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Meta-analyses of HIV prevention interventions targeting improved partner communication: effects on partner communication and condom use frequency outcomes

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Abstract Behavioral HIV prevention interventions designed to improve safer-sex communication skills with sexual partners may enhance engagement in protective behaviors and reduce HIV/STI risk. The current meta-analyses examined the efficacy of individual-based (i.e., not couples-based) HIV prevention interventions with a partner communication skills building component to increase frequency of: (a) safer-sex communication and (b) condom use with sexual partners among HIV at-risk groups (e.g., heterosexual African American females). Studies were retrieved from online bibliographic databases, a database of effective behavioral HIV prevention interventions, and an existing review of effective interventions. Eight manuscripts ($k = 10$ intervention vs. control comparisons) met inclusion criteria. Results indicated that compared to control conditions, at post-intervention follow-up, participants who were exposed to individual-based HIV prevention interventions with safer-sex communication skills training components had safer sex discussions with partners more frequently [$d_{random} = 0.35 \pm 0.10$, $p < .001$, 95% CI (0.16, 0.55)], and used condoms more frequently [$d_{random} = 0.39 \pm 0.07$, $p < .001$, 95% CI (0.25, 0.54)]. Including partner communication skills training in individual-based HIV prevention interventions may increase the frequency of both partner communication and condom use among the at-risk populations represented in the meta-analyses.

Keywords HIV prevention · HIV risk · Intervention · Partner communication · Condom use

Introduction

As of 2015, approximately 1.2 million individuals (age 13 and over) were living with HIV in the United States (U.S.), including an estimated 156,300 individuals whose seropositive status had not yet been diagnosed (CDC, 2015). According to the Centers for Disease Control and Prevention (CDC), approximately 40,000 people in the U.S. are newly infected with HIV each year (CDC, 2015). While antiretroviral medications are becoming increasingly available and extend the life expectancy of individuals infected with HIV (CDC, 2016a; Scandlyn, 2000), a principal public health strategy for decreasing the impact of the HIV epidemic is to prevent new incident cases.

Primary behavioral HIV prevention interventions are designed to reduce HIV-risk behaviors (e.g., having unprotected sex) among HIV-uninfected individuals, with the aim of reducing their likelihood of contracting HIV. Secondary prevention interventions are tailored to HIV-infected individuals to prevent HIV transmission to uninfected individuals. Communication between individuals engaging in sexual activity about safer sexual practices (e.g., condom use) is a behavior that both primary and secondary HIV prevention interventions often aim to increase through various intervention strategies (e.g., role

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play activities, psychoeducation, group discussions). The focus of the present study was to conduct meta-analyses of individual-based (i.e., not couples-based) HIV prevention interventions with a safer-sex communication component to examine their efficacy to increase the frequency of (a) safer-sex communication between sexual partners and (b) condom use, regardless of relationship status. The term "partner" within the context of the current meta-analyses refers to sexual partners in general (i.e., any individual with whom another individual engages in sexual activity) regardless of relationship status (e.g., main partner, casual partner).

Literature on non-condom use suggests that engaging in unprotected sex may serve communicative purposes (e.g., convey closeness, trust, or perceived un-infectedness) among single MSM (Goldenberg et al., 2015; Starks et al., 2017), single heterosexual men (Flood, 2003), heterosexual women in casual "dating" relationships (Bolton et al., 2010), as well as among same-sex (Worth et al., 2002) and heterosexual couples (Corbett et al., 2009). Accordingly, previous research has suggested that individuals may engage in unwanted unprotected sex specifically to avoid conveying the implicit messages associated with suggesting condom use (e.g., that one is infected with STI/HIV, that one is having sex with other partners or that one suspects one's partner is having sex with other partners; East et al., 2007). Overall, these findings indicate that non-condom use may serve as a form of implicit communication, and that suggesting condom use to a partner may undesirably convey the converse of these messages. This body of literature highlights the need for HIV prevention interventions to enhance explicit safer-sex communication skills as a means of increasing condom use to reduce HIV-risk.

Indeed, key theoretical frameworks that inform HIV prevention interventions, including the AIDS Risk Reduction Model (ARRM; Catania et al., 1990) and the Information-Motivation-Behavior (IMB) skills model (Fisher & Fisher, 2000), emphasize communication between sexual partners as a key determinant in subsequent sexual risk behavior engagement (e.g., condomless sex). For example, the ARRM proposes that individuals will be more successful in changing their risky sexual behaviors if they involve their sex partners in the behavior change process. Accordingly, engaging partners in safer-sexual behavior change is facilitated by having good communication and negotiation skills between sexual partners, as well as social support (Catania et al., 1990). Similarly, behavior skills such as partner communication are central to engaging in preventative behaviors (e.g., condom use) according to the IMB model of HIV health-related behaviors (Fisher & Fisher, 2000). From the IMB perspective, individuals engage in HIV preventative behaviors when they (a) are well-informed about HIV risk, (b) are motivated to engage in protective behaviors, and (c) possess the objective behavioral skills and perceived self-efficacy necessary to effectively enact those behaviors. These behavioral skills include partner communication skills, particularly negotiating consistent condom use (Fisher & Fisher, 2000). Empirical support for ARRM- and IMB-informed HIV prevention interventions indicates that interventions that include communication skills training may promote long-term maintenance of sexual health-related behavior changes (Malow et al., 1994), such as more frequent condom use.

Communication with a sexual partner about condom use has been identified as a factor associated with condom use behaviors among various high-risk populations such as African American females (Crosby et al., 2002; Sales et al., 2012), men who have sex with men (Lo et al., 2011; Xiao et al., 2013), African American and Hispanic adolescents (Small, Weinman, Buzi, & Smith, 2010), and college students (Zamboni et al., 2000). For instance, a meta-analysis of psychosocial correlates associated with heterosexual condom use found that *partner communication about condom use* was the most highly correlated factor in association with condom use (Sheeran et al., 1999). There is also empirical evidence to suggest that partner communication may explain or mediate the relationship between other constructs and condom use-related behaviors; for example, Salazar et al. (2004) found that lower levels of partner communication mediated the relationship between negative self-concept and less frequent refusal of unprotected sex among African American females (Salazar et al., 2004).

Moreover, research indicates that increased partner communication frequency may play a central role in an HIV prevention intervention's efficacy in increasing condom use behaviors. Sales et al. (Sales et al., 2012) found that increased partner communication frequency partially mediated the effect of an individual-based HIV prevention intervention on increased proportion of condom use, as well as consistent condom use among African American adolescent females. Similarly, among serodiscordant heterosexual couples, safer-sex communication frequency mediated a couples-based HIV prevention intervention's effects on increased proportion condom use, more consistent condom use, and reduced frequency of unprotected sex (El-Bassel et al., 2016). In examining factors associated with non-response to individual-based HIV prevention interventions, Sales et al. (2014) found that African American females who increased condom use had more frequent partner communication than African American females who did not increase condom use post-intervention (Sales et al., 2014). Thus, interventions that enhance part-

ner communication frequency may consequently result in increased condom use.

