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[Intervention Review]

Interactive computer-based interventions for sexual health promotion

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ABSTRACT

Background

Sexual health promotion is a major public health challenge; there is huge potential for health promotion via technology such as the Internet.

Objectives

To determine effects of interactive computer-based interventions (ICBI) for sexual health promotion, considering cognitive, behavioural, biological and economic outcomes.

Search methods

We searched more than thirty databases for randomised controlled trials (RCTs) on ICBI and sexual health, including CENTRAL, DARE, MEDLINE, EMBASE, CINAHL, British Nursing Index, and PsycINFO. We also searched reference lists of published studies and contacted authors. All databases were searched from start date to November 2007, with no language restriction.

Selection criteria

RCTs of interactive computer-based interventions for sexual health promotion, involving participants of any age, gender, sexual orientation, ethnicity or nationality. 'Interactive' was defined as packages that require contributions from users to produce tailored material and feedback that is personally relevant.

Data collection and analysis

Two review authors screened abstracts, applied eligibility and quality criteria and extracted data. Results of RCTs were pooled using a random-effects model with standardised mean differences (SMDs) for continuous outcomes and odds ratios (ORs) for binary outcomes. We assessed heterogeneity using the I^2 statistic. Separate meta-analyses were conducted by type of comparator: 1) minimal intervention such as usual practice or leaflet, 2) face-to-face intervention or 3) a different design of ICBI; and by type of outcome (cognitive, behavioural, biological outcomes).

Main results

We identified 15 RCTs of ICBI conducted in various settings and populations (3917 participants). Comparing ICBI to 'minimal interventions' such as usual practice, meta-analyses showed statistically significant effects as follows: moderate effect on sexual health knowledge (SMD 0.72, 95% CI 0.27 to 1.18); small effect on safer sex self-efficacy (SMD 0.17, 95% CI 0.05 to 0.29); small effect on safer-sex intentions (SMD 0.16, 95% CI 0.02 to 0.30); and also an effect on sexual behaviour (OR 1.75, 95% CI 1.18 to 2.59). Data were insufficient for meta-analysis of biological outcomes and analysis of cost-effectiveness.

In comparison with face-to-face sexual health interventions, meta-analysis was only possible for sexual health knowledge, showing that ICBI were more effective (SMD 0.36, 95% CI 0.13 to 0.58). Two further trials reported no difference in knowledge between ICBI and face-to-face intervention, but data were not available for pooling. There were insufficient data to analyse other types of outcome.

No studies measured potential harms (apart from reporting any deterioration in measured outcomes).

Authors' conclusions

ICBI are effective tools for learning about sexual health, and they also show positive effects on self-efficacy, intention and sexual behaviour. More research is needed to establish whether ICBI can impact on biological outcomes, to understand how interventions might work, and whether they are cost-effective.

PLAIN LANGUAGE SUMMARY

Computer programmes for sexual health promotion

Sexual health promotion is a major public health challenge. There is huge potential for health promotion via technology such as the Internet, but it is not known whether interventions are effective. An interactive computer-based intervention provides information, and also offers personalised feedback. We searched databases for studies which were randomised controlled trials (RCTs) of computer/Internet-based interventions which aimed to improve sexual health. We included trials of computer-based interventions delivered to people of any age, gender, sexual orientation, ethnicity or nationality. The review evaluated 15 RCTs involving 3917 participants. Results showed that computer-based interventions have a moderate effect in improving people's knowledge about sexual health in comparison to minimal interventions such as 'usual practice' or a leaflet. We also found a small effect on safer sex self-efficacy (a person's belief in their capacity to carry out a specific action), a small effect on safer-sex intentions, and also an effect on sexual behaviour (such as condom use for sexual intercourse). We found that computer-based interventions seem better than face-to-face interventions at improving sexual health knowledge, but there were insufficient data to analyse other outcomes. No studies measured potential harms (apart from reporting any deterioration in outcomes). Interactive computer-based interventions for sexual health promotion are feasible in a variety of settings. They are effective tools for learning about sexual health, and they also improve self-efficacy, intention and sexual behaviour, but more research is needed to establish whether computer-based interventions can change outcomes such as sexually transmitted infections and pregnancy, to understand how interventions might work, and to assess whether they are cost-effective.

BACKGROUND

Sexual health

Sexual health promotion is a major public health challenge throughout the world (Chambers 2001; DOH 2001; Tripp 2005; WHO 2004). For example, epidemics of sexually transmitted human immunodeficiency virus (HIV) are gaining hold in Eastern

Europe and Asia (UNAIDS 2004), and there have been marked increases in sexually transmitted infections (STIs) such as genital chlamydia, gonorrhoea and syphilis in Western Europe in the last decade (Ellis 2004; Nicoll 2002). Sexual coercion is common (Garcia-Moreno 2005), as are psychosexual problems such as erectile dysfunction, orgasmic dysfunction and/or lack of sexual desire (Nazareth 2003; Nicolosi 2006). It is evident that safe, satisfying expression of sexuality is often difficult (Kaschak 2001; WHO 2002).

Particular socio-demographic groups are at disproportionate risk of poor sexual health, for example young people, men who have sex with men (MSM), refugees, sex workers (especially drug users and street workers) and prisoners (Elford 2003; Ellis 2004; Gray 2002). Sexual health concerns may not be addressed in healthcare encounters because of pressure on health services (White 2005) and patients' and physicians' reservations about raising complex and potentially sensitive topics (DOH 2001; Gott 2004; Viner 2005).

Sexual health interventions

Face-to-face interventions (such as school sex education programmes, and individual or group-based sexual health promotion) have had mixed success (Kirby 2007; NICE 2007; Rees 2004; Speizer 2003; Swann 2003). Systematic reviews of face-to-face interventions show moderate success in promoting condom use (Noar 2008; Shepherd 1999) and reducing unprotected sex (Johnson 2008), but much smaller impact on partner numbers (Noar 2008), contraceptive use (DiCenso 2002; NICE 2007), STIs (NICE 2007; Noar 2008; Underhill 2008), or unplanned/unwanted pregnancy (DiCenso 2002; NICE 2007; Underhill 2008). However, good quality evidence is often lacking for particular populations, and more needs to be known about the mechanism of action of interventions (Downing 2006; Ellis 2003). It is clear that improving sexual health presents a huge challenge, and that face-to-face behavioural interventions for individuals are only partially successful.

Technology such as the Internet provides access to increasing quantities of sexual health information (Kanuga 2004; Skinner 2003). However, simply providing information does not necessarily lead to behaviour change (Mellanby 1992; Stephenson 2003). There are large inequalities in access to Internet technology worldwide, for example, it is estimated that 74% of people in North America have access to the Internet, 49% of people in Europe, 30% in Latin America/Caribbean, 23% in the Middle East, 17% in Asia, and only 6% in Africa (Miniwatts 2009). Some populations at higher risk of adverse sexual health have less access to computers and the Internet, for example children not attending school, and poorer people within particular populations (Dutton 2005; Gray 2002; Kalichman 2005; Norton 2004). However, Internet and mobile phone access is increasing rapidly worldwide (Kanuga 2004), so there is huge potential for delivery of health promotion.

Interactive computer-based interventions

Interactive computer-based interventions (ICBI) are programmes that provide information and also decision support, behaviour-change support, and/or emotional support for health issues. 'Interactive' programmes require contributions from users to produce tailored material and feedback that is personally relevant. ICBI

have been effective in promoting behaviour change in people with chronic diseases such as diabetes or heart disease, leading to improved knowledge, social support, health behaviours and clinical outcomes (Murray 2005; Wantland 2004). Computer-based interventions are also feasible in health promotion contexts such as problem drinking (Linke 2004), smoking cessation (Strecher 1999), and nutrition and physical activity (Patrick 2001). A systematic review of computer-delivered interventions for health promotion showed improved health behaviours for nutrition, tobacco use, substance use, safer sexual behavior, and binge/purge behaviours (Portnoy 2008).

Computer-based interventions offer potential advantages over face-to-face interventions in that access can be anonymous, repeated, and at convenient times (Kanuga 2004; Skinner 2003). Interventions can offer individualised feedback, and can promote active learning through interactive elements (Barak 2001). Computer-based interventions have the potential to provide types of health promotion/treatment which may be difficult or embarrassing to access face-to-face, for example sex therapy (Ochs 1994), and dissemination can be fast and relatively cheap online (Barak 2001).

The Internet is a particularly appropriate route for the delivery of sexual health promotion to young people, since they are already confident and frequent users of Internet technology (in well-resourced countries) (Kanuga 2004). The Internet is widely used to access pornography, and the web can also facilitate finding new sexual partners and/or contact with commercial sex workers (Kanuga 2004). Meeting sexual partners via the Internet is associated with increased sexual risk-taking (Elford 2001; McFarlane 2000). In this context it makes sense for health educators to take advantage of new technologies to promote sexual health.

Why it is important to do this review

Digital technology such as the Internet offers exciting potential for sexual health promotion, and ICBI seem effective for HIV-related sexual health promotion (Noar 2010; Noar 2009) (see [Agreements and disagreements with other studies or reviews](#)). However, it is not known whether ICBI are effective for other sexual health problems, nor whether they are as effective as face-to-face sexual health interventions. It is also unclear how ICBI might work (in other words which components are an essential part of the intervention) and whether they are cost-effective. There is also the potential that Internet-based interventions may cause harm. This systematic review therefore identifies trials of ICBI, to assess their effects in comparison with minimal interventions, face-to-face interventions and other designs of computer-based intervention.

OBJECTIVES

To determine the effectiveness of interactive computer-based interventions for sexual health promotion, on cognitive, behavioural, biological and economic outcomes.

METHODS

Criteria for considering studies for this review

Types of studies

We included:

- randomised controlled trials (RCTs) (both individual and cluster randomised);
- studies which compared ICBI with: minimal exposure (e.g. usual practice or waiting list); non-interactive forms of education (e.g. written information, non-interactive computer packages); and face-to-face educational sessions;
- studies that compared two or more types of ICBI, in order to compare the effects of different designs of intervention, such as different technological modes of delivery (e.g. personal computer, mobile phone), different theoretical underpinnings, or different styles of presentation (e.g. graphical, audio, video);
- studies of multi-component interventions where it was possible to separately identify the effects of the ICBI; and
- any type of economic evaluations of ICBI.

Types of participants

Studies involving users/consumers of any age, gender, sexual orientation, ethnicity or nationality.

Types of interventions

Interventions meeting our definition of ICBI, and our definition of sexual health promotion.

Interactive computer-based interventions

We defined 'interactive' as meaning packages that require contributions from users (e.g. entering personal data, making choices) which alter pathways within programmes to produce tailored material and feedback that is personally relevant to users of the programme (Bellis 2002). Users may interact with programmes as members of a small group as well as individually.

Definitions of computer-based interventions are not used consistently in the e-health literature. Adapting the definitions for 'Consumer Health Informatics Systems' (Gustafson 2002) and 'Interactive Health Communication Applications' (Eng 1999) we have defined eligible interventions for this review as interactive computer-based programmes that provide information and one or

more of the following: decision support, behaviour-change support, or emotional support for health issues. Programmes should be available directly to users and allow independent access without needing expert facilitation. The Internet is likely to be the most common delivery route, although other technologies such as interactive television, mobile telephone, CD-ROM and handheld computers (personal digital assistants) are possible.

Sexual health promotion

'Sexual health' and 'health promotion' are difficult to define because these concepts are socially and culturally relative (WHO 2004). Risk factors can be seen as individual (e.g. accurate knowledge, beliefs, motivation and skills to change behaviour) and environmental (e.g. socio-cultural norms, the law, availability and access to services) (WHO 2004). It is a complex interplay of these factors that leads to outcomes such as condom use, or acquisition of an STI (Ellis 2004).

We have adapted the Public Health Agency of Canada's definition of health promotion (PHA Canada 2006), taking sexual health promotion to mean strategies for improving the sexual health of the population by providing individuals, groups and communities with the tools to make informed decisions about their sexual well-being.

Sexual well-being can be thought of as "a state of physical, emotional, mental and social well-being in relation to sexuality; it is not merely the absence of disease, dysfunction or infirmity. Sexual health requires a positive and respectful approach to sexuality and sexual relationships, as well as the possibility of having pleasurable and safe sexual experiences, free of coercion, discrimination and violence. For sexual health to be attained and maintained, the sexual rights of all persons must be respected, protected and fulfilled" (WHO 2002).

Studies meeting our definition of sexual health promotion could therefore include those aiming to enhance 'life skills' such as decision-making and assertiveness with the aim of enhancing sexual well-being, as well as studies aiming to reduce adverse biological outcomes such as STI or unwanted pregnancy. Seeking sexual health care may also improve the sexual health of others, for instance where genitourinary screening or HIV testing result in a reduction in the spread of disease.

We therefore included interventions which facilitate the active seeking of sexual well-being, including accessing sexual health services (e.g. vaccination, STI screening, contraceptive advice, psychosexual counselling, etc.), but we excluded interventions that aim to optimise health care once in a healthcare setting.

Exclusions

We excluded the following interventions:

- simple information packages with no interactive elements;
- non-interactive mass media interventions such as TV advertisements;

- interventions designed to be used with others' help (e.g. teacher or health professional);
- interventions targeted for health professionals or teachers;
- computer-mediated delivery of individual healthcare advice (e.g. online physicians);
- electronic history-taking or risk assessment with no sexual health information or interactive elements;
- treatment decision aids, unless fulfilling the criteria for interactive computer-based interventions;
- interventions designed to optimise sexual health care by clinicians;
- interventions designed to facilitate provider-user communication.

All included interventions had to meet the definitions for interactivity, computer-based intervention, and sexual health promotion, as well as being RCTs (or economic evaluations of trials).

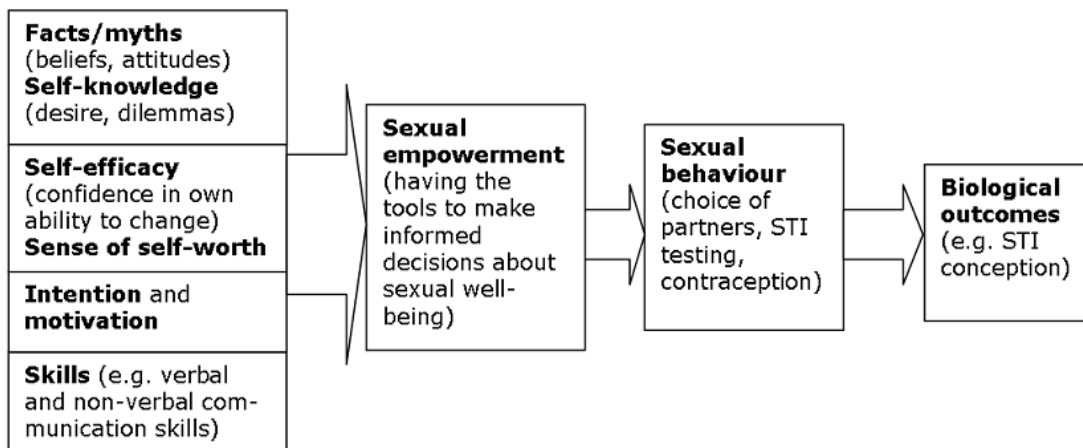
Types of outcome measures

Outcome measures for individual participants can be divided into cognitive, behavioural and biological (Stephenson 2003). The first two are generally self-reported, whilst biological outcomes may be measured objectively. Whilst self-reported outcomes are more susceptible to inaccuracy and bias than objectively measured outcomes, they give valuable information about the possible mechanisms of action of interventions (Stephenson 2003). Many trials

measure cognitive and behavioural outcomes because biological measurement may be costly to obtain, less acceptable to participants, and trials may need to be very large to detect changes in relatively rare outcomes such as STI or pregnancy rates. We analyse these different types of outcomes (cognitive, behavioural and biological) in separate meta-analyses since the relationship between them is complex and non-linear (Stephenson 2003); for example, someone may become motivated to use condoms but their partner refuses; or increases in condom use may make little difference to HIV acquisition in populations with low initial prevalence of HIV.

Populations at risk of sexual health problems (e.g. adolescents, MSM), their risk behaviours, and the contexts in which sexual risk occurs are obviously very diverse (Johnson 2001; Stephenson 2003). Similarly, patterns of computer or Internet use vary (see 'Background'). However, we postulate that the underlying psychological pathways of behaviour change with ICBI are similar for participants in different contexts. For example, increase in knowledge, change in self-efficacy, and improvement in skills may be needed to affect behaviour change leading to improved sexual health. The specific context and combination of these and other factors is likely to be different for different populations, but we postulate that on a theoretical level, ICBI would work in a similar way (Hardeman 2002; Hobbis 2005) (see Figure 1, Behaviour Change Theoretical Model).

Figure 1. Behaviour change theoretical model



We therefore included studies if they measured one or more of the following outcomes:

- Cognitive outcomes e.g. knowledge; self-efficacy (a person's belief in their capacity to carry out a specific action); attitude

(overall evaluation of performing a behaviour).

- Affective outcomes e.g. sexual satisfaction.
- Behavioural outcomes e.g. consistency of condom use for

vaginal or anal intercourse; partner numbers; sexual activity whilst intoxicated; health seeking behaviour (such as increased STI testing and treatment, uptake of cervical cytology screening); age at first sex, condom use at first sex (young people), consistency of contraceptive use (heterosexual participants); negotiation/communication skills.

- Biological outcomes e.g. STI rate; HIV acquisition rate; conception rate; abortion rate.
- Adverse effects i.e. data on unintended adverse outcomes attributable to the intervention.
- Economic outcomes e.g. costs of developing and implementing interactive computer-based interventions; costs and savings for health services or other agencies (such as costs of screening tests and increased use of health services versus costs of untreated STI); costs and savings for users/consumers (such as costs associated with uptake of preventative health services versus costs of unwanted pregnancy).

Search methods for identification of studies

We designed a four-part search strategy. Firstly, we searched electronic bibliographic databases for published work; secondly, we searched the grey literature for unpublished work; thirdly, we searched trials registers for ongoing and recently completed clinical trials. Finally, we searched reference lists of published studies and contacted authors and e-health research groups. We did not hand search individual journals. All databases were searched from their start date to November 2007. There were no limitations by language.

The search strategy comprised three overlapping concepts:

1) RCT study design filter ([Robinson 2002](#))

AND

2) Computer/Internet-based applications

AND

3) Sexual health.

We used the search strategy presented in [Appendix 1](#) to search MEDLINE, using an Ovid platform. Search terms were modified for other databases where subject heading indexing differed from the terms used in MEDLINE (See [Appendix 2](#); [Appendix 3](#); [Appendix 4](#); [Appendix 5](#); [Appendix 6](#); [Appendix 7](#); and [Appendix 8](#)).

Databases

- Cochrane HIV/AIDS, STD, Fertility Regulation, and Consumers and Communication Review Group's registers of trials.
- *The Cochrane Library*: Cochrane Database of Systematic Reviews, Cochrane Central Register of Controlled Trials (CENTRAL), DARE (Database of Abstracts of Reviews of Effects), NHSEED (NHS Economic Evaluation Database), Health Technology Assessment Database.

- Medical electronic bibliographic databases: MEDLINE (using an Ovid platform), EMBASE (Excerpta Medica Database), CINAHL (Cumulative Index to Nursing & Allied Health Literature), and British Nursing Index, (using a Dialog Datastar platform).

- Social Science databases: Sociological abstracts, Web of science (science and social science citation index), HMIC (Health Management and Policy Database), PsycINFO, Communication Abstracts, Applied Social Sciences Index and Abstracts.

- Education databases: ERIC (Educational Resources Information Centre), Campbell Collaboration databases (C2-SPECTR; C2-PROT; C2-RIPE), British Education Index.

- Public health databases: Bibliomap, DoPHER (Database of promoting health effectiveness reviews), TRoPHI (Trials Register of Promoting Health Interventions), Centers for Disease Control and Prevention (CDC) HIV/AIDS Prevention Research Synthesis Project Compendium of Evidence Based Interventions.

- Other databases: AIDSLINE (National Library of Medicine), HIV/AIDS Prevention Research Synthesis Project Compendium of Evidence-based Interventions and POPLINE (POPulation information onLINE).

Grey (unpublished) literature

- Australasian Digital Theses Program.
- Networked Digital Library of Theses and Dissertations.
- ProQuest Digital Dissertations and Theses.
- Index to Theses (Great Britain and Ireland).
- Dissertation Abstracts (North American) via British Library.

Ongoing and recently completed clinical trials

- National Research Register, International Register of Controlled Trials.
- National Institute of Health clinical trials database.
- ReFer (Research Findings register, DOH).
- African Trials Register.

Data collection and analysis

Selection of studies

JB downloaded all citations identified by the search into Reference Manager software. Two review authors (JB and GR) then independently screened titles for relevance (and abstracts where available), using the criteria discussed above (i.e. RCTs of ICBI which aim to promote sexual health). We categorised citations into three groups:

1. possibly relevant studies,
2. background literature, and

3. excluded (clearly irrelevant) studies. The full text of any candidate studies (1, possibly relevant) was obtained, using a low threshold for inclusion if there was any doubt. JB and GR then independently screened these candidate studies to determine eligibility. Disagreements were resolved by discussion, or by seeking a third opinion (EM) (see '[Potential biases in the review process](#)'). Where studies described the development or evaluation of an ICBI for sexual health promotion, JB contacted authors to find out whether an RCT evaluation had also been conducted.

Data extraction and management

We used a data extraction form based on the data extraction template of the Cochrane Consumers and Communication Review Group, including details of study methods, participants and settings, ethical permissions, informed consent, consumer involvement, funding source for study, theoretical framework, description of interventions and controls, study quality and outcomes (including reported adverse outcomes).

JB and CM independently extracted data from included studies using the data extraction form, entering data into separate Excel charts. Disagreements were resolved through discussion or by seeking a third opinion (EM). We contacted the authors of included studies where necessary, to clarify details of study design (e.g. method of randomisation) and for missing data. JB transferred data from Excel software into Review Manager software, with GR and RM checking the accuracy of data transfer.

Assessment of risk of bias in included studies

We recorded the quality of studies by assessing study validity on the basis of a number of criteria:

Selection bias due to non-random selection of control and intervention groups

We recorded the quality of procedures to assign participants randomly to intervention or control groups, and to conceal allocations until the point of allocation. We rated this A) adequate sequence generation and concealment of allocation, B) unclear or C) inadequate sequence generation and/or concealment. Studies rated (C) were excluded completely from analysis, because of the potential for selection bias inherent in the study design.

Blinding of participants, those who administer the interventions, and researchers

In many trials, it will have been obvious to participants whether they had been allocated to an ICBI or a comparison such as a face-to-face intervention or usual practice. Blinding participants is more possible in online trials of two different designs of computer-based intervention. We recorded the adequacy of procedures to

blind participants where this was actually possible. ICBI by definition were self-administered, but it is not possible to blind those who administer face-to-face interventions. We recorded whether outcome assessors were blinded as to participants' allocation (intervention or comparator).

Attrition bias (differences in drop-out rates)

We recorded overall losses to follow-up, and differences in drop-out rates between control and intervention groups.

We also noted whether outcome data were selectively reported (i.e. whether outcomes were measured but results not presented), and whether authors imputed values for missing data and/or conducted intention-to-treat analyses. We recorded other quality criteria including ethical permission and consent procedures, user involvement in intervention development, baseline imbalances between groups, whether validated outcome scales were used, and the duration of follow-up. We tabulated the quality assessments in the '[Characteristics of included studies](#)' tables. The quality of randomisation procedure and allocation concealment was judged (A, B or C) and used as a study inclusion criterion; other quality factors were considered in interpretation and discussion of the results, but were not given ratings.

We assessed differences between studies in terms of populations, settings and interventions, differences in the way that studies were conducted, and differences in types of outcomes, which helped to inform decisions as to whether formal meta-analysis was possible and appropriate. These decisions were made at project steering group meetings.

Data synthesis

Selection of outcomes for meta-analysis

Where multiple outcomes were reported in one study, we selected one outcome only from the following conceptual groups (knowledge, self-efficacy, intention, sexual behaviour, and biological outcomes), so that individual studies made fair contributions to separate meta-analyses. For example, Downs et al. measured three behavioural outcomes: abstinence, condom use with every partner, and condom failures: we chose only one of these (condom use with every partner) to include in a synthesis of behavioural outcomes. Where there were multiple outcomes to choose between, we used criteria which were decided in advance at a steering group meeting:

- Authors' primary outcomes where stated.
- Outcomes reflecting the main aim of the intervention.
- Sexual health outcomes in preference to other domains of outcome.
- Condom-related outcomes (e.g. self-efficacy, intention, behaviours).
- Laboratory measured biological outcomes.

