Peer education for HIV prevention among high-risk groups: a systematic review and meta-analysis

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Abstract

Background: Peer education has become a strategy for health promotion among high-risk groups for HIV infection worldwide. However, the extent to which peer education could have an impact on HIV prevention or the long-term effect of this impact is still unknown. This study thus quantifies the impact of peer education over time among high-risk HIV groups globally. Method: Following the PRISMA guidelines, a systematic review and meta-analysis was used to assess the effects and duration of peer education. A thorough literature search of PubMed, Web of Science, Embase and Cochrane Library was performed, and studies about peer education on high-risk HIV groups were reviewed. Pooled effects were calculated and the sources of heterogeneity were explored using meta-regression and subgroup analysis. Results: A total of 60 articles with 96484 subjects were identified, and peer education was associated with 36% decreased rates of HIV infection among overall high risk groups (OR: 0.64; 95%CI: 0.47-0.87). Peer education can promote HIV testing (OR=3.19; 95%CI:2.13,4.79) and condom use (OR=2.66, 95% CI: 2.11-3.36) while reduce equipment sharing (OR=0.50; 95%CI:0.33,0.75) and unprotected sex (OR=0.82; 95%CI: 0.72-0.94). Time trend analysis revealed that peer education had a consistent effect on behavior change for over 24 months and the different follow-up times were a source of heterogeneity. Conclusion: Our study shows that peer education is an effective tool with long-term impact for behavior change among high-risk HIV groups worldwide. Low and middle-income countries are encouraged to conduct large-scale peer education.

Background

Acquired immune deficiency disease (AIDS), caused by the human immunodeficiency virus (HIV) is a severe infectious disease. High risk HIV groups, including men who have sex with men (MSM), people who inject drugs (IDUs) and female sex workers (FSWs) are those who have high-risk behaviors and thus tend to be disproportionately infected by HIV virus[1]. As the 2018 Joint United Nations Program on HIV/AIDS reported, such high risk groups and their sexual partners accounted for 47% of new HIV infections globally[1]. Compared with the general population, MSM have a 27 times higher infection risk of HIV, IDUs 23 times , and FSWs 13 times[2]. These groups also have a series of high-risk behaviors, such as unprotected sex[2], failing to get HIV tests[3] and sharing drug equipment[4]. Effective behavioral intervention strategies are therefore urgently needed for health promotion among them. One of the key approaches is peer education[5-7].

Peer education is a common strategy for preventing HIV and promoting health worldwide[8] and typically involves recruiting members of a specific at-risk group to encourage members to change risky sexual behaviors and maintain healthy sexual behaviors[9]. What distinguishes peer education from mass media programs is that there is more interpersonal interaction in both directions[9]. Peers are much more likely to influence the behavior of fellow group members since they are assumed to be able to gain a level of trust, which allows for more open discussions on sensitive topics[10, 11]. They also have better access to hidden populations who may have limited interaction with traditional health programs[12]. Finally, they are cost effective in comparison with traditional health-care providers[13, 14].

Previous studies have shown that peer education could reduce risk behaviors[15, 16] and promote health[17-21], but some researchers measured the influence of peer-based intervention on conversations about HIV prevention and highlighted the effect declined and the frequency of conversations on the topics decreased[22]. Previous meta-analyses only synthesized the effect of peer education in developing countries in general population[8] and only revealed the effect of peer education on condom use[17] or HIV testing[23] among MSM groups. What's more, it is also still unclear whether peer education can bring about positive effects and maintain the changes consistently among different high risk HIV groups both in developed and developing countries.

Consequently, an up-to-date and comprehensive systematic review and meta-analysis is urgently needed to evaluate the effect of peer education on different behaviors among high risk groups. To address these issues, we conducted a systematic review and meta-analysis to examine and summarize the effects of peer education on different behaviors, including condom use, HIV testing, unprotected sex, equipment sharing and, HIV incidence both in developed and developing countries among high risk HIV groups. We also conducted a time analysis of peer education to measure its persistent effects over time.

Methods

Search strategy

This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)[15]. The literature was searched using four electronic databases: PubMed, Web of Science, EMBASE, and the Cochrane Library. The search included all the literature published from January 2000 to April 2019. We used the search terms ("peer education" OR "peer-led intervention" OR "peer counseling" OR "peer approaches") AND ("HIV" OR "AIDS") AND ("MSM" OR "homosexual" OR "IDUs" OR "drug users" OR "FSWs" OR "female entertainment workers"). References of retrieved full-text articles and other reviews were screened for additional eligible publications. All publications were exported to a NoteExpress file and the duplicates were deleted.

Study selection and eligibility criteria

Studies were selected if they met the following inclusion criteria: (1) peer education intervention related; (2) the intervention was conducted in high-risk HIV groups, including MSM, IDUs and FSWs; (3) original RCTs or quasi-experimental intervention studies or post-intervention studies or serial cross-sectional intervention studies with quantitative data; (4) behavioral, psychological or social outcome(s) related to HIV health promotion; and (5) the article was published in a peer-reviewed journal from January 2000 to April 2019, without language restrictions. We defined peers as demographically-similar counterparts of the target population. Studies were excluded if they were: (1) review or qualitative studies; (2) not presenting outcome data after peer education; (3) conference abstracts or brief reports.

The titles and abstracts were independently reviewed by two authors (He JY and Wang Y), and full texts of potentially eligible studies were downloaded and further screened for final inclusion in our study. When

there was uncertainty or disagreement between the two authors as to the eligibility of a study, another author (Hao YT) was invited for guidance in reaching a consensus.

Data extraction

All data were extracted independently by two authors (He JY and Wang Y) using common abstraction forms. The characteristics recorded for each eligible study included the first author's name, publication year, study country, study object, mean age of participants, study design, sample sizes, description of intervention in study aims and comparison aims, duration of follow-up, study outcomes, number of events in trial and control groups, outcome indicators, and 95% confidence intervals (CIs).