The present meta-analyses were conducted to determine whether individual-based HIV prevention interventions with partner communication skills training are associated with improved safer-sex partner communication and condom use frequency among HIV at-risk populations, regardless of study sample characteristics. We examined these two outcomes separately to examine whether, according to the IMB model, the development of partner communication behavioral skills and engagement in protective behaviors such as condom use co-occur. Moreover, we chose to focus on individual-based HIV prevention interventions delivered to sexually active populations, as these interventions may be fundamentally different from interventions delivered to either non-sexually active individuals or dyadic interventions delivered to couples. For example, within dyadic couples-based interventions, each member of the dyad acquires information and skills to increase engagement in safer-sexual behaviors, whereas interventions delivered to individuals (whether they are in relationships or not) provide intervention content to only one individual within a sexual dyad. Including both individual and dyadic interventions would introduce heterogeneity to the meta-analyses, which already included differences in population characteristics (e.g., sexual orientation, gender) as a potential source of heterogeneity.

Method

Search strategy

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Moher et al., 2009) were followed when conducting these meta-analyses. Studies screened for inclusion were selected from: (a) the CDC's Diffusion of Effective Behavioral Interventions (DEBI) database of high impact behavioral HIV prevention interventions; (b) a review of effective HIV prevention interventions (Sales et al., 2006); and (c) electronic databases (*PubMed, PsycINFO, MEDLINE, ERIC, Health Source: Nursing/Academic Edition, Psychology and Behavioral Sciences Collection*). Electronic database searches included Boolean searches of various combinations of the following keywords, including mesh terms: HIV prevention, intervention, partner communication, safer-sex communication, condom negotiation, sexual assertiveness training. Searches were carried out September 2015 through October 2015 by the first author (NKG). Searches were restricted to include only peer-reviewed articles available in English.

Study inclusion and exclusion criteria

Studies were included if: (a) it utilized a randomized controlled trial (RCT) design; (b) examined the efficacy of an HIV prevention intervention that explicitly addressed sexual topics and behaviors; (c) the intervention was delivered to individuals (i.e., not delivered to couples or both members of a sexual dyad); (d) the sample included only sexually active participants; (e) the sample did not include injection drug users or sex workers; (f) the intervention was not conducted in a school setting (i.e., it could be based in a clinic or community setting); (g) partner communication skills training was a key component of the intervention (operationally defined as approximately 1 h of the intervention focusing on developing skills related to safer-sex communication with partners); (h) the control condition did not include a partner communication skills building component; and (i) the study reported results for both a partner communication-related outcome variable (e.g., frequency of partner communication, partner communication self-efficacy) and condom use frequency. In addition, the partner communication skills addressed during the intervention could include: sexual refusal training, sexual assertiveness training, and/or condom negotiation strategies. It was also decided that the intervention may use any strategy to address partner communication skills (e.g., role play of safer-sex communication; group discussions of safer-sex communication) as long as the intervention was not delivered to both members of a sexual dyad.

While carrying out literature searches, abstracts were reviewed and full-text manuscripts were retrieved by the first author (NKG) to determine whether inclusion criteria were met. The approximate duration of the partner communication component of each intervention was determined based on descriptions of intervention sessions and their duration or by contacting the study's lead author for additional details regarding the length of the partner communication component.

Inclusion criteria were based on the notion that HIV prevention interventions delivered to non-sexually active individuals may take an approach that factors in this population's lack of experience with sexual encounters and communication. Relatedly, studies were excluded if they were conducted in a school setting to avoid samples that included both sexually active and non-sexually active youths. Studies were also excluded if they included injection drug users, as their HIV-related risk may be associated with substance use behaviors (e.g., sharing unclean needles), as opposed to risky sexual behaviors alone. Similarly, studies that included sex workers were excluded because the dynamics of their sexual encounters and sexual communication may be distinguished from those involved in non-transactional sexual encounters. See Fig. 1 for

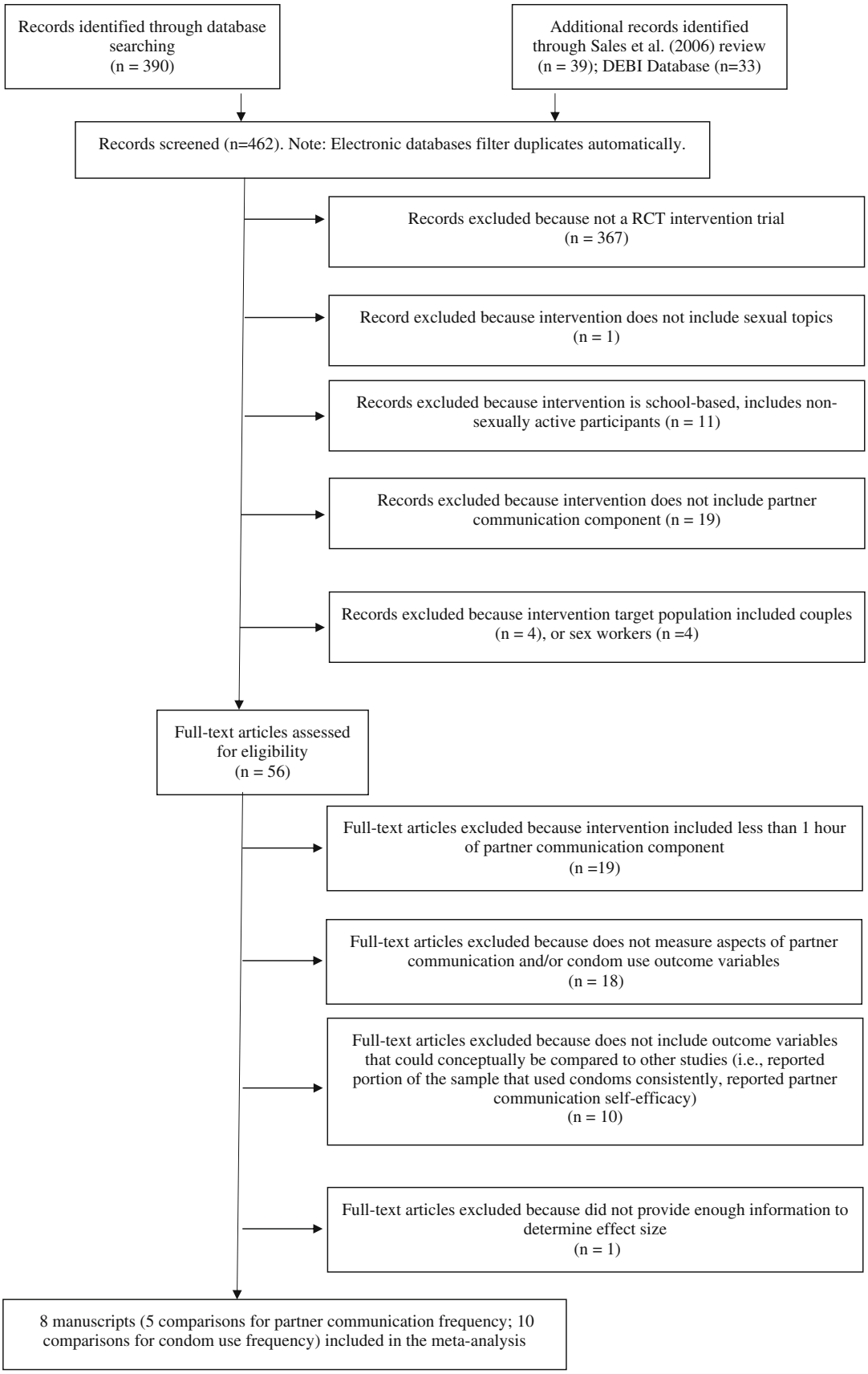

Fig. 1 Flow of study selection from electronic databases and Sales et al. (2006) review

information regarding the inclusion and exclusion of studies found through the various search mechanisms utilized in the current meta-analyses. A total of eight manuscripts satisfied criteria and were included in the current meta-analyses (see Table 1).