- Data from the longest measured follow-up period.

We chose authors' primary outcomes and outcomes reflecting the main aim of interventions to allow us to see whether interventions had an effect on the dimensions that authors had chosen as the most salient. Authors' primary outcomes took precedence over other criteria. We chose specific sexual health outcomes in preference to outcomes such as alcohol use or mental health: whilst other domains are intimately bound up with sexual well-being, these do not feature in our hypothesised model of sexual behaviour change (see [Figure 1](#)). We selected condom-use outcomes in preference to abstinence or partner numbers because a fulfilling sex life with reference to the WHO definition could well involve seeking sex with more/new partners. We chose laboratory measured biological outcomes rather than self-reports since laboratory measures are more reliable. We chose the longest follow-up period available since it is important that any change in outcomes is sustained over time.

Data analysis

We sought numerators and denominators for dichotomous variables (i.e. numbers of events out of possible totals), and means and standard deviations for continuous variables (i.e. averages and their distributions for outcomes measured on a scale). When authors presented only mean values of outcomes with no standard deviation (and authors could not supply missing data), we calculated standard deviations from F statistics where available. We derived standard deviations by calculating the between-group mean square from the means, then deriving the within-group mean square using the F statistic. We took the square root of the within-group mean square to derive an estimated within-group standard deviation ([Armitage 2001](#)).

Where appropriate, we pooled the results of RCTs using a random-effects model which gives an estimate of the average intervention effect. A random effects model is more conservative than a fixed effects model since it allows for statistical heterogeneity rather than assuming that differences between studies are due to chance alone. We used standardised mean differences (SMDs) for continuous outcomes and odds ratios (ORs) for dichotomous outcomes. These measures allow combination of outcomes which may have been measured using different scales, giving averages or ratios which are adjusted by trial size. We comment on the size of SMDs using Cohen's rules of thumb, judging 0.2 to be 'small', 0.4 to be 'moderate', and 0.8 a 'large' effect ([Cohen 1988](#)).

If studies had not accounted for the effects of clustering in their trial design, we planned to adjust sample sizes by a design effect ([Ukoununne 1999](#)). We did not find papers which cited intra-class coefficients (ICCs) for studies of online sexual health interventions, so we planned to derive the design effect from ICCs given in cluster randomised studies of face-to-face sexual health interventions. Two trials had not accounted for their cluster randomised design, but suitable data for statistical adjustment were

not available: number of clusters and the size of clusters is not known for [Di Noia 2004](#); and standard deviations could not be calculated for [Kann 1987](#). In [Roberto 2007](#), two schools were randomly allocated to either intervention or comparator by coin toss: since there were only 2 clusters (2 schools), it is not possible to adjust for clustering effects. In addition, intervention effects are confounded with school: in other words it is not possible to separate out the effects of the intervention from coincidental effects of being in one school or the other. We therefore decided to omit [Roberto 2007](#) from meta-analyses, but report the results of this study separately.

We analysed and present separately the results for studies that compare ICBI to minimal intervention (group 1), those that compare intervention to non-computerised, face-to-face sexual health education (group 2), and those that compare two or more different designs of computer-based sexual health intervention (group 3). Separate meta-analyses were also conducted for type of outcome (cognitive, behavioural, biological), selecting outcomes to combine using concepts derived from a theoretical pathway for sexual behaviour change (see [Figure 1](#)), (sexual health knowledge, self-efficacy, intention/motivation, sexual behaviour, and biological outcomes).

We assessed heterogeneity using the I^2 statistic (to check whether combining different trials is valid) ([Higgins 2003](#)), and if the I^2 statistic was large, we used the calculated Tau^2 statistic which represents the between-study variance in effect size. A 95% range of possible effect sizes was calculated from $2 \times \text{Tau}$ below the random-effects pooled estimate, to $2 \times \text{Tau}$ above it (to estimate how widely distributed the study results were) ([Higgins 2009](#)). We present and discuss our findings by type of outcome, in other words cognitive, behavioural and biological, and then discuss any sources of heterogeneity in the findings.

It was not possible to report data on unintended adverse outcomes attributable to the intervention(s) because there were no adverse outcomes reported by study authors. We did not find any economic evaluations of RCTs, so we are unable to comment on the economic effects of interactive computer-based interventions.

Consumer participation

'Consumers' for interactive computerised interventions include members of the general population who access the Internet seeking sexual health information, website designers, and also parents, teachers, clinicians or policy makers who may wish to recommend suitable websites to others. Members of the consumer advisory group comprised two sexual health website users, one website designer, one sexual health clinician, one teacher who is also a parent of teenagers, and one person who is a sexual health policy-advisor. Consultation with the consumer advisory group has helped to refine the aims of the systematic review, to interpret results, and to consider the implications of findings.

RESULTS

Description of studies

The search generated 11,363 citations. From these, we identified 143 citations for possible inclusion. Five further citations were obtained from reference lists, two from a personal contact, four following contact with authors, and two from online searching for specific authors' work using Google and Google Scholar. We assessed this final set of 156 citations, excluding 139 because they were not RCTs and/or did not meet our definitions of ICBI or sexual health promotion. Fifteen studies described in 17 papers therefore met our criteria for inclusion. Fourteen other studies appeared to meet our criteria. However, three were later excluded because they were not RCTs (Paperny 1989; Reis 1992; Roberto 2007a). Correspondence with authors established that Lightfoot 2007 was an RCT, but it was not clear whether the intervention met our definition of ICBI. Four studies met the definition for ICBI, but were administered by teachers or health workers (Noell 1997; Pacifici 2001; Tian 2007; Yom 2005). Four studies did not meet our definition of ICBI: one intervention provided information with a multiple choice test but included no decision support, behaviour change, or emotional support (Marsch 2004); one intervention provided web-based learning materials to facilitate group learning, but did not feature individual tailoring or feedback (Lockyer 1999); one intervention was a computer-generated booklet which is not an ICBI since users did not interact directly with the programme, and the delivery route was by post (Scholes 2003); and one intervention provided professional counselling by email as well as web-based information and a discussion forum, and the effects of ICBI alone could not be ascertained (Lou 2006) (see 'Characteristics of excluded studies' table). One study met the criteria for inclusion, but separate data on the effect of the ICBI were not available (Ochs 1994). We also located a trial of ICBI which could not be included because large loss to follow-up meant that there were insufficient data for analysis (Bull 2004).

Results of the search

We therefore included 15 studies described in 17 papers (see 'Characteristics of included studies' table). The total number of participants for which outcome data were available was 3917. One thousand, six hundred and two participants received an ICBI. These were compared in two arm or three arm trials with 1629 who received minimal intervention (e.g. usual practice or waiting list); 426 who received face-to-face sexual health interventions; and 260 who received a different design of computerised sexual health intervention in comparison.

Included studies

Study characteristics

The 15 included studies differed in terms of their settings, target populations, the design of the intervention (e.g. nature of interactivity, theoretical underpinning, involvement of consumers), delivery of the intervention (e.g. format and number of sessions), duration, and timing of follow-up data collection (see 'Characteristics of included studies' table).

All included papers were published in English.

The earliest included study was published in 1987 (Kann 1987), but most studies were dated 2000 or later. Three studies were dissertations that had not been published in peer-reviewed journals (Davidovich 2006; Mikolajczak 2008; Van Laar 2000).

Settings and participants

Three studies were conducted entirely online: two with Dutch speaking participants (Davidovich 2006; Mikolajczak 2008) and one with English-speaking American participants (Bowen 2007). The remaining twelve studies relied on some face-to-face contact with researchers. All of these were conducted in the USA.

The target populations varied, with six studies focusing on adolescents (Alemi 1989; Di Noia 2004; Downs 2004; Kann 1987; Roberto 2007; Van Laar 2000), four focusing on adult men who have sex with men (Bowen 2007; Davidovich 2006; Mikolajczak 2008; Read 2006), three studies focusing on college or university students (Avina 2006; Evans 2000; Kiene 2006), one on male soldiers (Jenkins 2000) and one on 'adults at risk of HIV', including MSM and intravenous drug users (Perry 1991).

Participants were recruited into studies through a variety of routes: three studies through schools (Kann 1987; Roberto 2007; Van Laar 2000), three through colleges or universities (Avina 2006; Evans 2000; Kiene 2006), two through social services programmes (Alemi 1989; Di Noia 2004), four through medical centres (Downs 2004; Jenkins 2000; Perry 1991; Read 2006) and three studies recruited participants online (Bowen 2007; Davidovich 2006; Mikolajczak 2008). Seven studies gave details both about ethical committee permission, and procedures for obtaining informed consent: (Bowen 2007; Davidovich 2006; Downs 2004; Evans 2000; Kiene 2006; Read 2006; Van Laar 2000).

The studies varied in size from 26 participants (Van Laar 2000) to 1704 (Mikolajczak 2008). Two of the studies which enrolled over 1000 participants had recruited participants online (Davidovich 2006; Mikolajczak 2008), but these studies also had much lower retention rates (31 to 42% retention at follow-up) than studies recruiting face-to-face (see 'Characteristics of included studies' table). Bowen 2007 also recruited online, with a retention rate of 79% of their 90 participants.

Aims and design of interventions

All interventions were computer-based, and were delivered either on individual computers, or via the Internet. Eight interventions

focused on HIV prevention (Bowen 2007; Davidovich 2006; Di Noia 2004; Evans 2000; Kiene 2006; Mikolajczak 2008; Perry 1991; Read 2006), three on sexually transmitted infection including HIV (Downs 2004; Jenkins 2000; Roberto 2007), two on preventing unwanted pregnancy (Alemi 1989; Van Laar 2000), one on 'responsible sexual behaviour' (Kann 1987) and one on preventing sexual assault and enhancing positive dating experiences (Avina 2006).

Intervention designs drew on a large variety of theoretical models (see 'Characteristics of included studies' table). These included Social Cognitive Theory (Bowen 2007; Evans 2000; Mikolajczak 2008); the Information, Motivation, Behavioural Skills model (Davidovich 2006; Kiene 2006); practice in decision-making (Alemi 1989); four-step model of assertive decision-making (Di Noia 2004); trans-theoretical model (stages of change) (Kiene 2006), information processing model of social competence (Avina 2006); extended parallel process model (Roberto 2007); and cognitive re-structuring of beliefs (Van Laar 2000). Several studies drew on a combination of theories (e.g. Downs 2004; Kann 1987; Kiene 2006; Mikolajczak 2008).

Studies involved stakeholders in intervention development in different ways. Several studies drew upon expert opinion (Avina 2006; Downs 2004; Evans 2000; Mikolajczak 2008) and/or involved community organisations in programme development (Alemi 1989; Davidovich 2006; Read 2006). Several studies involved consumers in the development or pre-trial evaluation of interventions, using a variety of different methods: focus groups (Avina 2006; Bowen 2007; Downs 2004; Mikolajczak 2008; Read 2006; Roberto 2007), surveys (Mikolajczak 2008; Roberto 2007), an 'Internet-based assessment' (Bowen 2007) and pilot testing (Davidovich 2006; Evans 2000).

Programmes produced material that was personally relevant to users of the programme in a variety of ways: the most common format was feedback on knowledge tests which was tailored according to the answers given (Perry 1991; Di Noia 2004; Jenkins 2000; Kiene 2006; Mikolajczak 2008; Roberto 2007; Van Laar 2000); feedback on personality traits (Roberto 2007); tailoring according to baseline knowledge, motivation and behavioural skills (Davidovich 2006; Kiene 2006); scenarios tailored according to participants' previous experiences (Van Laar 2000); selecting a personal goal with feedback on achievement (Kiene 2006); providing feedback following virtual decisions (Avina 2006; Read 2006); rehearsal of communication skills and decisions (Downs 2004; Kann 1987); appraising 'dysfunctional thoughts' (Perry 1991); and a virtual baby following a decision to have unprotected sex (Alemi 1989). Some programmes provided the stimulus for 'real world' activities, including discussing with others to obtain answers to knowledge tests (Alemi 1989); practising putting a condom onto a penis model, and practising communication and negotiation skills (Kiene 2006).

Programmes made imaginative use of multimedia capability, for example, games to test knowledge (Di Noia 2004); stories, scenar-

ios and simulations (Avina 2006; Bowen 2007; Davidovich 2006; Di Noia 2004; Evans 2000); virtual characters with choices to make (Alemi 1989; Downs 2004); interactive virtual dates (Read 2006; Roberto 2007); conversations with the computer or virtual characters (Alemi 1989; Evans 2000; Kann 1987; Kiene 2006; Mikolajczak 2008); and animations, music and cartoons (Van Laar 2000).

Delivery of interventions

All interventions were accessed by users without mediation from others (such as teachers or health professionals). Most interventions were delivered to individuals, but one was delivered to small groups (Alemi 1989). The duration of access and intensity of use of an intervention is likely to have an impact on its effect: several studies involved one single session of interaction with the intervention (Alemi 1989; Di Noia 2004; Evans 2000; Jenkins 2000), with most involving multiple sessions or access to interventions over a period of time (Avina 2006; Bowen 2007; Perry 1991; Downs 2004; Kann 1987; Kiene 2006; Mikolajczak 2008; Read 2006; Roberto 2007; Van Laar 2000) (see 'Characteristics of included studies' table).

Timing of follow-up

Studies varied in the timing of their follow up: 2 weeks or less post-intervention (Alemi 1989; Bowen 2007; Di Noia 2004; Evans 2000; Van Laar 2000), 3 weeks to 5 months post-intervention (Avina 2006; Perry 1991; Jenkins 2000; Kann 1987; Kiene 2006; Mikolajczak 2008; Read 2006; Roberto 2007), and 6 months (Davidovich 2006; Downs 2004).

Comparators

Group 1:

This group of studies or study arms compared ICBI with minimal intervention. We defined minimal intervention to be non interactive, or non sexual health comparators, for example usual practice, waiting list, leaflet or book, or ICBI on non-sexual health topics.

Four studies used 'no intervention' (Davidovich 2006; Evans 2000; Kann 1987; Roberto 2007); Three studies used waiting list control groups (Avina 2006; Bowen 2007; Di Noia 2004); Three compared ICBI plus 'standard clinical care' (such as routine HIV counselling) with standard care only (Jenkins 2000; Perry 1991; Read 2006). In two studies the comparator was a 'placebo': (a nutrition tutorial in Kiene 2006 and an ICBI about career planning in Van Laar 2000). One study compared ICBI to leaflets or a book with the same content (Downs 2004).

Group 2:

This group of studies or study arms compared ICBI with non-computerised, face-to-face sexual health education such as lectures, group learning and face to face counselling.

Three studies used a lecture/teaching with the same sexual health content (Alemi 1989; Evans 2000; Kann 1987), and two used face-to-face counselling (Jenkins 2000; Perry 1991)

Group 3:

This group of studies or study arms compared two different designs of computerised sexual health intervention.

Tailoring: One study compared an ICBI with a non-tailored computer-based intervention for sexual health promotion (Davidovich 2006).

Risk-framed messages: One study compared an ICBI which did not use risk-based messages with a computer-based intervention which did (Mikolajczak 2008).

One other study compared an ICBI with a computerised risk profile with feedback messages combined with face-to-face problem-based counselling, but this study arm did not meet the inclusion criteria for groups 1, 2 or 3 (Jenkins 2000, see [Characteristics of included studies](#) table, comparator 1).

Outcomes

All outcomes were tabulated using categories derived from the theoretical pathway for sexual behaviour change (see [Figure 1](#) and [Table 1](#), [Table 2](#), and [Table 3](#)).

Cognitive outcomes

a) Sexual Health Knowledge

Knowledge about STI, HIV, reproductive health and/or condom use was measured in ten studies (Alemi 1989; Bowen 2007; Di Noia 2004; Downs 2004; Evans 2000; Jenkins 2000; Kann 1987; Kiene 2006; Perry 1991; Roberto 2007). Authors used a wide variety of scales which were either adapted from existing measures or developed specifically.

b) Self-efficacy

Self-efficacy (a person's belief in their capacity to carry out a specific action) was measured in nine studies. Studies all used different instruments to measure self-efficacy, focusing on sexual behaviours (e.g. safer sex/condom use (Evans 2000; Kiene 2006; Read 2006; Roberto 2007; Van Laar 2000), 'HIV risk reduction'

(Di Noia 2004), safe sex assertiveness (Bowen 2007) and self-efficacy towards taking an annual sexual health check-up (Mikolajczak 2008)). One additional study reported perceived behavioural control for several safer sex behaviours (the perceived ease with which a skill can be practised), which we judged to be conceptually similar to self-efficacy (Davidovich 2006).

c) Intention

Behavioural intention was reported in six studies. Authors asked about intention towards the following behaviours: taking an annual sexual health check-up (Mikolajczak 2008); HIV-related behaviours (Read 2006); condom use for anal sex (Davidovich 2006), negotiated safety (steady partners testing for HIV and agreeing to be monogamous or to have safe sex outside the relationship) (Davidovich 2006); condom use with current or future partners (Evans 2000; Kiene 2006); and preparatory behaviours such as carrying condoms (Kiene 2006). One study reported readiness to change with respect to condom use, and selection of 'high risk' partners (Jenkins 2000). Another study reported various dimensions of motivation (physical outcomes, social outcomes, and self-evaluative outcome motivation towards practising HIV preventative behaviours), but these concepts were not defined (Evans 2000).

d) Attitudes

Attitudes were measured in twelve studies. Attitude measures ask participants to assess dimensions such as values and beliefs. Study authors asked about: attitudes towards sex ('conservative' or 'liberal') (Alemi 1989); comfort with interpersonal communication and assertiveness (Kann 1987); belief in the benefits of negotiated safety (Davidovich 2006); attitudes towards condoms (Bowen 2007; Van Laar 2000); peer approval (Jenkins 2000); family and friends' beliefs about condom use (Kiene 2006); attitudes towards getting an annual sexual health check-up (Mikolajczak 2008); locus of control (Alemi 1989); attitude towards waiting until marriage before having sex (Roberto 2007); and perceived susceptibility to pregnancy, STI or HIV (Jenkins 2000; Roberto 2007).

Affective outcomes

Depression and anxiety were reported as outcomes in one study, using standard scales (Perry 1991).

Behavioural outcomes

A variety of different behavioural outcomes were reported in 10 of the 15 studies, including several different measures of condom use: keeping condoms handy in the last 30 days (Kiene 2006); carrying condoms (Jenkins 2000); condom use in the last 30 days

(Kiene 2006) and 3 months (Downs 2004); frequency of persuading partners to use condoms (Kiene 2006); condom failures in last 3 months (Downs 2004); condom use for anal sex (Read 2006; Davidovich 2006); and condom use at last (heterosexual) intercourse (Roberto 2007). Number of sexual partners was also measured in different ways: number of partners in the last 4 months (Roberto 2007); and one or more new 'high-risk' partners in 2 weeks (Jenkins 2000). Also measured were: initiating sexual activity (sexual debut) (Roberto 2007); sexual bingeing (Jenkins 2000); new partners in high risk venues (Jenkins 2000); having partners with genital warts or sores (Jenkins 2000); abstinence in the last 3 months (Downs 2004); negotiated safety (defined above) (Davidovich 2006); going out for the purpose of meeting new sex partners (Jenkins 2000); HIV testing in the last 3 months (Mikolajczak 2008); adherence to medication for urethritis (Jenkins 2000); alcohol use (Avina 2006; Jenkins 2000); sharing needles (Jenkins 2000); sexual victimisation (unwanted or unwelcome sexual activity) (Avina 2006); communication skills (decision-making, assertiveness and interpersonal communication behaviour) (Kann 1987) and individuals' perception of their communication of sexual intentions in dating situations and participation in undesired sexual activity (Avina 2006).

Biological outcomes

One study measured self-reported chlamydia diagnosis as well as chlamydia DNA by Polymerase Chain Reaction on self-administered vaginal swabs (Downs 2004). One study reported HIV antibody serology (Perry 1991), and another measured self-reported HIV status (Davidovich 2006).

Economic outcomes

No studies reported economic outcomes.

Adverse effects

No studies measured potential harms (apart from reporting any deterioration in measured outcomes).

Combining outcomes

Table 1, Table 2, and Table 3 provide summaries of studies and show which outcomes were measured. We have indicated which outcomes we selected for meta-analysis in bold typeface in the tables. The sexual health outcomes of included studies are diverse because sexual health interventions are tailored for different populations, and outcomes reflect the aims of interventions (for example, reduction in unprotected anal sex in MSM, reduction in pregnancy in adolescent girls). We justify the meta-analysis of diverse outcomes since we are addressing the question of whether ICBI change the behaviour they are designed to change. To draw on a metaphor, we are comparing apples and pears in order to draw

conclusions about the properties of fruit: combining outcomes such as pregnancy in adolescent girls and unprotected anal sex in MSM allows us to comment on the effect of targeted, tailored, culturally appropriate sexual health promotion interventions on sexual behaviour.

Combining cognitive outcomes

Decisions to combine knowledge, self-efficacy and intention outcomes from different studies were generally straightforward. Locus of control (Alemi 1989) was felt to be a different concept to self-efficacy, so was excluded from analysis.

We decided not to combine any attitudinal outcomes in meta-analyses. Social and cultural phenomena such as values and beliefs are hugely important in shaping the context in which sexual behaviour occurs. However, attitudinal variables such as attitude to condoms, peer approval, and comfort with interpersonal communication are not easily measured since their meanings are complex, and this complexity is lost in the reduction to a numerical assessment (Potter 2001). It is also not necessarily obvious whether an increase or a decrease in a particular attitude is desirable. For example, it is not clear whether a 'conservative' or 'liberal' attitude towards sex (Alemi 1989) or waiting until marriage before having sex (Roberto 2007) is desirable in terms of a holistic definition of sexual health (WHO 2002). We therefore report studies' attitudinal outcomes in the tables, but did not combine attitudinal outcomes in meta-analyses.

Combining affective outcomes

We did not include depression and anxiety (Perry 1991) in a meta-analysis since these do not feature in our hypothesised model of sexual behaviour change.

Combining behavioural outcomes

The selection of behavioural outcomes for meta-analysis required considerable debate, since studies often reported a number of different behavioural outcomes without clarifying which were primary outcomes. One study measured decision-making behaviour, assertiveness behaviour and interpersonal communication behaviour (Kann 1987); these outcomes fit with a holistic definition of sexual health, but were excluded because they were not clearly defined conceptually (i.e. it was not clear what was being measured). Avina 2006 et al. measured risky sexual communication (Individuals' perception of their communication of sexual intentions in dating situations and participation in undesired sexual activity). We chose sexual victimisation over this outcome since it reflects the main aim of the intervention.

Combining biological outcomes

Few studies measured biological outcomes, but decisions to combine objectively measured biological outcomes were straightforward.

See [Table 1](#), [Table 2](#), and [Table 3](#).

Risk of bias in included studies

Differences in the way that studies were conducted

All included studies stated that participants had been randomly allocated, with only five studies clearly reporting adequate sequence generation and concealment of allocation ('A') ([Avina 2006](#); [Bowen 2007](#); [Davidovich 2006](#); [Downs 2004](#); [Mikolajczak 2008](#)) (see 'Characteristics of included studies' table). The remainder gave insufficient detail to judge whether there were adequate sequence generation and/or concealment of allocation, so were rated 'B'. We excluded studies rated 'C' ([Paperny 1989](#); [Reis 1992](#); [Roberto 2007a](#)).

Blinding of participants as to whether they were in intervention or control groups is usually not possible for trials of a computer-based intervention with a very different comparator (e.g. usual practice, face-to-face intervention). Blinding is more possible where two computerised interventions are being compared, for example ([Davidovich 2006](#); [Mikolajczak 2008](#) or [Van Laar 2000](#)). Information about procedures for blinding outcome assessors was not available from included papers.

Three studies were cluster randomised and did not account for this in their statistical analyses ([Di Noia 2004](#); [Kann 1987](#); [Roberto 2007](#)), but statistical adjustment was not possible (see 'Data collection and analysis').

Despite random allocation of subjects, several studies reported baseline differences between intervention and comparator groups on demographic variables ([Di Noia 2004](#); [Jenkins 2000](#); [Read 2006](#)) and/or baseline measurements of outcome variables ([Downs 2004](#); [Jenkins 2000](#); [Roberto 2007](#)). Some studies adjusted for these differences before analysis ([Di Noia 2004](#); [Read 2006](#)). We planned to use only unadjusted outcome measures, since when studies are combined this should even out baseline differences if participants have been adequately randomised. However, unadjusted data were not available for these studies.