We then performed a quality assessment of each study included using an 8-point scale which was first used in a meta-analysis in 2009[8] and has subsequently been cited by other researchers[24-26, 83]. One point was awarded for each of the following items: (1) prospective cohort; (2) control or comparison group; (3) pre/post intervention data; (4) random assignment of participants to the intervention; (5) follow-up rate of 80% or more; (6) comparison groups equivalent in terms of social-demographic measures; (7) comparison groups equivalent at baseline in terms of outcome measures; and (8) sample size≥100. Therefore, the total rigor score for each study ranged from 0 to 8.

Statistical analysis

Meta-analysis was performed using the package 'meta' in R software (version 3.4.3). We converted effect size estimates to the common metric of an odds ratio (OR). ORs and their 95% CIs were extracted directly from reports when available, with adjusted ORs extracted preferentially over unadjusted ORs. If an included study did not report ORs, crude ORs were calculated from extracted data.

The I^2 statistic was used to assess the level of heterogeneity across included studies, with values of 50%, and 75% representing low to moderate, and high heterogeneity, respectively[16]. Both a fixed-effect model for low heterogeneity studies and a random-effect model for moderate and high heterogeneity studies were used to calculate pooled effect sizes. We explored sources of heterogeneity by performing subgroup analyses among different high risk groups. If substantial heterogeneity was detected (I^2>90), we performed multivariate meta-regression analyses to investigate the proportion of study variance accounted for by country, follow-up time, and high risk groups. Publication bias was assessed using funnel plots and Egger's test[27]. We also performed sensitivity analyses by removing one study at a time and recalculating the pooled estimates.

In order to evaluate the time effect of intervention, we developed subgroup analyses of different follow-up times. Different studies reported outcome effects at different follow-up times. Therefore, we conducted meta-analyses of different duration for each intervention result based on the principle of making full use of the information: (1) unprotected sex behavior: 3, 6 and 12 months, (2) equipment sharing behavior: 3, 6, 12, and 24 months, (3) HIV testing behavior: 3, 6, 12, and 24 months, (4) condom use behavior: 3, 6, 12, 24, 36, 48 months, (5) HIV infection: 12, 24, and 48 months. Combined ORs of outcome were calculated in

each group. Line charts of combined ORs on each intervention result were conducted to see whether the effect of peer education appeared to decline over time.

Selection of study endpoints

A meta-analysis was conducted on four behavioral outcomes and one biological outcome which were reported across multiple studies: HIV testing, condom use, injection drug equipment sharing, unprotected sex, and HIV measure. HIV testing was the dichotomous proportion of respondents who did or did not have an HIV test. Condom use was always measured as a multiple categorical variable in the studies, such as used condom in last sexual encounter, always used condom, used condom with clients, used condom with sexual partners etc. We prioritized the general and comprehensive variable which can most reduce risk and represent the most cases, such as always used condom. We also conducted subgroup analyses on condom use including condom use with regular partners, condom use with casual partners and consistent condom use. Intravenous drug equipment sharing included reported episodes of sharing needles/syringes, rinse water, and/or cooking utensils. HIV measures including incidence and prevalence, were measured by self-reports, chart reviews, and clinical diagnoses. For all outcomes, our selection of the outcomes to be included in the meta-analysis prioritized the comparison with the longest follow-up time.

Results

Search

The initial search of our chosen four electronic databases yielded 1499 articles; of which 274 duplicates were removed. Of the remaining 1225, 1064 were excluded due to lack of relevance to peer education, the target population i.e. not HIV risk groups, or because they were reviews. Full text screening of the remaining 131 papers led to the further exclusion of 64 papers for the following reasons: lack of information on target outcomes (n=26), not a peer-led intervention (n=36), and two articles could not be downloaded. Thus, 60 studies met our predefined inclusion criteria (Figure 1). One of these 60 studies was not included in the meta-analysis because it lacked quantitative data. The characteristics of each study are detailed in Table 1. The information of the selected studies can be found at Supplemental material 1.

Of these 60 studies, 34 articles employed randomized controlled trials or quasi-experiments, and 9 articles were cohort studies. The remaining 18 studies were serial cross-sectional studies. As shown in Table 1, 25 studies were conducted in East and Southeast Asia, 9 in Central Asia, 15 in North America, eight in Africa, 7 in Europe, and one in South America with some studies conducted across two countries.

Target populations included MSM (n= 18)[17-21, 28-40], injected drug users (n= 22)[41-62], female sexual workers (n= 20)[63-82]. The included studies were undertaken between 2001 and 2009, and the population number ranged from 69 to 7,015. Mean or median age varied from 16 to 43 years. Study quality assessment scores ranged from 2 to 8, with a mean score of 5.05 out of 8 which is the most

rigorous (Supplemental Table 1). According to the sensitivity analysis, the results were robust after moving each study (Supplemental Figure 1-8) and the Egger tests indicated that there was no publication bias, which are shown in the supplemental material (Supplemental Table 2).

Impact of peer education on outcome measures

Table 2 presents a summary of the pooled effect sizes for the five outcomes, including overall effects, effects stratified by the three target populations, as well as the level of a country's economic/social development.

HIV testing

Fifteen studies[18, 19, 22, 28, 31, 32, 36, 40, 49, 65, 77, 78, 81, 82] reported the quantitative outcomes on HIV testing with a combined study population of 12775 and two studies did not show an increase rate of HIV testing. The outcome of the random effect model suggested that the effect was significant (OR: 3.19; 95%CI: 2.13-4.79) with substantial heterogeneity across studies (I^2 = 92%). This thus indicates that the peer education was able to increase the rate of HIV testing among high risk HIV groups globally (Figure 2).

Equipment sharing

Sixteen studies[22, 43-45, 47-53, 55-57, 59, 60] generated 17 discrete effect sizes on equipment sharing with a combined study population of 13,830. Although seven of the sixteen studies reported non-significant changes in equipment sharing before and after intervention, the outcome of the random effect model indicated that the overall effect was significant (OR: 0.52; 95%CI: 0.35-0.76) with substantial heterogeneity across studies (I^2 =93%). The meta-analysis of these 16 articles suggested that through peer education, IDUs would reduce equipment sharing (Figure 3)

Unprotected sex

Ten studies generated[17, 20, 39, 40, 44, 53, 55-57, 72] 11 independent effect sizes on unprotected sex with a combined study population of 6289. Four of the articles showed a significant reduction in unprotected sex, while four of the articles showed a non-significant reduction. Another three studies found no changes before and after peer education intervention. The fixed effect meta-analysis model showed that peer education lowered 18% of unprotected sex among high risk groups worldwide (OR: 0.82; 95%CI: 0.72-0.94; I^2 =50%) (Figure 4).