Outcome measures

Partner communication frequency

This meta-analysis focused on retrospective recall of the frequency of partner communication events with sexual partners (i.e., not referring to specific partner types) as the primary partner communication outcome variable of interest. These measures could include multi-item assessments of communication frequency (e.g., Partner Health Protective Sexual Communication Scale; Catania et al., 1995), or open-ended response formats (e.g., number of times "talked with a sex partner about using condoms or safer sex" during the past 3 months). Studies that were included in the condom use meta-analysis but were excluded from the partner communication meta-analysis assessed various other indices related to partner communication. Studies that relied on (1) a dichotomous indicator of refusing unsafe sex or suggesting condom use in the past 3 months (DiClemente & Wingood, 1995; Kalichman et al., 1999), (2) facilitator ratings of communication skills (Hobfoll et al., 2002; Kelly et al., 1994), and (3) assessment of communication self-efficacy (Kalichman et al., 2001) were excluded from the partner communication frequency meta-analysis. See Table 2 for descriptions of the partner communication outcome measure of each study included in the partner communication frequency meta-analysis.

Condom use frequency

Studies included in the condom use frequency meta-analysis assessed condom use with sexual partners (i.e., not referring to specific partner types) retrospectively (e.g., "How many times did you use a condom in the past 3 months?"). Assessments included proportion condom use (e.g., a continuous measure of proportion of condom protected episodes in a specified time period) and a frequency scale (e.g., *every time, usually, seldom, never*). See Table 3 for descriptions of the condom use outcome measure of each study included in the condom use frequency meta-analysis. Condom use frequency was treated

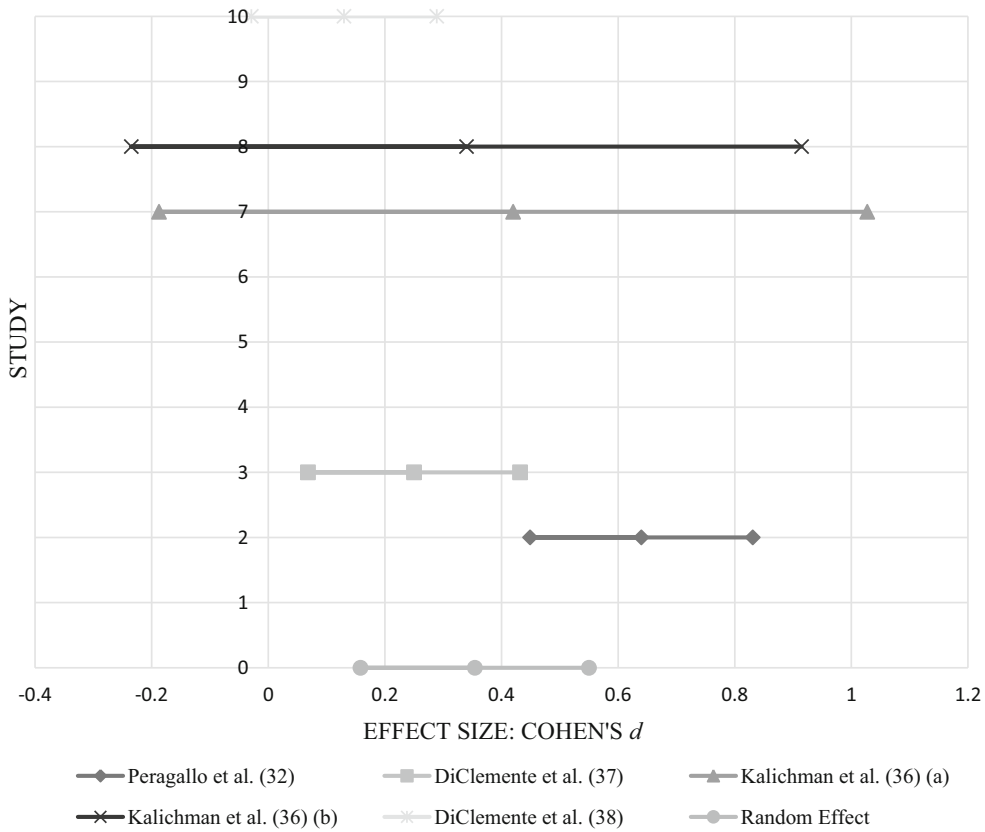

Fig. 2 Forest plot of individual study effect sizes and random effects model estimate with corresponding 95% CIs for partner communication frequency