Retention at follow-up in trials with face-to-face recruitment varied from 49% in [Jenkins 2000](#) to 95% in [Kiene 2006](#) (see 'Characteristics of included studies'). There was poor retention in two of the online trials (31 to 42% at 6 months in [Davidovich 2006](#) and 31% at 3 months in [Mikolajczak 2008](#)), but 79% in [Bowen 2007](#). Several studies reported drop-out rates which differed by more than 10% between intervention and comparator groups ([Davidovich 2006](#); [Mikolajczak 2008](#); [Perry 1991](#); [Van Laar 2000](#)), with data unavailable to assess for [Di Noia 2004](#), [Jenkins 2000](#); and [Kann 1987](#).

Four studies allowed for missing data by including the last observation available ([Avina 2006](#); [Bowen 2007](#); [Kiene 2006](#); [Mikolajczak 2008](#)), which may produce bias in either direction.

Selective reporting is an important quality criterion, since if only the more statistically significant outcomes are presented, this will augment the apparent effect of an intervention. Outcomes had been selectively reported in one study ([Jenkins 2000](#)), with raw data not available for many of the non-significant outcomes. In [Read 2006](#) it was unclear exactly which outcome variables had been measured before combination into composite measures of protected and unprotected anal sex.

Effects of interventions

Comparison 1: Are ICBI effective?

We combined outcomes from group 1 studies to address this question of whether ICBI are effective, taking studies which compared ICBI with minimal interventions (e.g. usual practice, or leaflet).

Sexual health knowledge

Do ICBI improve sexual health knowledge?

Standard deviations were calculated from F statistics for [Di Noia 2004](#) and [Evans 2000](#), allowing us to combine data from six studies which reported sexual health knowledge outcomes (see [Analysis 1.1](#)). Meta-analysis shows a statistically significant positive effect on sexual health knowledge, with a standardised mean difference (SMD) of 0.72 (95% CI 0.27 to 1.18). This is a moderate effect size using Cohen's criteria ([Cohen 1988](#)), and shows that ICBI do improve sexual health knowledge.

We were not able to adjust for clustering effects in [Di Noia 2004](#) (see 'Data collection and analysis'): it is likely that adjustment would have widened the SMD confidence intervals. The I^2 statistic (91%) shows substantial statistical heterogeneity between these studies: the 95% range of study effect sizes was -0.36 to 1.80, suggesting that the SMD in the most favourable scenario could be as great as 1.80, but could also be as small as -0.36 in the least favourable scenario (meaning that ICBI could have less effect on sexual health knowledge than minimal intervention).

One additional study showed no statistically significant differences in HIV knowledge ([Jenkins 2000](#)), and another showed statistically significant improvement in knowledge, but data suitable for analysis were not available ([Kann 1987](#)). The study by [Roberto 2007](#) was not included in meta-analysis because it was a two-school trial. Their results are consistent with the finding that ICBI have a positive effect on sexual health knowledge (SMD 0.49, 95% CI 0.27 to 0.71), but this may not be a causal association (see 'Data collection and analysis').

Self-efficacy

Do ICBI improve self-efficacy with respect to sexual health?

We combined data from six studies which reported data on self-efficacy (see [Analysis 1.2](#)), with standard deviations calculated from F statistics for [Di Noia 2004](#) and [Evans 2000](#). Only one of these studies showed a statistically significant effect on self-efficacy ([Bowen 2007](#)), but combining outcomes from studies gave a standardised mean difference of 0.17 (95% CI 0.05 to 0.29). This is a small effect size using Cohen's criteria ([Cohen 1988](#)), showing that ICBI have a small effect on self-efficacy.

We were not able to adjust for clustering effects in [Di Noia 2004](#) (see 'Data collection and analysis'): it is likely that adjustment would have widened the confidence intervals. The I^2 statistic was 3%, suggesting that there was little statistical inconsistency. One study had very large confidence intervals, attributable to its small sample size ($n = 26$) ([Van Laar 2000](#)).

One additional study reported no difference between intervention and control for self-efficacy, with data unavailable from authors ([Read 2006](#)). The study by [Roberto 2007](#) was not included in meta-analysis because it was a two-school trial (see 'Data collection and analysis'). The results from this study showed no effect on self-efficacy (SMD 0.08, 95% CI -0.14 to 0.29).

Intention

Do ICBI increase safer-sex intentions?

We combined data from three studies which measured intention on continuous measurement scales (see [Analysis 1.3](#)). None of these individual studies showed statistically significant difference between intervention and control for safer-sex intentions, but the SMD became significant on combining outcomes in a meta-analysis (SMD 0.16, 95% CI 0.02 to 0.30), which is a small effect size. The I^2 statistic was 0%, suggesting that there was little statistical inconsistency.

One additional study reported no statistically significant difference between intervention and control for intention, with raw data unavailable from authors ([Read 2006](#)). Another study reported condom use readiness to change ([Jenkins 2000](#)): the control group (usual practice) showed more improvement at two weeks than the intervention group (interactive video disc) ($\text{Chi}^2 7.28, P = 0.03$). This outcome was also measured at two months, but data were not available from authors, so this outcome was not included in meta-analysis.

Sexual behaviour

Do ICBI have an effect on sexual behaviours targeted by the ICBI?

We combined data from three studies which measured sexual behaviour as dichotomous outcomes (numbers of events) (see [Analysis 1.4](#)). The outcomes combined were sexual victimisation ([Avina 2006](#)), negotiated safety or condom use ([Davidovich 2006](#)), and condom use in the last 3 months 'every time with every partner' ([Downs 2004](#)). We calculated the number of participants who did *not* experience sexual victimisation for [Avina 2006](#) since this represents a desirable outcome. None of these individual studies showed statistically significant difference between intervention and control for sexual behaviours, and the odds ratio remained non-significant after meta-analysis (OR 1.54, 95% CI 1.00 to 2.38). The I^2 statistic was 0%, suggesting that there was little statistical inconsistency.

Data were unavailable for [Jenkins 2000](#) (condom use with risky partners). [Roberto 2007](#) was not included in meta-analysis because it was a two-school trial (see 'Data collection and analysis'). The results from this study showed no difference between intervention and control for condom use at last intercourse (for the sexually active subgroup): OR 1.38 (95% CI 0.59 to 3.24).

Two studies measured sexual behaviour on continuous measurement scales: condom use in the last 30 days ([Kiene 2006](#)); and protected anal sex ([Read 2006](#)). However, standard deviations were unavailable for [Read 2006](#), and it was not possible to calculate these from F statistics. Data from [Kiene 2006](#) shows an SMD of 0.61 (95% CI 0.11 to 1.11), showing a moderate effect on condom use in the last 30 days, but with wide confidence intervals, which decreases the certainty of the result ([Analysis 1.5](#)).

We converted the SMD from the study by [Kiene 2006](#) into an odds ratio ([Chinn 2000](#)) so that this study could be combined with the other studies reporting sexual behaviour outcomes (those in [Analysis 1.4](#)). This resulted in a combined odds ratio for the four studies of 1.75 (95% CI 1.18 to 2.59), ([Analysis 1.6](#)) which is a statistically significant effect on sexual behaviour. The I^2 statistic was 0%, suggesting that there was little statistical inconsistency.

Biological outcomes

Do ICBI affect biological outcomes?

Two studies measured biological outcomes: HIV antibody serology ([Perry 1991](#)), and vaginal chlamydia DNA ([Downs 2004](#)). [Davidovich 2006](#) measured self-reported HIV status, but did not use this as an outcome variable. There were no new diagnoses of HIV in the [Perry 1991](#) study, so this study could not contribute to the meta-analysis ([Analysis 1.7](#)). The incidence of vaginal chlamydial DNA was relatively low in [Downs 2004](#) (7%), and the sample size was not large, so the resulting confidence interval for the intervention effect was wide, meaning that it is not possible to be certain of the effect. There were therefore insufficient data to draw conclusions about the effect of ICBI on biological outcomes.

Summary (ICBI versus minimal intervention)

In summary, meta-analysis shows that interactive computer-based interventions have statistically significant effects as follows: a moderate effect on sexual health knowledge (Analysis 1.1); a small effect on self-efficacy (Analysis 1.2); a small effect on safer-sex intentions (Analysis 1.3); and also an effect on sexual behaviour (Analysis 1.6). There were insufficient data to draw conclusions about biological outcomes (Analysis 1.7).

Estimates of practical impact

The results above (using standardised mean differences) give an idea of the strength of evidence, but SMDs do not indicate what this might mean in practice. We therefore took the largest studies with available baseline data to work out estimates of practical significance. For knowledge, an SMD of 0.72 (Analysis 1.1) translates into an increase in score from 6.75 to 8.50 on a 12-item true/false HIV knowledge test (Roberto 2007) (obtained by multiplying the baseline standard deviation for knowledge in Roberto 2007 by the combined effect size for knowledge derived from meta-analysis (0.72)).

Considering self-efficacy (Analysis 1.2), Roberto 2007 et al. measured adolescents' confidence in using a condom correctly on a five-point Likert scale. An SMD of 0.17 translates into an increase in score from 4.10 at baseline to 4.18, which is a small gain in confidence.

For safer sex intention (Analysis 1.3), Kiene 2006 et al. measured students' likelihood of using condoms and engaging in preparatory condom use behaviours on a five-point Likert scale from 'very unlikely' to 'very likely'. An SMD of 0.16 translates into an increase in score from 3.77 to 3.96 out of 5.

These estimates of practical significance need to be treated with great caution: there are no widely used, validated scales for knowledge, self-efficacy or intention, so we do not have reliable estimates of baseline means and standard deviations for particular populations. Despite this, there seems to be a useful gain in knowledge (15%), but barely any gains in self-efficacy or intention. In these studies, participants' baseline confidence and intentions were high, so there was not much room for improvement.

Comparison 2: Are ICBI as effective as face-to-face sexual health interventions?

We combined outcomes from group 2 studies to address the question of whether ICBI are as effective as face-to-face interventions, taking studies which compared ICBI with non-computerised, face-to-face sexual health education. These trials are equivalence trials, in that it is a positive finding if there is no difference in effectiveness between ICBI and face-to-face interventions.

Sexual health knowledge

We combined data from the two studies with available data on sexual health knowledge: the first study compared ICBI with stress training (Perry 1991), and the second compared ICBI with lectures (Evans 2000) (see Analysis 2.1). Meta-analysis shows an SMD of 0.36 (95% CI 0.13 to 0.58), which is a small effect size. There were too few studies to estimate heterogeneity using an I^2 statistic. Two further studies reported no statistically significant differences between ICBI and a) a lecture with the same content (Alemi 1989), and b) face-to-face counselling (Jenkins 2000), but data were not available to include in the meta-analysis. Kann 1987 was a three arm trial which compared ICBI to no intervention, and a lecture to no intervention: data on ICBI vs. lecture were not available.

Self-efficacy

Only one study in group 2 reported self-efficacy (Evans 2000). We calculated the standard deviation from an F statistic, with calculations indicating no statistically significant difference between ICBI and a lecture (SMD 0.38, 95% CI -0.01 to 0.77) (Analysis 2.2). However, this was a small study (n = 102 at follow-up), reducing confidence in the result.

Intention

One study reported condom use intention (Evans 2000). We calculated an SMD from an F statistic, with results indicating greater intention after ICBI than after a lecture (SMD 0.46, 95% CI 0.06 to 0.85) (Analysis 2.3). This is a moderate effect size. However, the study was small (n = 102 at follow-up), reducing confidence in the result.

One study reported readiness to change condom use at 2 weeks, showing greater improvement in the face-to-face intervention arm than ICBI (Jenkins 2000). This outcome was also measured at 2 months, but data were not available from authors, so were not included in meta-analysis.

Sexual behaviour

Only one study reported sexual behavioural outcomes which met our criteria for inclusion (Jenkins 2000): the outcome selected was condom use with risky partners, but data for this outcome were not available.

Biological outcomes

Only one study reported a biological outcome (HIV seroconversion) (Perry 1991). The study could not show a difference between ICBI and stress prevention training since there were no new diagnoses.

Summary (ICBI versus face-to-face interventions)

Meta-analysis was only possible for knowledge, and this showed a small advantage for ICBI over face-to-face interventions for two studies combined, with two further studies showing no statistically significant difference between ICBI and face-to-face intervention. There is insufficient evidence to be certain about the effectiveness of ICBI in comparison to face-to-face interventions in terms of self-efficacy, intention, sexual behaviour and biological outcomes.

Comparison 3: How do ICBIs work?

This type of comparison can address questions about how ICBIs work, combining outcomes from studies which control for particular components of a computerised intervention (e.g. tailoring, type of interactivity, theoretical underpinning etc.).

The effect of tailoring:

One study explored the effect of tailoring a computerised sexual health intervention according to individuals' knowledge, motivation and skills (Davidovich 2006). The authors report on comparisons of ICBI with control (no intervention); and non-tailored computer-based intervention with control: we ran analyses to compare the (tailored) ICBI with the non-tailored computer-based intervention. These analyses showed no statistically significant difference between intervention and control for self-efficacy (perceived behavioural control for safe sex agreements outside the relationship) (SMD 0.05, 95% CI -0.12 to 0.22) (Analysis 3.1) or intention to practise negotiated safety measured immediately after the intervention (SMD 0.07, 95% CI -0.10 to 0.24) (Analysis 3.2). However, at six month follow-up the tailored ICBI was more effective than the non-tailored computerised intervention in terms of an increase in negotiated safety with current partners (OR 3.47, 95% CI 1.45 to 8.31) (for the subgroup of men who had a new steady partner at 6 months) (Analysis 3.3).

It is difficult to interpret this apparently contradictory finding (i.e. no effects on self-efficacy or intention, but a positive effect on negotiated safety), since these outcomes were measured at different time points, and negotiated safety was measured only in men who had a new steady partner at 6 months ($n = 89$).

Risk-based messages:

One study tested the hypothesis that positive framing for messages (e.g. emphasising the advantages of HIV testing and peer acceptance) would be more effective than emphasising the risks of HIV, as a strategy to increase the uptake of HIV testing (Mikolajczak 2008). Data from authors showed no difference between intervention and control for self-efficacy (SMD 0.01, 95% CI -0.17 to 0.18) (Analysis 4.1); intention (SMD 0.15, 95% CI -0.02 to 0.32) (Analysis 4.2); or STI/HIV testing at 3 month follow-up (OR 0.79, 95% CI 0.52 to 1.20) (Analysis 4.3).

Summary (ICBI versus other computerised interventions)

We could not combine the two studies in this group since they were testing different hypotheses about ICBI design. There were insufficient data to draw conclusions about the effectiveness of tailored computerised interventions, or risk-based intervention messages.

DISCUSSION

Summary of main results

Are ICBIs effective?

Six studies contributed to the meta-analysis of knowledge, six to analysis of self-efficacy, three to safer sex intention, and four studies to the combined meta-analysis of sexual behaviour. We found that interactive, computer-based interventions have statistically significant effects as follows: a moderate effect on sexual health knowledge (Analysis 1.1); a small effect on self-efficacy (Analysis 1.2); a small effect on safer-sex intentions (Analysis 1.3); and also an effect on sexual behaviour (Analysis 1.6). ICBI therefore show promising effects on the mediators of change in sexual behaviour (knowledge, self-efficacy and intention), and also an effect on safer-sex behaviours. We were unable to draw conclusions about the effects of ICBI on biological outcomes, since only one study contributed data (Analysis 1.7).

Cost-effectiveness and harms

We are unable to draw conclusions about cost-effectiveness since no studies reported these data. No studies measured potential harms (apart from reporting any deterioration in measured outcomes).

Are ICBIs as effective as face-to-face sexual health interventions?

Meta-analysis was only possible for knowledge, and this showed a small advantage for ICBI over face-to-face interventions for two studies combined (Analysis 2.1), with two further studies showing no statistically significant difference between ICBI and face-to-face intervention. There is insufficient evidence to be certain about the effectiveness of ICBI in comparison to face-to-face interventions in terms of self-efficacy, intention, sexual behaviour and biological outcomes. Larger sample sizes (total 786 participants, 393 per group) are needed to detect a small effect size at 80% power and 5% significance level.

Face-to-face sexual health interventions have had mixed success in changing sexual behaviour: for example, a synthesis of meta-

analyses of face-to-face interventions for HIV prevention showed a median increase of 35% in the odds of condom use, and 32% reduction in the odds of unprotected sex, but non-statistically significant reductions in odds of sexually transmitted infection or partner numbers (Noar 2008). ICBI may actually have some advantages over face-to-face interventions. For example, ICBI may have better capacity to tailor for individuals' preferences and needs (Lustria 2009); access can be repeated and private; and ICBI can easily accommodate differences in pace of learning (Barak 2001). Multi-media features may help to hold participants' attention, and another potential advantage is that images, audio or video content may help to reach those with poor literacy. ICBI also have the advantage of being easy to disseminate and potentially more cost-effective (Barak 2001) than face-to-face interventions.

How do ICBI work?

Sexual health interventions are complex interventions in that they have a number of components that may interact with each other and act at different levels simultaneously (Craig 2008) but it is often difficult to clearly define the components needed for a successful intervention (Speizer 2003). There are many theories which seek to explain why people engage in risky behaviour: the concepts within theoretical models overlap greatly, but models have differing emphases (Noar 2007a). For example, in trying to explain risky behaviour, the Health Belief Model highlights low perceptions of risk; Social Cognitive theory highlights negative attitudes, the influence of social norms, and a lack of confidence in one's abilities and skills; the AIDS risk reduction model includes the individual's readiness to change as a factor; and the Multiple Domain Model also includes sensation-seeking, impulsive decision-making and environmental influences. A clear theoretical underpinning helps to provide a framework for the design of interventions. However, there is little evidence to guide the choice of one theoretical model over another in a sexual health context (Noar 2007a). Two studies in this review explored how ICBI might work, testing different theoretical approaches: Davidovich 2006 explored the effect of tailoring according to individuals' knowledge, motivation and skills, and Mikolajczak 2008 explored different ways of framing health promotion messages.

Tailoring

Tailoring can be defined as "a process for creating individualised communications by gathering and assessing personal data related to a given health outcome in order to determine the most appropriate information or strategies to meet the person's unique needs" (Lustria 2009). A review of computer-tailored health interventions delivered over the web describes many different forms of intervention tailoring, for example by demographic characteristics, health beliefs, risk behaviours, or theoretical concepts such as stage of change (Lustria 2009). There are also many different ways

of customising messages, including personalisation, feedback on responses, and adaptation of programmes according to responses. Whilst it appears that tailoring marginally enhances the effectiveness of printed interventions (Noar 2007), there is less evidence for computer-based interventions (Lustria 2009). In Davidovich 2006, feedback was tailored according to participants' information needs, motivation, and behavioural skills, but there were insufficient data to allow conclusions to be drawn about the effectiveness of this.

Risk-based messages

The Health Belief model suggests that increasing an individual's perception of risk will lead to protective behaviours, and health promotion messages are commonly based on this premise. However, empirical research brings this assumption into question: for example, perceived risk for HIV infection is not associated with increased HIV testing for MSM (Lauby 2006). Mikolajczak 2008 sought to test the effectiveness of risk-based messages in a trial, but there were insufficient data to allow conclusions to be drawn.

Effects over time

The optimum time to assess the effect of an intervention is not known (Noar 2008): for example, participants may forget information over time, but become more skilled in sexual negotiation with practice over time. Only one (small) study measured outcomes repeatedly, showing no change in sexual victimisation between 3 and 12 weeks (Avina 2006). No study measured outcomes after more than six months, and this time period may not be long enough for behaviour change to become routine.

Overall completeness and applicability of evidence

Search end date

This review includes studies which were available up to the end of 2007. This is a rapidly developing field, and the inclusion of more studies in the next update will allow us to carry out more of the proposed analyses, as well as increasing the precision of the results presented.

Losses to follow-up

Losses to follow up were variable (see 'Characteristics of included studies' table). Retention at follow-up was 80% or more in 6 out of the 12 trials using face-to-face recruitment (Alemi 1989; Downs 2004; Evans 2000; Kiene 2006; Read 2006; Roberto 2007). There was poor retention in two of the online trials (31% to 42% at 6 months in Davidovich 2006 and 31% at 3 months in Mikolajczak

2008), but Bowen et al managed 79% in their online trial (Bowen 2007). Poor retention threatens validity since an unrepresentative sample may be assessed at follow-up, leading to attrition bias. Study authors did not give details of how missing data were dealt with (for example, accounting for missing data by assuming that those who dropped out did not benefit from the intervention). Poor retention may lead to the decision not to publish the results of online trials (e.g. Bull 2004).

Selective reporting of outcomes

Selective reporting of outcomes allows for the possibility of reporting bias: adherence to the CONSORT guidelines for the conduct and reporting of RCTs should ensure that there is no suspicion of this (Moher 2001). A recent systematic review of RCTs promoting effective condom use found 90 different outcome measures for STI, pregnancy and condom use in 139 studies (Free 2009). Free et al. suggest that a consensus agreement is needed on outcome measurement, which will reduce opportunities to selectively report positive outcomes and enable easier comparison of trials and synthesis of outcomes. In our review there were eight different measures of condom use reported (see 'Results of the search'). More detailed reporting would also facilitate judging the quality of procedures for participant allocation and for blinding.

Quality and fidelity of interventions

We did not assess the quality of interventions, since it is not known what defines a good quality ICBI. It is important that intervention design and delivery is consistent in good quality trials: researchers have good control over the contents and presentation of computer-based interventions (Murray 2009). On the other hand, the user has control over the use they make of a computer-based intervention, including the frequency and amount of use. Each user can construct their own unique experience of any given intervention. This may make it hard to determine whether an intervention works: it may be that the intervention can work if used in the way planned by the developer, but that most users use it in a way that renders it ineffective, or vice-versa. This highlights the importance of process evaluations to gather users' viewpoints and to assess how interventions are used.

Generalisability

There was a predominance of studies from economically developed countries (especially the USA) in our systematic review. Whilst there are huge inequalities in access to computer/Internet technology (Miniwatts 2009), computer-based interventions may still be useful in resource-poor settings, using a different model for dissemination. For example Tian 2007 et al. distributed computers to health workers in three counties in China, offering access to a sexual health website, computer skills teaching and ongoing logistic support for diffusing information to surrounding villages.

Quality of the evidence

Complexity of sexual health research

Researching sexual behaviour is challenging because sex and sexuality are embedded in a web of often contradictory social significance. Sex is usually conducted in private, and open admission of sexual activity or preference may be difficult because of stigma or taboo (Marston 2006). The personal and medical significance of sex and relationships may be very different: for example, unprotected sex in ongoing relationships between gay men may be a manifestation of trust and love, whereas medically it is conceptualised as 'unprotected anal sex with a high risk partner' (Flowers 1997). Qualitative research gives access to deeper understandings about sexual behaviour (e.g. Marston 2006; Flowers 1997), but does not yield quantifiable estimates of the effect of interventions. Capturing a 'true' picture of sexual beliefs, attitudes and behaviour is challenging with quantitative tools because standardised questionnaires strip away the complexity and context (Potter 2001).

Quality of outcome measures

Knowledge

The acquisition of new knowledge can be reliably tested, and we are confident from meta-analyses (Analysis 1.1; Analysis 2.1) that ICBI improve sexual health knowledge.

Self-efficacy, intention, attitudes, behaviours

These outcomes are important variables in understanding sexual behaviour, but pose a challenge in survey research because they are self-reported and self-assessed. There are concerns that self-reported outcomes are subject to social desirability bias for sexual beliefs and behaviours which carry a stigma or prestige (Fenton 2001). For example, men tend to report more sexual partners than women do (Fenton 2001). Over-reporting might be expected for outcomes which reflect the aims of an intervention (e.g. condom use). However, the small effect sizes we found for self-efficacy and intention suggest that 'desirable' outcomes were not being over-reported, and if the magnitude of social desirability bias is similar between groups, this would not affect the estimate of intervention effect.

Dichotomous measurement of sexual behaviour is perhaps less sensitive to change than continuous measurement: for example, 'condom use every time with every partner' (Downs 2004) may well remain negative, even if condom use has actually increased over time. A continuous scale may be more sensitive to change (for example the five point Likert scale from 'never' to 'always' used in Kiene 2006).

A continuous scale may be potentially more nuanced than 'yes/no' questions, but it may still be difficult to define what exactly the scale is measuring. A typical survey question is the following: "I consider taking a sexual health checkup on a yearly basis to be ('very difficult' to 'very easy')", measured on a seven point Likert scale (Mikolajczak 2008). The answer to this depends upon how the question is interpreted: 'difficult' could mean difficult to physically get to the clinic, difficult to make time, difficult to confront anxiety about examination, reluctance to receive potential bad news and so on. Although the same questions are asked of all respondents in a particular study, they will be interpreted in unique ways by different people (Potter 2001). Self-reported quantitative outcomes should therefore be interpreted with these limitations in mind.

