand HIV-Related Sexual Risk Behavior? A Systematic Review of Longitudinal and Experimental Studies Predicting Sexual Behavior

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Abstract Behavioral interventions to reduce sexual risk behavior depend on strong health behavior theory. By identifying the psychosocial variables that lead causally to sexual risk, theories provide interventionists with a guide for how to change behavior. However, empirical research is critical to determining whether a particular theory adequately explains sexual risk behavior. A large body of cross-sectional evidence, which has been reviewed elsewhere, supports the notion that certain theory-based constructs (e.g., self-efficacy) are correlates of sexual behavior. However, given the limitations of inferring causality from correlational research, it is essential that we review the evidence from more methodologically rigorous studies (i.e., longitudinal and experimental designs). This systematic review identified 44 longitudinal studies in which investigators attempted to predict sexual risk from psychosocial variables over time. We also found 134 experimental studies (i.e., randomized controlled trials of HIV interventions), but of these only 9 (6.7%) report the results of mediation analyses that might provide evidence for the validity of health behavior theories in predicting sexual behavior. Results show little convergent support across both types of studies for most traditional, theoretical predictors of sexual behavior. This suggests that the field must expand the body of empirical work that utilizes the most rigorous study designs to test our theoretical assumptions. The inconsistent results of existing research would indicate that current theoretical models of sexual risk behavior are inadequate, and may require expansion or adaptation.

Keywords HIV · Sexual risk · Sexual orientation

Introduction

For the first three decades of the HIV epidemic, efforts to control the HIV crisis focused almost exclusively on behavioral interventions designed to reduce sexual risk behavior. With recent advances in biomedical approaches to HIV prevention (e.g., pre-exposure prophylaxis), behavioral interventions are now just one part of combination strategies to avert new infections. However, most epidemiologic modeling work suggests that to effectively control infection at a population level, behavioral risk reduction interventions will remain a cornerstone of HIV prevention (Beyrer et al., 2012; Desai et al., 2008; Lou et al., 2014; Malunguza, Mushayabasa, Chiyaka, & Mukandavire, 2010; Phillips et al., 2013; Shafer et al., 2014), particularly in communities where biomedical technologies are slow to catch on or infeasible because of limited resources.

The success of behavioral interventions to reduce sexual risk behavior requires that interventions be solidly grounded in theory that accurately describes the reasons why people engage in various sexual behaviors. For instance, if one theorizes that sexual risk behavior occurs because of a lack of knowledge about HIV, then an appropriate intervention aim would be to increase knowledge. To the extent that interventions are actually targeting those factors that influence risk behavior, they will be maximally successful. The purpose of the present review is to critically examine the behavioral science evidence regarding what causes sexual risk behavior, with a focus on studies that have the strongest designs (i.e., longitudinal and experimental).

Theories of Sexual Risk Behavior

In the early years of the HIV epidemic, researchers and interventionists appropriated theories that had previously been used

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to describe other health behaviors (e.g., smoking) and applied them in an effort to explain sexual behavior. These theories, such as the Health Belief Model (Rosenstock, Strecher, & Becker, 1994) or the Theory of Reasoned Action (Fisher, Fisher, & Rye, 1995), generally suggested that some combination of cognitive factors (e.g., how serious one perceived an illness to be) would predict health behaviors (e.g., condom use). As the field of HIV prevention progressed, these theories served as the foundation for HIV-specific theories, such as the AIDS Risk Reduction Model or the Information Motivation Behavioral Skills model (Catania, Kegeles, & Coates, 1990; Fisher, Fisher, & Shuper, 2009). Although still largely focused on cognitive determinants of health behaviors, these theories attempted to narrow in more specifically on the reasons for engaging in behaviors relevant to HIV (i.e., sexual behavior or needle use). Eventually, some scholars became critical of the emphasis placed on individual, cognitive determinants of sexual behavior, and instead called for greater application of theoretical models that recognized the broader relational, cultural, and socioeconomic contexts that might influence sex (Aggleton, 2004; Coleman, 2011; Diaz, Stall, Hoff, Daigle, & Coates, 1996; Latkin, Weeks, Glasman, Galletly, & Dolores, 2010; Robinson, Bockting, Rosser, Miner, & Coleman, 2002; Wingood & DiClemente, 2009).

Testing Causal Pathways

The common supposition shared by all theories applied to sexual risk behavior is that changes in the theory-derived determinant of sexual behavior (e.g., perceived severity, socioeconomic status) should result causally in changes in sexual risk behavior. Causality is established when three criteria are met: association (x and y must covary), temporal precedence (if x causes y , x must precede y), and nonspuriousness (the association between x and y cannot be due simply to the influence of an unmeasured factor). These criteria map roughly onto the three most commonly used research designs in the social sciences: cross-sectional, longitudinal, and experimental. In cross-sectional research, individuals are assessed at a single point in time, with the goal of determining whether a series of variables are related to one another. The limitations of this approach to establishing causality are well documented—although useful for establishing association, cross-sectional studies cannot demonstrate temporal precedence or nonspuriousness. Longitudinal designs in which participants are followed over time have a stronger ability to document temporal precedence, but also are limited in their ability to rule out the influence of extraneous factors that might result in a temporal association between two variables (i.e., confounds or “third” variables). The gold standard for establishing causality is the experiment. In an experiment, a researcher randomly assigns participants to groups, and then manipulates variables thought to cause a hypothesized outcome. Random assignment helps control the influence of extraneous variables, yielding groups that

should differ only on the hypothesized causal predictors. Within the field of HIV prevention, virtually any randomized, controlled intervention study meets these criteria for an experiment. These experiments have the potential to illuminate causal predictors of risk if they first report whether the experimental manipulation (i.e., the intervention) changes the mechanism of interest (e.g., self-efficacy), and then report whether those changes in experimentally manipulated (variables) are associated with subsequent changes in sexual risk behavior.

Cross-Sectional Studies of Sexual Risk and Their Limitations

A large body of cross-sectional research has documented a variety of theory-based correlates of sexual risk behavior, and much of this work has already been reviewed elsewhere (e.g., Albarracín, Fishbein, Johnson, & Muellerleile, 2001; Albarracín et al., 2005; Sheeran, Abraham, & Orbell, 1999; Sheeran & Taylor, 1999). Some of these reviews suggest that attitudes and behavioral intentions (Albarracín et al., 2005; Sheeran et al., 1999) are particularly important, which is clear from extensive literature linking these constructs to risk (Basen-Engquist & Parcel, 1992; Catania et al., 1992; Lawrence et al., 1998; Rosario, Mahler, Hunter, & Gwadz, 1999; Sacco, Levine, Reed, & Thompson, 1991). Behavioral skills have also been identified as a key correlate of sexual behavior in both literature reviews and primary research (Bryan, Fisher, & Fisher, 2002; Kalichman, Picciano, & Roffman, 2008; Rosario et al., 1999; for a review, see Albarracín et al., 2005).