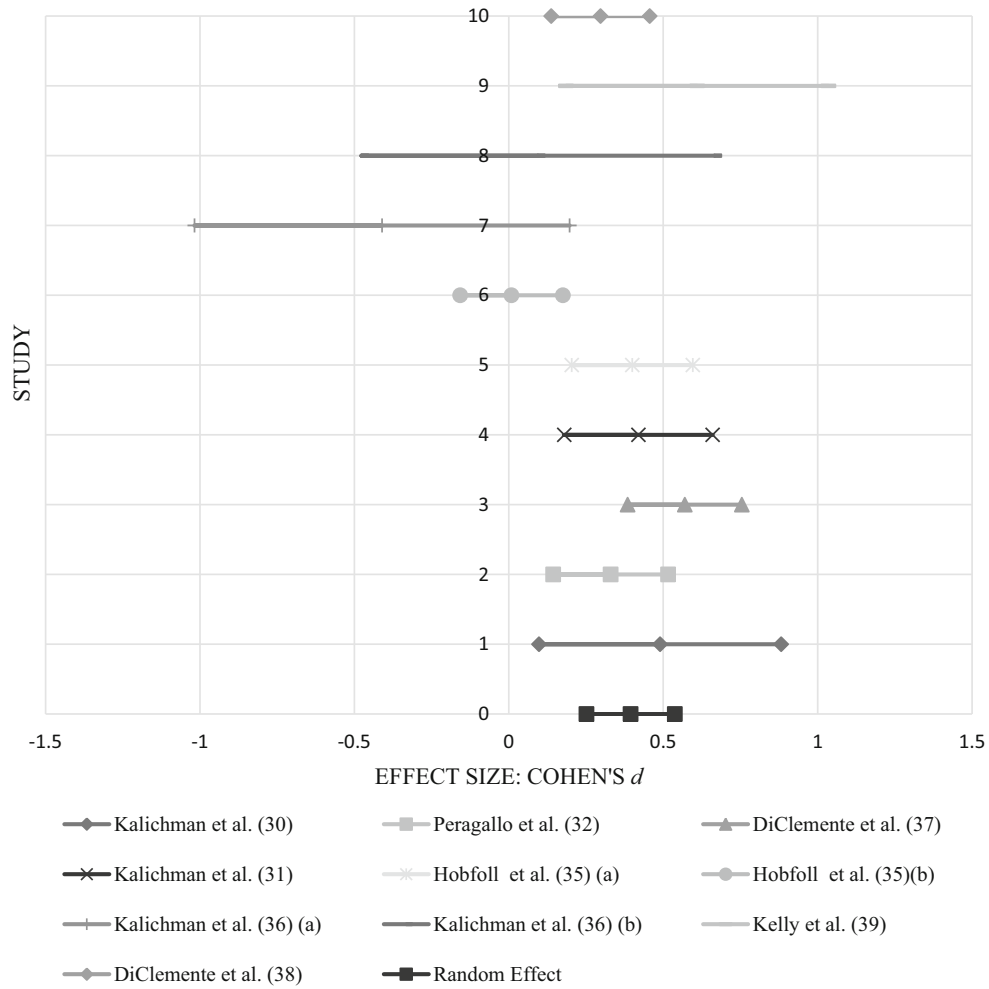

Fig. 3 Forest plot of individual study effect sizes and random effects model estimate with corresponding 95% CIs for condom use frequency

as a continuous variable for the purposes of the current meta-analysis.

Overview of studies included in meta-analyses

Partner communication frequency meta-analysis

A subset of the eight manuscripts reported partner communication frequency as a study outcome (n = 4; DiClemente et al., 2004, 2009; Kalichman et al., 1996; Peragallo et al., 2005). One manuscript (Kalichman et al., 1996) included two different intervention conditions with a partner communication component and one control condition that did not include a partner communication component; as such two separate effect sizes (i.e., intervention 1 vs. control; intervention 2 vs. control) were computed for this manuscript. In sum, there were a total of five comparisons in partner communication frequency between intervention and control conditions at post-intervention follow-up. The remaining studies (Hobfoll et al., 2002; Kalichman et al., 1999, 2001; Kelly et al., 1994) were excluded from the partner communication frequency meta-analysis as their measures did not meet inclusion criteria.

Condom use frequency meta-analysis

All eight manuscripts satisfied criteria and were included in the condom use frequency meta-analysis. One manuscript (Hobfoll et al., 2002) included two different control conditions that did not include a partner communication component, and one intervention condition that included a partner communication component. For this manuscript, two separate effect sizes were calculated: (1) intervention versus control 1 and (2) intervention versus control 2. Another manuscript (Kalichman et al., 1996) included two different intervention conditions that included a partner communication component and one control condition that did not include a partner communication component. As

Table 1 Descriptive information of the studies included in present meta-analysis

Study	Study sample	Sample size at baseline	Partner communication component	Approximate duration of partner communication component	Intervention name and sample size at follow-up	Control name and sample size at follow-up	Setting	Total intervention length	First follow-up time point
Kalichman et al. (1999)	Heterosexual adult African American men	N = 117	Session 2: build sexual communication skills. Showed clips from videos with African American heterosexual men. Scenes were stopped and participants were asked what the male character could say or do at that moment to create a safer sex experience.	Approximately 1 h[a]	NIA 3-month n = 49	HIV education 3-month n = 47	Community center	Two 3-h group session delivered in the same week	3-months post-intervention
Peragallo et al. (2005)	Latina young women who live in poverty	N = 454	Session 4: ways to improve communication with our partner. Role playing (e.g., for increasing partner communication, negotiating condom use), skill demonstration (e.g., condom use, communication, and assertiveness).	2 h	SEPA baseline n = 263	Unspecified baseline n = 191	Unspecified[b]	Six 2-h group sessions	3-months post-baseline (1.5 months post-intervention)
DiClemente et al. (2004)	Heterosexual African American women	N = 522	Session 3: role-play and cognitive rehearsal, enhanced adolescents' confidence in initiating safer-sex conversations, negotiating safer sex, and refusing unsafe sexual encounters	4 h	SIHLE 6-month n = 226	General health promotion 6-month n = 243	Community health agency	Four 4-h group sessions	6-months post-baseline (5 months post-intervention)
Kalichman et al. (2001)	HIV-infected adult men and women (74% African American)	N = 328	Sessions 1–3: building self-efficacy for disclosing HIV serostatus. Discussion of barriers to disclosure, potential adverse outcomes of disclosure. Disclosure role play.	6 h	Healthy Relationships 3-month n = 150	Health-maintenance support group 3-month n = 121	HIV clinic	Five 2-h group sessions delivered over 2.5 weeks	3-months post-intervention

Table 1 continued

Study	Study sample	Sample size at baseline	Partner communication component	Approximate duration of partner communication component	Intervention name and sample size at follow-up	Control name and sample size at follow-up	Setting	Total intervention length	First follow-up time point
Hobfoll et al. (2002)	Adult women residing in inner cities (55% African American)	N = 935	Session 3: discussing sexual history, saying no to unwanted sex, and developing a mutual sexual behavior plan with partners. Negotiation paradigm in role plays included: (a) goal identification; (b) goal achievement strategy; (c) listening skills; (d) identifying partners' feelings, ideas, and goals; (e) searching for common ground that meets the criteria of safer sex for the woman; (f) making the "offer–proposal"; and (g) "closing the deal" (a full protocol is available from the authors).	Approximately 1 h[a]	AIDS prevention 6-month n = 285	Standard care 6-month n = 158[c] General health promotion 6 month n = 275[d]	Clinic	Six group sessions delivered over 2-3 months	6-months post-intervention

Table 1 continued

Study	Study sample	Sample size at baseline	Partner communication component	Approximate duration of partner communication component	Intervention name and sample size at follow-up	Control name and sample size at follow-up	Setting	Total intervention length	First follow-up time point
Kalichman et al. (1996)	Adult African American women	N = 92	Identify environmental and cognitive-affective triggers for HIV-risk behaviors. Managing triggers with protective behavioral strategies, in addition to the communication components described below.	Approximately 1 h[a]	Sexual Communication skills + Behavioral skills 3-month n = 20[e] (1.5 session focusing on sexual communication; 1.5 session focusing on behavioral skills)	HIV education 3-month n = 25	Unspecified[b]	Four group sessions delivered over 2 weeks	3-months post-intervention
			Assertiveness, negotiation, and risk refusal skills. Instruction, modeling and practice to increase skills to resist partner coercion to engage in intercourse without condoms and increasing comfort discussing safer sex with partners prior to sexual activity.	Approximately 1 h[a]	Sexual Communication skills-only 3-month n = 24[f] (3 sessions focusing on sexual communication)				
Kelly et al. (1994)	Adult women residing in low-income urban settings (87% African American)	N = 187	Role play initiating discussion of AIDS concerns and condom use with a potential sexual partner. Role play resisting sexual pressure.	Approximately 1 h[a]	HIV/AIDS risk reduction 3-month n = 54	General health information 3-month n = 39	Community primary health care clinic	Four weekly 90-min group sessions	3-months post-intervention
DiClemente et al. (2009)	African-American adolescent and young-adult women	N = 715	Persuasive communication techniques to enhance male partner responsibility for condom use.	1.5 h	HORIZONS 6-month n = 298	Enhanced standard of care 6-month n = 314	Clinic	Two 4-h sessions and 4 telephone contracts over 12 month period	6-months post baseline (5.5 months post-intervention)