Biological outcomes

Biological outcomes such as genital chlamydia or HIV are objectively measurable and therefore more reliable than self-reported outcomes. However, measuring change in biological outcomes is difficult because these events are relatively rare (in statistical terms). For example, although genital chlamydia is the most common sexually transmitted infection in young people, sample sizes must be very large to detect differences in cumulative incidence. Changes in HIV incidence are even more difficult to detect because acquisition is more rare than for chlamydia (especially during relatively short study follow-up periods). For example, Downs 2004 measured genital chlamydia in healthcare settings, using self-administered vaginal swabs at baseline and at final (6 month) follow up, offering \$10 to \$20 a visit. The study retention rates were good (over 80%), but the study was not large enough to detect an impact on chlamydia rates.

Complex pathways for behaviour change

It is well established that information (knowledge) alone is not necessarily enough to change behaviour (Mellanby 1992; Noar 2007a). There are complex relationships between mediators (e.g. knowledge, attitudes, beliefs) and behaviour (Stephenson 2003): for example, study participants may gain the knowledge, confidence and intention to practise safer sex, but this will not impact on condom use unless a partner is also willing to change behaviour. In addition, condoms are not 100% effective against STI, especially if they are used inconsistently or incorrectly (Noar 2008). The specific mechanisms of behaviour change are likely to be different for different populations: for example, resisting peer pressure may be particularly important for young people (Noar 2007a). Sexual decisions do not usually follow a dispassionate weighing up of pros and cons, but are embedded within cultural norms such as beliefs about commitment, trust and love (Flowers 1997) and gendered power relationships (Marston 2006). Social and cultural norms are deeply ingrained, and it is difficult for any brief intervention to impact on these in a way which leads to behaviour

change. Such complex determinants of risk require complex interventions, and the optimal design for computer-based interventions is not known.

Potential biases in the review process

Selection of studies for inclusion

It was generally easy to decide whether a study was an RCT, and/or a sexual health intervention by our definitions (see 'Criteria for considering studies for this review'). It was also generally easy to decide whether interventions were computer-based programmes that provide information and one or more of the following: decision support, behaviour-change support, or emotional support for health issues. However, it was more difficult to decide whether interventions met our definition of interactivity (i.e. packages that require contributions from users which alter pathways within programmes to produce tailored material and feedback that is personally relevant to users of the programme). For example, interactivity and tailoring could be very simple (e.g. a quiz which provides comments on right or wrong answers), to more complex (e.g. personalised messages based on information, motivation and behavioural skills assessment). There was therefore no clear boundary between 'interactive' and not, and one study was excluded only after steering group discussion and correspondence with the authors (Lockyer 1999) since it comprised web-based learning materials to facilitate group learning, with no individual tailoring and feedback.

Combining diverse outcomes

We combined outcomes from studies with differing aims, in differing population groups, in differing settings, and using differing sexual health outcomes. Where studies reported multiple outcomes of the same type (cognitive, behavioural or biological) (see Table 1, Table 2, Table 3), quite extensive steering group discussion was required to apply the principles for selection of outcomes for inclusion in meta-analysis (see 'Description of studies'). Combining diverse studies and diverse outcomes addressed the question of whether ICBLs changed the behaviour they were designed to change, allowing us to draw conclusions about the effect of targeted, tailored, culturally appropriate sexual health promotion interventions on sexual behaviour. Combining diverse studies could have led to a reduction in effect sizes if interventions were effective in some populations or settings and not others. One meta-analysis (Analysis 1.1, knowledge) showed a high level of statistical heterogeneity (variety) which makes it harder to be certain of the size of the pooled result.

Agreements and disagreements with other studies or reviews

Three meta-analyses of computer-based interventions for sexual health promotion are available: one examined mediators of HIV preventative behaviour (Noar 2010); one examined HIV-related behaviours (Noar 2009); and one examined computer-based interventions for a variety of health behaviours including safer sex (Portnoy 2008).

Meta-analysis of theoretical mediators of safer sex

Noar 2010 focused exclusively on HIV prevention, and used a looser definition of computer-mediated intervention than our review (“studies had to... use computer technology in the delivery of the intervention, including desktop or laptop computers, the Internet, interactive video, cell phones or personal digital assistants”). The authors included 20 studies in meta-analyses, seven of which feature in our review. We excluded Lockyer 1999, Lou 2006, Marsch 2004, and Scholes 2003 since the interventions did not meet our definition of ICBI (see ‘Characteristics of excluded studies’ table). We excluded Tian 2007 (two studies) and Noell 1997 because access to the intervention was facilitated or mediated by others. Roberto 2007a and Halpern 2008 (2 studies) are not RCTs. Data for Ito 2008, Lau 2008 and Chib 2008 were not available at the time of searching. Noar’s meta-analyses combined minimal intervention comparators with face-to-face comparators, whereas we separated these into group 1 and group 2 comparisons. Noar reported HIV knowledge (SMD 0.28, 95% CI 0.23 to 0.33), condom self-efficacy (SMD 0.19, 95% CI 0.12 to 0.26), intention to use condoms (SMD 0.11, 95% CI 0.01 to 0.23), and also analysis of attitudes and condom-related communication. Our review describes a greater effect size for knowledge, and similar effect sizes for self-efficacy and intention (see Data and analyses).

Efficacy of computer-technology-based HIV prevention interventions

Noar 2009’s systematic review used similar inclusion criteria to Noar 2010, combining studies of computer-mediated interventions which aimed to increase condom use for HIV prevention. The review included 12 studies, six of which are included in our systematic review. We excluded Scholes 2003 since it did not meet our definition of ICBI. For 3 studies, results were not available at the time of searching (Bull 2009 (two trials); Peipert 2007). Two citations were abstracts, but no more information could be obtained from authors (Redding 2002; Redding 2004). Noar 2009 found a small effect on increased condom use (SMD 0.26, 95% CI 0.20 to 0.32), a small effect on sexually transmitted disease incidence (SMD 0.14, 95% CI 0.04 to 0.25), and a moderate effect on number of sex partners (SMD 0.42, 95% CI 0.12 to 0.73).

Computer-delivered interventions for health promotion and behavioral risk reduction

Portnoy 2008 conducted a systematic review of interventions to promote healthy behaviour, analysing 75 RCTs for tobacco and substance use, physical activity, nutrition, weight loss, diabetes, binge/purge behaviour, general health maintenance, and safer sexual behaviour. Combining all studies with relevant outcomes, the authors found a moderate effect on knowledge (SMD 0.36, CI 0.22 to 0.50); small effects on attitudes (SMD 0.23, 95% CI 0.09 to 0.37) and intentions (SMD 0.18, 95% CI 0.10 to 0.25); and no effect on social norms (SMD 0.27, 95% CI -0.03 to 0.57) or self-efficacy (SMD 0.16, 95% CI -0.02 to 0.33). Four studies focusing on sexual behaviour were included in the authors’ meta-analysis. Two of these studies feature in our review (Kiene 2006; Roberto 2007), and two we excluded, one because it is not an RCT (Bosworth 1994), and one because we were unable to establish whether the intervention met the definition of ICBI (Lightfoot 2007). Portnoy 2008 derived an SMD of 0.35 (CI 0.10 to 0.60) for safer sexual behaviour which is a moderate effect size.

AUTHORS’ CONCLUSIONS

Implications for practice

The diversity of included studies shows that ICBI are feasible for a variety of people in different settings (in high-income countries). Computer-based interventions in this review were delivered to participants of different ages including school-age children, college students, and adults (see ‘Characteristics of included studies’ table). Interventions were effective with heterosexually active people of different ages (especially school/college age), and with men who have sex with men.

This review suggests that ICBI are effective tools for learning about sexual health, with meta-analysis showing gains in knowledge, both for ICBI in comparison with minimal intervention, and also for ICBI in comparison with face-to-face interventions. This has significant implications for the teaching of sexual health knowledge, and suggests that ICBI could usefully enhance the educational efforts of teachers and of health carers. However, although adequate knowledge is necessary for informed decision-making, knowledge is poorly correlated with sexual behaviour (Noar 2008). The best design for ICBIs is not yet clear; for example, which theory works best for which populations (Noar 2007a), how to best to target and tailor interventions (Lustria 2009), and how to harness the potential of interactive design and communication technology to facilitate behaviour change (Hardin 1997). Implementation of ICBIs in practice needs to be accompanied by rigorous evaluation.

Technology is evolving, and patterns of computer and Internet use are changing rapidly, for example to more collaborative patterns of

Internet use (Web 2.0) with web users uploading their own content, and interacting independently. Lessons learned about successful programme designs risk being wasted: for example, many of the interventions described in this review are no longer available because of incompatibility with newer generations of computer hardware and software. Individuals and organisations are now designing their own web pages, and it is a challenge to design an intervention which will attract and engage users' interest in the context of so many available websites.

Implications for research

ICBI are promising in terms of their effect on outcomes such as knowledge, safer sex intention, self-efficacy and sexual behaviour. Trials which have adequate power are needed to establish whether ICBI can impact on biological outcomes. We also need data on potential adverse effects, and the cost-effectiveness of ICBI.

The diversity of studies in this review shows that ICBI are feasible in a variety of settings in high-income countries: evidence is needed for the effectiveness of interventions in different settings globally, and with a range of participants including women who have sex with women or older age groups for example.

We also need more evidence on whether ICBI are as effective, or more effective than face-to-face interventions, and whether a combination of both is more effective than either alone. Trials are needed which test whether ICBI can usefully supplement school sex education and/or clinical sexual health services. Equivalence trials to address these types of questions are expensive since they need to be sufficiently large to be confident of 'evidence of no difference' rather than 'no evidence of difference' between interventions. However, face-to-face interventions are very expensive to deliver, and it is therefore very important to know the effects, effectiveness, and cost-effectiveness of ICBI.

We need to know what components are necessary for an effective intervention. Qualitative ground work is essential in helping to understand the realities and complexity of sexual behaviour (Marston 2006), and to understand which behaviour change theory is most applicable (Noar 2007a). For example, knowing the main reasons for risky behaviour in a particular population (e.g. inaccurate knowledge, impulsive behaviour, power imbalance) helps to suggest which factors an intervention should target. User involvement is essential to ensure that interventions meet their needs and preferences and are attractive to users. Comparing two different designs of computer-based intervention is relatively easy to do in an online trial, with the advantage that participants can easily be blinded as to which form of intervention they have received. Such trials can test intervention design, for example tailoring, different theoretical approaches to behaviour change, types of interactive multi-media and so on.

Online trials have a number of advantages over trials which involve face-to-face contact with researchers, for example access to

large numbers of people including hard-to-reach populations; automated randomisation; blind allocation to online interventions; the opportunity for more user-friendly data collection and outcome measurement; automated and secure data entry; automated reminders; and possibly reduced research costs. Whilst online recruitment may be exceptionally good, there are often also high drop-out rates (Bull 2004). Research is needed to address the best ways to conduct online trials including how to recruit and retain participants, to verify identity online, and to ensure that data collected are valid and reliable (Murray 2009; Pequegnat 2007).

Whilst many trials are well designed and conducted, there is a need to improve standards of trial conduct and reporting by adhering to the CONSORT recommendations (Moher 2001). It is important that study authors describe intervention theory, design and delivery in detail, to make the design principles clear, and to describe exactly what intervention participants received (Abraham 2008). There is also an urgent need for a consensus on outcome measurement, for example international agreements on condom use outcomes (Free 2009). However, it is not possible to produce a universally applicable battery of outcome measures, since outcomes need to be relevant for particular interventions and for particular populations.

Composite outcomes for sexual health may be better at reflecting the complexity of sexual health (Stephenson 2003). For example, penetrative sex without a condom may have different significance and sexual health implications depending upon whether a partner is regular or 'casual'. Combining this kind of information in composite outcomes makes data more meaningful. Understanding the meaning and motivation for sexual activity is also important: for example, teenage pregnancies may be wanted and welcomed by young women, and in some settings marriage and pregnancy at early ages are usual (Swann 2003).

There is increasing realisation that sexual health education should include emotional, mental and social well-being in relation to sexuality and not just physical health (Ingham 2005). This represents a challenge for those who design and evaluate sexual health interventions, since these dimensions are individually, socially and culturally defined rather than objectively measurable. Interventions which may be unsuccessful from a public health perspective may be successful by other criteria: for example, whilst an intensive school-based intervention did not have an impact upon age at first intercourse, condom use, conceptions or pregnancy terminations, it did increase knowledge, and reduce regret of first sex (Wight 2002). It is therefore important that interventionists' criteria for success take into account broader definitions of sexual health, and also that the aims of an intervention match participants' priorities.

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* Indicates the major publication for the study

CHARACTERISTICS OF STUDIES

Characteristics of included studies [ordered by study ID]

Alemi 1989

Methods	Randomised controlled trial.	
Participants	Teenagers who had experienced pregnancy. Special service programme for previously pregnant adolescents USA	
Interventions	<p>ICBI: Players asked to decide what the main character should do. Computer responds. Make friendships and relationships with other characters. Unsafe sex leads to a pregnancy and unpredictable baby behaviour. Wrong answers stop the program, so must ask others. One session, In groups of 5</p> <p>Theory: Practice in decision-making, triggers for talking to others</p> <p>Consumer involvement: 'active involvement of 30 different people from different community institutions'</p> <p>Comparator: Lecture with same content</p>	
Outcomes	<p>Immediately post-intervention</p> <p>Knowledge</p> <p>Liberal/conservative attitudes (desirability of this is not clear)</p> <p>Locus of control (presumably internal locus of control=improvement)</p>	
Aim and target population	To prevent adolescent pregnancy (to increase teenager-parent/teacher communication, rehearse decision-making)	
Notes		
Risk of bias		
Bias	Authors' judgement	Support for judgement
Adequate sequence generation?	Unclear risk	'We randomly assigned 20 teenagers to the control and 20 to the experimental group'
Allocation concealment?	Unclear risk	Sequence generation and allocation concealment rated 'B'.
Incomplete outcome data addressed? All outcomes	Unclear risk	Data presumably complete, since no apparent drop-outs (measurement immediately post-intervention)
Free of selective reporting?	Low risk	Data presented for all outcomes. No comment on blinding of outcome assessors
Absence of large or differential losses to follow up?	Unclear risk	Not stated, but immediate post-testing done

Avina 2006

Methods	Randomised controlled trial.
Participants	Female university students (mostly psychology students) USA
Interventions	ICBI: to improve women's ability to recognise risk situations, devise effective responses and engage in effective behaviours to avoid risk of sexual assault. Developing effective communication skills. Decoding skills, decision skills and enactment to respond effectively. Four scenarios with feedback, vignettes. Access over 12 weeks Theory: information-processing model of social competence: decoding skills, decision-making and enactment Consumer involvement: expert consultants and focus groups of college women (n = 19 women) Comparator: Waiting list
Outcomes	3 weeks and 12 weeks Alcohol control and risk reducing strategies (Not clear what represents improvement) Sexual communication perception of communication of sexual intentions and participation in undesired sexual activity. (Not clear what represents improvement) Sexual victimisation (new incidence of sexual victimisation) (lower score=improvement)
Aim and target population	Sexual assault prevention (to help women have positive dating experiences and make good decisions in sexual situations)
Notes	Slightly different figures given e.g. for drop-out rates

Risk of bias

Bias	Authors' judgement	Support for judgement
Adequate sequence generation?	Low risk	Computer randomised. 'The program was designed to randomly assign participants to an experimental or wait-list control condition'
Allocation concealment?	Low risk	Concealment until revealed by computer allocation. Sequence generation and allocation concealment rated 'A'
Incomplete outcome data addressed? All outcomes	Low risk	Missing data imputed by last observation carried forward method
Free of selective reporting?	Low risk	Data presented for all outcomes. No comment on blinding of outcome assessors
Absence of large or differential losses to follow up?	Unclear risk	22% attrition at time 2 (3 weeks); 16% at time 3 (12 weeks). Overall 59% retention. No significant differences in drop-out between group

Bowen 2007

Methods	Randomised controlled trial.	
Participants	Rural Men who have Sex with Men, over 18 years old, recruited online USA	
Interventions	<p>ICBI: Online. Intervention content included HIV prevention information not generally known to MSM residing in rural areas & was presented as a conversation between an HIV+ gay man who represented the 'expert' & an 'inexperienced' HIV- man who had recently engaged in high-risk sex. Conversation continues after the character has a negative HIV result. 2 modules of 20 minutes, not less than 24 hours apart</p> <p>Theory: Social cognitive theory</p> <p>Consumer involvement: 'Focus groups, and an Internet-based assessment'</p> <p>Comparator: Waiting list</p>	
Outcomes	<p>One week. Further outcomes at 2 weeks (T3), after waiting list group had also had intervention</p> <p>HIV/AIDS knowledge</p> <p>Outcome expectancies (condom use and insisting on safe sex)</p> <p>Self-efficacy (safe sex assertiveness and safer sex communication)</p>	
Aim and target population	HIV risk reduction for rural MSM	
Notes		
Risk of bias		
Bias	Authors' judgement	Support for judgement
Adequate sequence generation?	Low risk	Computer randomised. 'Participants... were randomly assigned by the computer to the intervention group or to the wait-list control group
Allocation concealment?	Low risk	Concealment until revealed by computer allocation. Sequence generation and allocation concealment rated 'A'
Incomplete outcome data addressed? All outcomes	Low risk	Pre-test scores used as follow-up scores for drop-outs
Free of selective reporting?	Low risk	Data presented for all outcomes. No comment on blinding of outcome assessors
Absence of large or differential losses to follow up?	Low risk	20% of ICBI group and 21% of waiting list group dropped out (no significant differences in demographics)

Davidovich 2006

Methods	Online randomised controlled 3 arm trial.	
Participants	Dutch-speaking men who have sex with men, recruited online	
Interventions	<p>ICBI (tailored): Delivered online. Information: Negotiated Safety and HIV testing Motivation: emphasising risk of HIV and burdens of combination therapy, correcting faulty beliefs. Skills: communication strategies for reaching agreements with partners. Tailored according to knowledge, motivation, and skills. One online session Theory: Information, motivation, behavioural skills model, tailored. Cognitive behavioural Consumer involvement: not stated Comparator 1: ICBI (non-tailored), delivered online: (all of the intervention modules) Comparator 2: No intervention.</p>	
Outcomes	<p>Baseline, immediately post, and at 6 months. Immediate only for controls Response efficacy (knowledge of and belief in benefits of negotiated safety) Intention to practice negotiated safety, intention to use condoms Perceived behavioural control (cf. self-efficacy): safer sex outside relationship, mutual HIV testing, monogamy agreement, warning partner Negotiated safety with new steady partners (HIV testing, then monogamy or condoms outside the relationship) Condom use with steady partner Self-reported HIV status</p>	
Aim and target population	Reduce HIV risk in MSM (increase negotiated safety between steady partners)	
Notes	35% had a steady partner by 6 months (130/668). Analysis based only on these	
<i>Risk of bias</i>		
Bias	Authors' judgement	Support for judgement
Adequate sequence generation?	Low risk	Individually randomised by computer. 'A computer program allocated at random each person... to one of the study's arms' (info from author)
Allocation concealment?	Low risk	Concealment until revealed by computer allocation. Sequence generation and allocation concealment rated 'A'
Incomplete outcome data addressed? All outcomes	High risk	Drop-outs excluded
Free of selective reporting?	Low risk	Data presented for all outcomes. No comment on blinding of outcome assessors

Davidovich 2006 (Continued)

Absence of large or differential losses to follow up?	High risk	Retention at 6 months: 42% control (n = 140), 31% non-tailored (n = 107), 38% tailored (n = 128). No significant differences by demographic variables. No differential drop-out by motivation
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Di Noia 2004

Methods	Cluster randomised trial.
Participants	Girls from social services agencies USA
Interventions	ICBI: Keeping it Safe' CD-ROM. Information about HIV, game with feedback re. facts and myths, video personal story of HIV, four-step model of assertive responding using scenarios and simulations. Single 30 minute session Theory: ? Four-step model of assertive responding Consumer involvement: not stated Comparator: Waiting list for intervention
Outcomes	2 weeks after intervention HIV-AIDS Knowledge Risk-reduction self-efficacy
Aim and target population	To forestall initiation of HIV related risk behaviours among adolescent girls (to alter HIV/AIDS related knowledge, protective attitudes and self-efficacy for risk reduction)
Notes	Data adjusted for baseline differences in age and ethnicity. Randomised by site (not clear how many sites were involved)

Risk of bias

Bias	Authors' judgement	Support for judgement
Adequate sequence generation?	Unclear risk	Not stated. 'The efficacy of the program was evaluated in a randomized blocks design with site as the unit of randomization'
Allocation concealment?	Unclear risk	Not stated. Sequence generation and allocation concealment rated 'B'
Incomplete outcome data addressed? All outcomes	Unclear risk	Not stated
Free of selective reporting?	Low risk	Data presented for all outcomes. No comment on blinding of outcome assessors

Di Noia 2004 (Continued)

Absence of large or differential losses to follow up?	Unclear risk	Drop-out rate not stated.
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Downs 2004

Methods	3 arm randomised controlled trial.	
Participants	Girls recruited from healthcare sites USA	
Interventions	<p>ICBI: 4 domains for content of all 3 interventions: negotiation, condom use, reproduction, and STDs. Characters with choices to make. Cognitive rehearsal in own head. 30 minutes, then 15 minute booster sessions at 1, 3 and 6 months</p> <p>Theory: mental models, decision theory, addressing gaps and misconceptions</p> <p>Consumer involvement: panel of experts, then 48 semi-structured interviews with adolescent females</p> <p>Comparator 1 and 2 combined: Leaflets or book with same content</p>	
Outcomes	<p>STD Knowledge at 3 and 6 months</p> <p>Abstinence</p> <p>Condom use, Condom failures</p> <p>STD self-report at 3 months and 6 months</p> <p>Chlamydia PCR at 6 months</p>	
Aim and target population	To reduce adolescent girls' STD risk.	
Notes	Leaflet and book outcomes combined.	