Condom use

Thirty-two studies[19, 28, 29, 31, 33-38, 41, 49, 51, 54, 61, 63, 64, 66, 68-71, 73-82] reported a condom use outcome after intervention with a population of 46,130. Results across these studies were mixed but most revealed an increase in condom use, and only six of the 32 studies showed insignificant condom use after intervention. In general, after the peer education intervention, condom use among the HIV risk

population increased with a combined OR of 2.66 (95%CI: 2.11-3.36; I^2=90%) (Figure 5). Subgroup analyses also demonstrated significant results among FSWs, MSM and IDUs, with a pooled OR effect of 3.19 (95%CI: 2.41-4.23; I^2=88%), 1.76 (95%CI:1.37-2.26; I^2=72%) and 2.84 (95%CI: 1.08-7.48; I^2=95) respectively, which indicated a positive effect of peer education on condom use (Supplemental figure 9-11).

Subgroup analyses were also carried out by different partner types and using patterns, revealing that peer-led intervention increased condom use both with casual sexual partners (OR: 2.79; 95%CI: 2.13-3.66; I^2=84%) and regular sexual partners (OR: 2.45 ; 95%CI: 1.64-3.66; I^2=95%). Considering that consistent condom use had a more profound impact on preventing HIV, we also conducted a meta-analysis and found it increased after peer education (OR: 1.80; 95%CI: 1.47-2.21; I^2=86%) (Supplemental figure 12-14).

HIV measures

Nine studies[34, 46, 58, 62, 63, 69, 70, 73, 74] generated 10 independent effect sizes on the HIV measure with a population of 28,061. Five showed an insignificant reduction in HIV measure after prevention, and one study found an increased odds of HIV infection. However, the overall results of the meta-analysis suggested 36% lower odds of HIV measure in high risk groups (OR: 0.64; 95%CI: 0.47-0.87; I^2=83%) (Figure 6).

Duration effect of peer education

Figure 7 presents the effectiveness of peer education among high risk groups for the five outcomes at different time periods.

A. Unprotected sex

The follow-up time of the articles reporting the outcome of unprotected sex was mainly within 12 months of peer education, thus we only analyzed the time effect of unprotected sex at 3, 6, and 12 months. The results highlighted a non-significant effect after 3 and 6 months, with a pooled OR of 0.68 (95% CI:0.37-1.26) and 0.93 (95% CI:0.80-1.08) respectively. However, a significant effect was found after 12 months of peer education, justifying its ability to reduce the cases of unprotected sex in the long term (OR:0.64; 95% CI:0.52-0.80).

B. Equipment sharing

Peer education had a non-significant impact on reducing equipment sharing behaviors within 12 months however the pooled odds ratio showed a downward trend. After 24 months of intervention, the combined effect was 0.32 (95%CI: 0.16-0.63), suggesting that peer education was still valid in reducing equipment sharing over a long period.

C. HIV testing

The persistent effect of peer education on HIV testing was significant with an overall OR of 6.85 after 24 months of intervention, higher than the effects after 3,6,12 months of 2.54 (95%CI: 1.35-4.78), 2.36 (95%CI: 1.21-4.60), 1.78 (95%CI: 1.26-2.52) collectively. The general increasing trend indicated that peer education had a persistent positive impact on encouraging high risk groups to get an HIV test.

D. Condom use

The overall time effect of condom use was positive but variable. During the first year after the intervention, the significant impact decreased with a pooled OR of 1.98 (95%CI:1.25-3.13), 1.81 (95%CI:1.25-2.63), 1.54 (95%CI:1.35-1.76) after 3, 6,12 months respectively. However after 12 months, the effect began to increase from 1.81 (95%CI:1.22-2.69) in 24 months to 2.65 (95%CI:1.62-4.35) in 36 months, and finally reaching 2.86 (95%CI:2.2-3.71) in 48 months, suggesting a general persistent effect of peer education on condom use.

E. HIV measure

The follow-up time of the HIV measure in the studies focused mainly on 1 to 3 years, thus so we conducted the time analysis in 12, 24, 36 months. Results indicated that after 12 months and 24 months intervention, HIV measure significantly declined with a pooled effect of 0.56 (95%CI:0.43-0.73) and 0.33 (95%CI:0.20-0.55) respectively. Although it still reduced the HIV measure after 36 months, the intervention effect was not statistically significant (OR:0.77; 95%CI:0.55-1.09), implying that the preventive effect of HIV measure may have a slight decline over time.

Meta-regression

For the HIV test, equipment sharing and condom use meta analyses whose heterogeneity were over 90%, a multivariate meta regression was conducted. The meta regression model quantified the impact of the follow-up time, study sites and high risk groups. Supplemental table 3 highlights that the follow-up time was the source of heterogeneity for both the meta analyses of HIV testing and equipment sharing, while the study sites and high risk groups did not show significant heterogeneity among these three meta analyses. Although the heterogeneity in the meta-analysis of condom use was relatively high, we had not found the source of heterogeneity. After adjusting for the impact of follow-up time, the pooled effect of the meta-analysis was still significant, which was shown in the results of the effect of duration.

Discussion

We conducted a systematic review and meta-analysis by combining 59 studies to examine the effectiveness of peer education and analyzed its long-term effects among high risk HIV groups in both developed and developing countries.

Our findings revealed that peer education can effectively promote HIV testing, condom use and reduce unprotected sex and HIV measure among MSM, IDUs and FSWs. The time trend analysis has indicated that this intervention can transform the behaviors consistently with significant results for over maximum

24 months. Moreover, peer education had a more significant effect in developing countries than developed countries, indicating that peer education may be particularly suitable in low and middle-income countries.