In addition to those constructs highlighted by pre-existing reviews, cross-sectional studies have also found evidence for virtually every variable common to health behavior models, such as perceived risk (Carballo-Diequez & Dolezal, 1996; Prata, Morris, Mazive, Vahidnia, & Stehr, 2006; Reitman et al., 1996) and perceived severity of HIV infection, as well as HIV knowledge and safer sex motivations (Cooper, Shapiro, & Powers, 1998; van der Snoek et al., 2006), self-efficacy (Berg, 2008; Diaz et al., 1996; Lin, Simoni, & Zemon, 2005; Wulfert, Wan, & Backus, 1996; Zhao et al., 2012) and peer norms for condom use (Catania, Coates, & Kegeles, 1994; DiClemente, 1991; Jones et al., 2008; Liu et al., 2009; Waldo, McFarland, Katz, MacKellar, & Valleroy, 2000).

As we have described, a key limitation of cross-sectional evidence is the inability to establish temporality, and some theoretical and empirical work suggests that this concern is not trivial in research on sexual behavior. Several well-supported theories describe the ways in which an individual's previous behavior can influence subsequent attitudes and beliefs about that behavior (e.g., Self Perception Theory or Cognitive Dissonance Theory; Bem, 1972; Festinger, 1962). Applied to sexual risk behavior, these theories suggest that an individual's past risk behavior could cause individuals to change their attitudes and beliefs about sexual behavior, resulting in significant cross-

sectional correlations that could be misinterpreted as support for health behavior theories. Some empirical work supports this possibility. One longitudinal study found that although sexual risk behavior was correlated with perceived norms and attitudes toward risk in cross-sectional data, the only longitudinal direction of effect went from sexual risk to subsequent norms and attitudes, rather than the reverse, as health behavior theories would suggest (Huebner, Neilands, Rebchook, & Kegeles, 2011). These findings are consistent with research on “HIV treatment optimism” (the idea that HIV is a more treatable and less threatening disease), showing that optimistic attitudes about treatments may not always lead to subsequent risk behavior, but rather, that risk behavior can temporally precede increases in optimism (Huebner, Rebchook, & Kegeles, 2004).

Present Systematic Review

Undoubtedly, at least some of the abundant correlational evidence linking psychosocial variables to sexual risk behavior is reflective of true underlying causal associations of the kind that health behavior theories suggest. However, given the concerns we discuss above, it is critical that the field more closely examine the evidence from stronger longitudinal and experimental designs in order to determine which constructs have the greatest predictive power and therefore would make for the most promising intervention targets. Thus, the purpose of the present review is to identify and summarize the results of longitudinal and experimental studies that attempt to link a theoretically informed psychosocial variable to HIV-related sexual risk behaviors.¹ A careful review of the literature across successive steps of methodological rigor (i.e., cross-sectional evidence already documented, longitudinal, and, finally, experimental) has the potential to highlight strengths and weaknesses in current models of sexual risk behavior, guiding both future theoretical and intervention work.

Method

Review and Inclusion Criteria

Trained research assistants used multiple strategies to identify all relevant published research that was available as of January 2014. First, electronic searches were conducted in relevant databases using a number of keywords (see in Appendix Table 4). For intervention studies, searches were conducted first including terms specific to randomized trials and mediation, and then conducted with those search terms removed to avoid missing relevant studies using search criteria that were overly restrictive. Searches were conducted using first narrow

¹ We opted to conduct a systematic review, rather than a formal meta-analysis, because of the diversity of constructs utilized as predictors of sexual risk within the literature and the relatively small number of studies that explore any single construct.

search terms and then broad to make the identification and coding process more efficient (i.e., articles identified with narrow search terms were almost certainly relevant and could be immediately mined for relevant data, whereas articles identified using broad search terms required more careful reading to determine inclusion or exclusion).

Searches were also conducted in 20 relevant HIV, health, and sexual behavior journals, as well as journals that frequently publish the results of randomized controlled trials (RCTs) (see in Appendix Table 4). These searches were done by searching those journals specifically using the selected search terms, as well as manually searching article titles of past issues of the journal for relevant studies published over the past 10 years. RCTs of HIV prevention interventions were also identified through the Center for Disease Control and Prevention’s (CDC) compendium of evidence-based HIV prevention interventions (<http://www.cdc.gov/hiv/prevention/research/compendium/rr/index.html>). Finally, the reference lists of identified articles were checked to search for any additional eligible studies (i.e., the ancestral method).

Articles were eligible for inclusion in the longitudinal review if they reported on any predictor of sexual risk behavior using a longitudinal design. Experimental studies were eligible if they reported the results of a RCT of an HIV or sexual risk prevention intervention that included any of the following outcomes: unprotected anal or vaginal intercourse, consistency of condom use, or number of sexual partners.

Data Extraction

Trained reviewers abstracted information from eligible articles using a standardized form. The standardized coding form included study information (e.g., setting and sample size), participant characteristics (e.g., gender and sexual orientation), and outcome information (e.g., operationalized sexual risk outcome). For interventions, we also extracted intervention-specific information (e.g., length of intervention and theoretical foundation (if any noted)) and information on tests of mediation (e.g., tests of each mediation path separately and article descriptions of mediating variables). For longitudinal studies, we extracted information related to the predictors (e.g., article description of predictor and scale sample item if available). Quality of extraction was maintained by holding weekly discussions with the extraction team and by having one of the authors verify both sets of extracted information independently.

Results

Longitudinal Studies

We identified a total of 44 longitudinal studies examining prospective predictors of sexual risk behavior (see Table 1).