[a]While exact length of time could not be determined, based on the description of methods and the intervention, it is believed that approximately 1 h or more of the intervention focused on partner communication skills and related content

[b]Study was delivered to non-school aged, sexually active participants

[c]Effect size for AIDS Prevention versus Standard Care denoted by Hobfoll et al. (2002) (a)

[d]Effect size for AIDS Prevention versus General Health Promotion denoted by Hobfoll et al. (2002) (b)

[e]Effect size for Sexual Communication Skills + Behavioral Skills versus HIV Education denoted by Kalichman et al. (1996) (a)

[f]Effect size for Sexual Communication Skills-Only versus HIV Education denoted by Kalichman et al. (1996) (b)

Table 2 Summary of individual study results for partner communication frequency

Study	Outcome measure	Covariates	Treatment M (SD)	Control M (SD)	Effect size (*d*)	Variance of effect size	95% CI lower limit	95% CI upper limit
Peragallo et al. (2005)	10-item sexual communication frequency scale (adapted from the Partner Health Protective Sexual Communication Scale; (Catania et al., 1995)	Acculturation, ethnicity, poverty, insurance, living with partner	4.52	2.38 Average SD across treatment and control groups = 3.33[a]	0.64	0.01	0.45	0.83
DiClemente et al. (2004)	5-item sexual communication frequency scale (Wingood & DiClemente, 1998)	Baseline sexual communication frequency, douching, depression, pregnancy desire, and having a new sex partner in the past 30 days	9.44 (4.25)	8.30 (4.73)	0.25	0.009	0.07	0.43
Kalichman et al. (1996) (a)	Number of times "talked with a sex partner about using condoms or safer sex" during the past 3 months (open-ended response format)	Baseline partner communication frequency during the past 3 months	4.5 (7.2)	2.1 (4.2)	0.42	0.10	− 0.19	1.03
Kalichman et al. (1996) (b)	Number of times "talked with a sex partner about using condoms or safer sex" during the past 3 months (open-ended response format)	Baseline partner communication frequency during the past 3 months	6.4 (17.7)	2.1 (4.2)	0.34	0.09	− 0.23	0.91
DiClemente et al. (2009)	6-item partner communication frequency scale (Wingood & DiClemente, 2002)	Baseline partner communication frequency, cohort, time, government financial aid, having a boyfriend, a history of emotional abuse	Adjusted mean difference (95% CI) 0.63 (− 0.15 to 1.41)[b]		0.13	0.007	− 0.03	0.29

[a]Peragallo et al. (2005) reported the average standard deviation in partner communicaiton frequency across the treatment and control groups; however, being that they also reported the effect sizes(*d*), the average standard deviation was not used for any calculations in the present meta-analysis, and it presented for descriptive purposes only

[b]DiClemente et al. (2009) reported the adjusted mean difference in partner communication frequency between the treatment and control groups and the surrounding 95% CI; adjusted by baseline partner communication frequency, cohort, time, and other covariates (government financial aid, having a boyfriend, history of emotional abuse). Variance of the mean difference was calculated using the width of the CI, from which an estimate of the pooled standard deviation was computed; *d* was calculated by dividing the reported adjusted mean difference by the pool standard deviation estimate

such, two separate effect sizes (e.g., intervention 1 vs. control; intervention 2 vs. control) were computed for this manuscript. In sum, a total of 10 comparisons for condom use frequency between intervention and control conditions at post-intervention follow-up were included.

Data extraction and effect size calculations

Effect sizes comparing the intervention to control conditions for partner communication frequency and condom use frequency at the first post-intervention follow-up assessment were extracted by two authors (NKG and NN). The current study focused on the first post-intervention follow-up in order to assess the most immediate intervention effect. The majority of the studies assessed partner communication and condom use frequency on a continuous scale. As such, effect sizes (*d*) were reported as the difference between the intervention and control conditions in mean partner communication frequency (or condom use frequency) at the first post-intervention follow-up time point divided by the pooled standard deviation. If a study did not report an effect size (*d*) directly, effect sizes comparing intervention to control condition were calculated using the means and standard deviations provided. In the absence of standard deviations, a sensitivity analysis was performed using information available from other studies reporting the same outcome variable. One study included in the condom use frequency meta-analysis (DiClemente et al., 2009) reported the adjusted mean difference in condom use frequency between intervention and control conditions, and the surrounding 95% confidence interval (CI). For this study, the width of the CI was used to calculate the variance of the mean difference, which was then used to calculate an estimate of the pooled standard deviation; *d* was then estimated by dividing the reported adjusted mean difference by the pooled standard deviation estimate. Multiple effect sizes were calculated for

Table 3 Summary of individual study results for condom use frequency

Study	Outcome measure	Covariates	Treatment M (SD)	Control M (SD)	Effect size (*d*)	Variance of effect size	95% CI lower limit	95% CI upper limit
Kalichman et al. (1999)	Proportion of condom protected sexual occasions during the past 3 months (#of condom protected occasions/total # of occasions)	Baseline proportion condom use during the past 3 months, age, education	70.9 (28.2)	53.6 (41.4)	0.49	0.04	0.10	0.88
Peragallo et al. (2005)	Proportion of condom protected sexual activity (oral, anal, vaginal) during the past 3 months; # of condom protected activities/total # of activities	Acculturation, ethnicity, poverty, insurance, living with partner	35.85	22.67 Average SD across treatment and control groups = 39.6[a]	0.33	0.01	0.16	0.54
DiClemente et al. (2004)	Percentage of condom protected vaginal intercourse acts during the past 6 months; # of condom protected vaginal sex act/total # of vaginal sex acts	Baseline proportion condom use for vaginal intercourse during the past 6 months, douching, gang involvement, depression, pregnancy desire having a new sex partner in the past 30 days	82.29 (30.24)	61.65 (40.70)	0.57	0.01	0.39	0.75
Kalichman et al. (2001)	Proportion of condom protected anal and vaginal intercourse occasions during the past 3 months; # of condom protected acts/total # of acts)	Baseline proportion condom use during the past 3 months, age, gender, randomization block	79.9 (36.8)	62.8 (45.3)	0.42	0.02	0.18	0.66
Hobfoll et al. (2002) (a)	Frequency of condom use for vaginal sex during the past 2 months (*every time, usually, seldom, never*)	Baseline frequency of condom use during the past 2 months	2.45 (1.08)	2.01 (1.11)	0.40	0.01	0.20	0.60
Hobfoll et al. (2002) (b)	Frequency of condom use for vaginal sex during the past 2 months (rated on a categorical scale: *every time, usually, seldom, never*)	Baseline frequency of condom use during the past 2 months	2.45 (1.08)	2.44 (1.15)	0.01	.007	− 0.16	0.18
Kalichman et al. (1996) (a)	Proportion of condom protected anal and vaginal intercourse occasions during the past 3 months; # of condom protected acts/total # of acts	Baseline proportion condom use during the past 3 months	31.0 (36.3)	48.0 (45.6)	− 0.41[b]	0.10	− 0.20	1.02
Kalichman et al. (1996) (b)	Proportion of condom protected anal and vaginal intercourse occasions during the past 3 months; # of condom protected acts/total # of acts	Baseline proportion condom use during the past 3 months	51.9 (37.0)	48.0 (45.6)	0.09	0.09	− 0.48	0.67
Kelly et al. (1994)	Proportion of vaginal intercourse occasions on which condoms were used during the past 3 months; # of condom protected vaginal sex occasions/total # of vaginal sex occasions	Baseline proportion condom use during the past 3 months	56 (SD not reported)	32 (SD not reported)	0.61	0.05	0.19	1.03