Risk of bias

Bias	Authors' judgement	Support for judgement
Adequate sequence generation?	Low risk	Random number table. 'We created a random numbers table for each site, and when people enrolled in the study they were assigned to the next condition on the list of random numbers' (info from authors)
Allocation concealment?	Low risk	Sequence generation and allocation concealment rated 'A'.
Incomplete outcome data addressed? All outcomes	High risk	Drop-outs excluded
Free of selective reporting?	Unclear risk	Results for self-reported STD not presented, but these analyses were underpowered

Downs 2004 (Continued)

Absence of large or differential losses to follow up?	High risk	Retention at 6 months: 84% ICBI, 87% leaflet and book combined
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Evans 2000

Methods	3 arm randomised controlled trial.	
Participants	Students on sexuality course (college) USA	
Interventions	<p>ICBI: A. Individual interaction with computer. Stories, role modelling, demonstrations. Not tailored. Video vignettes, rehearsal of communication skills (typing). 1 hour with computer</p> <p>Theory: Social cognitive theory</p> <p>Consumer involvement: reviewed by several experts in adolescent sexual health and pilot-tested with 31 college students</p> <p>Comparator 1: Lecture to group (on same content and theoretical principles). 1 hour</p> <p>Comparator 2: 'No intervention'.</p>	
Outcomes	<p>Immediately post-intervention</p> <p>HIV knowledge</p> <p>HIV preventative self-efficacy</p> <p>Intended condom use with current and future partners</p> <p>Physical outcomes motivation, social motivation, self-evaluative outcome motivation</p>	
Aim and target population	To influence HIV prevention behaviours	
Notes		

Risk of bias

Bias	Authors' judgement	Support for judgement
Adequate sequence generation?	Unclear risk	Not stated. 'All students who volunteered and signed a consent form (n = 162) were randomly assigned to one of three groups'
Allocation concealment?	Unclear risk	Not stated. Sequence generation and allocation concealment rated 'B'
Incomplete outcome data addressed? All outcomes	High risk	Drop-outs excluded
Free of selective reporting?	Low risk	Data presented for all outcomes.
Absence of large or differential losses to follow up?	Unclear risk	Drop-out rates: 7%, 4%, 2%

Jenkins 2000

Methods	4 arm randomised controlled trial.	
Participants	Army men with urethritis, clinic attenders USA	
Interventions	<p>ICBI: interactive video disc: computer tailored feedback based on responses to questions. videodisc done alone. One session</p> <p>Theory: designed to fit with military behavioural norms.</p> <p>Consumer involvement: not stated</p> <p>Comparator 1: STD/HIV risk appraisal: computerised risk profile and specific feedback messages with problem-focused counselling</p> <p>Comparator 2: Targeted situational behaviour: face-to-face counselling based on usual partner-seeking behaviour</p> <p>Comparator 3: standard clinical care: STD counselling and medication advice</p>	
Outcomes	<p>Two weeks and two months post intervention</p> <p>HIV knowledge</p> <p>Readiness to change (condom use, partner choice, alcohol consumption)</p> <p>Peer approval, perceived vulnerability to HIV</p> <p>Sex with high risk partners, condom use with risky partners, sharing needles, sexual bingeing, use of alcohol, new partners in high risk venues, carrying condoms, having partners with genital warts or sores. Adherence to medication. Proportion of men with >1 partner at 2 weeks. Proportion going to meet new sex partner.</p>	
Aim and target population	To reduce STD and HIV infection risk behaviours	
Notes		
Risk of bias		
Bias	Authors' judgement	Support for judgement
Adequate sequence generation?	Low risk	Random number table. 'Patients were randomized to 1 of the 4 study conditions, with assignment based on a random number table'
Allocation concealment?	Unclear risk	Sequence generation and allocation concealment rated 'B'.
Incomplete outcome data addressed? All outcomes	Unclear risk	Not stated
Free of selective reporting?	High risk	Many variables measured, but few results presented, particularly the 2 month outcome data
Absence of large or differential losses to follow up?	Unclear risk	73.2% retention at two weeks, 48.5% retention at two months. No statistically significant differences between groups

Kann 1987

Methods	3 arm cluster randomised trial ('quasi experimental').	
Participants	Health science students in secondary schools USA	
Interventions	<p>ICBI: Three simulation-based programmes for decision-making, assertiveness and interpersonal communication. Conversations between students and computer. Structured decision-making process. 3 sessions</p> <p>Theory: Maskay: decision-making process model. Miller: interpersonal communication programme. Del Greco: assertion training</p> <p>Consumer involvement: not stated</p> <p>Comparator 1: regular classroom instruction with same content: lectures, discussion and role play</p> <p>Comparator 2: no intervention</p>	
Outcomes	<p>Immediately afterwards and 5 weeks</p> <p>Decision-making knowledge, assertiveness knowledge, interpersonal communication knowledge</p> <p>Assertiveness attitude, interpersonal communication attitude</p> <p>Decision-making behavior, assertiveness behaviour, interpersonal communication behaviour</p>	
Aim and target population	To promote responsible sexual behaviour (enhance decision-making, assertiveness and interpersonal communication)	
Notes		
Risk of bias		
Bias	Authors' judgement	Support for judgement
Adequate sequence generation?	Unclear risk	Not stated. 'At each school, intact classes were assigned randomly to one of the three groups.'
Allocation concealment?	Unclear risk	Not stated. Sequence generation and allocation concealment rated 'B'
Incomplete outcome data addressed? All outcomes	High risk	Excludes incomplete data sets
Free of selective reporting?	Low risk	Data presented for all outcomes.
Absence of large or differential losses to follow up?	Unclear risk	391/599 (65%) of whole sample

Kiene 2006

Methods	Randomised controlled trial.	
Participants	Psychology students (university) USA	
Interventions	<p>ICBI: Condom use info, motivation and behavioural skills. Goal setting. Tailoring by baseline Information, Motivation and Behavioural skills. Self-selected goals. 2 sessions: 1) 15-40 minutes 2) 2 weeks later follow up. Private room</p> <p>Theory: Information, Motivation, Behavioural skills model; Motivational Interviewing and Stages of Change</p> <p>Consumer involvement: not stated</p> <p>Comparator: Nutrition education tutorial (also computer delivered): no more details given</p>	
Outcomes	<p>4 weeks</p> <p>Condom knowledge</p> <p>Condom use behavioural skills (efficacy and difficulty)</p> <p>Condom use intentions, condom use stage of change</p> <p>Condom-related attitudes and social norms (family and friends' beliefs)</p> <p>Condom use in last 30 days, keeping condoms handy, persuading a partner to use condoms</p>	
Aim and target population	To increase HIV/AIDS preventive behaviours	
Notes		
<i>Risk of bias</i>		
Bias	Authors' judgement	Support for judgement
Adequate sequence generation?	Low risk	'A software random number function assigned participants to condition'
Allocation concealment?	Unclear risk	Sequence generation and allocation concealment rated 'B'.
Incomplete outcome data addressed? All outcomes	Unclear risk	All participants included in analysis of IMB constructs (including intention), but not for safer sex behaviours Missing data appear to have been imputed. Analyses based on participants randomised rather than participants at follow-up
Free of selective reporting?	Low risk	Data presented for all outcomes. No comment on blinding of outcome assessors
Absence of large or differential losses to follow up?	Low risk	107/112 at 4 weeks (ICBI); 42/45 at 4 weeks (control) (95% overall, no significant differences)

Methods	Randomised controlled trial.	
Participants	Dutch men who have sex with men (online)	
Interventions	<p>ICBI: Delivered online. 'Queermasters'. Video: tailored to age and partner status. Statement game: opinions about regular sexual health checkups, tailored feedback from showmaster, emailed information Wheel of knowledge with tailored feedback. Interactivity: with virtual people, and email. Second session at 3 months</p> <p>Theory: Social Cognitive Theory and others. Theory of Planned Behaviour. Avoidance of stimulating fear response</p> <p>Consumer involvement: Extensive consumer involvement, with focus groups and online questionnaire with MSM and expert opinion</p> <p>Comparator: comparison website, delivered online.. Risk checklist, risk indicator (own assessment vs. professional assessment), HIV and/or STI testing recommendation</p>	
Outcomes	<p>3 months</p> <p>Self-efficacy for doing an STI/HIV check up</p> <p>Intention to do STI/HIV check up</p> <p>Attitude, Social norm</p> <p>STD/HIV test in last 3 months</p>	
Aim and target population	To motivate MSM to take HIV test (to compare risk-framed messaging with non-risk messages (2 websites))	
Notes		
<i>Risk of bias</i>		
Bias	Authors' judgement	Support for judgement
Adequate sequence generation?	Low risk	'Participants were allocated to one of two conditions by means of a random procedure which was pre-programmed [by computer]' (info from author)
Allocation concealment?	Low risk	Concealment until revealed by computer allocation. Sequence generation and allocation concealment rated 'A'
Incomplete outcome data addressed? All outcomes	Low risk	Data adjusted for variables associated with differential drop-out rates and missing data allowed for. Unadjusted data obtained from authors
Free of selective reporting?	Low risk	Data presented for all outcomes. No comment on blinding of outcome assessors
Absence of large or differential losses to follow up?	High risk	529/1704 retention = 31%. Experimental condition were significantly more likely to drop out

Perry 1991

Methods	Three arm randomised controlled trial.	
Participants	Adults at risk of HIV, recruited for free HIV testing and counselling as part of a longitudinal study USA	
Interventions	<p>Tailored pre-HIV test counselling with psychiatric nurse (for all 3 groups)</p> <p>ICBI: Post-HIV test counselling plus interactive video on computer terminal. 3 x 45 min sessions in private on HIV testing, transmission, informing others, seeking medical care and social support. MCQs as tailored feedback. PI in white coat for re-framing and relaxation messages</p> <p>Theory: not stated</p> <p>Consumer involvement: not stated</p> <p>Comparator 1 (face-to-face intervention): post-HIV test counselling plus stress prevention training. Individual, six 60 min sessions (CBT and stress inoculation)</p> <p>Comparator 2 ('standard care'): post-HIV test psychiatric nurse counselling</p>	
Outcomes	Pre- and 3 months post-intervention (Card 1993) Knowledge about HIV and AIDS (higher score=improvement), HIV serology (Perry 1991) Beck Depression inventory, Trait Anxiety Inventory, State Anxiety Inventory, Brief Symptom Inventory, Hamilton Depression Rating Scale	
Aim and target population	To enhance HIV counselling to increase knowledge about HIV and AIDS and reduce emotional distress and HIV-related risk behaviours	
Notes	Same study as Card 1993, but reporting different outcomes	
Risk of bias		
Bias	Authors' judgement	Support for judgement
Adequate sequence generation?	Unclear risk	Not stated. 'We randomized subjects immediately after completion of post-test [HIV] counseling'
Allocation concealment?	Unclear risk	Not stated. Sequence generation and allocation concealment rated 'B'
Incomplete outcome data addressed? All outcomes	High risk	Drop-outs excluded
Free of selective reporting?	Low risk	Data presented for all outcomes. No comment on blinding of outcome assessors
Absence of large or differential losses to follow up?	High risk	(Card 1993) 68% had data available at baseline and 3 month follow up (328/481). Differential drop-out (73% ICBI and 83% the control groups). Subjects who returned tended to

Perry 1991 (Continued)

		be the less knowledgeable at intake (but non-significant trend) (Perry 1991). 3/12 outcome data for 307/380
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Read 2006

Methods	Randomised controlled trial
Participants	MSM recruited after negative HIV test results USA
Interventions	ICBI: Interactive virtual date. Physically, emotionally and socially realistic situation. Modelling and directed practice of the cognitive and behavioural skills needed to negotiate safer sex. 2 sessions, the second after 3 months Theory: importance of replicating realistic situations including emotional/sexual feelings Consumer involvement: focus groups, and consultation with staff from a gay and lesbian community centre Comparator: usual post-HIV test counselling.
Outcomes	Weekly for 8 weeks, 3 months and 5 months No significant effects on self-efficacy, attitudes, behavioural intention, but data not presented Protected and unprotected sexual behaviour (anal, oral, rimming) , although different scales so can't be compared. Adjusted means (by ethnicity)
Aim and target population	To prevent HIV in MSM (reduce risky sex)
Notes	Adjustment for baseline differences in ethnicity. Two references: Read and Miller 2006, and Miller and Read 2006 Two experimental groups n = 38; n = 36 and one control group (n = 36) ... 'we collapsed findings across conditions and report the comparisons between the combined experimental groups and the control condition'

Risk of bias

Bias	Authors' judgement	Support for judgement
Adequate sequence generation?	Unclear risk	'Participants were randomly assigned to receive IAV..... or not'
Allocation concealment?	Unclear risk	Not stated. Sequence generation and allocation concealment rated 'B'
Incomplete outcome data addressed? All outcomes	High risk	Not addressed (info from authors)
Free of selective reporting?	Unclear risk	Unclear exactly which outcome variables had been measured: giving and receiving anal sex with and without a condom were combined into measures of protected or

Read 2006 (Continued)

		unprotected anal sex respectively No comment on blinding of outcome assessors
Absence of large or differential losses to follow up?	Low risk	81% retention at 8 weeks. No differences in attrition

Roberto 2007

Methods	Cluster randomised controlled trial (by school).	
Participants	High school students USA	
Interventions	<p>ICBI: 7 week intervention. 6 computer-based activities and one catch-up week. Sensation-seeking, Truth or Myth, Impulsive decision-making, Risky behaviour, Virtual date, Original refusal line, Radio announcement, Weekly outside of class/school lessons. 15 min sessions. Optional</p> <p>Theory: Extended parallel process model (Witte 1992). Increase threat but also increase efficacy</p> <p>Consumer involvement: >1,700 surveys and 4 focus groups with adolescents.</p> <p>Comparator: Data collection only.</p>	
Outcomes	<p>5 months after baseline</p> <p>Knowledge Condom self-efficacy, condom negotiation, situational self-efficacy, refusal self-efficacy Attitude towards waiting, perceived susceptibility to pregnancy, STD or HIV Ever had sexual intercourse, Number of partners in last 4 months, Use of condom at last intercourse</p>	
Aim and target population	To prevent pregnancy, STD and HIV in rural adolescents	
Notes		
Risk of bias		
Bias	Authors' judgement	Support for judgement
Adequate sequence generation?	Unclear risk	'If memory serves Dr Z and I flipped a coin to determine which would be the intervention school' (info from author)
Allocation concealment?	Unclear risk	Not stated. Sequence generation and allocation concealment rated 'B'
Incomplete outcome data addressed? All outcomes	High risk	No. Only completers of both surveys

Roberto 2007 (Continued)

Free of selective reporting?	Low risk	Data presented for all outcomes. No comment on blinding of outcome assessors
Absence of large or differential losses to follow up?	Low risk	ICBI group: 85% completion at 5 months. Control group: 87% completion at 5 months

Van Laar 2000

Methods	Randomised controlled trial.	
Participants	High school students USA	
Interventions	<p>ICBI: seven modules: intent, prepare, purchase, carry, discuss and negotiate, peer support. CD ROM, during school day. Audio parts through earphones</p> <p>Theory: cognitive restructuring of irrational beliefs</p> <p>Consumer involvement: not stated</p> <p>Comparator: Internet based program focused on altering irrational career beliefs</p>	
Outcomes	<p>One week.</p> <p>Contraceptive self-efficacy, 4 brief self-efficacy scales</p> <p>Attitude towards condom scale, sexual risks scale (composite including attitudes, norms, perceived risk, intention)</p>	
Aim and target population	<p>To change irrational beliefs which interfere with effective contraception use</p> <p>Comparison of two Internet-based cognitive restructuring programmes</p>	
Notes	<p>Comparator could have an effect on sexual health. Authors treated it as inactive</p>	

Risk of bias

Bias	Authors' judgement	Support for judgement
Adequate sequence generation?	Unclear risk	'Subjects were randomly assigned to either the experimental or control treatment conditions'
Allocation concealment?	Unclear risk	Not stated. Sequence generation and allocation concealment rated 'B'
Incomplete outcome data addressed? All outcomes	High risk	Drop-outs excluded
Free of selective reporting?	Low risk	Data presented for all outcomes. No comment on blinding of outcome assessors

Absence of large or differential losses to follow up?	High risk	3/20 in experimental group dropped. 6/18 in comparison group dropped
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Characteristics of excluded studies [ordered by study ID]

Study	Reason for exclusion
Bull 2004	Insufficient data for analysis (large drop-out rate).
Kok 2006	Info from authors: 'the Gay Cruise evaluation was seriously limited by the large rate of attrition'
Lightfoot 2007	Unable to establish whether it meets the definition of ICBI (by Oct 2009). Numerical outcome data needed
Lockyer 1999	Inclusion debated. Excluded since not an ICBI: web-based learning materials to facilitate group learning. No individual tailoring and feedback
Lou 2006	Website provided professional counselling by email as well as web-based information and a discussion forum, so the effects of ICBI alone could not be ascertained. Unclear whether randomly allocated
Marsch 2004	Not an ICBI: information with multiple choice questions. No decision support, behaviour change, emotional support
Noell 1997	ICBI, but accessed with teachers.
Ochs 1994	Separate data on the effect of the ICBI were not available.
Pacifci 2001	ICBI, but accessed with teachers.
Paperny 1989	Controlled trial but not RCT.
Redding 2002	Abstract only: no response to request for more information.
Redding 2004	Abstract only: no response to request for more information.
Reis 1992	Not randomised.
Roberto 2007a	Not randomised. Institutional cycle design: successive cohorts in school.
Scholes 2003	The intervention was a computer-generated booklet, tailored with data collected by researchers over the telephone, and also a postal safe sex kit with condoms. Users did not interact directly with the programme, and the delivery route was paper by post
Seidner 1996	Not RCT.

(Continued)

Tian 2007	Not ICBI, but web-based information which was disseminated by health workers, women's groups and teachers. One computer in each region
Yom 2005	ICBI, but accessed with teachers.

DATA AND ANALYSES

Comparison 1. ICBI versus minimal intervention

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Knowledge	6	1032	Std. Mean Difference (IV, Random, 95% CI)	0.72 [0.27, 1.18]
2 Self-efficacy	6	1152	Std. Mean Difference (IV, Random, 95% CI)	0.17 [0.05, 0.29]
3 Intention	3	831	Std. Mean Difference (IV, Random, 95% CI)	0.16 [0.02, 0.30]
4 Sexual behaviour (dichotomous)	3	485	Odds Ratio (M-H, Random, 95% CI)	1.54 [1.00, 2.38]
5 Sexual behaviour (continuous)	1	77	Std. Mean Difference (IV, Random, 95% CI)	0.61 [0.11, 1.11]
6 Sexual behaviour (combined)	4	562	Odds Ratio (Random, 95% CI)	1.75 [1.18, 2.59]
7 Biological outcomes	2	395	Odds Ratio (M-H, Random, 95% CI)	0.74 [0.25, 2.14]

Comparison 2. ICBI versus face-to-face interventions

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Knowledge	2	317	Std. Mean Difference (IV, Random, 95% CI)	0.36 [0.13, 0.58]
2 Self-efficacy	1	102	Std. Mean Difference (IV, Random, 95% CI)	0.38 [-0.01, 0.77]
3 Intention	1	102	Std. Mean Difference (IV, Random, 95% CI)	0.46 [0.06, 0.85]

Comparison 3. ICBI versus non-tailored computerised intervention

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Self-efficacy	1	533	Std. Mean Difference (IV, Random, 95% CI)	0.05 [-0.12, 0.22]
2 Intention	1	533	Std. Mean Difference (IV, Random, 95% CI)	0.07 [-0.10, 0.24]
3 Sexual behaviour (dichotomous)	1	89	Odds Ratio (M-H, Random, 95% CI)	3.47 [1.45, 8.31]

Comparison 4. Non risk-based ICBI versus risk-based website

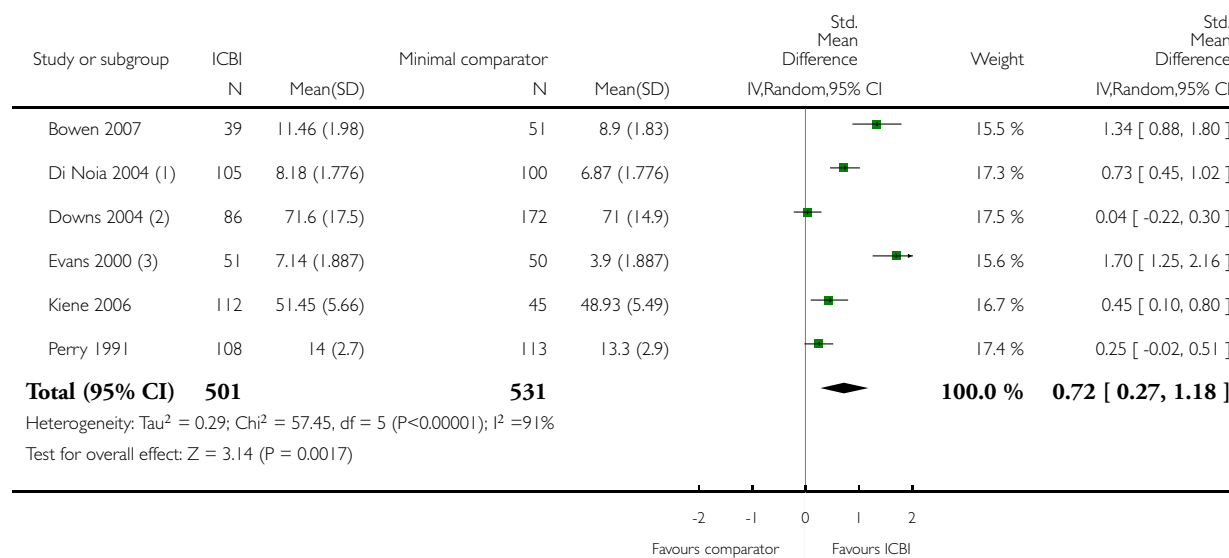
Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Self-efficacy	1	527	Std. Mean Difference (IV, Random, 95% CI)	0.01 [-0.17, 0.18]
2 Intention	1	527	Std. Mean Difference (IV, Random, 95% CI)	0.15 [-0.02, 0.32]
3 Sexual behaviour	1	529	Odds Ratio (M-H, Random, 95% CI)	0.79 [0.52, 1.20]

Analysis 1.1. Comparison 1 ICBI versus minimal intervention, Outcome 1 Knowledge.

Review: Interactive computer-based interventions for sexual health promotion

Comparison: 1 ICBI versus minimal intervention

Outcome: 1 Knowledge



(1) SDs calculated from F stats. (F=27.86)

(2) Percentages. Data from authors

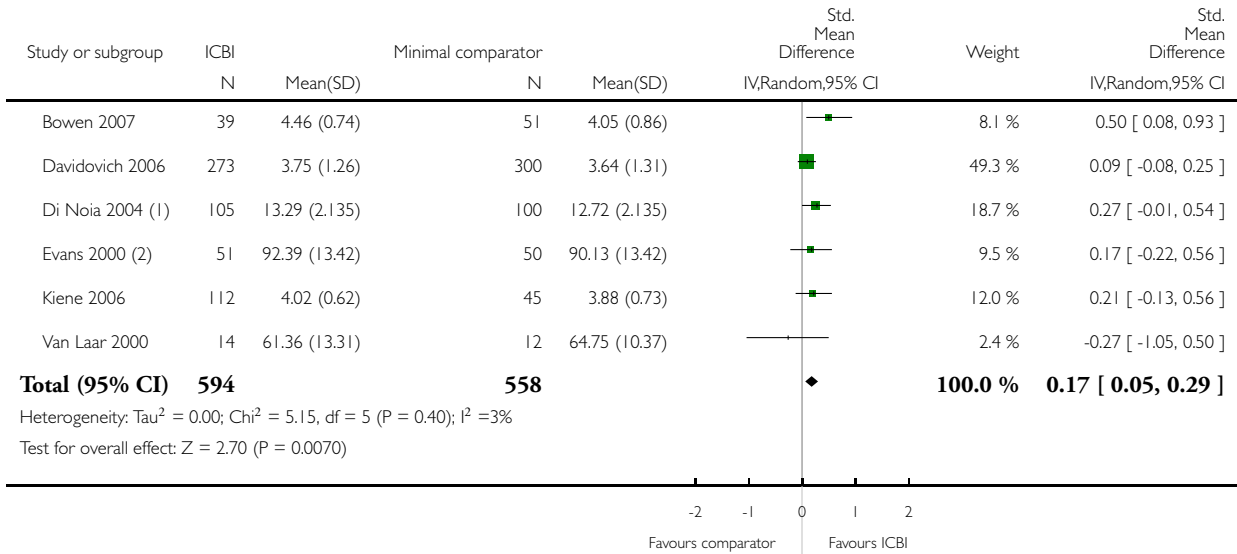
(3) SDs calculated from F statistic. (F=39.21)

Analysis 1.2. Comparison 1 ICBI versus minimal intervention, Outcome 2 Self-efficacy.

Review: Interactive computer-based interventions for sexual health promotion

Comparison: 1 ICBI versus minimal intervention

Outcome: 2 Self-efficacy



(1) SD calculated from F stats (F=3.65)

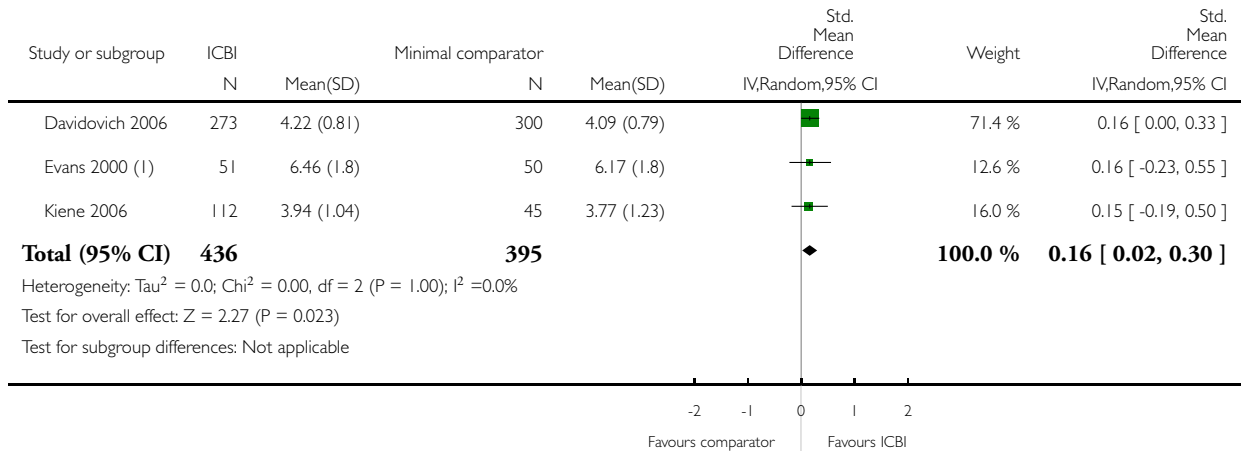
(2) SD calculated from F statistic (F=1.91)

Analysis 1.3. Comparison 1 ICBI versus minimal intervention, Outcome 3 Intention.