Table 1 Studies predicting sexual behavior longitudinally

Author and Year	Sample	Length of Follow-up	Outcome	Predictor	Significant effect of predictor	Controlled for outcome at baseline
Agot et al. (2010)	N = 648; 100 % male; sexual orientation not reported	6 assessments; 1, 3, 6, 9, and 12 months apart	Unprotected vaginal intercourse (total number of sex acts/number of weeks between assessments; 0 = low risk (no risky sex acts), 1 = medium risk (0–0.5 average risky sex acts per week, 2 = high risk (>0.5 average risky sex acts per week	Circumcision	Yes	Yes
Aspinwall, Kemeny, Taylor, Schneider, & Dudley (1991)	N = 389; 100 % MSM	2 assessments, 6 months apart	Unprotected receptive anal intercourse, past 6 months, dichotomized (0 = no URAI or unprotected only with concordant primary partner; 1 = unprotected with more than one partner or a primary partner who was HIV-positive or unknown status)	Baseline number of sexual partners Perceived barriers to change Demographics (entered together) Cues to Action HIV status Intentions Partner HIV status Perceived barriers to change Perceived risk Self-efficacy Social Norms	Yes Yes No No No No No Yes No No No No	Yes Yes Yes Yes Yes Yes Yes Yes Yes Yes Yes
Bechange et al. (2010)	N = 455; 40 % male, 60 % female	4 assessments every 6 months	Unprotected sex, past 3 months, dichotomized (inconsistent condom use with HIV-positive or unknown status partner)	AIDS-related anxiety Desiring children Perceiving HIV as curable Age Education Gender Marital status Perceptions of risk Source of income	Yes Yes Yes No No No No No No No No	No No No No No No No No No No No
Bidas, Birkett, Newcomb, & Mustanski (2012)	N = 119, 100 % MSM	4 assessments, 6 months apart	Count of unprotected anal intercourse acts, past 6 months	African-American race Major depressive disorder (between-person) Post-traumatic stress disorder × Psychological Distress (within-person) Age Age at baseline Major depressive disorder × Psychological Distress (within-person) Post-traumatic stress disorder (between-person) Psychological distress	Yes (negatively associated) Yes Yes No No No No No Yes Yes	No No No No No No No No No No No No

Table 1 continued

Author and Year	Sample	Length of Follow-up	Outcome	Predictor	Significant effect of predictor	Controlled for outcome at baseline
Blashill et al. (2014)	N = 490; 100 % MSM	Approximately 12, every 2 months	Condom use, past 6 months (1 "Never to 4 "Always")	BMI	Yes	
Bogart, Galvan, Wagner, & Klein (2011)	N = 181; 100 % male	3 assessments, 6 months apart	Unprotected anal or vaginal intercourse, past month, dichotomized	Depression Depression × BMI HIV conspiracy beliefs Employment Income	Yes Yes Yes No No	Yes Yes Yes
Brook et al. (2010)	N = 296; 52 % male; 48 % female	2 assessments, 1 year apart	Sexual risk (latent variable combination of number of partners, ever sexually active, frequency of condom use)	Discrimination/victimization Father-child relationship Substance use	Yes Yes Yes	No No No
Bryan, Ray, & Cooper (2007)	N = 267; 77 % male; 23 % female	2 assessments, 6 months apart	Condom use past 6 months (1 "Never" to 5 "Always")	Impulsivity Alcohol use	Yes No	No No
Bryan, Schmiege, & Braodius (2007)				Alcohol use × Gender Impulsivity Alcohol use × Sexual Enhancement Expectancy	Yes Yes No	No No No
Bryan et al. (2002)	N = 225, 58 % male, 42 % female; N = 160, 46 % male, 54 % female	2 assessments, 1 month apart; 2 assessments, 2 months apart	Condom use, past month (1 "Never used" to 5 "always used")	Alcohol use × Sexual Risk Expectancy Gender Preparatory safer sexual behavior	No Yes Yes; Yes (men only)	No No No; No
Darbes, Chakravarty, Neilands, Beougher, & Hoff (2014)	N = 566 same-sex couples; 100 % MSM	6 assessments, first 1 year apart and then every 6 months	Unprotected anal intercourse with a serodiscordant primary partner, past 3 months, dichotomized	Communication Investment in sexual agreement Negative relationship dynamics	Yes Yes Yes	Yes Yes Yes
DiClemente et al. (2001)	N = 609; 100 % female	2 assessments, 6 months apart	One member of couple had unprotected anal intercourse with outside partner, past 3 months (0 = both partners report zero acts, 1 = only one partner reported UAI, 2 = both partners reported UAI)	Attachment HIV-specific social support Intimacy	Yes Yes Yes	Yes Yes Yes
Epstein et al. (2014)	N1 = 808, 48 % female, 51 % male; N2 = 1,040, 47 % female, 53 % male	N1: 9 assessments, every year from ages 10–16, ages 18, 21, 24; N2: 7 assessments, 1 per year	Unprotected vaginal sex, past 6 months, dichotomized	Greater depression	Yes	Yes
Grov, Golub, Mustanski, & Parsons (2010)	N = 47; 100 % MSM	30 assessments, 1 day apart	Lifetime partners Sex under the influence (0 = less than half the time, 1 = More than half the time)	Sexual debut Family management Sexual debut	Yes Yes Yes	Yes Yes Yes
Hatzenbuehler, O'Cleirigh, Mayer, Mimiaga, & Safren (2011)	N = 314, 100 % HIV + MSM	5 assessments, at baseline, 3, 6, 9, and 12 months	Unprotected anal intercourse with a risky partner (HIV serodiscordant main partner, any HIV-status non-primary partner), dichotomized	Negative activation Sexual activation Anxious arousal Positive activation	Yes Yes No No	No No No No
			Count of unprotected anal intercourse (HIV-negative or unknown status partners), past 3 months	Anxiety Greater depression HIV-related stigma	No No Yes	Yes Yes Yes

Table 1 continued

Author and Year	Sample	Length of Follow-up	Outcome	Predictor	Significant effect of predictor	Controlled for outcome at baseline
Hatzenbuehler, Nolen-Hoeksema, & Erickson (2008)	N = 74; 100 % MSM	5 assessments; at 1 month, 6, 9, 13, and 18 months	Count of unprotected anal intercourse, past 6 months	Internalized homophobia Discrimination Perceived danger Perceived rise in homophobia	Yes No No No	No No No No
Hendershot, Magnan, & Bryan (2010)	N = 656; 66 % male, 34 % female	2 assessments; at baseline and 12-months	Condom use frequency, past 6 months (1 "Never" to 5 "Always")	Marijuana use (any) Marijuana use prior to sex Frequency of marijuana use Marijuana dependence symptoms Marijuana problems Marijuana-specific condom use intentions	No No No No Yes Yes	No No No No No No
Huebner et al. (2011)	N = 1,465; 100 % MSM	2 assessments, 18 months apart	Count of unprotected anal intercourse, past 2 months	Condom use intentions Peer norms Safe sex attitudes	Yes No No	No Yes Yes
Kalichman et al. (2011)	N = 343; 75 % male; 22 % female; 1 % transfemale	3 assessments, every 4 months	Count of unprotected anal or vaginal intercourse, past 4 months	CD4 count Currently taking antiretroviral medication Age Education HIV symptoms Knows viral load	Yes Yes No No No No No No	No No No No No No No No
Kang, Derren, Andia, Colon, & Robles (2004)	N = 952; 74 % male, 26 % female	2 assessments, 6 months apart	Multiple partners, past 30 days, dichotomized Transactional sex, past 30 days, dichotomized Unprotected sex, past 30 days, dichotomized	Self-reports undetectable Sexually transmitted infections Understands meaning of viral load Years since testing HIV+ Decline in self-efficacy over time Decline in self-efficacy over time Decline in self-efficacy over time	Yes Yes Yes No Yes No Yes Yes	No No No No Yes Yes Yes Yes