Our review is consistent with prior meta analyses showing the positive impacts of peer-based intervention for HIV prevention. In line with our results, a meta-analysis conducted in developing countries demonstrated that peer-led interventions could improve condom use with a combined OR of 1.92 among the general population[8]. However, our study indicated a stronger effect with a combined OR of 2.66, mainly because our target was high risk HIV groups who may involve in more sexual activities. Another meta-analysis showed that the odds of undergoing tests for HIV among MSM who were engaged in peer-led intervention were twice as high as counterparts who were not: the authors' results were thus almost the same as our analysis with a combined OR of 2.75 on HIV testing behavior[23]. A previous systematic review found a 32% reduction in unprotected sex for group-based interventions among MSM[83], slightly higher than our study (24%), which indicated a greater effect among MSM on unprotected sex behavior. We thus believe that our systematic review and meta-analysis contributes to the growing body of work on the utility of peer-led intervention by adding evidence for the critical outcome among high risk HIV groups worldwide.

Our subgroup analyses revealed that peer education has a significant effect on increasing condom use both with casual partners (OR=2.79) and regular partners (OR=2.45) as well as on consistent condom use (OR=1.80). Condom use has been proven to effectively prevent transmission among high risk HIV groups[66], especially among FSWs. Their regular partners and clients include different types of men, from "boyfriends" and sex work venue managers to "protectors" who prevent the women from being assaulted at night[84]. The HIV risk is probably high among these men who have many sex worker girlfriends[64]. From our findings, we strongly believe that the continuum of peer education was crucial in obtaining a high adherence level of FSWs to use condom with diverse partners. Nevertheless, a recent study by Karnataka suggested that if an FSW started sex work and subsequently acquires a regular sex partner, condoms were more likely to be used, compared with situations where marriage occurs first and sex work begins later on[85]. Thus more work is required to understand and mitigate sexual risk and to increase condom use among high risk HIV groups[63].

We believe that the greatest strength of this study is that we analyzed the time trend of peer education effectiveness among high risk HIV groups. Time analysis verified that peer education has a consistent effect on changing behaviors and reducing HIV incidence over 24 months, although with some fluctuations. The results of HIV testing and condom use were significant overall with a gradual increasing trend, indicating a persistent and positive effect on changing these two behaviors. As regards equipment sharing and unprotected sex, peer education might be able to reduce the occurrence rate significantly after 12 months. The effect became gradually robust which was in accordance with the HIV testing and condom use results. Stages of change (SOCs) revealed that people move through a series of stages when modifying behaviors[86, 87]. The transtheoretical model (TTM) posits that people move through five specific SOCs when changing health behaviors: precontemplation, contemplation, preparation, action,

and maintenance[88]. It is therefore normal that the outcomes were not completely clearly or even reversed during the behavior change process.

In terms of HIV infection, which included the time periods of 12, 24, 36 months, the significant results maintained, however the effects weakened at 36 months. There are other factors that may lead to HIV infection, such as economic pressures driving[66], the risk social environment[88], severe stigmatization and discrimination[63]. Other factors, such as the increasing registration for anti-retroviral treatment (ART) among adults and women, and the misconception that people on ART do not transmit HIV, could have contributed to newly-infected HIV cases[70]. Additional research is needed to identify the structural characteristics of the social networks of high-risk groups that may facilitate more successful peer education intervention.

Our review also has several limitations. First, we found evidence of publication bias in the meta-analysis of HIV testing and unprotected sex. Disproportionate reporting of significant associations in published work can result in an overestimate of the impact of peer education[89]. Therefore, we conducted sensitivity analyses and subgroup analyses in an attempt to reduce biases. Second, when analyzing the time trend of peer education effectiveness, biases might exist in studies which were conducted over a period of 12 months since they were mostly serial cross sectional studies. However, the sample size of those studies was sufficiently large to minimize biases as much as possible. Finally, the heterogeneity across studies was significant, which may overstate the pooled estimates. Considering that subgroup analyses and meta-regression were conducted, we believe that our results are still reliable.

Conclusions

In conclusion, peer education can effectively change behaviors and reduce HIV measure among high risk HIV groups. More importantly, it can maintain its effects consistently with significant results over 24 months period. Nevertheless, further RCT studies with longer follow-up period are still needed to precisely validate the effect of duration.] In order to significantly reduce the prevalence of HIV, peer education characterized by its low-costing features tend to particularly beneficial for low- and middle-income countries and should be promoted widely in resource-limited regions.

Abbreviations

95%CIs 95% Confidence Intervals

AIDS Acquired Immune Deficiency Syndrome

ART Antiretroviral Therapy

FSWs Female Sexual Workers

HIV Human Immunodeficiency Virus

IDUs Injected Drug users

MSM Men who have Sex with Men

OR Odds Ratio

PRISMA Preferred Reporting Items for Systematic Reviews and Meta-Analyses

RCTs Randomised Controlled Trials

SOCs Stage of Changes

TTM The Transtheoretical Model

Declarations

Data were collected from researches and literature so there was no ethics issue on this paper.

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Availability of data and materials

All data generated or analyzed during this study are included in this published article and its supplementary information files.

Competing interests

The authors declare that they have no competing interests.

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Authors' Contributions

He JY and Hao YT conceived and designed the study. He JY conducted the research and collected the data. He JY analyzed the data and wrote the fir draft of manuscript. Wang Y, Liao J and Du ZC guided the

research and revised the manuscript. He N gave advice on the manuscript. All authors contributed to data interpretation and writing of the manuscript. All authors have read and approved the final manuscript.