Review: Interactive computer-based interventions for sexual health promotion

Comparison: 1 ICBI versus minimal intervention

Outcome: 3 Intention



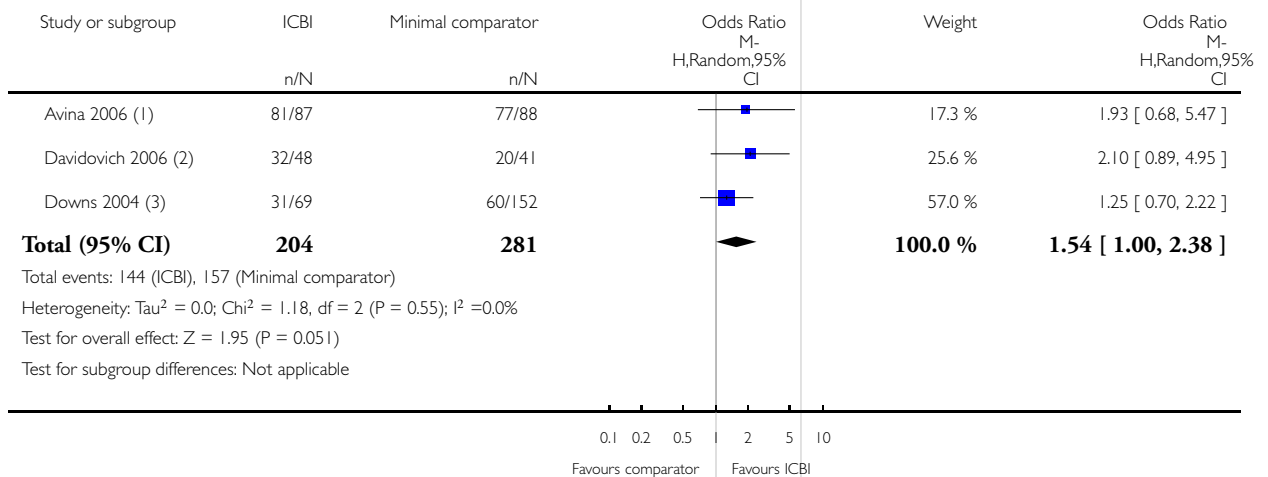
(1) SD calculated from F stat (F=2.80)

Analysis 1.4. Comparison 1 ICBI versus minimal intervention, Outcome 4 Sexual behaviour (dichotomous).

Review: Interactive computer-based interventions for sexual health promotion

Comparison: 1 ICBI versus minimal intervention

Outcome: 4 Sexual behaviour (dichotomous)



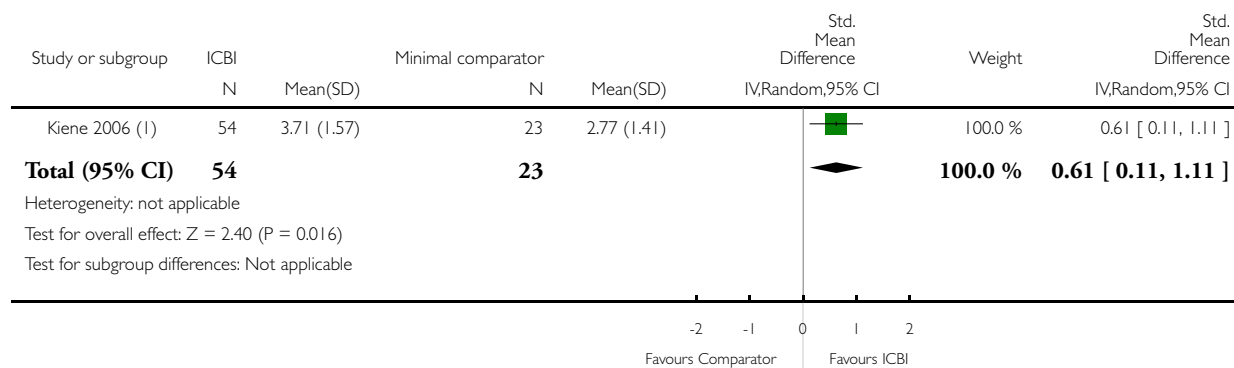
- (1) Number of participants who did *not* experience sexual victimisation.
- (2) Negotiated safety or condom use. Only men with a new steady partner since baseline. Data from authors
- (3) Condom use in last 3 months, 'every time with every partner', only for sexually active subgroup. Data from author

Analysis 1.5. Comparison 1 ICBI versus minimal intervention, Outcome 5 Sexual behaviour (continuous).

Review: Interactive computer-based interventions for sexual health promotion

Comparison: 1 ICBI versus minimal intervention

Outcome: 5 Sexual behaviour (continuous)



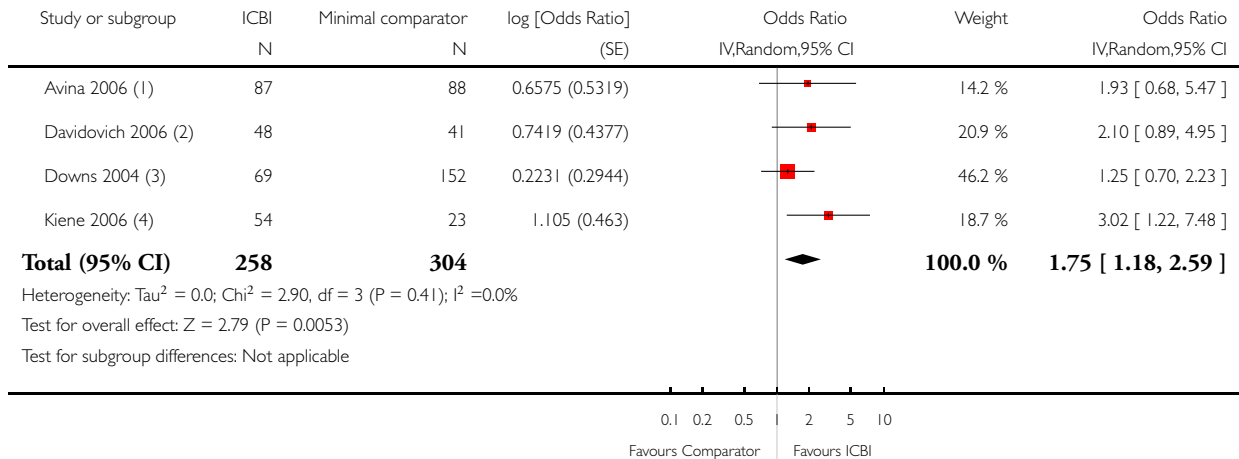
- (1) Condom use in last 30 days, only those sexually active since baseline

Analysis 1.6. Comparison 1 ICBI versus minimal intervention, Outcome 6 Sexual behaviour (combined).

Review: Interactive computer-based interventions for sexual health promotion

Comparison: 1 ICBI versus minimal intervention

Outcome: 6 Sexual behaviour (combined)



(1) Number of participants who did *not* experience sexual victimisation.

(2) Negotiated safety or condom use. Only men with a new steady partner since baseline. Data from authors

(3) Condom use in last 3 months, 'every time with every partner', only for sexually active subgroup. Data from author

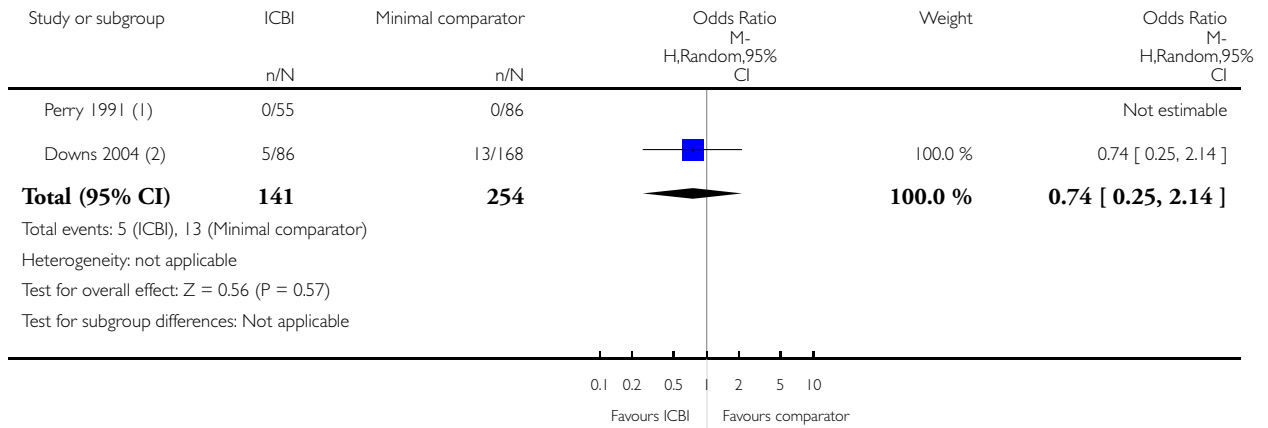
(4) Converted from SMD 0.61 [0.11 to 1.11] (Condom use in last 30 days)

Analysis 1.7. Comparison 1 ICBI versus minimal intervention, Outcome 7 Biological outcomes.

Review: Interactive computer-based interventions for sexual health promotion

Comparison: 1 ICBI versus minimal intervention

Outcome: 7 Biological outcomes



(1) HIV seroconversion for seronegative subgroup only. No new events.

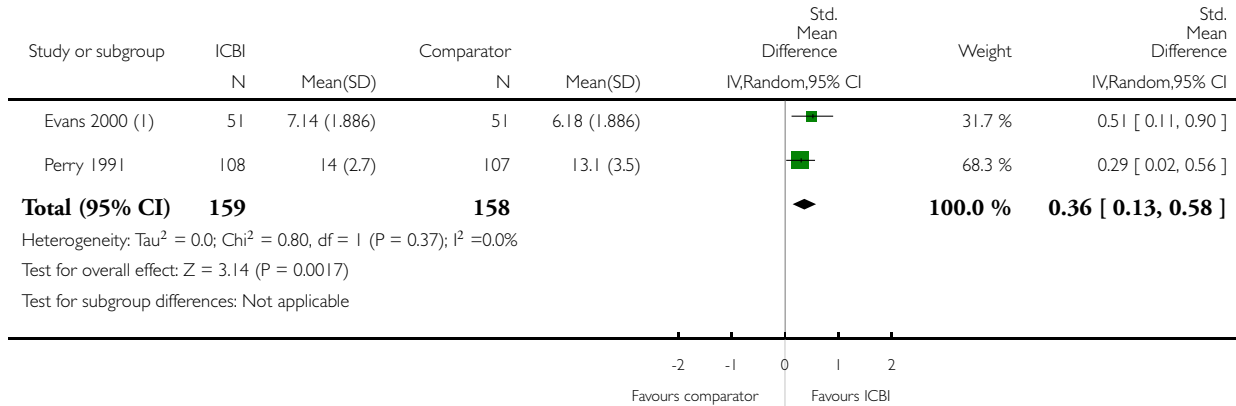
(2) Chlamydia PCR. Data from authors

Analysis 2.1. Comparison 2 ICBI versus face-to-face interventions, Outcome 1 Knowledge.

Review: Interactive computer-based interventions for sexual health promotion

Comparison: 2 ICBI versus face-to-face interventions

Outcome: 1 Knowledge



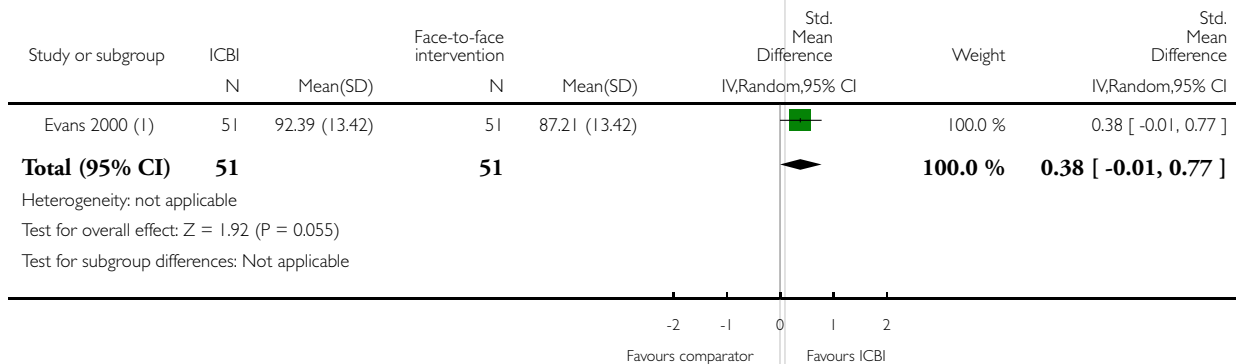
(1) SD calculated from F statistic. (F=39.21)

Analysis 2.2. Comparison 2 ICBI versus face-to-face interventions, Outcome 2 Self-efficacy.

Review: Interactive computer-based interventions for sexual health promotion

Comparison: 2 ICBI versus face-to-face interventions

Outcome: 2 Self-efficacy



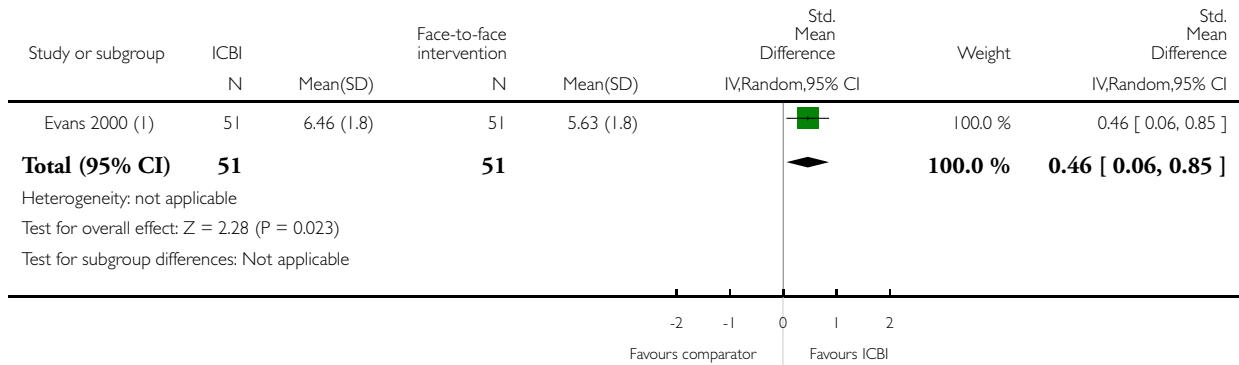
(1) SD calculated (F=1.91)

Analysis 2.3. Comparison 2 ICBI versus face-to-face interventions, Outcome 3 Intention.

Review: Interactive computer-based interventions for sexual health promotion

Comparison: 2 ICBI versus face-to-face interventions

Outcome: 3 Intention



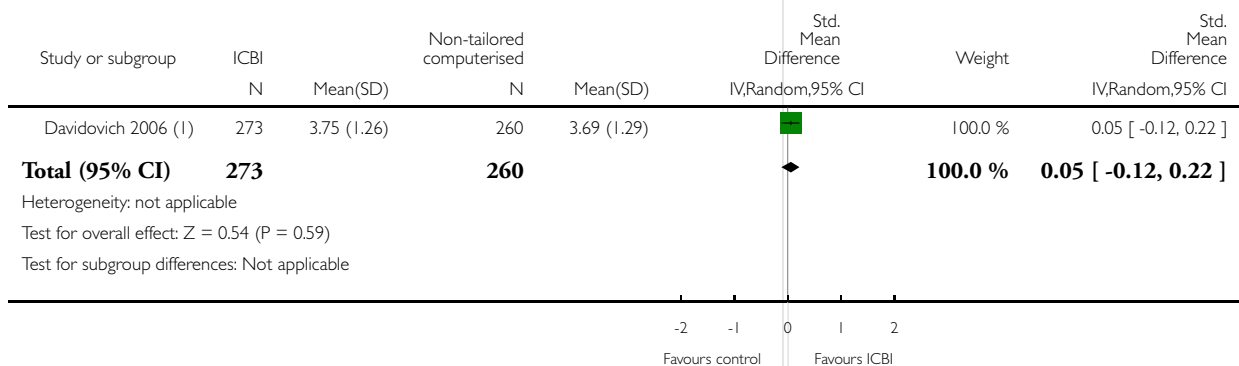
(1) SDs calculated (F=2.80)

Analysis 3.1. Comparison 3 ICBI versus non-tailored computerised intervention, Outcome 1 Self-efficacy.

Review: Interactive computer-based interventions for sexual health promotion

Comparison: 3 ICBI versus non-tailored computerised intervention

Outcome: 1 Self-efficacy



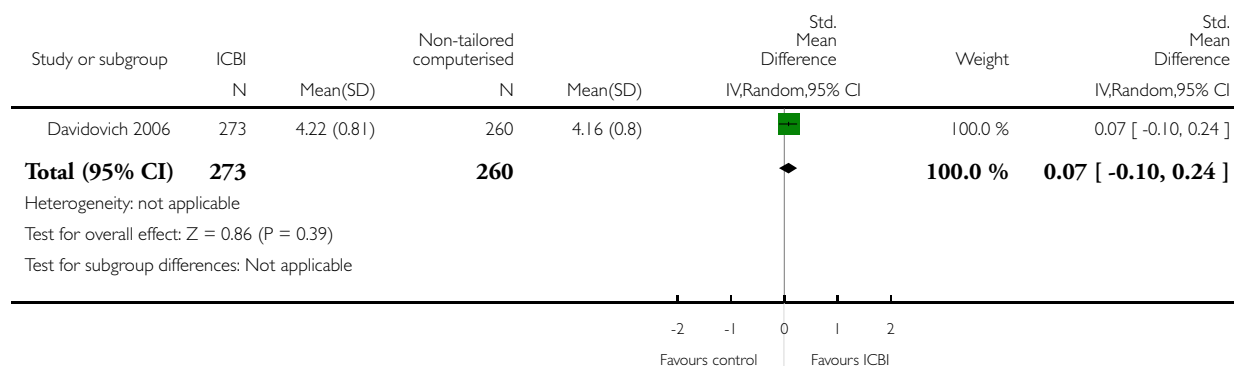
(1) Perceived behavioural control for safe sex outside the relationship

Analysis 3.2. Comparison 3 ICBI versus non-tailored computerised intervention, Outcome 2 Intention.

Review: Interactive computer-based interventions for sexual health promotion

Comparison: 3 ICBI versus non-tailored computerised intervention

Outcome: 2 Intention

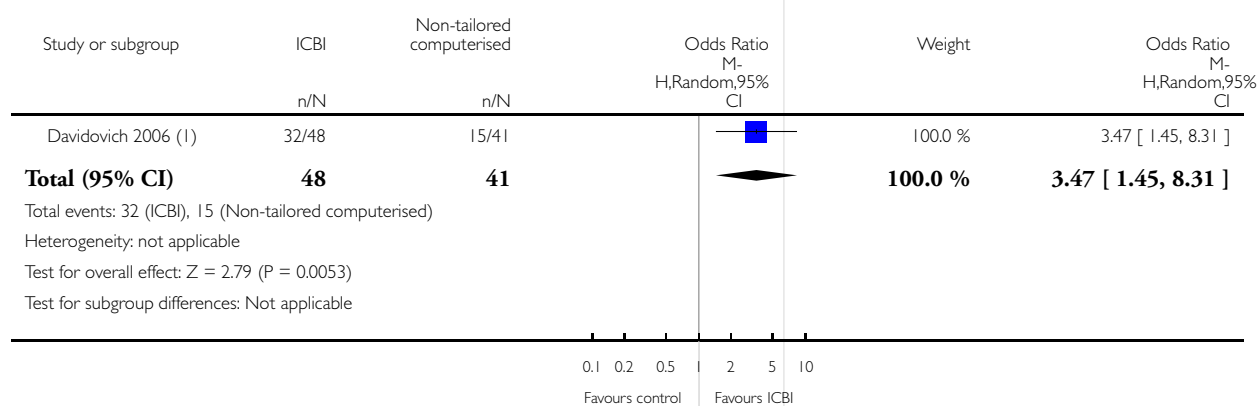


Analysis 3.3. Comparison 3 ICBI versus non-tailored computerised intervention, Outcome 3 Sexual behaviour (dichotomous).

Review: Interactive computer-based interventions for sexual health promotion

Comparison: 3 ICBI versus non-tailored computerised intervention

Outcome: 3 Sexual behaviour (dichotomous)



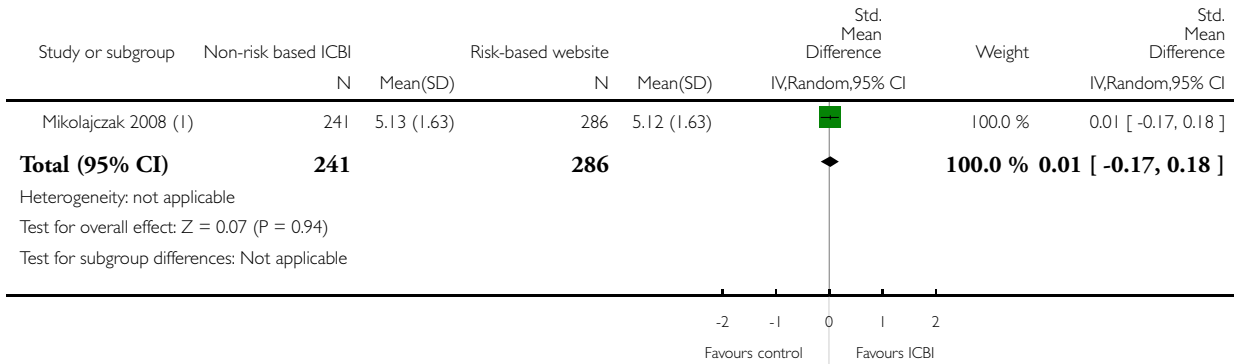
(1) Negotiated safety or condom use. Only men with a new steady partner since baseline. Data from authors

Analysis 4.1. Comparison 4 Non risk-based ICBI versus risk-based website, Outcome 1 Self-efficacy.

Review: Interactive computer-based interventions for sexual health promotion

Comparison: 4 Non risk-based ICBI versus risk-based website

Outcome: 1 Self-efficacy



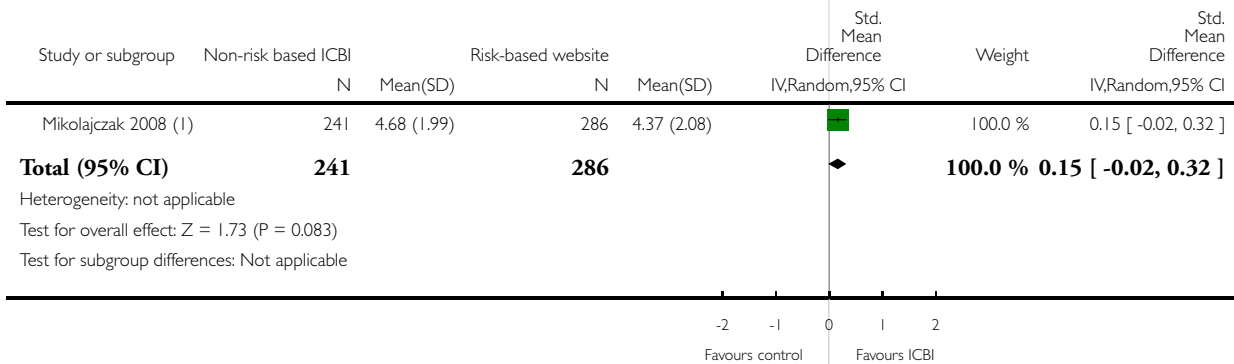
(1) Data from authors

Analysis 4.2. Comparison 4 Non risk-based ICBI versus risk-based website, Outcome 2 Intention.

Review: Interactive computer-based interventions for sexual health promotion

Comparison: 4 Non risk-based ICBI versus risk-based website

Outcome: 2 Intention



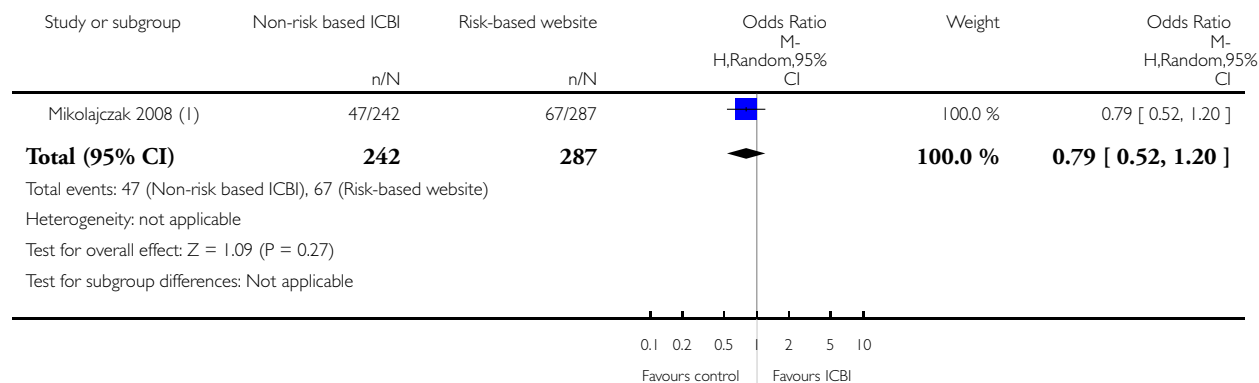
(1) Data from authors

Analysis 4.3. Comparison 4 Non risk-based ICBI versus risk-based website, Outcome 3 Sexual behaviour.