Table 3 continued

Study	Outcome measure	Covariates	Treatment M (SD)	Control M (SD)	Effect size (*d*)	Variance of effect size	95% CI lower limit	95% CI upper limit
DiClemente et al. (2009)	Proportion of condom protected sex acts in the past 60 days; # of times a condom use used during vaginal intercourse/total # of vaginal intercourse occasions	Baseline proportion condom use in the past 60 days, cohort, time, government financial aid, having a boyfriend, a history of emotional abuse	Adjusted mean difference (95% CI) 12.09 (5.64 to 18.55)[c]	0.30	0.007	0.14	0.46	

Proportions were multiplied by 100 by original authors to obtain percentages

[a]Peragallo et al. (2005) reported the average standard deviation in proportion condom use across the treatment and control groups; however, being that they also reported the effect size (*d*), the average standard deviation was not used for any calculations in the present meta-analysis, and it presented for descriptive purposes only

[b]Negative effect size indicates that control group had a higher average proportion condom use than intervention condition at follow-up

[c]DiClemente et al. (2009) reported the adjusted mean difference in proportion condom use between the treatment and control groups and the surrounding 95% CI; adjusted by baseline proportion condom use, cohort, time, and other covariates (government financial aid, having a boyfriend, history of emotional abuse). Variance of the mean difference was calculated using the width of the CI, from which an estimate of the pooled standard deviation was computed; *d* was calculated by dividing the reported adjusted mean difference by the pool standard deviation estimate

individual manuscripts that included multiple two-way comparisons between three or more groups (e.g., control 1 vs. intervention; control 2 vs. intervention; Hobfoll et al., 2002; Kalichman et al., 1996). Positive effect sizes indicated that participants in the intervention condition had more frequent condom use (or more frequent partner communication) than participants in the control condition. Effect sizes for each study were calculated by independent coders (NKG, NN) and compared for consistency. Inconsistencies in effect size calculations were addressed through discussion and reference to the study in question, and resolved by a finalized calculation of effect size.

Statistical analyses

Data analysis was conducted using SAS version 9.4 using random effects model estimation procedures to calculate weighted mean effect sizes and corresponding 95% confidence intervals (CIs), indicating whether the mean effect sizes were significantly non-zero. The heterogeneity statistic, Q, and corresponding degrees of freedom were computed for each outcome of interest (i.e., partner communication frequency, condom use frequency) to provide an estimate of the amount heterogeneity between individual study effect sizes (i.e., variance not due to within-study error). I^2 statistics and their 95% CIs were also computed to determine consistency in effect sizes across studies for each outcome variable. The I^2 statistic ranges from 0% (homogeneous) to 100% (completely heterogeneous), and provides an index of the proportion of the observed variance between effect sizes that is due to heterogeneity (i.e., real differences between effect sizes; Higgins & Thompson, 2002). I^2 is conceptually a measure of inconsistency across study effect size. Note that $I^2 = 100\%$ is impossible, as it would suggest that there is no within-study variance, and that the variance observed is completely due to between-study variation in effect sizes.

Sensitivity analysis for standard deviation of condom use outcome variable

One study (Kelly et al., 1994) did not report the standard deviation of condom use frequency for the intervention and control conditions. Standard deviations reported in other studies with the same outcome variable were used to approximate these parameters. The effect size for this study was calculated using the following estimates for the missing standard deviations: (a) the mean of the standard deviations reported in other studies for each condition; (b) the median of the standard deviations reported in other studies for each condition; (c) the smallest standard deviation reported for this outcome variable for each condition; and (d) the largest standard deviation reported for this outcome variable for each condition. The random effects model was estimated using each of the four effect size estimates produced by these parameters.

Results

Study and sample characteristics

Intervention, sample, and methodological details of the studies included in the meta-analyses are presented in

Table 1. Publication dates ranged from 1994 to 2009, representing nearly two decades of research evaluating HIV prevention intervention efforts. Overall, the majority of the studies targeted young HIV-uninfected minority females (DiClemente et al., 2004, 2009; Kalichman et al., 1999; Peragallo et al., 2005). Kelly et al. (1994), Hobfoll et al. (2002) and Kalichman et al. (1996) targeted adult females, and one study specifically targeted HIV-infected men and women (Kalichman et al., 2001). All of the interventions were conducted in group format over several sessions (*range* 2–6 sessions), and all of the studies had multiple follow-up assessments anchored as either post-baseline or post-intervention. One study (DiClemente et al., 2009) also included post-intervention telephone contacts delivered over a 12-month period. See Table 1 for information regarding the length of time until first follow-up assessment for each study. The average length of time between the end of intervention and the first follow-up assessment for the partner communication frequency comparisons was 3.6-, and 3.9-months for the condom use frequency comparisons. Interventions included various strategies for addressing partner communication within the context of sexual behaviors, including role play activities or video vignette discussions. The amount of time dedicated to partner communication skills ranged from approximately 1 h to 6 h.

Individual study results

Table 2 provides a summary of the individual study results for partner communication frequency; see Table 3 for the summary of individual study results for the condom use frequency outcome variable. A forest plot of the individual study effect sizes and corresponding 95% CIs for partner communication frequency is presented in Fig. 2 (with random effects model estimate and 95% CI). A forest plot of the individual study effect sizes and corresponding 95% CIs for condom use frequency is presented in Fig. 3 (with random effects model estimate and 95% CI).

Model results

Random effects model for partner communication frequency

The estimate of the population mean effect of HIV prevention interventions on partner communication frequency using the random effects model was $d_{random} = 0.35 \pm 0.10$, $p < .001$, 95% CI [0.16, 0.55]. The estimate for between-trial variance was $\tau^2 = 0.03 \pm 0.03$, $p > .05$, 95% CI [0.01, 0.83].