Table 1 continued

Author and Year	Sample	Length of Follow-up	Outcome	Predictor	Significant effect of predictor	Controlled for outcome at baseline
Kang, Deren, Andia, Colon, & Robles (2005)	N = 548; 38 % male, 62 % female	2 assessments 6 months apart	Multiple partners, past 30 days, dichotomized	Crack use	Yes	Yes
				Sex network characteristics	Yes	Yes
				Age	No	Yes
				Condom use norms	No	Yes
				Gender	No	Yes
				Education	No	Yes
				Homelessness	Yes	Yes
				IDU	Yes	Yes
				Safe sex self-efficacy	Yes	Yes
				Serostatus	No	Yes
				Age	Yes	Yes
				Sex network characteristics	Yes	Yes
				Condom use norms	No	Yes
				Crack use	No	Yes
				Gender	No	Yes
				Education	No	Yes
				Homelessness	No	Yes
				IDU	No	Yes
				Safe sex self-efficacy	No	Yes
				Serostatus	No	Yes
Serostatus	Yes	Yes				
Age	No	Yes				
Condom use norms	No	Yes				
Crack use	No	Yes				
Gender	No	Yes				
Education	No	Yes				
Homelessness	No	Yes				
IDU	No	Yes				
Safe sex self-efficacy	No	Yes				
Serostatus	No	Yes				
Serostatus	Yes	Yes				
Age	No	Yes				
Condom use norms	No	Yes				
Crack use	No	Yes				
Gender	No	Yes				
Education	No	Yes				
Homelessness	No	Yes				
IDU	No	Yes				
Safe sex self-efficacy	No	Yes				
Serostatus	No	Yes				
Serostatus	Yes	Yes				
Age	No	Yes				
Condom use norms	No	Yes				
Crack use	No	Yes				
Gender	No	Yes				
Education	No	Yes				
Homelessness	No	Yes				
IDU	No	Yes				
Safe sex self-efficacy	No	Yes				
Sex network characteristics	No	Yes				
Alcohol before sex	Yes	Yes				
Partner HIV status	Yes	Yes				
Partner type (primary vs. casual)	Yes	Yes				
Education	No	Yes				
Baseline sub use × 5HTTLPR gene	Yes	Yes				
Baseline substance use	Yes	Yes				
Gender	Yes	Yes				
Genetic risk	No	Yes				
Kiene et al. (2008)	N = 82; 30 % male, 70 % female	42 assessments, 1 per day	Count of unprotected anal or vaginal intercourse	Sex network characteristics	No	Yes
				Condom use norms	No	Yes
Kogan et al. (2010)	N = 259; African-American youth	2 assessments, 2 year apart	Unprotected sex, past 12 months (0 = never had sex, 1 = used condom every time, 2 = did not use a condom every time)	Partner type (primary vs. casual)	Yes	Yes
				Education	No	Yes

Table 1 continued

Author and Year	Sample	Length of Follow-up	Outcome	Predictor	Significant effect of predictor	Controlled for outcome at baseline
Mayne, Acree, Chesney, & Folkman (1998)	N = 100; 100 % MSM	12 assessments, every 2 months	Unprotected anal sex or receptive oral sex with ejaculation, past 2 months, dichotomized	Alcohol use Drug use Greater depression Dyadic adjustment Social support Information Motivation Behavioral skills Age	No No No No No No Yes No No	No No No No No Yes Yes Yes Yes
Mustanski, Donenberg, & Emerson (2006)	N = 175 youth; 42 % female, 58 % male	2 assessments, 6 months apart	Composite condom use, past three months (0 = abstinent, 1 = always used a condom, 2 = 1 sexual partner, inconsistent use, 3 = Multiple partners, inconsistent condom use, 4 = Multiple partners, never used condoms)	State anxious affect State positive affect State negative affect State sexual activation Trait anxious affect Trait positive affect Trait negative affect Trait sexual activation	Yes Yes Yes Yes No No No No	No No No No No No No No
Mustanski (2007)	N = 155; 100 % MSM	30 assessments, one per day	Composite sexual risk (0 = hand-genital; oral with condom; 1 = anal with condom, received oral without condom; 2 = gave oral without condom; 4 = unprotected insertive anal sex; 7 = unprotected receptive anal sex)	Alcohol use × Age Age Alcohol use	Yes Yes No	No No No
Mustanski (2008)	N = 155; 100 % MSM	30 assessments, one per day	Composite sexual risk (0 = hand-genital; oral with condom; 1 = anal with condom, received oral without condom; 2 = gave oral without condom; 4 = unprotected insertive anal sex; 7 = unprotected receptive anal sex)	Alcohol use × Age Age Alcohol use	Yes Yes No	No No No
Mustanski et al. (2011)	N = 122; 100 % MSM	3 assessments, every 6 months	Unprotected anal intercourse dichotomized Count of total unprotected anal or vaginal intercourse within a sexual partnership, past 6 months	Alcohol use × Age Age Alcohol use Age difference between partners Drug use prior to sex Forced sex Partner gets way in disagreements Partner having sex with outside partners Physical partner violence Repeat partner Serious relationship Wanted relationship to last Felt trapped in relationship Female partner Partner met online Partner paid for things	Yes No No Yes Yes Yes Yes Yes Yes Yes Yes Yes Yes No No No No	No No No Yes Yes Yes Yes Yes Yes Yes Yes Yes Yes Yes Yes Yes Yes Yes