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Figures

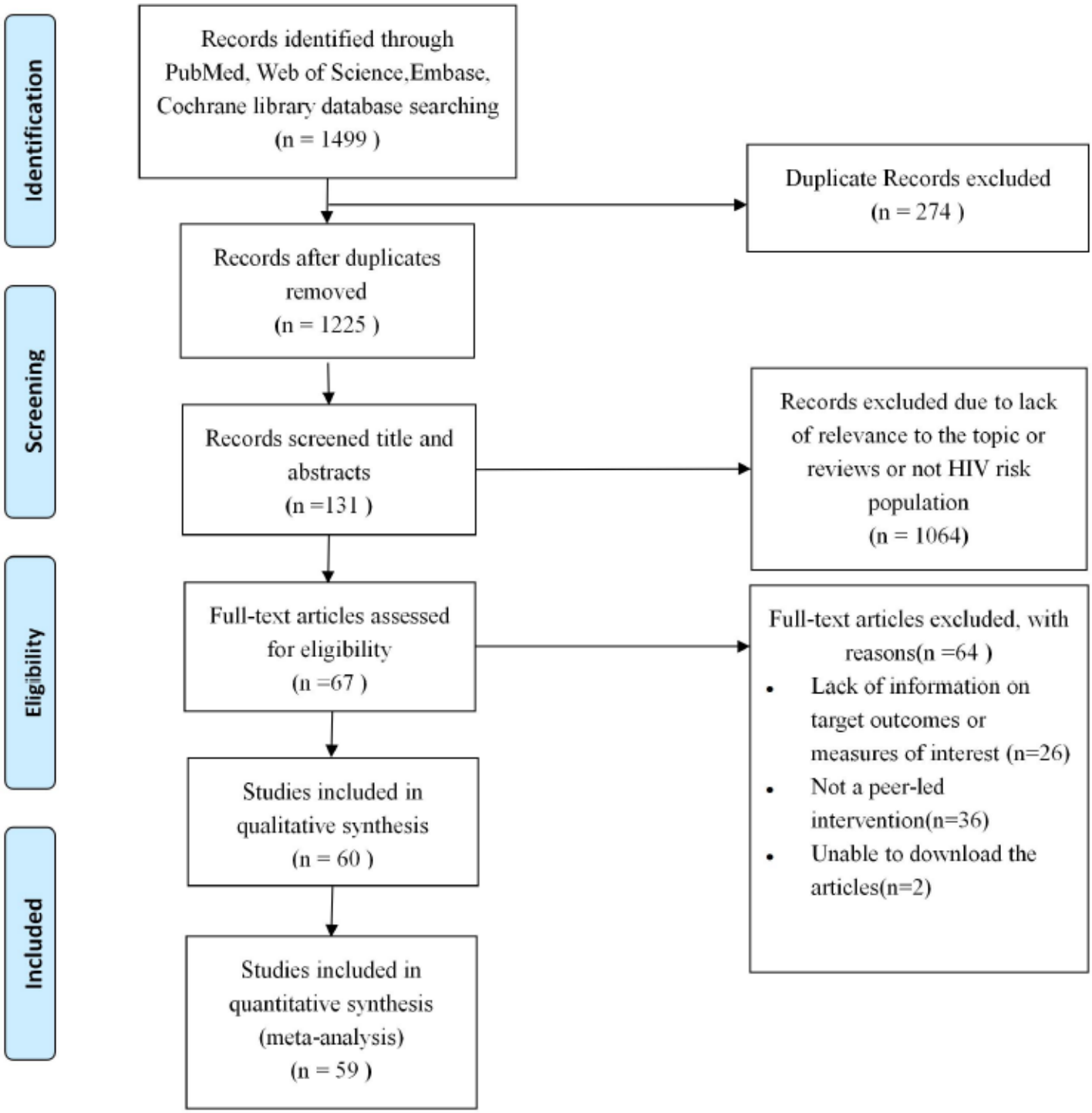

Figure 1

Flow chart of literature search and selection of studies

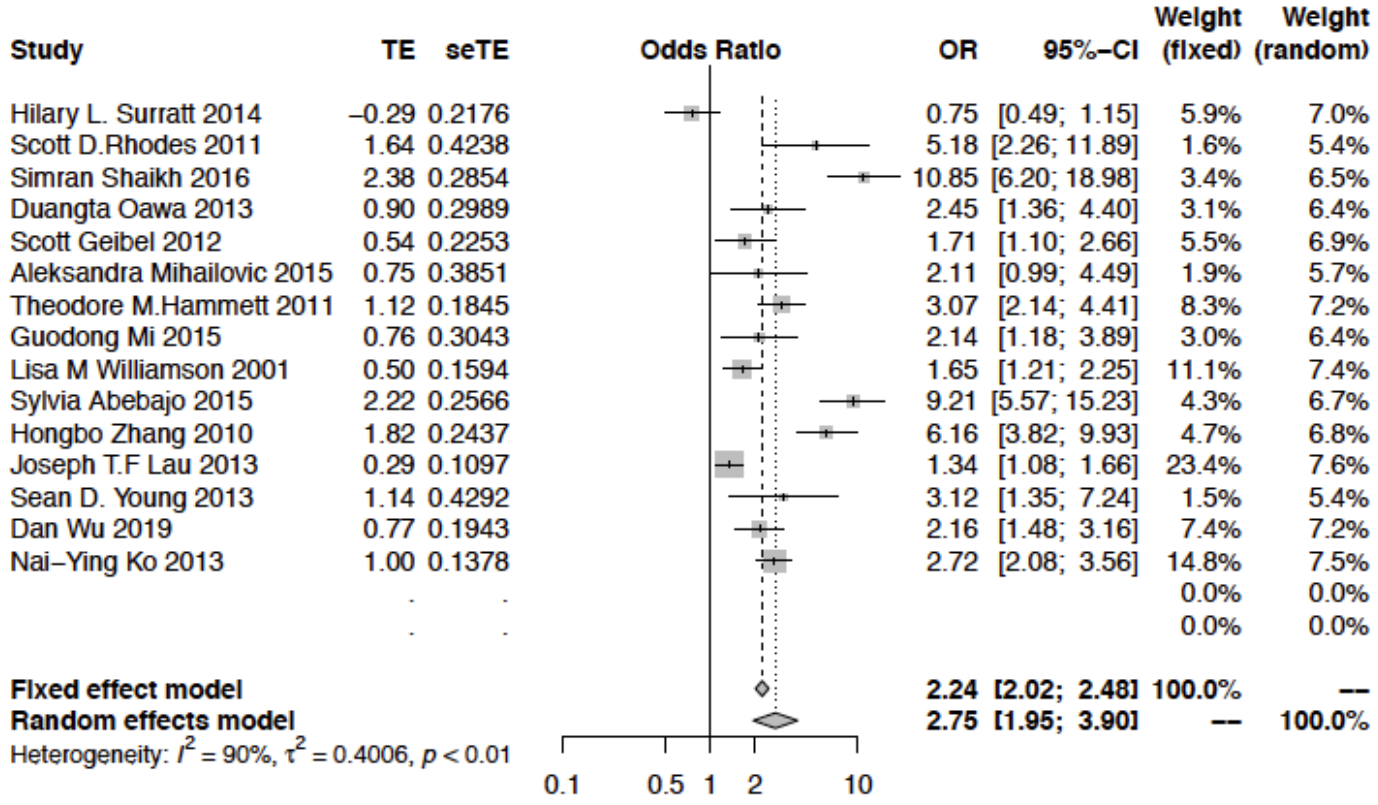