Assessment of heterogeneity and publication bias for partner communication frequency outcome variable

The Q statistic for the partner communication frequency outcome variable was $Q(4) = 16.93$, $p < .01$, and $I^2 = 76.38\%$, 95% CI [42.40%, 90.31%]. A funnel plot was inspected as a preliminary assessment of publication bias, and is available upon request. However, visual inspection of funnel plots is difficult when the sample size is not large, as in the current meta-analyses. Furthermore, current methods for detecting publication bias may be unreliable when studies are heterogeneous, such as those included in the meta-analysis of partner communication frequency (Terrin et al., 2003). As such, a more comprehensive statistical assessment of publication bias was not pursued.

Sensitivity analysis for standard deviation of condom use outcome variable

Results of the sensitivity analyses indicated that random effects estimate did not differ by a notable amount depending on which standard deviation estimates were used in place of the missing standard deviations. As such, the effect size calculated using the mean of the standard deviations reported by other studies for each condition as estimates for the missing standard deviations was used in present meta-analysis.

Random effects model for condom use frequency

The estimate of the population mean effect of HIV prevention interventions on condom use frequency using the random effects model was $d_{random} = 0.39 \pm 0.07$, $p < .001$, 95% CI [0.24, 0.53]. The estimate for between-trial variance was $\tau^2 = 0.03 \pm 0.02$, $p > .05$, 95% CI [0.01, 0.32].

Assessment of heterogeneity and publication bias for condom use frequency outcome variable

The Q statistic for the condom use frequency outcome variable was $Q(9) = 30.52$, $p < .001$, the $I^2 = 70.51\%$, 95% CI [43.59%, 84.59%]. A comprehensive assessment of publication bias was not pursued for the condom use frequency outcome due to the presence of heterogeneity (Terrin et al., 2003). A funnel plot pertaining to this outcome variable is also available upon request.

Discussion

Individual-based behavioral HIV prevention interventions aim to reduce HIV/STI risk by producing sustainable changes in sexual behavior. Supporting long-term behavioral change often involves promoting the development of skills that may be practiced outside of the intervention setting. HIV prevention interventions delivered to sexually active individuals (i.e., not delivered to couples or both members of a sexual dyad) provide individuals with behavioral skills to use with sexual partners who have not been exposed to the intervention.

While condom use is the most reliable method to reduce HIV/STI risk, it is also a complex sexual behavior. Not only is condom use collaborative (i.e., both partners agree to use or not use a condom), using a condom (or even suggesting using a condom) conveys potentially undesirable implicit messages (e.g., lacking trust, lacking commitment, being HIV/SIT-infected; Bolton et al., 2010; Corbett et al., 2009; East et al., 2007; Flood, 2003). Individual-based HIV prevention interventions aim to promote this collaborative and communicative behavior by providing one member of a sexual dyad with behavioral skills for engaging in condom use. As such, skills for communicating with sexual partners about condom use (e.g., initiating discussion about condom use, articulating motivations for condom use, negotiating condom use, disclosing HIV status) may be particularly important in translating the didactics of individual-based HIV prevention interventions into safer-sex behaviors. Indeed, according to the IMB model of HIV risk reduction, partner communication is necessary for converting safer-sex intentions into safer-sex behaviors (e.g., condom use; Fisher & Fisher, 1992, 2000).

Various approaches have been used by IMB-informed HIV prevention interventions to promote the development of partner communication skills (e.g., role plays, group discussions, observing models of effective communication) with the overall goal of increasing engagement in condom use. The aim of the current meta-analyses was to determine whether individual-based HIV prevention interventions that target partner communication are generally associated with increased (a) partner communication frequency and (b) condom use frequency at follow-up among sexually active populations at elevated risk for HIV.

Effect of HIV prevention interventions on partner communication frequency

The population mean effect of individual-based HIV prevention interventions that target partner communication indicated that individuals who received the intervention had more frequent partner communication than individuals in control conditions. This suggests that partner communication frequency is typically greater after exposure to an HIV prevention intervention with a safer-sex communication skills training component, as compared control conditions that do not include partner communication skills training (Cohen, 1988). However, the Q statistic indicated that there was a significant amount of between-study heterogeneity, and the I^2 statistic indicated that the between-study variation that was present was largely due to heterogeneity (as opposed to within-study sampling error). There are several potential sources of between-study heterogeneity in the current meta-analysis, including target population, relationships status, and intervention approach.

While interventions may be effective in increasing partner communication frequency, overall, there may be some populations in which this effect is stronger, perhaps among those who are particularly in need of communication skills (i.e., those for whom communication may be especially infrequent or ineffective). Various populations were included in the meta-analysis (i.e., heterosexual males, heterosexual females, HIV-infected individuals); however, the majority of interventions included exclusively or predominantly HIV-uninfected African American females, a population recognized as being at elevated risk for HIV/STI (CDC, 2016b). It is possible that this population may particularly benefit from partner communication skills training, as extant literature supports the association between greater partner communication frequency and comfort with safer-sex communication and engagement in condom use among African American females (Crosby et al., 2002; St. Lawrence et al., 1998; Sterk et al., 2011; Wingood & DiClemente, 1998). Indeed, there are several efficacious individual-based HIV prevention interventions tailored for African American females that include a partner commination skills building component (DiClemente et al., 2008; Klein et al., 2013; Saleh-Onoya et al., 2008; Wingood et al., 2011), and increased partner communication frequency may be a mechanism of an intervention's effect on increasing condom use among African American females (Crosby et al., 2002; El-Bassel et al., 2016; Sales et al., 2012, 2014). According to the Theory of Gender and Power as applied to elevated HIV/STI risk (Wingood & DiClemente, 2000), particular aspects of the female experience elevate HIV/STI risk; for example, these factors may include, ethnic minority status, young age ($>$ 18 years old), underpayment in a high-demand work environment, limited perceived control over condom use, conservative cultural or gender norms, and poor assertive communication skills. As such, a confluence of sociocultural factors that disempower African American females may elevate HIV/STI risk, which may partially explain why partner communication skills training is particularly relevant in reducing HIV/STI risk among this population,

and why this population is overrepresented among HIV prevention interventions with a partner communication skills component.

An additional source of heterogeneity may be that sexual communication frequency and the factors associated with vary depending on population characteristics (e.g., gender, sexual orientation). Accordingly, variance in the populations included in the meta-analysis may have contributed to the observed heterogeneity. Notably, only one study (Kalichman et al., 2001) included HIV-infected heterosexual, bisexual, and homosexual males and females, and none of the primary interventions exclusively targeted MSM. As such, findings cannot speak to whether HIV prevention interventions with a partner communication component are effective in increasing partner communication frequency across at-risk populations not represented in the current meta-analysis or via alternative intervention delivery modalities (e.g., couples-delivered interventions).