Table 1 continued

Author and Year	Sample	Length of Follow-up	Outcome	Predictor	Significant effect of predictor	Controlled for outcome at baseline
Ndase et al. (2012)	<i>N</i> = 3,380; 67 % male; 37 % female	8 assessments, every 3 months	Unprotected sexual intercourse, previous month, dichotomized	Sex with outside partners	Yes	No
Newcomb and Mustanski (2013)	<i>N</i> = 143; 100 % MSM	12 assessments, one per week	Unprotected anal or vaginal intercourse, dichotomized	Participant age Participant race (black vs other) Participant sexual orientation Partner age Partner race Partner age × race Partner age × race × participant age # Previous encounters # Previous encounters × age # Previous encounters × race # Previous encounters × age × race Partner gender (female vs. male) Partner HIV status	No Yes No No No Yes Yes No No Yes No Yes Yes No Yes Yes	Yes Yes Yes Yes Yes Yes Yes Yes Yes Yes Yes Yes Yes Yes Yes Yes
Newcomb and Mustanski (2014)	<i>N</i> = 143; 100 % MSM	12 assessments, one per week	Unprotected anal or vaginal intercourse, dichotomized	Condom use self-efficacy Condom use intentions Condom use norms HIV knowledge Motivation to become safer Perceived baseline risk Perceived severity HIV infection Greater depression Gender abuse	Yes No No No No No No Yes Yes No No No Yes Yes	Yes Yes Yes Yes Yes Yes Yes Yes Yes Yes Yes Yes Yes Yes Yes
Nuttbrock et al. (2013)	<i>N</i> = 230; 100 % transwomen; 59 % heterosexual	3 assessments, 1 year apart	Unprotected receptive anal intercourse, past 6 months, dichotomized	Moderate depression (relative to low and high depression) Age	Yes Yes	No No
O’Cleirigh et al. (2013)	<i>N</i> = 746; 100 % HIV+ MSM	3 assessments, every 6 months	Unprotected anal or vaginal intercourse, past 3 months, dichotomized	Moderate depression (relative to low and high depression) Age	Yes Yes	Yes Yes
Pantalone, Huh, Nelson, Pearson, & Simoni (2014)	<i>N</i> = 134; 100 % MSM	5 assessments: baseline, 2 weeks, 3, 6, and 9 months	Unprotected anal intercourse, past 6 months, dichotomized	Crystal methamphetamine Latino (vs. White) Life stress Low trait anxiety Education Number of partners Other race (vs. White) Years living with HIV	Yes Yes Yes Yes No No No No	Yes Yes Yes Yes Yes Yes Yes Yes

Table 1 continued

Author and Year	Sample	Length of Follow-up	Outcome	Predictor	Significant effect of predictor	Controlled for outcome at baseline
Wilson, Stadler, Boone, & Bolger (2014)	N = 106; 100 % male, 82 % MSM	6 assessments, one per week	Unprotected anal intercourse, dichotomized	Within-person variation in Depression over time relative to their average Within person variation in Well-being relative to their average Between-person variation in Depression Between-person variation in Well-being Age	Yes Yes No No No	Yes Yes Yes Yes Yes
Wingood & DiClemente (1998)	N = 128, African American; 100 % female	2 assessments, 3 months apart	Proportion of unprotected vaginal sex, past 3 months, (number of condomless sex acts divided by total sex acts)	Communication Desire to become pregnant Control over condom use Partner's commitment Perceived control over partner Age Ethnicity Residential status Employment status Secondary education enrollment	No No No No No No No No No No	Yes Yes Yes Yes Yes No No No No No
Wong, Schragar, Chou, Weiss, & Kipke (2013)	N = 526; 100 % MSM	5 assessments every 6 months	Unprotected anal intercourse, past 3 months (0 = no partners, 1 = consistent condom use, 2 = UAI with seroconcordant primary partner, 3 = Multiple partners or single partner serodiscordant)	Primary relationship Callous-uneemotional traits Conduct disorder traits	Yes No No	No No No
Wymbs et al. (2013)	N = 471; 51 % male; 49 % female	6 assessments, at 6, 12, 18, 24, 26, and 72 months	Frequency of contraceptive use, (0 = Never, 1 = sometimes, 2 = Always)		No	No

The most frequently studied psychosocial predictors included depression ($n = 10$) and substance use ($n = 20$), which interestingly have not featured prominently in most formal theories of health behavior or HIV risk. These were also the predictors with the most consistent evidence of a longitudinal association with sexual risk (see Table 3), although we should note that depression demonstrated inconsistent findings with regards to the direction of the association. Of the 8 studies that demonstrated a significant effect of depression, four found a positive effect of depression on condomless sex over time (DiClemente et al., 2001; Nuttbrock et al., 2013; Wagner, Ghosh-Dastidar, Slaughter, Akena, Nakasujja, & Musisi, 2014; Wilson, Emerson, & Donenberg, 2013); one found a negative effect of depression on condomless sex (Beidas, Birkett, Newcomb, & Mustanski, 2012) and three found complex effects (Blashill et al., 2014; O’Cleirigh et al., 2013; Wilson, Stadler, Boon, & Bolger, 2014), where the association of depression with condomless sex was non-linear, moderated, or varied within person. The other category of predictors that had consistent evidence of longitudinal associations with sexual risk was sexual history (e.g., having had a previous sexually transmitted infection). This is consistent with a large body of research from a variety of domains suggesting that past behavior is a strong predictor of future behavior (Ouellette & Wood, 1998). In contrast, constructs that have featured prominently in most health behavior theories (i.e., self-efficacy, intentions, condom attitudes, and norms) were studied relatively infrequently (see Table 3), and had inconsistent longitudinal associations with sexual risk.

Across HIV risk groups, 44.3 % of longitudinal studies focused on men who have sex with men (MSM), whereas the remainder comprised samples of heterosexual men or women. Studies were heterogeneous with respect to methodologies. Specifically, the length of follow-up and number of assessments differed widely, ranging from daily assessments over a 30-day period to annual assessments conducted over a span of 6 years. Another important methodological difference was whether baseline levels of risk were included as a covariate in predicting subsequent risk. This practice was employed in most, but not all studies. We were unable to identify any clear associations between methodological characteristics of studies and their tendency to observe longitudinal associations between predictors and sexual risk.

Experimental Studies

We identified a total of 134 reports of RCTs testing the efficacy of HIV preventive interventions. However, among these RCTs only 9 (6.7 %) included the results of a full mediation analysis—testing whether the intervention successfully manipulated variables thought to be causally predictive of risk behavior (i.e., mediators of the intervention effect) and also whether those changes in mediators were related to changes in sexual risk behavior. These studies are listed in Table 2. Self-efficacy for safe sex

behaviors was the most commonly tested mediator, and results of these tests were mixed. In studies where self-efficacy was not a significant mediator of intervention effects, it was most often the case that experimentally induced changes in self-efficacy were not associated with reductions in sexual risk (i.e., the effect of the mediator on the outcome was non-significant in that sample). Safe sex norms, knowledge, and outcome expectancies (e.g., self-evaluative expectancies, such as feeling good about oneself after having safe sex) were also tested in a number of studies. Norms and expectancies had mixed associations with sexual risk in these experimental paradigms. All five studies examining whether experimentally induced changes in knowledge resulted in reductions in risk found no effect.