Review: Interactive computer-based interventions for sexual health promotion

Comparison: 4 Non risk-based ICBI versus risk-based website

Outcome: 3 Sexual behaviour



(1) STD/HIV test in last 3 months

ADDITIONAL TABLES

Table 1. Main outcomes: ICBI versus minimal comparator

Study	N at follow-up	Timing of follow-up	Cognitive outcomes				Be-havioural outcomes*	Biological outcomes*
			Knowl- edge*	Self- efficacy*	Intention*	Attitudes		
Avina 2006	ICBI 87 Waiting list 88	3 weeks 12 weeks					Alcohol control: no difference Sexual victimisation: no difference Perception of risky sexual communication: no difference	
Bowen 2007	ICBI 39 Waiting list 51	1 week	HIV/AIDS knowledge: improved	Safe sex assertiveness: improved		Outcomes of condom use:		

Table 1. Main outcomes: ICBI versus minimal comparator (Continued)

				Safe sex communication: improved		improved Outcomes of insisting on safe sex: improved		
Perry 1991/ Card 1993	Standard counselling plus ICBI 108 Standard counselling alone 113	3 months	HIV/AIDS knowledge: improved					HIV serology: no difference (no conversions) (HIV outcomes: ICBI 55, Control 86)
Davidovich 2006	Tailored ICBI 273 'No intervention' 300 (n's at immediate follow-up)	Immediate (cognitive) 6 months (behavioural) (Only men with steady partners at 6 months: ICBI 48; Control 41)		PBC for safe sex outside relationship: no difference PBC mutual HIV test: no difference PBC monogamy agreement: no difference PBC warning partner: no difference	Intention to practice negotiated safety: increased Intention to use condoms: increased	Response efficacy (knowledge of and belief in benefits of negotiated safety): increased	Negotiated safety with new steady partners: increased Condom use (with steady partner): no difference	Self-reported HIV status: not reported
Di Noia 2004	ICBI 104 Waiting list 99 (2 missing)	2 weeks	HIV/AIDS Knowledge: improved	Risk reduction self-efficacy: no difference (unadjusted)				
Downs 2004	ICBI 86 Leaflet or book 172	1, 3 and 6 months	Specific STD knowledge: no change General STD knowledge: no change				Abstinence: no change Condom use with every partner in last 3 months: no change	Chlamydia self-report: improved Chlamydia PCR: no change

Table 1. Main outcomes: ICBI versus minimal comparator (Continued)

							Condom failures: improved
Evans 2000	ICBI 51 'No intervention' 50	Immediately post	HIV knowledge: improved	HIV preventative self-efficacy: no difference	Intention: Condom use with current partner: no difference Condom use with future partners: no difference	Physical outcomes motivation: improved Social outcomes motivation: improved Self-evaluative outcome motivation: no difference	
Jenkins 2000	ICBI 103 Standard care 97	2 weeks 2 months	HIV knowledge: no difference		Readiness to change for condom use: no difference Readiness to change for partner choice: improved Readiness to change for alcohol consumption: no difference	Peer approval, perceived vulnerability to HIV: no difference Condom use with risky partners: sample too small Condom availability: no difference Sex with high risk partners: no difference Sharing needles, sexual bingeing, alcohol use, partners with genital warts or sores (?) Sex whilst on STI treatment: improved Visit for test of cure: no	

Table 1. Main outcomes: ICBI versus minimal comparator (Continued)

							difference Part- ner notifica- tion: no dif- ference Number of partners: no difference	
Kann 1987	ICBI 151 'No inter- vention' 93	5 weeks	Decision- making knowledge: improved Assertive- ness knowl- edge: improved Communi- cation knowledge: improved			Assertive- ness atti- tude: no dif- ference Interper- sonal com- munication attitude: im- proved	Decision- making be- haviour: im- proved Assertive- ness be- haviour: im- proved Interper- sonal com- mu- nication be- haviour: im- proved (Behavioural outcomes vaguely de- fined, so ex- cluded)	
Kiene 2006	ICBI 107 Nutrition tutorial 42	4 weeks	Condom knowledge: improved	Condom use efficacy and diffi- culty (skills) : no differ- ence	Con- dom use in- tentions: no difference Condom use stage of change: not reported	Condom- related attitudes: no difference Social norms re. condom use: no dif- ference	Keeping condoms handy: im- proved Con- dom use in last 30 days: improved Persuade partner to use con- doms: no difference	
Read 2006	ICBI 74 Standard care 36	2 months 3 months 5 months		Self-effi- cacy: no dif- ference	Be- havioural inten- tion: no dif- ference	Attitudes: no difference	Protected sexual behaviour (anal sex): improved (?)	

Table 1. Main outcomes: ICBI versus minimal comparator (Continued)

Roberto 2007	ICBI 139 Data collection only 187	5 months	Knowledge: improved	Condom self-efficacy: no change Situational self-efficacy: improved Refusal self-efficacy: no change Condom negotiation: improved		Attitude towards waiting: improved Susceptibility to pregnancy/STD/HIV: worsened	Ever had sexual intercourse: Number of partners in last 4 months: fewer Condom use at last intercourse: no change	
Van Laar 2000	Sexual health ICBI 14 Career planning ICBI 12	1 week		Contraceptive self-efficacy: no difference 4 brief self-efficacy scales: no difference		Attitude towards condoms scale: no difference Sexual risks scale (composite): no difference		

Authors' assessments of statistical significance of study outcomes

* Outcomes selected for meta-analysis are indicated in bold formatting

(?) Authors did not report directly on this comparison

PBC: Perceived behavioural control

Table 2. Main outcomes: ICBI versus face-to-face comparator

Study	N at follow-up	Timing of follow-up	Cognitive outcomes				Behavioural outcomes*	Biological outcomes*
			Knowledge*	Self-efficacy*	Intention*	Attitudes		
Alemi 1989	ICBI 20 Lecture/teaching 20	Immediately post	Knowledge: no difference between groups	Internal locus of control: greater with ICBI		Liberal/conservative attitudes: more liberal with ICBI (desirability of this is not		

Table 2. Main outcomes: ICBI versus face-to-face comparator (Continued)

						clear)		
Perry 1991/ Card 1993	counselling plus ICBI 108 counselling plus stress training 107	3 months	HIV/AIDS knowledge: improved					HIV serology: no difference (no conversions)
Evans 2000	ICBI 51 Lecture 51	Immediately post	HIV knowledge: improved	HIV preventative self-efficacy: no difference	Intention: condom use with current partner: improved Condom use with future partners: no difference	Physical outcomes motivation: no difference Social outcomes motivation: no difference Self-evaluative outcome motivation: improved		
Jenkins 2000	ICBI 103 Counselling 101	(2 weeks) 2 months	HIV knowledge: no difference		Readiness to change for condom use: no difference Readiness to change for partner choice: improved (?) Readiness to change for alcohol consumption: no difference	Peer approval, perceived vulnerability to HIV	Condom use with risky partners: sample too small to analyse Condom availability: no difference Sharing needles, sexual bingeing, alcohol use, carrying condoms, partners with genital warts or sores (?) Sex whilst on STI treat-	

Table 2. Main outcomes: ICBI versus face-to-face comparator (Continued)

							ment: improved Visit for test of cure: (?) Partner no- tification: (?) Sex with high risk partners: no difference Number of partners: no difference	
Kann 1987	ICBI 151 Lecture 147 (3 arm trial: au- thors com- pared face- to-face inter- vention with no interven- tion rather than face-to- face with ICBI.)	5 weeks	Decision- making knowledge: improved (?) Assertive- ness knowl- edge: improved (?) Communi- cation knowledge: improved (?)			Assertive- ness atti- tude: no dif- ference Interper- sonal com- munication attitude: im- proved (?)	Decision- making be- haviour: im- proved (?) Assertive- ness be- haviour: im- proved (?) Interper- sonal com- mu- nication be- haviour: im- proved (?) (Be- havioural outcomes vaguely de- fined, so ex- cluded)	

Authors' assessments of statistical significance of study outcomes

*Outcomes selected for meta-analysis are indicated in bold formatting

(?) Authors did not report directly on this comparison

Table 3. Main outcomes: ICBI versus different design of computer-based intervention

Study	N at follow-up	Timing of follow-up	Cognitive outcomes				Be- havioural outcomes*	Biological outcomes*
			Knowl- edge*	Self- efficacy*	Intention*	Attitudes		

Table 3. Main outcomes: ICBI versus different design of computer-based intervention (Continued)

Davidovich 2006	Tailored ICBI 273 Non-tai- lored com- puter- based inter- vention 260 (n's at imme- diate follow- up)	Immediate (cognitive) 6 months (be- havioural) (Only men with steady partners in- cluded in follow- up: ICBI 48; non-tailored 41)		PBC for safe sex out- side rela- tionship: no difference PBC mutual HIV test: no difference PBC monogamy agreement: no difference PBC warn- ing part- ner: no dif- ference	Intention to practice ne- gotiated sa- fety: no dif- ference Intention to use con- doms: no difference	Response ef- fi- cacy (knowl- edge of and be- lief in bene- fits of nego- tiated safety) : increased	Negotiated safety with new steady partners: no difference Condom use (with steady partner): no difference	Self-re- ported HIV status: not reported
Mikolajczak 2008	ICBI with non-risk framed mes- sages 241 Website with risk- framed mes- sages 286	3 months		Self- efficacy towards do- ing an STI/ HIV check up: no dif- ference (?)	Intention to do STI/ HIV test: no difference (?))	Attitude: no difference (?)) Social norm: no differ- ence (?)	STD/HIV test in last 3 months: no difference	

Authors' assessments of statistical significance of study outcomes

*Outcomes selected for meta-analysis are indicated in bold formatting

(?) Authors did not report directly on this comparison

PBC: Perceived behavioural control

APPENDICES

Appendix I. MEDLINE search strategy

Using Ovid platform

1. randomized controlled trial.pt.
2. controlled clinical trial.pt.
3. randomized controlled trials.sh.
4. random allocation.sh.
5. double blind method.sh.
6. single blind method.sh.
7. or/1-6
8. animals/ not (human/ and animals/)
9. 7 not 8

10. clinical trial.pt.
11. exp clinical trials/
12. (clinic\$ adj25 trial\$).ti,ab.
13. ((singl\$ or doubl\$ or trebl\$ or tripl\$) adj25 (blind\$ or mask\$)).ti,ab.
14. placebos.sh.
15. placebo\$.ti,ab.
16. random\$.ti,ab.
17. research design.sh.
18. (latin adj square).tw.
19. or/10-18
20. 19 not 8
21. 9 or 20
22. Comparative study.tw.
23. exp Evaluation studies/
24. Follow-up studies.sh.
25. Prospective studies.sh.
26. (control\$ or prospectiv\$ or volunteer\$).tw.
27. Cross-over studies.sh.
28. or/22-27
29. 28 not 8
30. 9 or 21 or 29
31. (Computers or microcomputers or computers, handheld).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
32. (Internet or local area networks).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
33. Computer Communication Networks/
34. Medical Informatics/
35. Medical Informatics Applications/
36. Decision Support Techniques/
37. Educational Technology/
38. Audiovisual Aids/
39. (Decision trees or decision aid\$).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
40. (Software or software design).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
41. Telecommunications/
42. Multimedia/ or Health Education/
43. (CD-ROM or Compact disks or cd-rom or CDROM).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
44. Computer-Assisted Instruction/
45. Public Health Informatics/
46. User-Computer Interface/
47. (Cellular phone or Cellular telephone or (Mobile phone or Mobile telephone) or (Cell phone or Cell telephone)).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
48. (Electronic mail or e-mail or email).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
49. Hypermedia/
50. Video Games/
51. (Video recording or DVD).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
52. Computer Graphics/
53. (World wide web or world-wide-web or www or world-wide web or worldwide web or website\$).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
54. Internet/
55. (Online or on-line).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
56. (Chat room\$ or chatroom\$).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
57. (blog\$ or web-log\$ or weblog\$).mp. [mp=title, original title, abstract, name of substance word, subject heading word]

58. (bulletin board\$ or bulletinboard\$ or messageboard\$ or message board\$).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
59. Interactive health communicat\$.mp. [mp=title, original title, abstract, name of substance word, subject heading word]
60. interactive televis\$.mp. [mp=title, original title, abstract, name of substance word, subject heading word]
61. interactive video\$.mp. [mp=title, original title, abstract, name of substance word, subject heading word]
62. Interactive technology.mp. [mp=title, original title, abstract, name of substance word, subject heading word]
63. Interactive multimedia.mp. [mp=title, original title, abstract, name of substance word, subject heading word]
64. E-health/ or electronic health/ or ehealth.mp. [mp=title, original title, abstract, name of substance word, subject heading word]
65. Consumer health informatic\$.mp. [mp=title, original title, abstract, name of substance word, subject heading word]
66. Virtual reality.mp. [mp=title, original title, abstract, name of substance word, subject heading word]
67. (surf\$ adj4 web\$).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
68. (surf\$ adj4 internet).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
69. or/31-68
70. (Intercourse or Unprotected intercourse).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
71. (Contraception or contracepti\$ behavio?r or contraception-barrier).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
72. (Contraceptive devices, male or contraceptive devices, female).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
73. (Rubber dams or dental dam\$).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
74. (Contraceptives-oral or contraceptives, oral, combined or contraceptives, oral, hormonal or Contraceptive pill).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
75. (contraceptives, postcoital or contraception, post-coital or morning-after pill or emergency contraception).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
76. Intrauterine Devices/
77. (Condoms or condoms-female).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
78. ((Reproductive adj behavio?r) or Coitus).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
79. (Sexual adj health).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
80. (Safe sex or safer sex or unsafe sex).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
81. Sexual Abstinence/
82. Sexuality/
83. Sexual Partners/
84. (Pregnancy, unplanned or pregnancy, unwanted or teen\$ pregnancy or pregnancy in adolescence or unplanned pregnancy or unwanted pregnancy).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
85. (Unplanned conception or unwanted conception or teen\$ conception or adolescent conception).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
86. (Abortion, induced or termination of pregnancy).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
87. Sexually Transmitted Diseases/
88. Sexually transmitted infection\$.mp. [mp=title, original title, abstract, name of substance word, subject heading word]
89. (Sexual behavior or sexual behavio?r).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
90. Sex Education/
91. (Sex counseling or sex counselling).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
92. (HIV or AIDS or Human immunodeficiency virus or Acquired immune deficiency syndrome or HIV antibodies or AIDS serodiagnosis or HIV infections).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
93. (Hepatitis A or Hepatitis B or Chlamydia trachomatis or chlamydia or Gonorrhoea or Neisseria Gonorrhoeae or gonorrhoea).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
94. (pelvic inflammatory disease or Trichomoniasis or papillomavirus infections or papillomavirus infections or papillomavirus vaccines).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
95. (syphilis or herpes genitalis or Chancroid or granuloma inguinale or condylomata accuminata or Bacterial Vaginosis).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
96. (Cervical cancer or uterine cervical neoplasms).mp. [mp=title, original title, abstract, name of substance word, subject heading word]

97. (Cervical intra-epithelial neoplasia or uterine cervical dysplasia).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
98. Orgasm/
 99. Libido/
 100. Reproductive Rights/
 101. Sexual Dysfunctions, Psychological/
 102. Sexual Dysfunction, Physiological/
 103. Dyspareunia/
 104. Impotence/
 105. Rape/
 106. Sexual satisfaction.mp.
 107. Sexual pleasure.mp.
 108. Sexual assault.mp.
 109. Sexual problem.mp.
 110. or/70-109
 111. 30 and 69 and 110
- 3778 unique citations downloaded to Reference Manager

Appendix 2. EMBASE search strategy

Using Dialog Datastar platform

1. COMPUTER#.W..DE. OR MICROCOMPUTER.W..DE.
2. COMPUTER\$
3. INTERNET
4. INTERNET#.W..DE. OR INTERNET-PROTOCOL#.DE.
5. LOCAL-AREA-NETWORK#.DE.
6. COMPUTER-NETWORK#.DE.
7. MEDICAL-INFORMATICS#.DE.
8. EDUCATIONAL-TECHNOLOGY#.DE.
9. AUDIOVISUAL-EQUIPMENT#.DE.
10. DECISION-MAKING#.DE. OR DECISION-SUPPORT-SYSTEM#.DE. OR DECISION-TREE#.DE. OR DECISION-THEORY#.DE.
11. COMPUTER-PROGRAM#.DE.
12. TELECOMMUNICATION#.W..DE.
13. MULTIMEDIA#.W..DE.
14. CD-ROM OR CDROM
15. COMPACT-DISK#.DE.
16. COMPUTER-ASSISTED-THERAPY#.DE. OR COMPUTER-PROGRAM#.DE. OR HUMAN-COMPUTER-INTERACTION#.DE. OR COMPUTER-INTERFACE#.DE.
17. COMPUTER-NETWORK#.DE. OR ONLINE-SYSTEM#.DE. OR ONLINE-SYSTEM#.DE.
18. MEDICAL-INFORMATICS#.DE.
19. MOBILE-PHONE#.DE.
20. CELLULAR ADJ PHONE OR CELLULAR ADJ TELEPHONE OR MOBILE ADJ PHONE OR MOBILE ADJ TELEPHONE
21. ELECTRONIC ADJ MAIL OR EMAIL OR E-MAIL
22. HYPERMEDIA
23. VIDEO ADJ GAMES\$
24. VIDEO ADJ RECORDING OR DVD
25. COMPUTER-GRAPHICS#.DE.
26. WORLD ADJ WIDE ADJ WEB OR WORLD-WIDE-WEB
27. WORLD-WIDE ADJ WEB OR WORLDWIDE ADJ WEB
28. WEB ADJ SITE OR WEBSITE
29. (ONLINE OR ON-LINE).TI.

30. CHAT ADJ ROOM OR CHATROOM
31. BLOG\$ OR WEB-LOG\$ OR WEBLOG\$
32. BULLETIN ADJ BOARD\$ OR BULLETINBOARD\$ OR MESSAGEBOARD\$ OR MESSAGE ADJ BOARD\$
33. INTERACTIVE ADJ HEALTH ADJ COMMUNICATION\$
34. INTERACTIVE ADJ TELEVIS\$
35. INTERACTIVE ADJ VIDEO
36. INTERACTIVE ADJ TECHNOLOGY
37. INTERACTIVE ADJ MULTIMEDIA
38. E-HEALTH OR EHEALTH OR EHEALTH
39. ELECTRONIC ADJ HEALTH
40. CONSUMER ADJ HEALTH ADJ INFORMATICS\$
41. VIRTUAL ADJ REALITY
42. VIRTUAL-REALITY#.DE.
43. SURF\$ NEAR WEBS\$
44. SURF\$ NEAR INTERNET
45. 1 OR 2 OR 3 OR 4 OR 5 OR 6 OR 7 OR 8 OR 9 OR 10 OR 11 OR 12
46. 13 OR 14 OR 15 OR 16 OR 17 OR 18 OR 19 OR 20 OR 21 OR 22 OR 23
47. 24 OR 25 OR 26 OR 27 OR 28 OR 29 OR 30 OR 31 OR 32 OR 33
48. 34 OR 35 OR 36 OR 37 OR 38 OR 39 OR 40 OR 41 OR 42 OR 43 OR 44
49. 45 OR 46 OR 47 OR 48
50. SEXUAL-INTERCOURSE#.DE.
51. UNPROTECTED ADJ INTERCOURSE
52. CONTRACEPTION#.W..DE. OR CONTRACEPTIVE-AGENT#.DE. OR VAGINA-CONTRACEPTION#.DE.
53. BARRIER-CONTRACEPTION#.DE. OR HORMONAL-CONTRACEPTION#.DE. OR INTRAUTERINE-CONTRACEPTIVE-DEVICE#.DE. OR ORAL-CONTRACEPTION#.DE. OR EMERGENCY-CONTRACEPTION#.DE.
54. LOW-DOSE-ORAL-CONTRACEPTIVE#.DE. OR ORAL-CONTRACEPTIVE-AGENT#.DE.
55. CONTRACEPTIVE-DEVICE#.DE. OR UTERINE-CERVIX-CAP#.DE. OR INJECTABLE-CONTRACEPTIVE-AGENT#.DE.
56. POSTCOITUS-CONTRACEPTIVE-AGENT#.DE.
57. CONTRACEPTIVE ADJ PILL
58. DENTAL ADJ DAM\$
59. RUBBER ADJ DAMS
60. EMERGENCY ADJ CONTRACEPTION
61. POSTCOITAL ADJ CONTRACEPTION
62. CONDOM\$
63. CONDOM#.W..DE.
64. REPRODUCTIVE-HEALTH#.DE. OR REPRODUCTIVE-RIGHTS#.DE.
65. REPRODUCTIVE ADJ BEHAVIOR
66. SEXUAL-HEALTH#.DE.
67. SEXUAL ADJ HEALTH
68. SAFE-SEX#.DE.
69. UNSAFE-SEX#.DE.
70. SAFE\$ ADJ SEX
71. UNSAFE ADJ SEX
72. SEXUAL-BEHAVIOR#.DE.
73. SEXUAL ADJ ABSTINENCE
74. SEXUALITY#.W..DE.
75. SEXUAL ADJ PARTNERS\$
76. TEEN\$ ADJ PREGNANCY
77. UNPLANNED ADJ PREGNANCY
78. UNWANTED ADJ PREGNANCY
79. ADOLESCENT ADJ PREGNANCY
80. ADOLESCENT-PREGNANCY#.DE. OR UNPLANNED-PREGNANCY#.DE. OR UNWANTED-PREGNANCY#.DE.