While some interventions included in the meta-analysis were delivered regardless of relationships status, others targeted individuals not in relationships with steady partners. Literature suggests that individuals may approach and differentially engage in sexual discussions depending on the type of partner with whom they are communicating (i.e., casual or main partner), which may have contributed to the heterogeneity observed in the present meta-analysis. For example, partner-level variables (e.g., partner type, perceived partner trust) affect sexual communication among MSM (Bird et al., 2017), and individuals generally tend to communicate about sex less frequently with casual partners (e.g.., "friends with benefits") than romantic partners (Lehmiller et al., 2014). In addition, there may be certain intervention approaches (e.g., discussions of videos, active role play activities) that are more effective in increasing partner communication frequency overall (and perhaps among certain populations), which may have also contributed to the observed heterogeneity.

Effect of HIV prevention interventions that target partner communication on condom use frequency at follow-up

Findings indicated that individual-based HIV prevention interventions that target partner communication are associated with greater condom use frequency at follow-up as compared to control conditions (Cohen, 1988). This is consistent with the AIDS Risk Reduction Model (ARRM; Catania et al., 1990) and the Information-Motivation-Behavior (IMB) model (Fisher & Fisher, 2000), both of which suggest that protective sexual behaviors such as condom use are more likely to occur when an individual has good communication skills and involves his/her partner in decisions regarding sexual behaviors. Overall, results suggest that partner communication skills training during an intervention is associated with more frequent discussions with partners about safer-sex *and* more frequent condom use.

Similar to results regarding partner communication frequency, there was a significant amount of between-trial heterogeneity. While interventions that target partner communication may be effective in increasing condom use frequency, overall, there may be some populations for whom this effect is stronger; perhaps those for whom partner communication or negotiation is a particular barrier to condom use (e.g., African American females). As previously noted, potential sources of between-study heterogeneity include, variations in population characteristics, partner type, and intervention approach. For example, research indicates that heterosexual individuals are more likely to use condoms with casual partners than steady partners, and that partner communication is a stronger determinant of condom use with casual partners than it is with steady partners (De Visser & Smith, 2001). As such, interventions delivered to individuals who were reporting on condom use with casual partners may have had a stronger effect on condom use frequency. Moreover, heterosexual men may find it more difficult to use condoms with casual partners than heterosexual women (Woolf & Maisto, 2008). Although the HIV interventions included in the present analyses included partner communication skills training components, they varied with regards to the other content that was included in the intervention, which may have differentially affected condom use behaviors at follow-up. Furthermore, not only may there have been between-study heterogeneity in treatment composition, it may also be the case that within individual studies, distinct aspects of the intervention were differentially effective regarding condom use frequency.

Strengths and limitations

Determining the consistency of the effect of individual-based HIV prevention interventions incorporating partner communication skills building on partner communication and condom use frequency allows researchers to understand, more broadly, the extent to which integrating these types of intervention components may benefit at-risk populations. However, it should be noted that there are several limitations of the present study. The amount of variation due to heterogeneity suggests that future studies may consider using meta-regression analyses to determine which homogenous subpopulations within a heterogeneous set of studies benefit the most from partner communication skills training. This might inform the design and tailoring of future HIV prevention interventions for specific populations (e.g., integrating communication elements when

designing interventions that specifically target heterosexual females).

Both the partner communication frequency and condom use frequency outcome variables referred to a partner in general as opposed to a specific partner (e.g., main partner). Due to the generalized nature of these outcomes, it is possible that these measures may differ across partner type. The variability in partner communication outcomes reported by the studies included in the condom use frequency meta-analysis precluded the inclusion of several studies in the partner communication meta-analysis, which resulted in a smaller subset of studies to assess the overall efficacy of interventions on partner communication frequency. Additionally, our meta-analysis focused on interventions delivered to individuals rather than dyadic intervention approaches for couples. Lastly, this meta-analysis relied on self-report data, which is bound to be imbued with more error than objective measures such as HIV/STI incidence (Brown & DiClemente, 2015). Self-report retrospective data is subject to recall biases, as well as social desirability biases, especially when the topic involves sexual behaviors.

Future directions

Future research should determine the underlying mechanisms of the association between partner communication skills training and increased partner communication frequency within the context of individual-based HIV prevention interventions. It may be that partner communication skills training increases perceived control or confidence in one's ability to initiate partner communication behaviors. Notably, the majority of studies reviewed for the current meta-analysis reported either partner communication frequency *or* partner communication self-efficacy. To clarify the nature of the relationship between partner communication skills training, partner communication self-efficacy, and partner communication frequency, future research (and to some extent, meta-analyses) should determine whether partner communication self-efficacy predicts later changes in partner communication frequency. In addition, future research may determine whether partner communication frequency mediates the relationships between perceived control over partner communication or partner communication self-efficacy and condom use frequency.

Although the current meta-analysis did not examine whether partner communication frequency is directly associated with greater condom use frequency, research indicates that partner communication is associated with condom use frequency (Miles, 1993; Saul et al., 2000), and a number of studies suggest that partner communication frequency mediates the effect of HIV prevention interventions on condom use behaviors (Crosby et al., 2002; El-Bassel et al., 2016; Sales et al., 2012, 2014). Future research should assess this effect using meta-analytic techniques to determine if increases in communication frequency account for changes in condom use behaviors across interventions. Indeed, prior meta-analytic research has identified condom negotiation and sexual communication components as characteristics of efficacious HIV prevention interventions for adolescents (Sales et al., 2006), and has indicated that partner communication frequency about condom use is associated with condom use behaviors (Noar et al., 2006). The current meta-analysis expanded on these findings and suggests that targeting partner communication skills within an intervention setting is associated with both increased partner communication frequency and condom use frequency. Lastly, while the current meta-analysis excluded dyadic interventions delivered to couples, a future meta-analysis may consider focusing on dyadic interventions or perhaps examine whether intervention efficacy is moderated by couple- or individual- based designs.

Conclusions and clinical implications

While an HIV prevention intervention may be successful in increasing awareness of HIV risk and motivation to engage in safer-sex behaviors, the overall goal of behavior change may be abated if it does not promote skills for implementing safer-sex behaviors and overcoming potential barriers. Initiating and sustaining sexual health-related behavior change is challenged by the fact that these behaviors are influenced by both individual-level factors (e.g., partner communication self-efficacy) and partner-level factors (i.e., partner preferences for condom use). Integrating partner communication skills training may offer a means for translating safer-sex intentions into actual behavior by managing partner-level influences on condom use behaviors (e.g., insistence on unprotected sex) through effective communication and negotiation. Overall, findings indicated that individuals exposed to HIV prevention interventions with a partner communication skills training component had greater partner communication frequency and more frequent condom use at follow-up as compared to individuals randomized to the control condition. This suggests that including safer sex communication skills training in individual-based HIV prevention interventions may improve both partner communication and condom use frequency, and that these improvements may be sustained for several months post-intervention.

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Compliance with ethical standards

Conflict of interest The authors Nicole K. Gause, Jennifer L. Brown, Jeffrey Welge, and Nathan Northern declare that they have no conflict of interest.

Human and animal rights and Informed consent This article does not contain any studies with human participants performed by any of the authors. Informed consent was not obtained by any of the authors directly, as these meta-analyses did not collect data directly from participants in any of the studies included.

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