Findings Across Designs

Table 3 summarizes the results of both longitudinal and experimental studies, indicating the number of studies of each design that showed significant and non-significant effects on sexual risk for each predictor variable. Interestingly, some of the predictors with the largest bodies of longitudinal evidence (e.g., depression, mental health, and substance use) have rarely, if ever, been tested as mediators of intervention effects. This is likely the case because they are not prominent features of health behavior theories, and are generally less likely to be targeted in the context of sexual risk reduction interventions. Other predictors that have relatively consistent longitudinal associations with sexual risk (e.g., history of childhood sexual abuse and experiences of discrimination) also have no experimental evidence because interventions would not sensibly or ethically manipulate the variable of interest (e.g., sexual abuse), or because intervening to change the variable is daunting and rarely attempted (e.g., exposure to discrimination). In these cases, lack of experimental evidence obviously cannot be taken as an indication that the constructs are unimportant theoretically.

Discussion

The most notable feature of this systematic review is the relative dearth of studies that use more rigorous designs to examine potential predictors of sexual risk behavior. We were able to locate only 44 longitudinal studies examining predictors of sexual risk, and only 9 (or 6.7 %) of the randomized controlled intervention trials we identified reported the results of a mediation analysis that would provide the strongest evidence for a causal link between a variable and sexual behavior. Moreover, the results of the studies we were able to identify suggested very mixed support for any predictive associations with sexual risk behavior. Substance use had the most consistent temporal association with sexual risk behavior, but did not have any experimental support. Childhood sexual abuse had consistent longitudinal associations with sexual risk, but was the subject of only

Table 2 Studies empirically testing mediation within randomized controlled trials

Author and Year	Trial	Sample	Theory	Outcome	Mediator	Effect of Intervention on outcome	Effect of Intervention on Mediator	Effect of Mediator on Outcome	Overall Mediation Significant
Bull, Pratte, Whitsell, Rietmeijer, & McFarlane (2009)	<i>Keep It Real</i> (Original trial)	N = 991 (Internet intervention), 53 % male, 47 % female; 574 (clinic intervention), 22 % male, 78 % female	SCT; TPB	Proportion of sex acts protected by condoms past 60 days (number of protected acts/total number of sexual acts)	Condom use norms Condom use self-efficacy	Yes Yes	Yes (internet sample) Yes, negatively (clinic sample)	Yes (internet sample) No	Yes (internet sample) No
Comman, Schmiege, Bryan, Joseph Benziger, & Fisher (2007)	<i>Truckers' Health Project</i> (Original trial)	N = 250, 100 % male	IMB; SCT	Condom use with marital partners, past 4 months, dichotomized	Outcome expectancies Partner norms Information Attitudes Norms Intentions Behavioral skills	Yes Yes Yes Yes Yes Yes Yes	No No No Yes Yes Yes Yes	No No No Yes No Yes Yes	No No Yes Yes Yes Yes No
O'Leary et al. (2012)	Let us Protect Our Future (Jemmott et al., 2010)	N = 1,057, 47 % male; 53 % female	SCT	Frequency of condom use with <i>non</i> -marital partners (1 "Never" to 5 "Always"), past 4 months Unprotected sexual intercourse, past 3 months, dichotomized	Self-efficacy to avoid risk Perceived parental disapproval Abstinence prevention expectancy Abstinence career opportunity expectancy Self-efficacy to refuse sex HIV risk reduction knowledge Cultural myths HIV transmission Self-efficacy to avoid risk	Yes Yes Yes Yes	Yes Yes Yes Yes	Yes Yes No No	Yes Yes No No
O'Leary, Jemmott, & Jemmott (2008)	Sister to Sister (Jemmott, Jemmott, & O'Leary, 2007)	N = 564; 100 % female	SCT	Condom use at last intercourse, dichotomized	Partner reaction outcome expectancies Partner approval of condom use Self-efficacy to carry condoms Self-efficacy for impulse control HIV knowledge Hedonistic outcome expectancies	Yes Yes Yes Yes	Yes Yes No No	Yes No No No	Yes No No No No No

Table 2 continued

Author and Year	Trial	Sample	Theory	Outcome	Mediator	Effect of Intervention on outcome	Effect of Intervention on Mediator	Effect of Mediator on Outcome	Overall Mediation Significant
O'Leary et al. (2005)	Seropositive Urban Men's Intervention Trial (SUMIT) (Wolitski, Gómez, Parsons, & SUMIT Study Group 2005)	N = 811; 100 % MSM	SCT; IMB; TPB	Unprotected anal intercourse, dichotomized	HIV status assumptions Self-evaluative outcome expectancy Hedonistic outcome expectancy Personal responsibility Sexual compulsivity Anxiety Hostility Depression Drug use Peer norms Self-efficacy	No No No No No No No No No No No	Yes No Yes No No Yes No No No No No	Yes Yes Yes Yes No No No Yes No No No	No No No No No No No No No No No
NIMH Multisite HIV Prevention Trial Group (2001)	NIMH Multisite Prevention Trial (The NIMH Multisite HIV Prevention Trial Group 1998)	N = 3,706; 42 % male; 58 % female	SCT	Count of unprotected intercourse, past 3 months	Condom use self-efficacy Safe Sex Knowledge—Condoms Safer Sex Knowledge—Other Activities Hedonistic outcome expectancy Partner reaction outcome expectancy Self-approval outcome expectancy	Yes Yes Yes Yes Yes Yes Yes	Yes Yes Yes Yes Yes Yes Yes	Yes Yes Yes Yes Yes Yes Yes	Yes No No Yes Yes Yes Yes
Sales et al. (2012)	HORIZONS (DiClemente et al. 2009)	N = 715; 100 % female	SCT; TGP	Proportion of condom-protected sex acts, past 60 days, dichotomized	Partner Communication Frequency HIV knowledge Condom use self-efficacy	Yes Yes Yes	Yes No No	Yes Yes Yes	No Yes Yes
Schmiege, Levin, Broadus, & Bryan (2009)	Original trial	N = 484; 83 % male, 17 % female	SCT; TPB	Unprotected sexual intercourse, past 3 months, composite score (Frequency of sex, condom use combined)	Attitudes Norms Self-efficacy Intentions Restricting social sexual norms	Yes Yes Yes Yes Yes	Yes Yes Yes Yes Yes	No No No No No	No No No No No
Stigler, Kugler, Komro, Leshabari, & Klepp (2006)	Klepp, Ndeki, Leshabari, Hannan, & Lyimo (1997)	N = 814; 47 % male, 53 % female	TRA; social learning	Condom use intentions (0 = No, 1 = I don't know, 2 = Yes, maybe, 3 = Yes, I am sure)		Yes	Yes	Yes	Yes