81. ABORTION#.W..DE.
82. INDUCED-ABORTION#.DE.
83. TERMINAT\$ WITH PREGNANCY
84. SEXUALLY-TRANSMITTED-DISEASE#.DE.
85. SEXUALLY ADJ TRANSMITTED ADJ INFECTION\$
86. SEXUAL ADJ BEHAVIO\$
87. SEXUAL-EDUCATION#.DE.
88. SEX\$ ADJ EDUCATION
89. SEX\$ ADJ COUNSELLING OR SEX\$ ADJ COUNSELING
90. HUMAN-IMMUNODEFICIENCY-VIRUS#.DE. OR HIV-EDUCATION#.DE. OR HUMAN-IMMUNODEFICIENCY-VIRUS-VACCINE#.DE. OR HUMAN-IMMUNODEFICIENCY-VIRUS-1#.DE. OR HUMAN-IMMUNODEFICIENCY-VIRUS-2#.DE.
91. HUMAN-IMMUNODEFICIENCY-VIRUS-ANTIBODY#.DE.
92. ACQUIRED-IMMUNE-DEFICIENCY-SYNDROME#.DE.
93. HIV
94. HUMAN ADJ IMMUNODEFICIENCY ADJ VIRUS
95. HIV ADJ TEST
96. HEPATITIS#.W..DE. OR HEPATITIS-A#.DE. OR HEPATITIS-A-VIRUS#.DE. OR HEPATITIS-B#.DE. OR HEPATITIS-B-VACCINE#.DE. OR HEPATITIS-B-VIRUS#.DE. OR HEPATITIS-C#.DE. OR HEPATITIS-C-VIRUS#.DE.
97. CHLAMYDIA-TRACHOMATIS#.DE.
98. CHLAMYDIA
99. GONORRHEA#.W..DE.
100. GONORRH\$
101. NEISSERIA-GONORRHOEAE#.DE.
102. PELVIC-INFLAMMATORY-DISEASE#.DE.
103. TRICHOMONIASIS#.W..DE.
104. TRICHOMONAS
105. WART-VIRUS#.DE. OR WART-VIRUS-VACCINE#.DE.
106. PAPILLOMA ADJ VIRUS OR PAPILLOMAVIRUS
107. SPHILIS#.W..DE. OR SYPHILIS-SEROLOGY#.DE.
108. GENITAL ADJ HERPES
109. GENITAL-HERPES#.DE.
110. GRANULOMA-INGUINALE#.DE.
111. CONDYLOMATA ADJ ACUMINATA
112. BACTERIAL ADJ VAGINOSIS
113. UTERINE-CERVIX-CANCER#.DE.
114. UTERINE-CERVIX-DYSPLASIA#.DE.
115. CERVICAL ADJ SMEAR
116. ORGASM#.W..DE. OR ORGASM-DISORDER#.DE. OR ANORGASMIA#.W..DE.
117. LIBIDO#.W..DE. OR LIBIDO-DISORDER#.DE. OR LIBIDO#.W..DE.
118. SEXUAL-DYSFUNCTION#.DE. OR FEMALE-SEXUAL-DYSFUNCTION#.DE. OR PSYCHOSEXUAL-DISORDER#.DE.
119. DYSPAREUNIA#.W..DE.
120. IMPOTENCE#.W..DE. OR PSYCHOGENIC-IMPOTENCE#.DE. OR ORGANIC-IMPOTENCE#.DE.
121. RAPE.W..DE.
122. SEXUAL-CRIME#.DE.
123. SEXUAL ADJ ASSAULT
124. SEXUAL-SATISFACTION#.DE.
125. SEXUAL ADJ SATISFACTION
126. SEXUAL ADJ PLEASURE
127. SEXUAL ADJ FREEDOM
128. 50 OR 51 OR 52 OR 53 OR 54 OR 55 OR 56 OR 57 OR 58 OR 59 OR 60 OR 61 OR 62 OR 63 OR 64 OR 65 OR 66 OR 67 OR 68

129. 69 OR 70 OR 71 OR 72 OR 73 OR 74 OR 75 OR 76 OR 77 OR 78 OR 79 OR 80 OR 81 OR 82 OR 83
 130. 84 OR 85 OR 86 OR 87 OR 88 OR 89 OR 90 OR 91 OR 92 OR 93 OR 94 OR 95 OR 96 OR 97 OR 98 OR 99 OR 100
 OR 101 OR 102
 131. 103 OR 104 OR 105 OR 106 OR 107 OR 108 OR 109 OR 110 OR 111 OR 112 OR 113
 132. 114 OR 115 OR 116 OR 117 OR 118 OR 119 OR 120 OR 121 OR 122 OR 123 OR 124 OR 125 OR 126 OR 127
 133. 128 OR 129 OR 130 OR 131 OR 132
 134. RANDOMIZED-CONTROLLED-TRIAL#.DE. OR RANDOMIZED-CONTROLLED-TRIAL#.DE.
 135. CONTROLLED-CLINICAL-TRIAL#.DE. OR CLINICAL-TRIAL#.DE. OR CLINICAL-TRIAL#.DE.
 136. RANDOMIZATION#.W..DE.
 137. DOUBLE-BLIND-PROCEDURE#.DE.
 138. SINGLE-BLIND-PROCEDURE#.DE.
 139. 134 OR 135 OR 136 OR 137 OR 138
 140. ANIMAL#.W..DE.
 141. HUMAN#.W..DE.
 142. 140 AND 141
 143. 140 NOT 142
 144. CLINICAL-TRIAL#.DE. OR CLINICAL-TRIAL#.DE. OR CLINICAL-TRIAL#.DE.
 145. CLINIC\$ WITH TRIAL\$
 146. (SINGL\$ OR DOUBL\$ OR TREBL\$ OR TRIPL\$) WITH (BLIND\$ OR MASK\$)
 147. PLACEBO#.W..DE. OR PLACEBO#.W..DE.
 148. PLACEBO\$
 149. RANDOM\$
 150. LATIN ADJ SQUARE
 151. 144 OR 145 OR 146 OR 147 OR 148 OR 149 OR 150
 152. COMPARATIVE-STUDY#.DE.
 153. COMPARATIVE ADJ STUDY
 154. EVALUATION#.W..DE.
 155. FOLLOW-UP#.DE.
 156. PROSPECTIVE-STUDY#.DE.
 157. CONTROL\$ OR PROSPECTIV\$ OR VOLUNTEERS\$
 158. CROSSOVER-PROCEDURE#.DE.
 159. 152 OR 153 OR 154 OR 155 OR 156 OR 157 OR 158
 160. 139 OR 151 OR 159
 161. 160 NOT 143
 162. 49 AND 133 AND 161
 4275 unique references downloaded to Reference Manager

Appendix 3. PsycINFO search strategy

Using Dialog Datastar platform

1. Computers#.w.de or analog computers.de or microcomputers#.w.de
2. Computers.ti,ab
3. Internet.ti.ab
4. Internet#.w.de or online therapy#.de or online social networks#.de or Internet usage#.de
5. Decision support systems#.de
6. Computer software#.de
7. Telecommunications medi#.de
8. (CD adj ROM or CDROM).ti,ab
9. Computer assisted instruction#.de or computer assisted therapy#.de or computer games#.de or human computer interaction#.de or computer mediated communication#.de or computer simulation#.de
10. Online social networks#.de or online therapy#.de
11. (Cellular adj phone or cellular adj telephone or mobile adj phone or mobile adj telephone).ti.ab

12. (Electronic adj Mail or email or e-mail).ti
13. hypermedia#.w.de
14. Computer games#.de
15. DVD.ti,ab
16. Video.ti,ab
17. (World adj wide adj web or world wide web or worldwide adj web or world-wide adj web).ti,ab
18. websites#.w.de
19. (web or website).ti,ab
20. (online or on-line).ti
21. (chat adj room or chatroom).ti,ab
22. (blog\$ or web log\$ or weblog\$).ti,ab
23. bulletin adj board\$ or message adj board\$
24. messageboard\$ or message adj board\$
25. (interactive adj health adj communication\$).ti,ab
26. (interactive adj televis\$).ti,ab
27. (interactive adj video).ti,ab
28. (interactive adj technology).ti,ab
29. (interactive adj multimedia).ti,ab
30. (E-health or ehealth or ehealth).ti,ab
31. (Electronic adj health).ti,ab
32. (consumer adj health adj informatics).ti,ab
33. virtual reality#.de
34. (surf near web\$).ti,ab
35. (surf near Internet).ti,ab
36. 1 OR 2 OR 3 OR 4 OR 5 OR 6 OR 7 OR 8 OR 9 OR 10 OR 11 OR 12 OR 13 OR 14 OR 15 OR 16 OR 17 OR 18
37. 19 OR 20 OR 21 OR 22 OR 23 OR 24 OR 25 OR 26 OR 27 OR 28 OR 29 OR 30 OR 31 OR 32 OR 33 OR 34 OR 35
38. 36 OR 37
39. Sexual intercourse human#.de
40. Contraceptive devices#.de or oral contraceptives#.de
41. Birth control#.de
42. Contracep\$.ti
43. (postcoital adj contraception).ti,ab
44. (Emergency adj contraception).ti,ab
45. Condoms#.w.de
46. Condom\$.ti,ab
47. (Sexual adj health).ti,ab
48. Safe sex#.de
49. (Unsafe adj sex).ti,ab
50. Sexual abstinence#.de or sexual abuse#.de or extramarital intercourse#.de or sexual arousal#.de or sexual attitudes#.de or psychosexual behavior#.de or orgasm#.d eor promiscuity#.de or inhibited sexual desire#.de or female sexual dysfunction#.de or sexual partners#.de or sexual risk taking#.de or sexuality#.de
51. (teens adj pregnancy).ti,ab
52. (unplanned adj pregnancy).ti,ab
53. (unwanted adj pregnancy).ti,ab
54. (adolescent adj pregnancy).ti,ab
55. Adolescent pregnancy#.de
56. Induced abortion#.de
57. Abortion.ti,ab
58. (termination with pregnancy).ti,ab
59. Sexually transmitted diseases'.de
60. (sexually adj transmitted).ti,ab
61. (sexual adj behavio\$).ti,ab
62. (sex adj education).ti,ab

63. (sex adj counselling or sex\$ adj counseling).ti,ab
 64. HIV#.de or HIV testing#.de
 65. HIV.ti,ab
 66. Gonorrh\$.ti,ab
 67. (hepatitis adj B).ti,ab
 68. (pelvic adj inflammatory adj disease).ti,ab
 69. Chlamydia\$.ti,ab
 70. Herpes genitalis#.de
 71. (cervical adj cytology).ti,ab
 72. (pap adj smear).ti,ab
 73. (pap adj test).ti,ab
 74. (cervical adj smear).ti,ab
 75. libido#w.de
 76. (sexual adj dysfunction).ti,ab
 77. Erectile dysfunction#.de
 78. Sexual satisfaction#.de
 79. (sexual adj pleasure).ti,ab
 80. 39 OR 40 OR 41 OR 42 OR 43 OR 44 OR 45 OR 46 OR 47 OR 48 OR 49 OR 50 OR 51 OR 52 OR 53 OR 54
 81. 55 OR 56 OR 57 OR 58 OR 59 OR 60 OR 61 OR 62 OR 63 OR 64 OR 65
 82. 66 OR 67 OR 68 OR 69 OR 70 OR 71 OR 72 OR 73 OR 74 OR 75 OR 76 OR 77 OR 78 OR 79
 83. 80 OR 81 OR 82
 84. Clinical trials#.de
 85. Randomised adj controlled adj trial or randomized adj controlled adj trial
 86. clinic\$ with trial\$
 87. (singl\$ or doubl\$ or trebl\$ or tripl\$) with (blind\$ or mask\$)
 88. Placebo\$
 89. Placebo#w.de
 90. Random\$
 91. Comparative adj study
 92. Experiment controls#.de
 93. Random\$ with allocat\$
 94. Pre adj test or pretest or post adj test or posttest
 95. Trial.ti,ab
 96. RCT.ti,ab
 97. Prospective adj study
 98. Follow adj up adj study
 99. Experimental design#.de or experimental methods#.de
 100. Economic adj evaluation
 101. 84 OR 85 OR 86 OR 87 OR 88 OR 89 OR 90 OR 91 OR 92 OR 93 OR 94 OR 95 OR 96 OR 97 OR 98 OR 99 OR 100
 102. 38 AND 83 AND 101
- 417 unique citations downloaded to Reference Manager

Appendix 4. CINAHL search strategy

Using Dialog Datastar platform

1. CLINICAL-TRIALS#.DE.
2. RANDOMISED ADJ CONTROLLED ADJ TRIAL OR RANDOMIZED ADJ CONTROLLED ADJ TRIAL
3. CLINIC\$ WITH TRIAL\$
4. (SINGL\$ OR DOUBL\$ OR TREBL\$ OR TRIPL\$) WITH (BLIND\$ OR MASK\$)
5. PLACEBO\$
6. RANDOM\$,
7. COMPARATIVE ADJ STUDY
8. RANDOM\$ WITH ALLOCAT\$
9. PRE ADJ TEST OR PRETEST OR POST ADJ TEST OR POSTTEST
10. TRIAL.TI,AB
11. RCT.TI,AB
12. PROSPECTIVE ADJ STUDY
13. FOLLOW ADJ UP OR FOLLOW-UP
14. ECONOMIC ADJ EVALUATION
15. Single-Blind-Studies#.DE
16. Double-Blind-Studies#.DE.
17. Experimental-Studies#.DE. OR Quasi-Experimental-Studies#.DE.
18. Control-Group#.DE. OR Pretest-Posttest-Control-Group-Design#.DE.
19. 1 OR 2 OR 3 OR 4 OR 5 OR 6 OR 7
20. 8 OR 9 OR 10 OR 11 OR 12 OR 13 OR 14 OR 15 OR 16 OR 17 OR 18
21. 19 OR 20
22. Decision-Making-Computer-Assisted#.DE. OR Computerized-Educational-Testing#.DE. OR Computer-Assisted-Instruction#.DE. OR Therapy-Computer-Assisted.DE. OR Therapy-Computer-Assisted#.DE.
23. Attitude-To-Computers#.DE. OR Computer-Communication-Networks#.DE. OR Computer-Environment#.DE. OR Computer-Graphics#.DE. OR Computers-Hand-Held#.DE. OR User-Computer-Interface#.DE.
24. Computer-Literacy#.DE. OR Microcomputers#.W..DE. OR Computers-Portable#.DE. OR Artificial-Intelligence#.DE. OR Computerized-Educational-Testing#.
25. Computer-Aided-Design.DE.
26. computer\$.TI., unrestricted
27. internet.TI., unrestricted
28. Internet#.W..DE., unrestricted
29. (online OR on-line).TI.
30. website.TI,AB., unrestricted
31. Online-Systems#.DE.
32. Decision-Making-Computer-Assisted#.DE. OR Decision-Trees#.DE.
33. Telecommunications#.W..DE.
34. (CD ADJ ROM OR cdrom).TI,AB.
35. (cellular ADJ phone OR cellular ADJ telephone OR mobile ADJ phone OR mobile ADJ telephone).TI,AB.
36. (electronic ADJ mail OR email OR e-mail).TI,AB.
37. Hypermedia#.W..DE
38. dvd.TI,AB
39. Video.TI,AB
- 40.(world ADJ wide ADJ web OR world-wide-web OR worldwide ADJ web OR world-wide ADJ web).TI,AB
41. Website-Development#.DE
42. (chatroom OR chat-room OR chat ADJ room).TI,AB.,
43. blog\$ OR web-log\$ OR weblog\$
44. (bulletin ADJ board\$ OR bulletinboard\$ OR messageboard\$ OR message ADJ board\$).TI,AB
45. (interactive ADJ health ADJ communication\$).TI,AB.,
46. (interactive ADJ multimedia).TI,AB
47. (interactive ADJ televis\$).TI,AB

48. (interactive ADJ technology).TI,AB
49. (interactive ADJ video).TI,AB
50. (E-health OR ehealth OR ehealth).TI,AB
51. (Consumer ADJ health ADJ informatic\$).TI,AB
52. Virtual-Reality#.DE.
53. (surf\$ NEAR internet).TI,AB
54. (surf\$ NEAR web\$).TI,AB
55. 22 OR 23 OR 24 OR 25 OR 26 OR 27 OR 28 OR 29 OR 30
56. 31 OR 32 OR 33 OR 34 OR 35 OR 36 OR 37 OR 38 OR 39 OR 40
57. 41 OR 42 OR 43 OR 44 OR 45 OR 46 OR 47 OR 48 OR 49 OR 50 OR 51 OR 52 OR 53 OR 54
58. 55 OR 56 OR 57
59. Sexual-Abstinence#.DE. OR Sexuality#.W..DE. OR Sex-Education#.DE. OR Unsafe-Sex#.DE. OR Sexual-Partners#.DE. OR Safe-Sex#.DE
60. Coitus#.W..DE. OR Sexuality#.W..DE. OR Attitude-To-Sexuality#.DE
61. Sexually-Transmitted-Diseases#.DE. OR Sexually-Transmitted-Diseases-Bacterial#.DE. OR Sexually-Transmitted-Diseases-Viral#.DE
62. Sexual-Health#.DE
63. Sex-Education#.DE
64. Contraception#.W..DE. OR Contraceptives-Postcoital#.DE
65. Contraceptive-Agents#.DE. OR Contraceptives-Oral-Combined#.DE. OR Contraceptives-Oral#.DE. OR Contraceptives-Postcoital#.DE. OR Contraceptives-Oral-Combined#.DE
66. Family-Planning#.DE
67. contracep\$.TI,AB
68. Condom\$.TI,AB
69. Condoms#.W..DE. OR Female-Condoms#.DE
70. (unsafe ADJ sex).TI,AB
71. (safe NEAR sex).TI,AB
72. (Teen\$ NEAR pregnancy).TI,AB
73. (adolescent NEAR pregnancy).TI,AB
74. (Unwanted NEAR pregnancy).TI,AB
75. (Unplanned NEAR pregnancy).TI,AB
76. Abortion-Induced#.DE
77. (Termination WITH pregnancy).TI,AB
78. Abortion.TI,AB
79. (Sexually NEAR transmitted).TI,AB
80. Human-Immunodeficiency-Virus#.DE. OR Hiv-Education#.DE. OR Hiv-Infections#.DE. OR Hiv-Seropositivity#.DE
81. HIV.TI,AB
82. Gonorrh\$.TI,AB
83. (hepatitis ADJ b).TI,AB
84. (pelvic ADJ inflammatory ADJ disease OR PID).TI,AB
85. Chlamydia\$.TI,AB
86. Herpes.TI,AB
87. Cervical-Smears#.DE
88. (Sexual ADJ satisfaction).TI,AB
89. (Sexual ADJ dysfunction).TI,AB
90. (Sexual ADJ pleasure).TI,AB
91. (Pap ADJ (test OR smear)).TI,AB
92. (Sexual ADJ health ADJ promotion).TI,AB
93. 59 OR 60 OR 61 OR 62 OR 63 OR 64 OR 65 OR 66 OR 67 OR 68 OR 69 OR 70 OR 71 OR 72 OR 73 OR 74 OR 75 OR 76
94. 77 OR 78 OR 79 OR 80 OR 81 OR 82 OR 83 OR 84 OR 85 OR 86 OR 87 OR 88 OR 89 OR 90 OR 91 OR 92
95. 93 OR 94
96. Animals#.W..DE. OR Animal-Studies#.DE
97. 21 AND 58 AND 95

98. 97 NOT 96

681 unique references downloaded to Reference Manager database.

Appendix 5. Trial register search strategy

Shortened search for trial registers

1. Internet
 2. Computer or computers
 3. Medical Informatics
 4. Educational Technology
 5. Software or software design
 6. CD-ROM or Compact disks or cd-rom or CDROM
 7. Computer-Assisted Instruction
 8. (Cellular phone or Cellular telephone or Mobile phone or Mobile telephone or Cell phone or Cell telephone)
 9. Hypermedia
 10. Video Games or DVD
 11. (World wide web or world-wide-web or world-wide web or worldwide web or website
 12. (Online or on-line).
 13. (Chat room\$ or chatroom\$)
 14. (blog\$ or web-log\$ or weblog\$
 15. (bulletin board\$ or bulletinboard\$ or messageboard\$ or message board\$
 16. Interactive televis\$
 17. Interactive video\$
 18. Interactive technology
 19. Interactive multimedia.mp
 20. E-health/ or electronic health/ or ehealth
- AND
21. Contraception or contraceptive behavior/behaviour
 22. (Contraceptives-oral or oral contraceptive or Contraceptive pill)
 23. (contraceptives, postcoital or post-coital contraception or morning-after pill or emergency contraception or emergency pill)
 24. Unprotected intercourse
 25. (Condoms or condoms-female
 26. Sexual health
 27. (Safe sex or safer sex or unsafe sex)
 28. Sexual Abstinence
 29. Sexual Partners
 30. (Pregnancy, unplanned or pregnancy, unwanted or teen\$ pregnancy or pregnancy in adolescence or unplanned pregnancy or unwanted pregnancy)
 31. (Unplanned conception or unwanted conception or teen\$ conception or adolescent conception)
 32. (Abortion, induced or termination of pregnancy)
 33. Sexually Transmitted Disease
 34. Sexually transmitted infection
 35. Sexual behavior or sexual behaviour
 36. Sex Education
 37. (HIV or AIDS or Human immunodeficiency virus or Acquired immune deficiency syndrome or HIV antibodies or AIDS serodiagnosis or HIV infections)
 38. Chlamydia trachomatis or chlamydia or Gonorrhoea or Neisseria Gonorrhoeae or gonorrhoea).
 39. Papillomavirus infections or papillomavirus vaccines or human papillomavirus
 40. (Cervical cancer or uterine cervical neoplasms)
 41. (Cervical intra-epithelial neoplasia or uterine cervical dysplasia)
 42. Orgasm
 43. Libido

44. Reproductive Rights
45. Sexual Dysfunction
46. Dyspareunia
47. Impotence
48. Rape
49. Sexual satisfaction
50. Sexual pleasure
51. Sexual assault
52. Sexual problem

Appendix 6. Search strategy for Web of Science database

1. Topic= (computer* or internet or video)
 2. Title= (CDROM)
 3. Title= (DVD)
 4. Topic= (technology or multimedia or ehealth)
 5. (1 or 2 or 3 or 4)
 6. Topic = (sexual*)
 7. Topic = (condom)
 8. Topic = (HIV)
 9. Topic = (contracept*)
 10. Topic = (gonorrh* or chlamydia or syphilis or HPV or human papillomvirus)
 11. (6 or 7 or 8 or 9 or 10)
 12. (5 AND 11)
 13. Topic = (animal)
 14. (12 not 13)
 15. Topic = (rat)
 16. (14 not 15)
 17. Topic = (trial or random* or experiment*)
 18. Topic = (evaluat*)
 19. Topic = (random* control* trial)
 20. (17 or 18 or 19)
 21. (16 AND 20)
 22. (21 not (13 or 15))
- 1,689 Citations downloaded to Reference Manager

Appendix 7. British Education Index, Campbell Collaboration databases, Bibliomap search strategies

1. Computer*
2. Internet
3. Website
4. Online
5. Video
6. DVD
7. CD-ROM
8. Technolog*
9. Multimedia
10. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9
11. Sexual*
12. HIV
13. Condom

14. "sex education"
15. "sexually transmitted"
16. Gonorrh*
17. Chlamydia
18. Syphilis
19. Contracept*
20. Birth control
21. Pregnant*
22. 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21
21. 10 AND 23

Appendix 8. Cochrane Central Register of Controlled Trials

1. (computer* or internet or online or interactive or web*) in Title, Abstract or Keywords
 2. (sexual* or HIV or contracept* or chlamydia* or gonorrh* or condom* or "family planning" or abstinence or "sex education") in Title, Abstract or Keywords
 3. 1 and 2
- 250 results out of 522340 records

HISTORY

Date	Event	Description
17 June 2008	Amended	Converted to new review format.

CONTRIBUTIONS OF AUTHORS

Roles and responsibilities

- Drafting the protocol: Julia Bailey, Elizabeth Murray, Greta Rait, Catherine Mercer, Richard Morris, Richard Peacock, Jackie Cassell, Irwin Nazareth.
- Developing a search strategy: Julia Bailey, Richard Peacock, Elizabeth Murray and Greta Rait.
- Searching for trials: Julia Bailey and Greta Rait.
- Obtaining copies of trials: Julia Bailey and Greta Rait.
- Selecting trials for inclusion: Julia Bailey and Greta Rait, with Elizabeth Murray as arbiter.
- Extracting data from trials: Julia Bailey and Catherine Mercer, double checked by Greta Rait and Richard Morris.
- Entering data into Review Manager software: Julia Bailey, checked by Greta Rait and Richard Morris.
- Performing the analysis: Julia Bailey, Catherine Mercer and Richard Morris.
- Interpreting the analysis: Julia Bailey, Elizabeth Murray, Greta Rait, Catherine Mercer, Richard Morris, Jackie Cassell and Irwin Nazareth.
- Drafting the final review: Julia Bailey, Catherine Mercer, Richard Morris, Elizabeth Murray, Greta Rait and Irwin Nazareth.
- Updating the review: Julia Bailey, Elizabeth Murray, Greta Rait

DECLARATIONS OF INTEREST

Julia Bailey, Elizabeth Murray, Irwin Nazareth and Greta Rait are members of a team which is developing an interactive computer-based intervention for sexual health, funded by the Medical Research Council (from October 2008).

SOURCES OF SUPPORT

Internal sources

- North Central London Research Consortium, UK.

External sources

- North Central London Research Consortium, UK.

JBs salary was funded through a part-time post-doctoral research fellowship from the North Central London Research Consortium (2006-7).

DIFFERENCES BETWEEN PROTOCOL AND REVIEW

In the protocol we said that we would analyse and present separately the results for studies that compare intervention to no intervention (or minimal intervention) (group 1), those that compare intervention to alternative forms of sexual health education (e.g. face-to-face teaching) (group 2), and those that compare two or more types of interactive computer-based intervention (group 3). We changed the inclusion criteria for the second and third categories slightly, to compare ICBI with non-computerised, face-to-face sexual health interventions (group 2) (because information-based forms of sexual health education such as leaflets are likely to be 'minimally active'), and to compare different designs of computer-based intervention (group 3) (because the design of an intervention can be investigated with computer-based interventions that are not ICBI by our definition).

We had intended to conduct sensitivity analyses (for example looking at studies' quality), and to investigate possible sources of heterogeneity (for example socio-demographic factors which could act as effect modifiers). We decided not to exclude studies on the basis of these factors but to describe studies' methodological or clinical heterogeneity narratively. We discuss possible effects of heterogeneity on the distribution of results, but did not re-run meta-analyses excluding studies.

INDEX TERMS

Medical Subject Headings (MeSH)

Computer-Assisted Instruction [*methods]; Health Promotion [*methods]; Randomized Controlled Trials as Topic; Sex Education [*methods]

MeSH check words

Humans