Figure 2

The meta analysis of the HIV testing

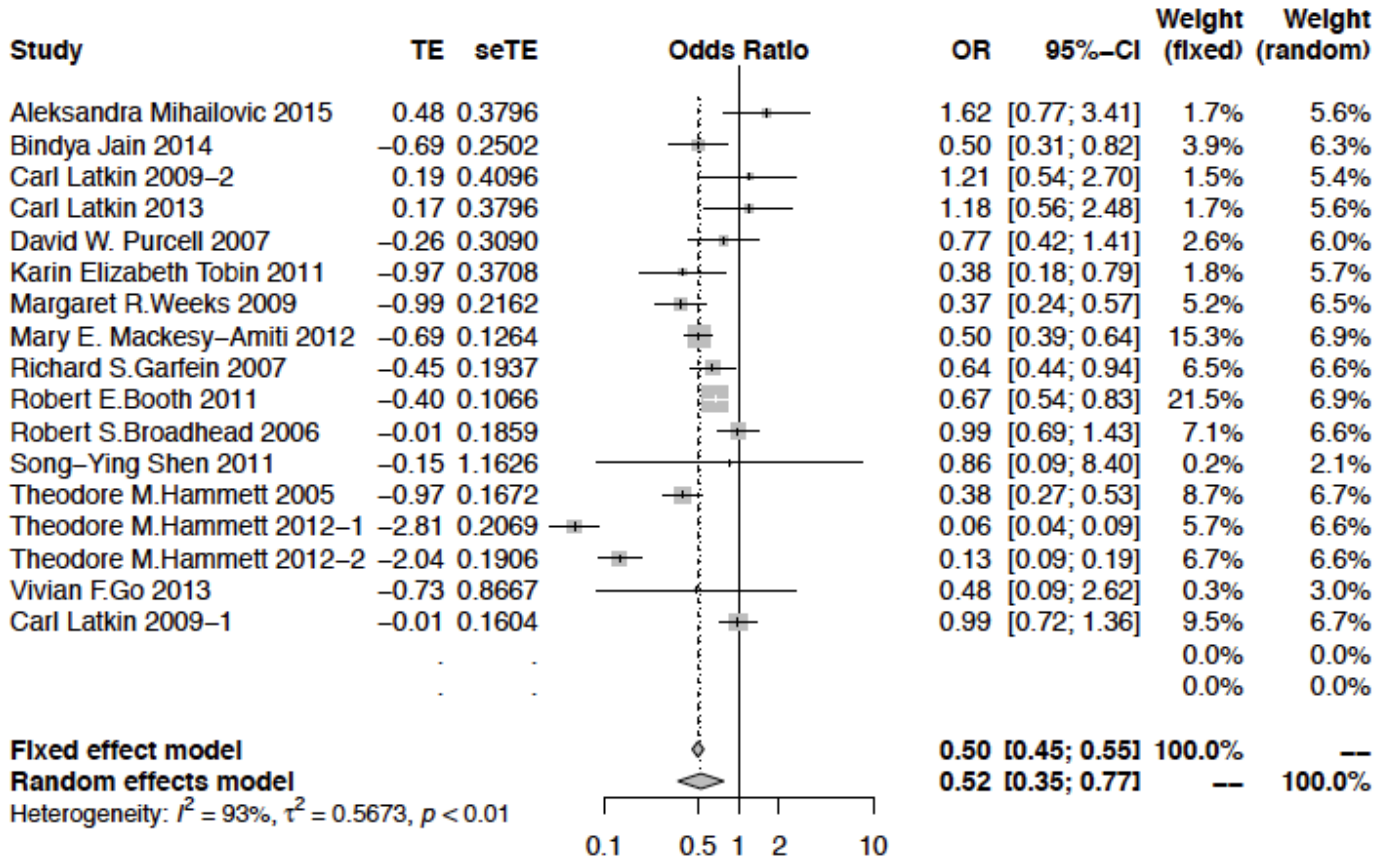

Figure 3

The meta-analysis of the equipment sharing

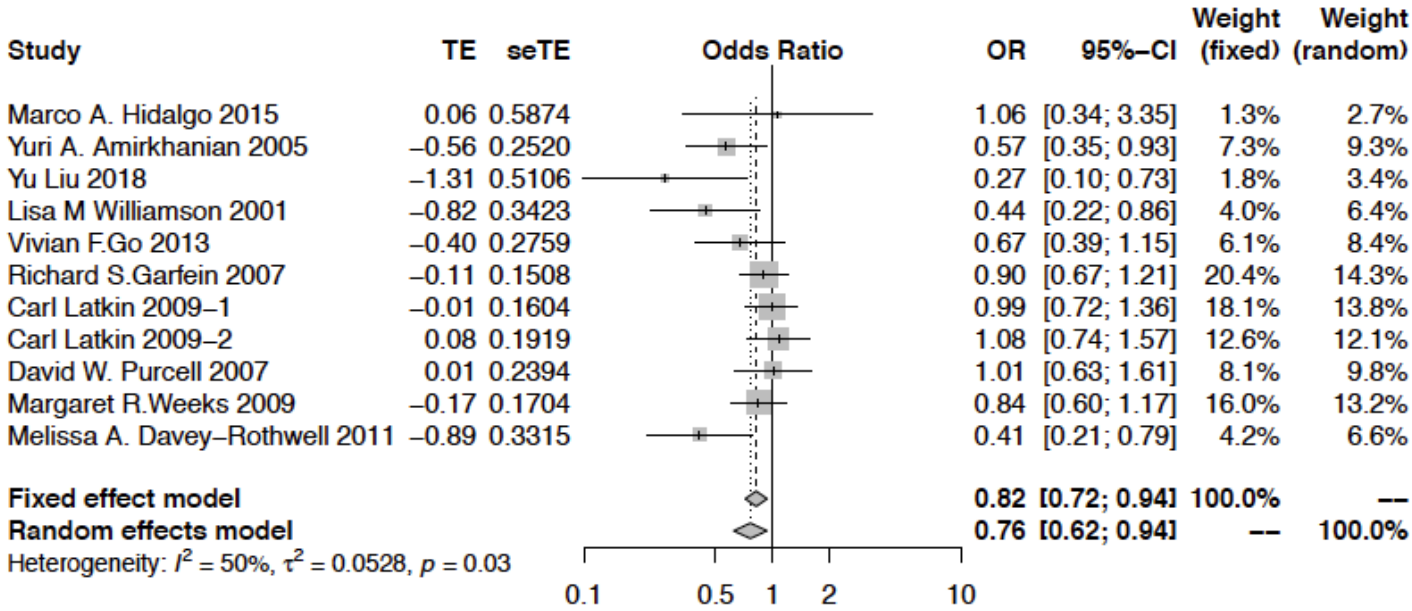