IMB Information, Motivation, Behavioral Skills Model, SCT social cognitive theory, TGP Theory of Gender and Power, TPB Theory of Planned Behavior

Table 3 Evidence for predictors of sexual risk in both longitudinal and experimental studies

Conceptual predictor	Example construct	Number of Longitudinal Studies Finding Association	Number of Longitudinal Studies Not Finding Association	Number of Studies of Mediation in Experimental Trials Finding Association	Number of Studies of Mediation in Experimental Trials Not Finding Association
Demographic characteristics	Age	5	16	NA	NA
Partner characteristics	Others (e.g., Education, Race)	12	8	NA	NA
HIV serostatus	Demographic characteristics of the sexual partner	4	1	NA	NA
Self-efficacy	Condom use self-efficacy, sexual refusal self-efficacy	1	1	NA	NA
Mental Health	Depression	3	4	4	3
	Other mental health (e.g., anxiety, state affect)	8	2	0	1
Substance use	Alcohol, Cocaine	8	2	0	0
Childhood abuse	Sexual, physical, neglect	14	6	0	1
Condom use norms	Peer norms around condom use	3	0	NA	NA
Condom use intentions	Personal intentions	1	4	2	2
Condom use attitudes	Personal attitudes toward condoms	3	2	1	0
Safer sex knowledge	Personal attitudes toward condoms	1	2	0	2
Behavioral skills	HIV-relevant knowledge	1	3	0	5
Interpersonal dynamics	Condom-use skills	3	0	0	0
	Intimate partner (e.g., trust, relationship investment)	4	2	2	1
Outcome Expectancies	Parent (e.g., communication about sex)	1	0	0	0
	Hedonistic outcome expectancies, Partner reaction expectancies	0	0	1	4
HIV Perceptions	Perceived severity of risk, perceived severity of HIV/AIDS	2	2	0	0
Sexual History	History of STI, lifetime sexual partners	8 ^a	1	NA	NA
HIV health	CD4+, Viral Load, Antiretroviral medication	1	2	0	0
Discrimination	Homophobia, Gender abuse	4	1	0	0

NA not applicable because the predictor variable (e.g., demographic characteristic, or childhood sexual abuse) cannot be manipulated through experimental intervention

^a The significant longitudinal associations between depression and sexual behavior are mixed. See Table 1 and Results for a more thorough description

three studies. Although not part of an explicit model of sexual risk, research on “syndemics” in the context of HIV suggests that mental health problems, substance use, and childhood sexual abuse are prevalent and prominent psychosocial stressors that interact negatively to increase HIV risk, particularly among MSM (Stall et al., 2003). No other predictor had strong or conclusive evidence for an association with sexual risk.

Weak and Inconsistent Findings

Cross-sectional studies have often found that the constructs described in health behavior theories are correlated with risk, and this has been taken as support for the utility of these theories in accurately describing what predicts sexual risk. The inconsistency of evidence from stronger designs, however, raises questions about whether those cross-sectional correlations are truly evidence of real causal associations that the theories assert. The limited number of studies precludes drawing any firm conclusions about this, but one possibility that we must entertain is simply that existing health behavior theories are not adequate descriptors of sexual behaviors. Indeed, many have written about the especially complex nature of sex (e.g., Boyce et al., 2007), especially when it is compared to other health behaviors, such as seatbelt use or exercise. Relative to some health behaviors, sex may be the outcome of more intense biological or emotional drives (Hyde, 2005; McKinney & Sprecher, 1991). Additionally, sex requires the participation of at least one other individual, a factor that immediately limits the utility of any individually based theory. Studies utilizing event-level data to explore sexual behavior have found that factors related to a specific event or partnership are more predictive of sexual risk behavior than are characteristics of the individual that operate across events (Mustanski, Newcomb, & Clerkin, 2011; Newcomb & Mustanski, 2013). Moreover, in some cases, sexual behavior may be mostly or entirely out of an individual’s own control (e.g., in coercive, threatening, or highly inequitable partnerships).

Another possibility suggested by the mixed nature of the evidence for theories of sexual risk is that existing theories may have greater predictive validity in some populations (or some individuals within populations), relative to others. Consistent with this idea, one large study of MSM found heterogeneous constellations of risk factors for unprotected anal intercourse, suggesting that different explanatory models might apply to different men (Chesney et al., 2003). In another test of this possibility, McGarrity and Huebner (2013) found that behavioral intentions to obtain an HIV test predicted subsequent HIV testing in higher status men (i.e., higher SES men and older men), but not in lower status men. It was concluded that higher status individuals might have greater agency and experience fewer barriers to enacting their behavioral intentions, a possibility which could also apply to sexual behavior. Beyond social status, other individual differences might also moderate the predictive utility of certain variables. Kogan et al. (2010), identified

in our review, found that the influence of substance use on subsequent risky sex among adolescents differed depending on the presence of a gene that has been associated with risk taking.

Alternatively, improper measurement or operationalization of constructs may explain why some studies fail to find an effect. For instance, approximately half of the studies in our review treated sexual risk behavior as a dichotomous outcome (any vs. none). Effectively, this differentiates participants into two groups—perfect condom users and a heterogeneous “at risk” group. Those “at risk” might include both people who never use condoms and those who almost always use condoms but experience an occasional “slip.” Most health behavior theories would posit that the individual who is a nearly perfect condom user would have health-related attitudes and beliefs that were more similar to the perfect condom users than he would to those who engage in very frequent unprotected sex. Yet the dichotomous operationalization of sexual risk masks this possibility and, therefore, might be a reason why studies that do so fail to find support for health behavior theories.

Why Do We Have So Few Studies?

The small number of studies with stronger designs is an obvious challenge for the field to address. Longitudinal research is obviously more expensive and time intensive to undertake, relative to cross-sectional research, and this is likely the most parsimonious explanation for the relatively small number of longitudinal studies in this area. However, this does not adequately explain why such a tiny fraction of the RCTs report the results of a mediation analysis. It is clear that most grant review panels funding intervention trials require the assessment of mediators of an intervention effect, and given that these data likely exist for most RCTs, it is surprising that we find so few published reports of those data. One possibility is that investigators are conducting mediation analyses but finding limited effects. In these cases, investigators may either fail to submit null effects for consideration for publication or find their submissions rejected, given the biases in publishing. Given the very mixed nature of findings in the published works we did identify, it is hard to believe that the “file drawer” contains a greater proportion of studies with clearer, more compelling results of mediation analyses. Another possibility is that investigators running RCTs first test to see if an intervention has an effect on the desired sexual risk outcomes—addressing their most central question. If an effect of the intervention is observed, they publish those results alone, deeming them to have the greatest public health significance, and move on to other projects before exploring the question of why their intervention might have worked. Regardless of which of these possibilities is true, the unfortunate consequence for the field is that we have lost a critical opportunity to test our theoretical assumptions. If our theories of sexual risk were subjected to greater refinement in response to failed hypothesis testing, our interventions might look very different.

Methodological Challenges in Mediation Analyses

One methodological challenge that faces interventionists is the statistical complexity of assessing mediation. This challenge is made even more difficult in intervention trials where assessment of multiple outcomes over several time points is common. Indeed, these complexities might be partially responsible for the limited number of studies that report the results of a mediation analysis. The history of mediation has expanded rapidly in recent years and multiple methods for assessing indirect effects exist (e.g., Bauer, Preacher, & Gil, 2006; Hardnett et al., 2009; Kenny, 2008; Krull & MacKinnon, 2001; Lockhart, MacKinnon, & Ohlrich, 2011). Initial tests of mediation involved causal steps analysis (Baron & Kenny, 1986), which then evolved to include significance testing of indirect effects (Sobel, 1986), and recently shifted to assessing indirect effects using asymptotic confidence intervals through various methods (e.g., MacKinnon, Fritz, Williams, & Lockwood, 2007). Past studies are naturally limited to using the best statistical methods available at the time and so it may be reasonably expected that mediation analyses of HIV interventions would not have been as common in the early years of prevention efforts.

Power is also an important consideration in conducting mediation analyses in the context of an intervention trial. Power anomalies in tests of mediation are common. For example, both the causal steps approach (Baron & Kenny, 1986) and the significance test of the indirect effect using a normal distribution (e.g., a Sobel test) are frequently underpowered (MacKinnon, Lockwood, Hoffman, West, & Sheets, 2002). Intervention studies are also often designed and powered to detect primary outcome effects (i.e., of the intervention on sexual risk) and not to test mediation, which may lead investigators to assume tests of mediation are inappropriate with their sample size. However, Kenny and Judd (2014) found evidence in a recent simulation study that statistical tests of the indirect effect (i.e., the *ab* product term) are often better powered than tests of the total effect. In their paper, Kenny and Judd recommend mediation may still be worth examining even in the absence of an overall total effect in certain cases, and suggest intervention studies as one example of this possibility. A number of recent HIV trials have not found significant differences between experimental and control groups (e.g., Koblin & EXPLORE Study Team, 2004; Rosser et al., 2010; Safren, O’Cleirigh, Skeer, Elsesser, & Mayer, 2013; Wolitski, Gómez, Parsons, & SUMIT Study Group, 2005), but in light of Kenny and Judd’s finding, there may still be value added in testing mediated processes. For example, O’Leary et al. (2005) were able to examine a number of theoretical mediators in the SUMIT intervention trial, despite not finding an overall difference across intervention and control groups (Wolitski et al., 2005).

We acknowledge that addressing the full complexity of mediation is beyond the scope of this review. Nevertheless, we maintain that empirically testing the indirect effects of

behavioral HIV interventions remains critical to improving our prevention efforts and refining theory. We strongly urge intervention scientists to not shy away from this challenge and refer interested readers to recent resources on advances in mediation methods (Bauer et al., 2006; Bryan, Schmiede, & Broaddus, 2007; Kenny & Judd, 2014; Krull & MacKinnon, 2001; Shrout & Bolger, 2002).

Limitations

Our review is subject to a number of limitations. First, given the small number of studies identified and the diversity of predictors studied, conducting a more formal meta-analysis was infeasible. Our approach of presenting a summary of results descriptively gives equal weight to studies with varying sample sizes or magnitudes of effect, and thereby might obscure trends that would emerge were a more formal analysis possible. Additionally, our review should not be understood as an explicit indictment (or promotion) of any specific theory. Many theories posit that psychosocial variables operate sequentially, through one another (e.g., the hypothesis that motivation leads to behavioral skills), and because our review focused on studies in which sexual risk was the outcome, we might have missed evidence that exists for other pieces of these theories.

Conclusions

If we hope to truly understand and prevent sexual risk behaviors, we must develop an evidence base that includes longitudinal and experimental studies. In the absence of more research, the inconsistency of findings from the existing studies we reviewed suggests that the models we currently use to understand sexual risk may need expansion, refinement, or adaptation. Meanwhile, the field of HIV prevention is undergoing a rapid transformation as biomedical technologies expand the options for prevention and decrease the field’s historic emphasis on reducing sexual risk behaviors. Behavioral science will be essential to maximizing the impact of these technologies. As our field works to understand behaviors such as medication adherence or adoption of pre-exposure prophylaxis, we must push ourselves to develop the strongest evidence base possible. This will require conducting studies that utilize longitudinal and experimental designs, attending carefully to the evidence that fails to support our assumptions, and revising our hypotheses, theories, and interventions accordingly.

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Appendix

See Table 4.

Table 4 Databases, specific journals, and search terms used in article identification

Journals	Databases	Search terms
<i>Health Psychology</i>	PsychInfo	Intervention studies
<i>Annals of Behavioral Medicine</i>	PubMed	Randomized controlled trial
<i>Archives of Sexual Behavior</i>	MEDLine	RCT
<i>Journal of Acquired Immune Deficiency Syndromes (JAIDS)</i>	EBSCO	HIV risk reduction
<i>AIDS</i>	EMBASE	Sexual risk reduction
<i>AIDS and Behavior</i>		STI risk reduction
<i>AIDS Patient Care and STDs</i>		Prevention
<i>AIDS Care</i>		Intervention(s)
<i>AIDS Education and Prevention</i>		Mediator(s)
<i>Journal of the Association of Nurses in AIDS care</i>		Mechanism(s)
<i>Journal of Consulting and Clinical Psychology</i>		Mediation
<i>Journal of Adolescent Health</i>		Indirect effect(s)
<i>American Journal of Public Health</i>		Longitudinal studies
<i>Journal of Primary Prevention</i>		Growth curve
<i>Health Education and Behavior</i>		Latent growth curve
<i>Journal of the American Medical Association</i>		
<i>Sexually Transmitted Diseases Prevention Science</i>		Longitudinal Prospective
<i>The Lancet</i>		Over time
<i>International Journal of STDs and AIDS</i>		Change over time
		Cohort
		HIV risk
		STI risk
		Sexual risk
		Condom use
		Condomless sex
		Unprotected sex
		Sexual behavior

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*References denoted with an asterisk were identified in the review of longitudinal studies and experimental studies testing mediation

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