Figure 4

The meta-analysis of the unprotected sex

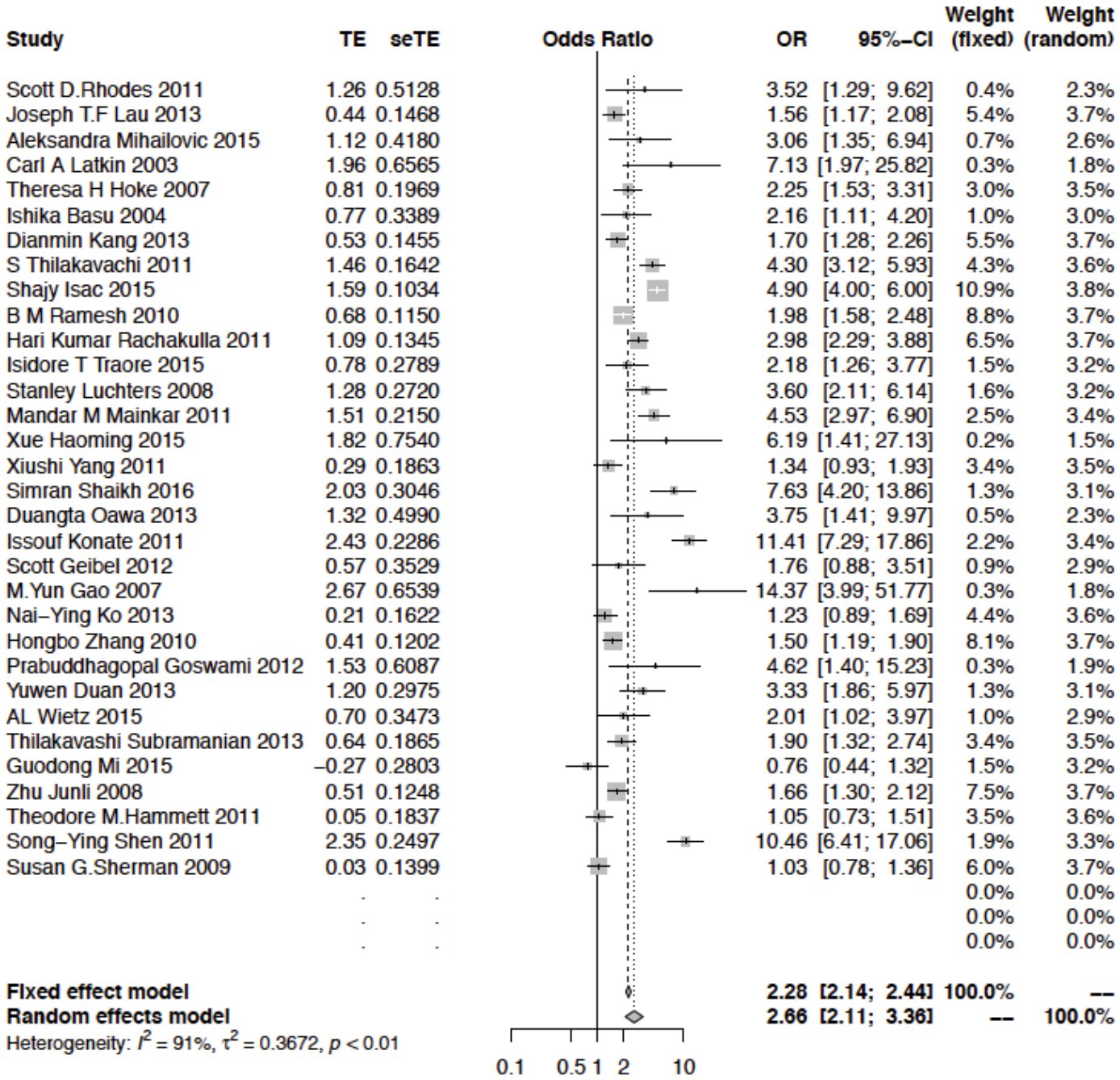

Figure 5

The meta-analysis of the condom use

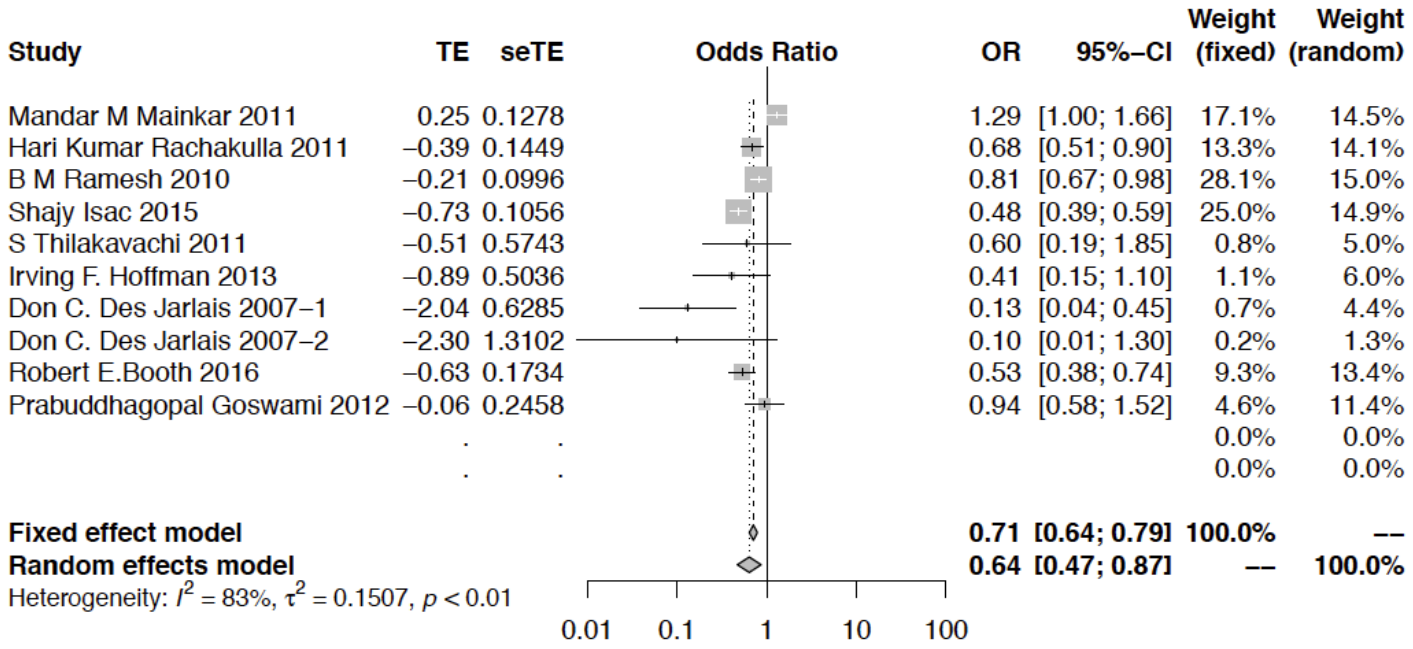

Figure 6

The meta-analysis of the HIV prevalence

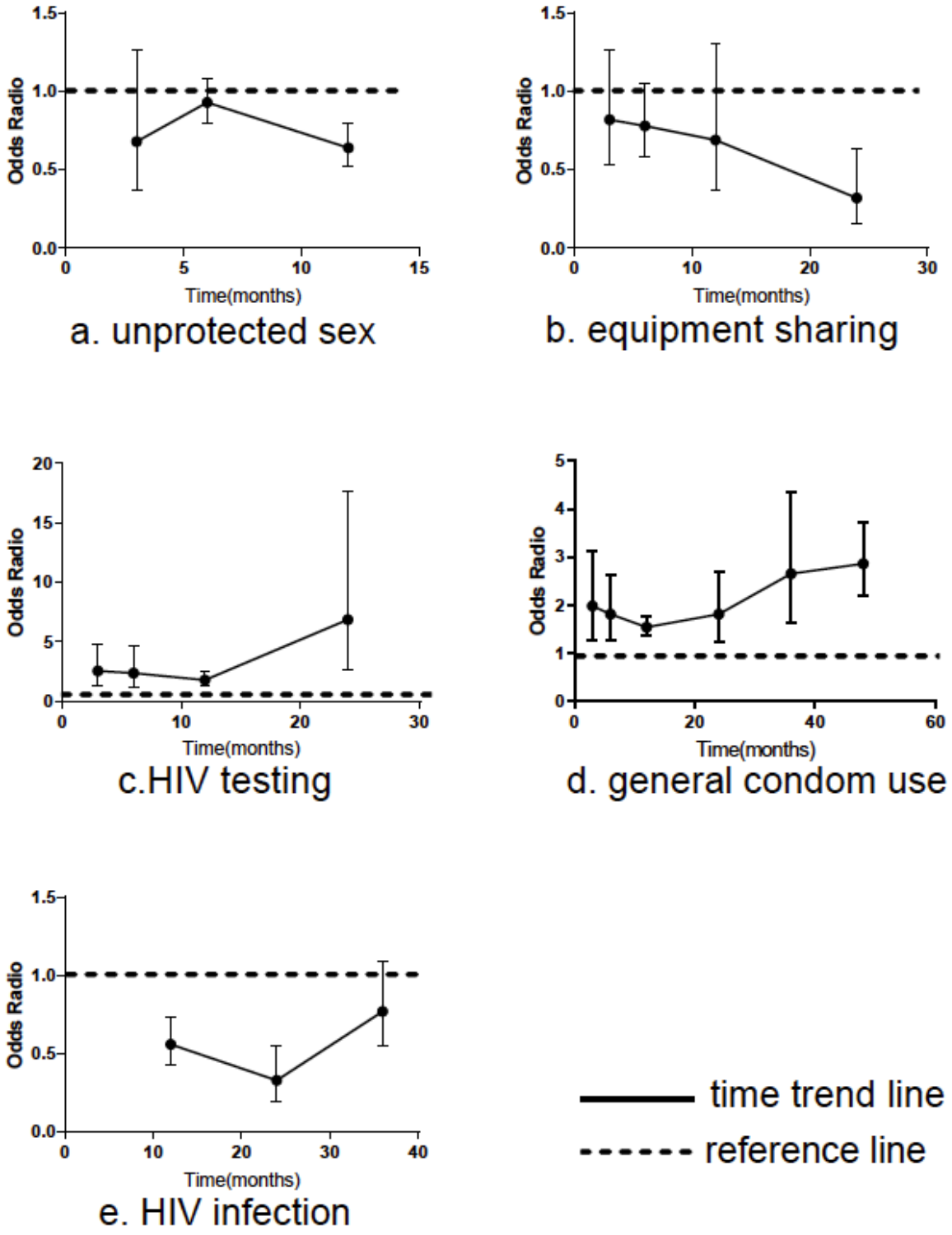

Figure 7

Time trend of peer education effectiveness among HIV high risk groups

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